UNIVERSITY OF YAOUNDE I

FACULTY OF SCIENCES

DEPARTMENT OF PLANT BIOLOGY

STRUCTURAL DISTRIBUTION OF WILD PRUNUS AFRICANA POPULATIONS ON THE KILUM MOUNTAIN FOREST

A thesis presented in partial fulfilment for the obtention of a Master II certificate

Presented by:

Charles NDIFON NCHAMCHAM

Matricule:

Forestry Engineer

June 2010

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EDICATION

To my lovely wife, Josephine
and
my two kids Elisabeth and William.

I will not live out my Dad, mom
and
my good friends Divine and Akwi.

WLEDGEMENTS

I will specially want to thank the research team that worked on *Prunus africana* that is: Dr Betti Lagard and the team of experts working on *Prunus* with ANAFOR

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Afromontane forests have for long be the main source of *Prunus africana* supplying the local and international markets. This longtime over extraction and unsustainable debarking techniques has led to classification by CITES II as an endangered species. In Cameroon, forest adjacent populations have been involved in the process of participative management commonly known as community forestry established by the Cameroonian government as a measure to promote sustainable management and fight poverty.

Information on the population structure and distribution of the remaining stands and their extraction techniques has proven to be a priority to promote the sustainability of the resource in recent times. To this effect, experimental plots were established in Oku, Jakiri, Belo and Fundong, covering the mount Kilum-Ijim. Inventories on this species was effected on these sample plots and a characterisation of the sites was done to bring out the population structure and distribution. A brief evaluation of the debarking effects on the plant was also considered. The frequency of pest attack on the plant with regards to debarking technique was equally evaluated.

To acchieve the above, experimental plots of 100 m x 100 m, subdivided into quadrats of 10 m x 10 m. then all plants within the plots were inventoried and diameter at base height(DBH) (1.30 m) was taken for each plant inventoried. Other information on exploited parts, extraction techniques and regeneration potential was also noted while evaluating the effects of their effect on the *Prunus* plant.

The results obtained show that Jakiri has the highest potential of *Prunus africana* (16 stems/ha) followed by Oku, Belo and Fundong respectively. The diametrical structures varied from one site to the other but with a representation of all the different diameter classes.

The *Prunus africana* population exploited represent 77% in Jakiri, 80.8% in Fundong, Oku 28.3% and the least in Belo with 6.4 %. Most of the trees were completely stripped up to the branches and the opposite quarter technique represent only 0.1%. 11 % of trees in Oku have only their stems exploited against 83.93% in Fundong. Contrarily trees with both stem and branches exploited represent 88.1% and 67.1% respectively in Oku and Jakiri. Fundong had the lowest frequency 16.1%. Plants with DBH less than 30 cm exploited represents 96.9%, 88% and 88.9% respectively in Fundong, Belo and Jakiri, with Oku having the lowest frequency 32.1%.

The majority of *Prunus* stems have their leaves attacked by pests and have yellowish coloration. The frequency of pest attack was highest in Jakiri and Fundong, representing 96.3% and 82.4% respectively of numbered stems. Trees in Oku have the highest number of dead branches compared to those of other sites.

The death of branches was correlated to poor debarking techniques and pest attacks. It should be noted that conservation measures are to be implemented strictly and swiftly to prevent the complete destruction of this plant.

RESUME

Les forêts montagnrdes ont longtemps constitué la principal source de *Prunus africana* qui approvissionne des marché local et international. Cette surexploitation avec des techniques qui demeure non durable on rendu lôespece menacé dôaprès la classificatioin de la CITES II. Au Cameroun les populations riverains ont été impliquer à la gestion participative des forêts communement connu comme la foresterie communautaire. Cette mesure prise par le governement Camerounaise est supposé promouvoir la gestion durable des ressources forestière et de lutté contre la pauvrété.

Lôinformation sur la structure et la repartition des *Prunus africana* existant ainsi que les techniques dôextraction de *Prunus* on demontré son importance pour promouvoir la durabilité de cette ressources pendants les derniers années. A cet effet, des parcels dôechantillonnage ont été réalisé à Oku, Jakiri, Belo et Fundong pour couvrir lôétendu de la forêt de montagne de Kilum-Ijim. Les inventaires de cette ressource ont été effectuer ausein de ces parcels experimentales et une caractérisation du site pour montré la structure et repartition de *Prunus*. Une évaluation des effets de lôecorcage sur la plant à été étudier. La fréquence des attacque des parasites lié aux techniques dôécorcage à également été évaluer.

Pour y arriver, nous avons mis en place des parcelles de 100 m x 100 m, subdivisées en quadrats de 10 m x 10 m. a lôintérieur de celles-ci, le diamètre à 1, 30 m (DHP) et la hauteur de toutes les tiges de *Prunus africana* ont été mesurés localisées a lôaide dôun GPS. Les informations sur les parties végétales exploitées, les techniques dôexploitation utilisées et lôétat physique des arbres ont été collectées.

Les resultats obtenus montrent que Jakiri a plus grand potentiel de *Prunus africana* (16 tiges/ha) et Oku, le plus faible (6.1 tiges/ha). Les structures diamétriques sont variables dôun site à lôautre.

La population de *Prunus africana* exploitée représente 77 % à Jakiri, 80.8% à Fundong et est la plus faible à Oku 28,3 %. Les arbres sont en majorité écorcés entièrement sur lôensmble des sites (99,9 %) et la la technique des quarts opposés ne représente que 0,1 %. 11 % des arbres ont le fût uniquement exploité à Oku contre 83,93 % à Fundong. Par contre les arbres à fut et branche écorcés représente 88,1 % et 67,1 % respectivement à Oku et Jakiri, Fundong présentant la plus faible fréquence (16,1 %). Les individus de DHP moins de 30 cm exploités représente 96,9 %, 88 % et 86,9 % respectivement à Fundong, Belo et Jakiri. Oku présente le faible fréquence(32,1 %). Les tiges de *Prunus africana* présentent en majorité des feuilles attacqués par des parasites avec Jaikiri et Fundong représentant 96,3 % et 82,4 % respectivement. Les plants à Oku on le plus grand nombre des branches morte.

La perte de nombreuse brances serait lôeffet de mauvaise technique dôécorcage et les parasites. Les mesures de conservation doivrent être renforcées pour que les peuplements jeunes ne subissent les mêmes effets.

Chapter 1: INTRODUCTION

1.1. Research justification and background

The natural forest milieu has always been considered by Man as an unlimited reserve of natural resources. This has led to mans continuous exploitation of nature for food and other livelihood options, which continue to have an unintended but negative or damaging effect on the environment.

Deforestation and land degradation leads to effects such as loss of water catchments, destruction of habitat for some species, soil erosion and loss of soil nutrients hence, fall in agricultural productivity, the extinction of some flora and fauna on which man depends on for food and subsistence due to the loss of habitat and fragmentation and global climatic changes(FAO, 1999, FAO, 2001a).

According to FAO (1995), forest and trees have an important role to play in the struggle to reduce poverty. Forest exploitation by man is to acquire timber and other non-timber forest products, which have for the past years been a main source of forest adjacent communities live resources. The importance of these products to forest adjacent communities daily needs such as food, shelter, healthcare, clothing, energy and source of income have attracted the attention of many developing agencies(Okafor, 1995; Ndoye et al., 1997; 1998; Kabuye, 1998; Neumann and Hirsch, 2000 and FAO, 2001b).

In Cameroon and particularly in the Northwest region studies by Kimbung (2002) showed that only half of the forest that covered the Oku area 20 years ago remains with a third of it highly degraded.

The vegetation of the Cameroon highlands, which is being increasingly cleared down, shares many species with those of East African mountains. However, most of the primary vegetation has been destroyed. It is estimated for instance that 96.5% of the original montane forest of the Bamenda Highlands has been lost (Check et al., 2000). Forest patches such as the Kilum-Ijim forest in the Bamenda Highlands that presently covers an area of about 20,000ha has been known as the last significant patch of the Afro-montane vegetation in the mainland of West Africa. The area is globally recognized as a center for endemism hosting plants and animals species nowhere else in the world such as Bannermanôs turaco and Banded wattle eye (BHFP, 1999).

, which has been under growing exploitation for
ıcts in the forest ecosystem from which they are harvested. *Prunus africana* is an afromontane forest tree known for the medicinal properties of its bark against prostate hyperplasia and benign hypertrophy. Becker (1993) carried out studies in the tropics showing that the harvesting of non-timber forest products would be less damaging to biodiversity than other uses such as timber extraction. Given the vested interest of these forest adjacent populations in the plant, efforts of insitu regeneration and domestication potentially promises a sustained product supply (Hall et al., 2000). This will tremendously sustain the endangered wild plants and drop pressure on the wild populations leading to the conservation of the ecological biodiversity.

The economic value of *Prunus africana* can serve as a stimulus for forest conservation and management by adding economic value to the forest and only product harvesting without killing the plants and insitu regeneration offers good properties of sustainable management (Sekhran, 1996). Hence proper sustainable management needs to consider both the regeneration, domestication and the conservation of natural stocks for long-term and quality of livelihood extraction (Jones et al., 2002). Therefore management options like sustainable harvesting methods, insitu regeneration of tree and sensitization need to be applied.

With this reasoning, we hereby seek to carry out a research on the structural distribution of wild *Prunus africana* populations so as to define the natural regeneration trends and establish a view on conservation possibilities of the plant.

1.2. Problem Statement.

1.2.1. General Problem field

The worldôs forest resources are dwindling at an alarming rate and this is a serious call for concern. Some natural resources are renewable usually at very high cost, meanwhile others are completely irreplaceable. Therefore it is completely imperative that resource management should fully involve consideration of long-term resource cost. Management programs, plans and schemes without long term considerations are bound to be costly, if not disastrous for the future. There is a complex inter-relationship between the components of an ecosystem and this relationship makes the survival of one component completely dependent on the others. Therefore an effect on one component can cause an indirect or direct impact on the others. There is also a link between forest degradation and poverty.

rosion which enhances depletion of soil quality, and

Catchment functions of forests are everywhere tangibly critical for those living in their watersheds (Wily, 1995a).

Forest degradation also contributes to climate change, which is characterized by increase in atmospheric temperature, changes in rainfall patterns reduced flow from watersheds, water scarcity and desertification.

Moreover human activities affects other form of life in different ways. Some activities that have direct impact are indiscriminate exploitation of the forest resulting in the destruction of habitats and highly endangered flora and fauna species that needs to be conserved. Other human activities that exert indirect effect on the environment include different pollution types and mismanagement of forest resource.

1.2.2. Specific Problem Area

The forest was traditionally considered as a source of timber, all other products no matter their value to the local populations and the national economy were considered as secondary (Falconer, 1990). But with recent interest being seen in the exploitation of Non Timber Forest Products, this viewpoint has gradually been shopped. In recent years the increasing interest in *Prunus africana* globally makes it necessary to better understand the resource base of this product. Growing interest has been observed in the extraction and the sale of forest resources like *Prunus africana* due to major shifts in global economic forces and concomitant changes in the ecological knowledge and management policies (Van Dyk, 1998; Neumann and Hirsch 2000; FAO 2001b). In the last 50 years, the mountain habitat of *Prunus africana* has degraded, with over-exploitation and illegal exploitation remaining a reality, despite the species listing as a ñvulnerableòRed Data species and its inclusion as an Annex II CITIES species.

The high current levels of demand for *Prunus africana* bark, particularly levels that cannot be met long-term from the wild population call for better management strategies that favours larger productivity and conservation. The current barn on *Prunus africana* bark trade due to the illegal extraction and poor harvesting techniques of bark also calls for more research on this plant so as to bring out current trends of its status in the natural milieu. Demand for *Prunus africana* bark is predicted to double or triple in a decade due to ageing populations and growing confidence on herbal medicines in major consumer

a. The traditional demand for bark is rated to about eys(unpublished data by CIFOR).

With the role played by *Prunus africana* in the local and international frame, this species has been under high and unsustainable exploitation following the harvest of its bark by the local population and companies (Plantecam-Medicam). Also the destruction of young shoots or wildings by pasturing animals (Tangwa, 1998) and the irregular fructification of *Prunus* make natural regeneration very difficult. The uncontrolled exploitation of bark (complete stripping or debarking) for so many years has led to the death of a majority of trees in the mountainous region of Oku (Cunningham et al., 1993). It is in this light that the species was classified in appendix II of CITES (Convention on International Trade of Endangered species of Wild Flora and fauna) in 1995 as endangered species (Cunningham et al, 1997). Though many attempts have been made on management and conservation of forests from which the product is being harvested through participatory rural appraisal approaches such as, community forestry, tree planting and sensitization of local communities (De Boer and Mc Dermott, 1996; Burnley, 1998), there still exist the problem of unsustainable exploitation of the species due to lack of basic scientific knowledge to elaborate appropriate conservation strategies. Among this basic knowledge, a structural distribution analysis of the wild stems of *Prunus africana* is essential to assess each population structure, the regeneration process, as well as the potential for exploitation.

The following research questions have been set for this study;

- What is the existing density of *Prunus africana* in the wild and on plantations?
- What is the structural distribution of the wild populations in the study zone?
- What type of exploitation techniques are being used to harvest the plant bark?
- What is the impact of debarking on regeneration?

This study will be effected using Bole Height analysis.

1.3. Objective of research

1.3.1. Main objective

The objective is to increase the knowledge of availability of *Prunus africana* stratification on the Kilum-Ijim mountain forest to provide stakeholders with the tools necessary for sustainable management of the resource for conservation purposes.

1.3.2. Specific objectives

More specifically this study aims at:

opulation on the Kilum-Ijim forest ;

ern of this population;

- bringing out bark harvesting techniques in the study zone;
- evaluating debarking effects on harvested plants.

1.4. Justification of work

This study could be useful in the following ways:

- To the local community forest CIG and villagers, this study seeks to provide information on the natural regeneration of *Prunus africana* in the Kilum-Ijim moutain forest.
- To the NGOs and policy makers this study hopes to give a detailed idea on the relationship between *Prunus africana* populations, its exploitation and the management of the montane forest ecosystems globally.
- To students and lecturers this study seeks to present a synthesis of the existing literature on the structural distribution of *Prunus africana* population in the Kilum-Ijim mountain forest.
- To researchers this study intends to bring out the gaps existing in the area of forest management, conservation of *Prunus africana* in the Jakiri region so that they can be working towards filling them.

1.5. Importance of study.

Given that the natural forest is gradually disappearing due to over exploitation for forest products, agricultural land and settlement, the conservation of biodiversity through the management of protected areas has acquired growing importance.

A close study of the *Prunus africana* population will provide information on natural regeneration aptitude of the mountain species and also because it is the favorable way to contain the growing demand of bark by pharmaceutical Industry (Nkuikeu, 2001).

Chapter 2: LITERATURE REVIEW AND THEORITICAL FRAMEWORK

2.1. Literature review

2.1.1. Introduction

Most forest adjacent communities had often considered the forest milieu as an unlimited reserve of natural resources. Hence, the level of extraction or exploitation of the forest resources has ever been high. This continuous and high rate of exploitation has rarely been backed by a sustainable management technique that could either be artificial or natural. FAOôs, state of world forest (2001a) stands at 3.870 million hectares of forest worldwide with 95% being natural forest and 5% representing forest plantation. With the tropical conception of the forest, deforestation, and destruction of the forests are regularly affecting the availability of forest goods and resources.

Following World Bankôs reports (2001), approximately 1.2 billion people in developing countries depend on trees and farms for food and cash. With the continuous increase in demand for forest products and the eminent scarcity of the natural resources, differences in the perception of the role of the forest and global conservation objectives has given rise to accepted attempts to secure the support of forest edge population by linking conservation (through participating approaches) to the provisions of benefits and compensatory rural development activities (Vabi and Tchamou, 1998).

The conservation and management of forest is now practically a top priority amongst nations and International Development Agencies. For instance FAO (2001a) reports that the annual estimated change in forest area worldwide during the past decade (1990-2000) was 9.4 million hectares representing the difference between the estimated annual rate of deforestation of 14.6 million hectares and the estimated annual rate of forest area of 5.2 milllion ha.

Forest degradation causes are numerous and varied, meanwhile others like the over exploitation of forest products can be avoided or limited by sound forest use and management, through contingency planning to mitigate effects of natural disasters such as fire.

the North-West Region over 200.000 people live epend on it for their livelihood [the products of particular importance include medical plants, Fuel wood, building materials, fibers and alpine bamboo (BHFPnd)]. Forests of the North-West Region are mostly afromontane, with lowland forest having limited acessibility due to their localisation in valleys and swamps (MINEF-PDEF/NW, 1994).

2.2. The Case study: Prunus africana (Hook F.) Kalkmann

2.2.1. Ecological context

Prunus africana (Hook f) Kalkman (Rosaceae) formerly referred to as *Pygeum africanum or Pygeum* is an indigenous species to Africa where it is endemic to many high conservation and catchment value mountain forests. *Prunus africana* is classified as a vulnerable species (IUCN, 2006) due to low densities, its shrinking and increasingly degraded montane ecosystem and the high levels of trade.

2.2.1.1. Ecology in Cameroon

The perfect understanding of its ecological milieu sets the foundation stone of quality management of *Prunus africana.* According to Cunningham and Mbenkum, 1993; Acworth et al., 1996; Dawson and Powell, 1999; Hall et al., 2000, Maisels 1999 *Prunus africana* as a tall (from 6-40 m for the largest specimens in Mt Cameroon and Adamaoua), long lived, dense wooded evergreen tree patchily distributed in montane forests, forest remnants or forest margins, found between 600-3000 m above sea level. Further south, where cooler latitudes compensate for altitude, it occurs at lower elevations (Hall et al 2000, Letouzey, 1978; White, 1983). In Cameroon inventories indicate that *Prunus* occurs between 600 and 3000 m, but the highest densities were found from 1700 m and especially above 2000 m in Adamaoua (Belinga, 2001; Chapman, 2004), from 2400 to 3000 m in Kilum Ijim (Maisels et al., 1999; Foaham, 2001), on Mount Cameroon from 900 to 2500 m, with highest densities from 1800 m to 2400 m (Foaham, Dagobert et al. 2009;(Ndam et al., 2000) and Mt Manengouba also from 1600 to 2400 m. Similar to experience in other African countries (Hall et al 2000), it is most abundant in natural forests in Cameroon in afromontane upper forests (broadleaved mixed, montane forest describes the ecology of *Prunus* in Cameroon and across Africa belts and *Prunus* moist montane, gallery forests) and near grassland borders. Local knowledge indicates that it has some fire resistance as it is found close to forest edges,

scrub where bush fires are common. A light nditions can grow to 14 m high and 37 cm diameter at breast height (dbh) in 18 years. In Adamaoua massive specimens of almost 200 cm dbh have been noted (Pers comm. Dr. Avana, University of Dschang, December 2008). This characteristic means that natural forest disturbance coupled to fruit dispersal into canopy gaps or on forest margins are important to landscape level population biology of *Prunus africana* and accounts for the scattered distribution of this species in Afromontane forests.

Photo 1 : *Prunus africana* montane ecosystem of the North-West Region

2.2.1.2. Biology

a. Reproductive biology

The main studies on the reproductive biology of *Prunus africana* were carried out in Central Kenya (Munjuga *et al*. (1999). Experiences in Cameroon however confirm the majority of this biological data. The flowers are white and hermaphrodite, with 17 flowers on average per raceme. Wilting starts with petals, anthers, then pistil and lastly sepals. The presence of two styles in the same flower has been observed and some flowers have none (Tonye, 1999). The anthers are cream colored and their number per flower varies with a mean of 32 anthers, arranged in 3 circular rows attached to base petalous tube. The pollen is sticky, light, spherical and elongated, measuring 35 mm in diameter. At anthesis, anthers dehisce by longitudinal slits. After anthesis, the pollenôs viability can be above 90%. The stigma is raised above the anthers, notched on one side and yellow in colour, with a mean diameter of 0.76 mm. The style is greenish in colour, with a mean length of 4.02 mm. There are two ovules in ovary but only one notched stigma. The stigma appears to be receptive one day before and two days after

flowering time, the flowering period has been he year (Stewart 1999). Many pollinators visit the inflorescence, the most frequent being hymenopteras (Apidae and Anthophoridae), bees (21% to flower pollination), hoverflys 6%, ants 2% and sunbird *Nectarinia* spp. 11.2%. The majority of visits are from 07 a.m. to 11 a.m. and 3 p.m. to 5 p.m. for bees and for birds from 09 a.m. to 12.00. Flies do not have a distinct time for visits (Munjuga *et al*., 1999). *Prunus africana* is reported as both self-fertile and out-crossing with out-crossing being proportionally higher than self-pollination. Ndam (1998) indicated that seedlings from clustered parent trees were more vigorous than those from isolated parents, justifying cross-pollination as the normal breeding system.

Prunus reproduces primarily from seed and is generally single stemmed, developing multi-stems when saplings are browsed or cut. Although young trees resprout, for example if browsed by forest antelope or goats, large trees have weak resprouting capability. In 1993 Iverson (quoted in Ndibi 1997) was unable to say if *Prunus africana* grows from stumps and coppices. Early in 1996, when examining ten trees felled on the eastern slope of Mount Cameroon (Bova area) about 20 years ago, Ndibi found no re-growth by 1997. Some coppice production (resprouting) has been noted to occur when surface roots are damaged and has been observed occasionally after felling or harvesting during inventories (Cunningham 2002, Ingram 2007). Fruit production starts when trees are around 15 years old and increases with tree age, with high fruit production years alternating with low fruit production years (Stewart, 2001). The fruit is a bitter, almond tasting drupe <10 mm in diameter, eaten by a wide range of animals, including many endemic species to the montane Highlands (Stewart 2003; Maisels & Forboseh, 1999; Fossey, 1983). Seeds are semi-recalcitrant and germinate when up to 4 months old, losing viability quickly if not stored in a moist atmosphere, such that few seeds older than 6 months old are viable. Germination rates of 60-80% can be attained if planted within 50 days (Mbuya et al, 1994). Ripe fruits germinate well in partial sunlight after a short (4 hr) drying period in an airy, shaded place. The seeds are most probably dispersed by birds and primates and their leaves are a preferred food sources for a range of endemic birds, frugivores (Farwig et al., 2006), red colobus monkeys (Chapman and Chapman, 2002; (Maisels and Forboseh, 1999), gorillas (Fossey, 1983) and black and white colobus monkeys (Fashing, 2004), despite containing high levels of cyanogenic glycosides. Wubet et al (2003) noted the presence of arbuscular

s africana. This has important implications for
tion is important for mineral nutrition and optimal growth of *Prunus africana* and the potential of this species for reforestation, land rehabilitation and agroforestry or forestry production (Haselwandter, 1997).

b. Mortality rates

The annual mortality of adult-sized *Prunus africana* trees in natural populations is 1.5% per year (Stewart, 2001). Based on a 15 year study of tree growth and mortality in Afromontane forest in South Africa (van Daalen, 1991), mortality rates of trees >10 cm diameter at breast height (dbh) averaged 0.71% per year. The mortality of *Prunus africana* trees ranges from 0 to 50%, with an average of 17%, in commercially harvested wild populations inventoried in Cameroon, where on average 48% have been harvested. This is significantly higher than natural mortality rates are assumed, which has implications for sustainable harvesting. The link between mortality rates and unsustainable harvest practices, with several years lag, was also highlighted by Meuer (2007) and Stewart (2007). Recent research (Stewart 2001, 2007 and in press) shows that the largest trees suffer the most mortalities and crown size reduction after harvest and that they contribute the most to the population growth rate because they produce the most seeds. The presence of pest and the lourantus plant parasite are also a major cause of plant mortality. Mortalities of these trees and the reduction of their crowns have important implications for future regeneration.

2.2.2. Taxonomy

Prunus africana (Hook.F, Kalkman) is found in the Rosaceae family (subfamily Amygdaloideae) and genus with the highest diversity in the temperate regions (Croquist, 1981).The sub family is generally considered monophyletic (Morgan *et al*., 1994), although studies of the relationships among the other subfamilies of Rosaceae and its closest relatives are sometimes conflicting (Kalkman; 1988; Morgan *et al*., 1994; Potter *et al*., 1999). It belongs to the genus Prunus that includes peaches (*P. persica* L.) Plums (*P. domestica* L), cherries (*P.avium* L) and almonds (*P. dulcis* Mill) D.A.Webb). *Prunus africana* is one of the two members of the genus on the African continent although Kalkman, (1965) claimed that the second species *P. crassifolia* (Hauman) Kalkman, endemic to the Kivu District in the Democratic Republic of Congo, is closely related.

e region is as follows; alumty in Bamenda, eluo in
nningham and Mbenkum, 1993).

***Prunus africana* classification**

Kingdom: Plant
Phylum: Spermaphytes

Sub phylum: Angiosperms

Class: Dicotyledons

Order: Rosales

Family: Rosaceae

Sub-family: Amygdaloideae

Genius : *Prunus*

Sub-genius : *Laurocerasus*

Species: *Prunus africana* (Hook. f.) Kalkman

2.2.3. Species Description

Prunus africana is a medium sized to large canopy tree 30-45m in height with immense, spreading crowns in older individuals. It has a diameter of 40-100 cm with a straight and cylindrical trunk and without branches at the inferior 1/3 of the tree height (Letouzey, 1978). Older trees have dark, platy, resinous bark, while younger trees possess smoother bark with prominent lenticels. Leaves are simple and alternatively arranged. They are evergreen but some fall prior to fruits development (Steward, 2001).

There is absence of buttress in certain trees (Friis, 1992) and occasionally in others (Hamilton, 1981). Meanwhile it is very developed in other individuals where they measure between 8 cm and 10 cm of thickness and 1 m above the soil and spreads by 1m of the tree by turning at the level of the soil surface (Letouzey, 1978).

Leaves, twigs, fruits and bark emit a cherry odor when crushed, characteristic of the genius. The odor is due to cyanogenic glycosides (Kalkman, 1965; Fraser et al., 1996).The fruit is a drupe. The reddish color of the mature fruits suggests it may be an important food source for birds (Howe and Westley, 1986).The heart wood is half hard, pink and brown in the pressure of light (Eggeling and Dale, 1951).

togeography.

ıus africana covers, Central Africa, East Africa and the Indian Ocean (mainly Madagascar and the Comores) where it is found in patches of populations. The species is found in South Africa, Burundi, Angola, Ethiopia, Cameroon, Fernando Po Equatorial Guinea, Great Comores, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Nigeria, Democratic Republic of Congo, Rwanda, Sao tome, Swaziland, Tanzania, Uganda, Zambia and in Zimbabwe (Hall *et al*, 2000).Its presence in Cote d`Ivoire and in Ghana as reported by certain authors is not possible since the species doesnȏt seem to exist in the East of Nigeria (http:/members. Lycoc.fr/ nru /prunusa fricana.htm).In Cameroon, the natural distribution zones of *Prunus africana* expands from the sub mountainous forest of Mount Cameroon (4080 m) to Mount Tchabal Mbabo (2500 m) passing through Mount Koupe, Manengouba , Bamboutos and Oku (Pouakouyou, 2000).

2.2.5. Debarking techniques

A controlled, sustainable harvest of *Prunus africana* bark was attempted by Plantecam in Cameroon between 1972 and 1987. This was based on a system of bark removal from opposing quarters of the tree trunk, by teams of Plantecam workers. This worked relatively well until the 1985 licences were issued to 50 entrepreneurs. The harvest quotas were demand based and not grounded in any inventories or assessments of sustainable harvest techniques.

The Forestry Administration is reported as prescribing the following rules for sustainable bark harvesting of medicinal plants in general, and of *Prunus africana* in particular in 1986 and 1999 (Ndibi and Kay, 1997; Ondigui, 2001) (Ministry of Agriculture (1992) Cahier des charges et al., 1986; Ministry of Agriculture (1986) Cahier des charges et al., 1992);

- Bark should be removed from the trunk in strips from 1.30 metres above ground level to the 1st branch.
- Only trees with diameter at breast height (DBH) >30 cm can be debarked.
- Trees with DBH <50 cm should be debarked on two strips in opposite sides, each strip no wider than 1/4 of the circumference of the tree.
- Trees with DBH of 50 cm should be debarked in 4 strips regularly distributed around the circumference, each no wider than 8 of the circumference.

iameter of 20 cm on trees with DBH 3 50 cm trees

- The debarking should then be done prior to clearing the root rhizosphere and should not exceed 1/4 of the root's circumference.
- After debarking, the root should be recovered by soil to avoid desiccation and to enable a rapid reconstitution of the bark.
- All trees with debarked roots and trunks should be marked with numbers.

Trees harvested by Plantecam staff using this method appeared to have fully recovered their bark after some time. Local people, especially those that had worked for Plantecam indicated a recovery time of about 5 years. However a significant number of these trees suffered from crown dieback and also stem borer attacks, which implies that the lifespan of these trees could have been shortened due to harvesting. Mortality among trees sustainably harvested was also lower compared to those whose barks had been poorly harvested. The trees continued to increase in diameter and produce seed. In contrast, over 90% of the trees that had been completely stripped of bark died (Ndam and Asanga, 2008).

The Mount Cameroon Project (Hall, OõBrien et al., 2000) popularised this 2 quarters technique, in the ñHarvest Prunus, No Killam posters and extension booklets. These specified a four stage process where debarking concerns only Prunus trees with a diameter at breast height of over 30 cm, and harvesting is carried out by debarking opposite quarters of the tree, at 1.30 m height from ground level and not above the first branch. Each tree debarked should completely recover before being subject to another debarking.

The Law of 1994 (Republic of Cameroon, 1994) requires the Regional Chief of Forestry to attach a technical report for Special Forest Products specifying the method of harvesting and the quantities of each species to be exploited. The technique for exploitation of Prunus is not specified.

Unfortunately, these harvesting norms have in reality been the exception rather than the rule for the majority of harvests in Cameroon, shown clearly in Photo 2. Meuers (2007) survey on Mt Cameroon indicated that 43% of trees harvested were unsustainably debarked, the majority of which occurred since 2000. The 2000 inventory also found the majority of trees were harvested unsustainably (36%). WHINCONET (2007) showed that

% in Ijim Community Forest were also harvested

Photo 2: stem peeled down to the cambium at Abuh

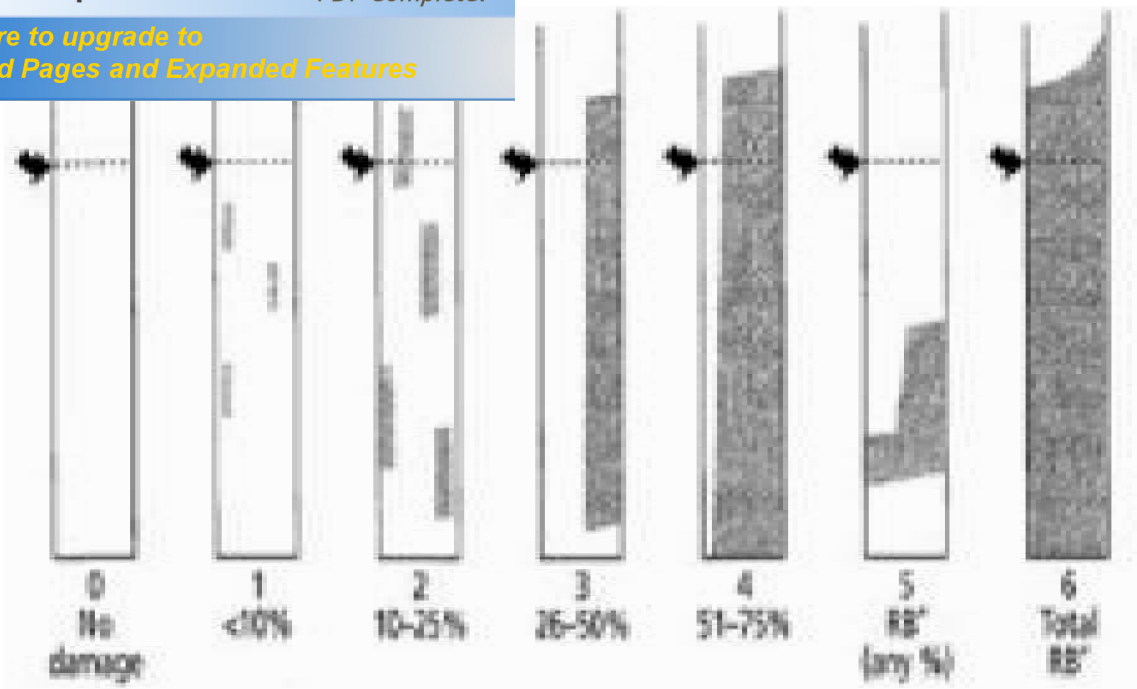
Photo 3: bole peeled down to the cambium at Laikom

The recovery of *Prunus africana* trees after harvest varies substantially. On Mt. Cameroon the 1996 and 2000 inventories indicated that properly harvested trees generally recovered well, but appeared to have a higher percentage of survival on the wetter South / Western flanks of the Mountain - probably because higher humidity reduced stress/damage to the stripped cambial layer. On the much drier Northern and Eastern flanks of the mountain, a higher percentage trees were dying, even after 'normal' debarking. This suggests that tree mortality might also be higher in the drier areas such as North West, West and Adamaoua regions (Ndam et al 2008). In moist sites, bark re-growth is better, but crown death of *Prunus africana* trees still occurs (Cunningham, Ayuk et al., 2002). Stewarts quantitative study (in press, see Stewart 2007) show that unsustainable harvesting frequently causes crown death. Poor bark re-growth in dry sites can also lead to wood-borer and fungal attack. In Adamaoua, when the first inventory was done, the majority of trees were healthy and could produce their full potential yield - because only 11% had previously been exploited.

Findings from two areas on Pico de Basilé (harvested once in 1998) and Maco harvested two or 3 times (in between 1998 and 2005) on Bioko Island, Equatorial Guinea, a comparable montane ecosystems to Mt Cameroon and Kilum-Ijim, indicate that repeated

decrease in crown size and higher mortality. It was tion rates, *Prunus africana* shows good recovery capacity following bark removal, as long as the proper techniques are used and the tree is left long enough for the bark to regenerate. Under these circumstances, the stress of harvest seems to cause a reversible loss of **vigor**, visible in **partial defoliation of the crown**, which later recovers as the **bark regenerates**. This explains the differences found in 2005 by Sunderland and Tako (1999).

In two of the main harvest areas of Cameroon more links have been found between unsustainable harvesting and high mortality rates. On Mt Cameroon crown health, die back and mortality rates were almost identical for all methods of debarking, from underexploited to totally debarked, with approximately 50 % of trees remaining healthy. Only zero debarking (>75 % healthy), felling and trees and unknown methods of debarking produced significant deviations. The latter were often trees that were already dead (> 70 % size class 9 and 10) but still standing, where the type of debarking could not be determined. Among the sustainably debarked trees, 30 % were old individuals more than 90 cm DBH, which probably died naturally and account for the high percentage of unhealthy individuals. The high number of overexploited trees with a high percentage of healthy crowns is possibly due to the recent exploitation activity within one year of monitoring. It was concluded that totally and bole debarked trees only show the effects of destructive debarking after one year, as sites where exploitation had occurred 2-3 years previously had higher levels of dead, destructively debarked trees dead (Meuer 2007). This observation is supported by the work on Bioko, where recently unsustainable exploited trees did not exhibit the effects of harvesting, but after seven years the effects of using different removal techniques and repeated harvesting were more obvious (Sunderland and Tako 1999; Navarro-Cerrillo, Clemente et al., 2008). Recent work in Bihkov CF in the North West also indicates that older trees over 60cm DBH die when poorly or over-exploited (Tah, 2009). The percentage of trees with high crown die-back rises with the intensity of exploitation from ~17% for normal debarking to over 30% for total debarking. The figure below show the different debarking techniques in the study zone.



Bark Damage

0 = no damage
1 = small patches removed (<10% bark stripping)
2 = larger patches removed (25% bark stripping)
3 = large strips removed (50% bark stripping)
4 = extensive bark removed (75% stripping)
5 = ring-barking or girdling
6 = complete girdling, all bark removed (100% stripping or certain death)

Photo 4 : *Prunus africana* Bark regeneration

2.2.6. Natural Regeneration of the Species

Prunus africana is a barochoric species. Consequently, natural regeneration occurs under the tree cover. Meanwhile animals also help in transporting the seeds of *Prunus africana* to other places for regeneration. Fructifications is irregular and each tree can produce up to

, 2000). Recalcitrant grains, loose their germinative derland and Nkefor, 1997). Natural regeneration of this plant is hindered by bush fires and tree felling (Cunningham and Mbenkum, 1993). The actual diameter structure of Mount Oku population of *Prunus africana* is very irregular with the absence of many classes due to uncontrolled exploitation of bark (Pouakouyou, 2000).To promote natural regeneration of *Prunus africana*, and reduce the human pressure exerted on the natural population, sustainable management plans have been elaborated (Hall et al., 2000). Hamilton (1981) proposed a 2 to 3 year rotation period, with the active ingredient being leave, stems and root extracts. In the same light, domestication has been stressed as being the only best approach for conservation and the restoration of the species (Leakey, 1995), Cunningham et al., 1998; Sunderland and Nkefor, 1997 and Simons et al., 1998): Meanwhile in the study zone, natural regeneration activities are not widespread. The main regeneration activity is enrichment planting of seedlings in certain degraded areas (as shown on the satellite image). The FMI raised nurseries for this purpose and for planting along external boundaries (FAO, 2002).

2.2.7. Regeneration potential

Regeneration, reforestation or enrichment planting refers to the replacement and replanting of trees that have been lost (due to natural or human causes) in natural forests.

The main regeneration activities have occurred in the North West in response to concerns about the over-exploitation in Kilum-Ijim (Parrott et al., 1989; Cunningham and Mbenkum, 1993) and resulting loss of highly important biodiversity and forest based livelihoods as part of the Kilum-Ijim Project and subsequent Bamenda Highlands Forest Project from 1987 to 2004, often in combination with encouragements for domestication of both fruit trees, timber and non-timber trees (Abott et al., 2001; Franzel, Ayuk et al., 2009). This has resulted in approximately some 15,000 *Prunus africana* trees being planted within Community Forests and as boundary markers.

The PAFRA project planted out 35,000 *Prunus* saplings, along with other species, as part of its reforestation programme in forest reserves, communal spaces and council forests in an area of some 105 hectares between 2001 and 2007.

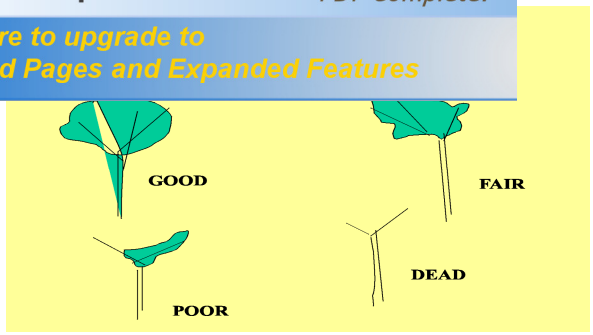


Photo 5 : Crown health

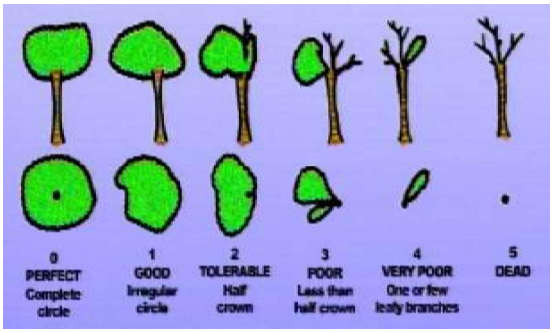


Photo 6 : Crown density

2.2.8. Conservation of Prunus africana

2.2.8.1. Conservation Provision and Action

Conservation policy, regulation and the degree of community involvement in the use and exploitation of the species, are the major strategic determinants of *Prunus africana* conservation.

2.2.8.2. Conservation Policy and regulation

As the export of its bark and bark extract has developed, into a significant source of foreign exchange, source countries have introduce various legislative measures and guidelines specific to *Prunus africana*. In Cameroon there are regulations applying to the harvesting of *Prunus africana* bark reflected in management plans developed in collaboration with local extraction industries and MINFOF (Walter and Rakotonirina, 1995; Ndibi and Kay, 1997, Verina et al., 2009).

Cameroon became a party to the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1981. The Convention was enacted into Cameroonian law by Decree No 2005/2869/PM of 29 July 2005 ñFixing the modalities of the application of certain dispositions of the CITES Convention in Cameroon, and Decision N° 0104/D/MINFOF/SG/DF/SDAFF/SN of 2 March 2006 designating ANAFOR as the CITES Scientific Authority for plants, and Arrêté No 067/PM of 27 June 2006, prescribing the organisation and functioning of the Inter- Ministerial Committee of Coordination and Monitoring of the implementation of CITES.

The Convention on International Trade in Endangered species of wild fauna and Flora (CITES) helps regulate the sustainable exploitation of natural products in source countries, their export and entry to external markets (CITES, 1999). *Prunus africana* was officially

S regulations since 1995 and exploitation band in
ainable harvest were observed.

The significant aspect of the existing regulations and quotas for sustainable harvesting, as far as the conservation of the species is concerned is that, harvesting regulations are not fully effective in area were *Prunus africana* is currently exploited.

Now prior granting and presentation of export permit is required for *Prunus africana* products to be traded. The permit can be granted only after being approved by both the designated scientific authority and the designated management Authority in the country from which *Prunus africana* is being exported.

Two Government institutions in Cameroon are responsible for developing guidelines on access to wildlife resources and forest research. These are mainly the Ministry of forest and Fauna and Ministry of Scientific Research. Within the former there is a section involved with non-timber forest products.

Although procedures for exploiting *Prunus africana* remains same as in the 1981 Forestry law, the 1994 law (94/01) introduced two major changes for all special forest products. First, the applicant must be granted approve for forest exploitation (section 41of the law) from the Prime Ministerôs office, and then seek permission from MINEF, creating a two-tiered system of control.

Secondly the Provincial chief of forest must provide a technical report which specifies the species and quantities to be exploited, the area in which exploitation will take place and the harvesting modalities to be used (article 59{2b} of decree of application). Based on this and in accordance with the recommendations of the Ministry of technical commission a Special permit can be issued.

2.2.9. Socio-economic and therapeutic importance of the species

2.2.9.1. Local use

Prunus africana is the fourth most popular medicinal plant according to the interview realized in the region of Mount Cameroon in 14% of families. In the Oku area, the barks are mixed with honey for the treatment of stomach ache and malaria fever by tradipractitioners (Neom and Dick, 1992). Leaves and roots of *Prunus africana* are used for fever treatment, stomachs aches, and heart infections (Bombardelli and Marrazoni,

Bark is also an important component of the Bubi d and Obama, 1999).The dry bark is crushed and drank as tea that serves as treatment for many different ailments.

In the Bui area, small trees are used for handle of tools (Nsom and Dick, 1992) meanwhile large trees are used for bridge building and dead trees are used as fuel wood.

2.2.9.2. Pharmaceutical Importance

Debat (1974) showed that the non-crystalline and purified crystalline extracts of *Prunus africana* plant are the active ingredient in the medical treatment of glandular disorders such as benign prostatic Hyperplasia (BPH). The extract in tablets and capsules are marketed under two names, Tadenan produced and marketed by Debat laboratory in France and pygenil produced by Indena spa in Italy (Cunningham and Mbenkum, 1993).

2.2.9.3. National and international trade of P. africana products

The price of bark depends on the quality of the bark and varies according to humidity level and to country (Cunningham et al., 1998). In the 1997, the price of a kilogram of bark was estimated to 170 FCFA and 0.20 U.S dollars respectively in Cameroon and Madagascar (Simons et al., 1998). The over in counter value of *Prunus africana* products at World market is 220 million dollars annually (Cunningham and Mbenkum, 1993).

World demands of *Prunus africana* have been estimated to 3500 tons of bark with 2000 tons coming from Cameroon (Cunningham et al., 1997). Also with increase ageing populations, and incidence of Prostatic patients, some pharmaceutical institutes believe that these demands will double and even triple during the next decade. This demand translates into a projected demand of 7000-11000 tons of bark trade annually and a net revenue of 850 to 1250 million FCFA are envisage (Simons et al., 1998).

hange, destruction and decay.

*__Ecosystem:__ Refers to the interaction between the living (biotic) and the non- living (abiotic) components of an environment. When this interaction is optimal, the ecosystem is in equilibrium.

*__Environment:__ It is the ecosystem from which products are gathered. In this case it is the forest.

*__Management:__ This is the skillful handling of natural resources within an area.

*__NTFP:__ They are defined as all goods of biological origin other than timber as well as services derived from (natural) forests and allied land use, such as medicinal plants, rattan, edible oils, nuts, honey, fuel wood and nature based tourism(Broeckhoven, 1996).

*__Population:__ This refers to the people living near or far away from a forest and who depend in one way or the other on NTFPs for their livelihood.

*__Sustainable Development:__ The management of natural resources for the benefit of the local populations.

*__Sustainable Management__: can be defined as the management of resources in such a way that their population remains optimal. i.e. off-take equals rate of reproduction or regeneration.

*__Sustainable forest management:__ It is the management of permanent forests for clear and defined objectives concerning sustainable production of desired goods and services to attain an intrinsic value, without compromising their future productivity and have no undesirable effect on the physical and social environment (OIBT, 1992)

*__Community forestry:__ Results from the 1994 forestry law, on the regime of forests, wildlife and fisheries which gives the communities a right to ask for a portion of their forest domain so as to participate actively in the management of their local forest resources with the aim of sustainably managing the forest and reduce poverty in their respective localities (Tadoum et al., 2002).

Chapter 3: PRESENTATION OF STUDY AREA AND METHODOLOGY

3.1. Presentation of study area

3.1.1. Geographical Location of site

The study area is located in the Jakiri, Oku, Fundong and Belo subdivisions, of the Bui and Boyo Divisions respectively in the North-West Region. In each subdivision, four villages were selected for research namely Jakiri (Vekovi, Kai, Ntur and Wvem), Oku (Mbokevu, Kessotin, Ngasie and Mbokenghas), Belo (Afua, Dichami, Anyajua and Anjin) and Fundong (Laikom, Abuh and Muteff) according to their advanced implication to community forest management. The research zone is situated between 6°5ô and 6° 20ô North of the latitude, and between 10°17ô 00ôôand 10°40ô 00ôô East of the longitude (ENGREF/CUDS, 1987). These sites are located towards the North-West, South to South-West, East to North-East and to the South-East to the North-East respectively of the Kilum-Ijim mountain forest.

Table 1: research site and villages

Area of study	Site	Ethnic group	Village	Situation	Forest Management Structure
Bui Division	Oku	Oku	Mbokevu	South(22Km)	Upper-shinga Cf
			Kessotin	South	Kedzem-Mawes Cf
			Ngashie	Centre	Emfveh-mii Cf
			Mbokenghas	South-West	Nchiiy Cf
	Jakiri	Nso	Ntur	North-West	Bihkov Cf
			Vekovi	North-West	Bihkov Cf
			Wvem	North-West	Bihkov Cf
			Kaii	North	Bihkov Cf
Boyo Division	Belo	Kom	Afua	East	Afua-Dichami Cf
			Dichami	East	Afua-Dichami Cf
			Anyajua	North-East	Anyajua Cf
			Anjin	North	Juambum Cf
	Fundong	Kom	Laikom	South-East	Laikom Cf
			Abuh	North-East	Abuh Cf
			Muteff	North-East	Muteff Cf

Cf: Community Forest.

very humid with very high presence of fog and mist almost through out the year(Fomete et al., 1998). The precipitation is unimodal (Provincial Delegation of Environment and Forestry of the North-West 2001). The dry season begin from November to mid March and the rainy season of 8 months long starts from mid March to the month of October (Kimbum, 2002). The total annual rainfall varies from 1800 mm to 3000 mm annually, with an average temperature that varies from 22°c at 1800 m altitude to 16°c in the higher altitude areas.

3.1.3. Topography and soil type

The topography of the area is hilly and constitutes a chain of mountains. The highest of these mountains is mount Oku with the height of about 3011m and constitutes the second highest mountain in Cameroon. The zone is a volcanic active zone with a crater lake. The geological landscape found here are mainly of Basalts, trachytes, rhyolites, gneiss and granite origin(Fomete et al., 1998).

The soils here as classified by Hawkins and Brunt (1965) are humified ferralitic soils with a high organic matter content favored by the humid climate and cold. These soils are well drained and of good permeability.

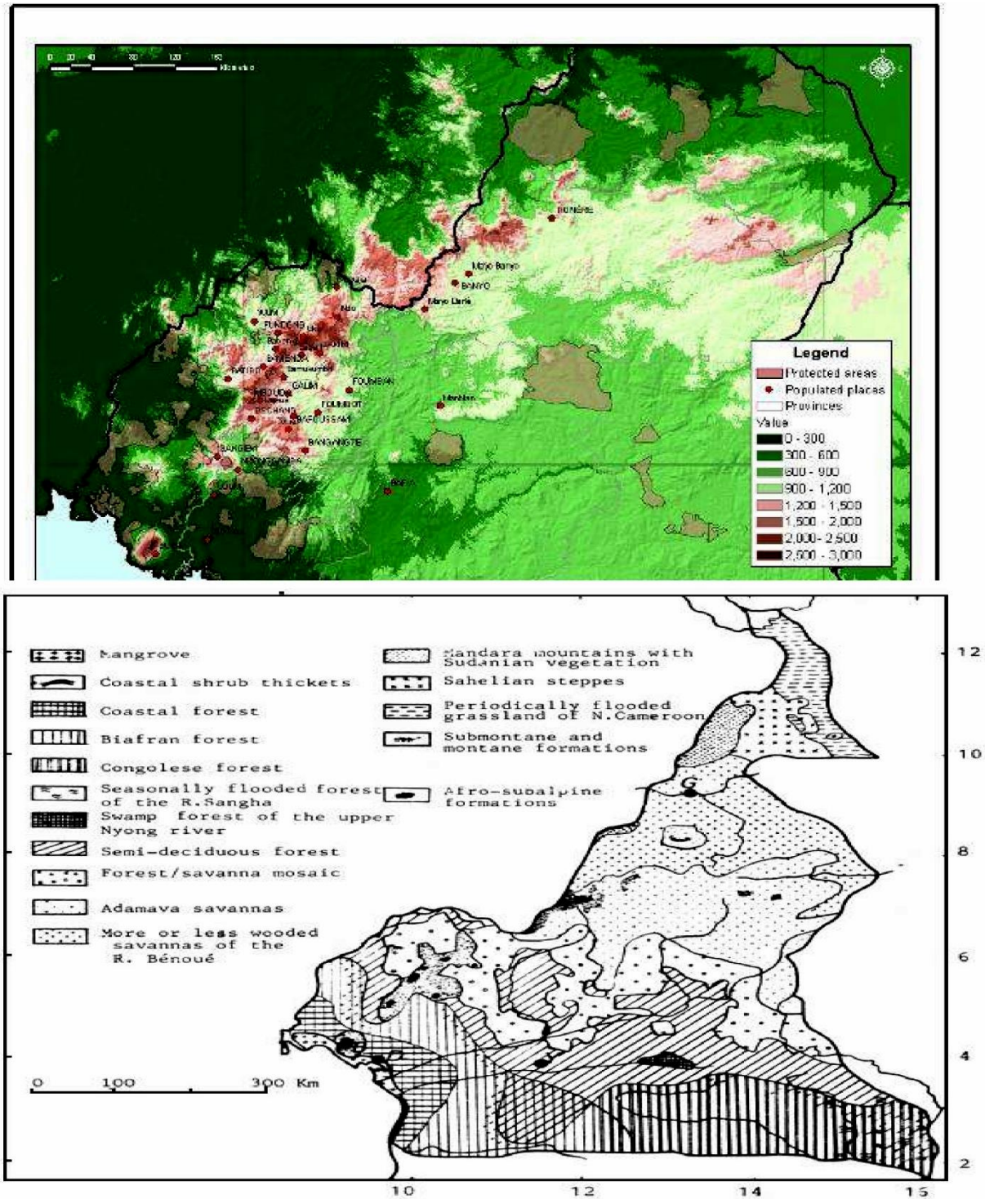
3.1.4. Vegetation and Wildlife

The montane forest has a unique ecosystem that provides a favorable milieu for the habitation of many endemic plant and bird species.

Studies carried out by a team from ENGREF of Montpellier and of the Dschang University Centre(CUDS) in 1987 and other research works by CIFOR, SNV and student researchers identified about 19 different kinds of plants on the kilum massive. Species like the *Podocarpus latifolius* are found between 2600 to 2900 m above sea level, degraded forest zones of *Gnidia glauca, Nuxia congesta, P. africana, Ropanea melanophocios* and highland prairie are observed above 2800 m. This prairie is dominated by *Pennisetum clandestinum* highly favoured by animals.

Birdlife international through the Kilum-Ijim mountain forest project had inventoried over 150 bird species with 53 endemic to the montane or sub alpine forest zone. Four of these species are threatened namely, the *Tauraco Bannermanii, Platysteiria laticincta*(endermic to the Bamenda highland region), *Malaconotus gladiator, Ploceus bannermani* and

nic to the research site. Mammals like monkeys; ; cane rats(Praomys hartwigi) and bats(Pipitrellus eisenteraiti). Many amphibians are equally existent with the *Xenopus* sp. probably endemic to the lake Oku zone.



Map 1 : Land cover montane zones Cameroon (Source: Letouzy, 1965)

In the study zone, four villages were chosen. The following criteria were used to select these villages:

- the presence of *Prunus africana* in the adjacent forest as well as in the village;
- the degree of human activities in the forest providing a possibility to determine the impact of these activities;
- the existence of a management structure of *Prunus africana* in the village;
- accessibility of the village and its closeness to the forest and the mountain

Sample plots of 100 m x 100 m were carved out with the aid of a compass and a GPS, in the four villages of each subdivision. This square was further divided into 10m x 10m quadrants. The choice of this unit according to Maitre (1986) and Condit (1995) permits a very intensive sampling of the plot which is supposed to be homogenous from the start, so as to obtain a critical mass of information.

Prospection of all *Prunus* plants will then be done by a team of prospectors and recorded by a pointer each time a plant is observed.

The different tree characteristics like tree height, circumference at base height, bole height and exploitation status will then be measured and recorded. This will be done for each tree with the aid of a 5 m ruban or 150cm ruban for smaller plants. Other observations like the type of pests or diseases that attack the plant was inventoried on both debarked and plants that have not been debarked. This was used as a measure to estimate the resistance of debarked plants to pest attacks.

For the measurement of slope a clisimeter (Suunto) was used and a peck of 4 m for bole height measurement.

3.2.2. Description of Experiments

At the registered points, we set up the different sampling plots with the aid of the GPS. We used a compass to delimit the plots.

The experimental unit put in the study zone is mainly a square plot of 10 000 m^2 .This square was further divided into 10m x 10m quadrats. The plot demarcation was carried out as follows;

of two machete men and a GPS and Compass reader
g,

- a counting transect creation team composed of a machete man and two people of the distance measurement team who were responsible for measuring and pecking.

After the inventory plots had been established, and the counting blocks demarcated, the prospection team composed of four villagers who are versed with *Prunus africana* for easy identification of the plant and the research team composed of a Botanist, a Forestry Engineer and an Msc. Research student. The identification and counting was done with the aide of the community forest guides (selected from each village visited to avoid conflicts) with aid of the botanist. When a *Prunus* plant was seen the prospector took measurements of the tree height, circumference at base height (1.3 m, which was later on used to obtain dbh) and the tree vigor and regeneration aptitude was estimated following provided information for evaluation.

3.2.3. Data analyses

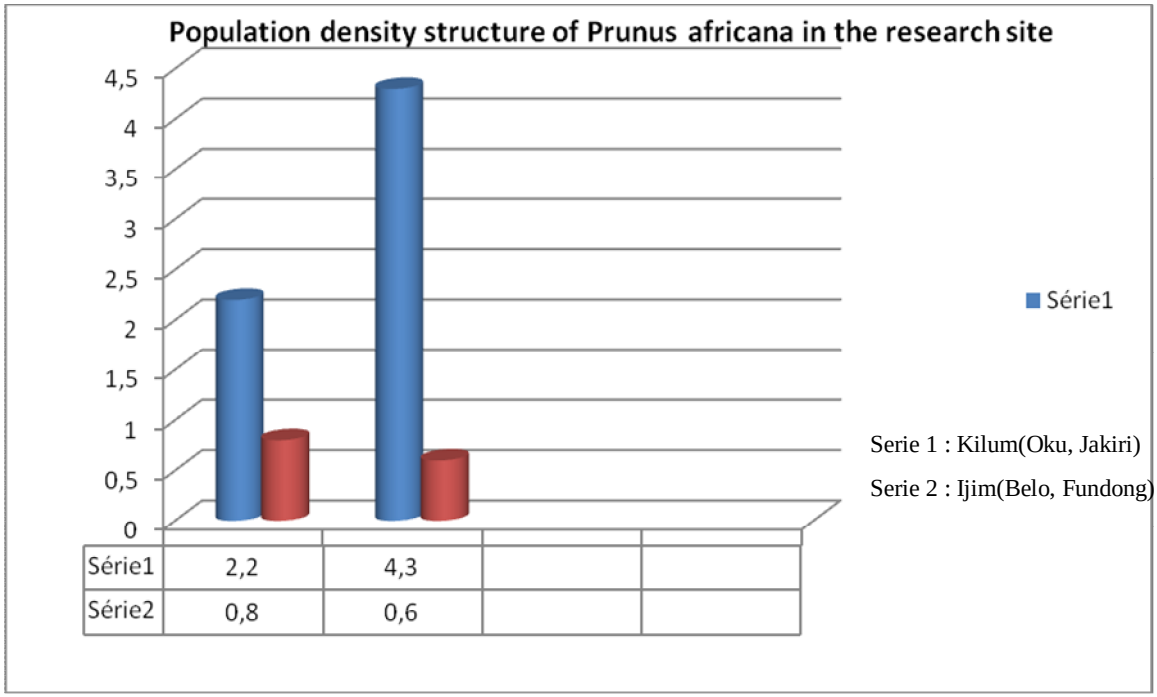
After data collection on the field, the circumference at 1.30m was converted into diameter (D) at 1.30m (dbh) using the formula D1.3=c1.3/3.14. The obtained diameter was grouped into diameter classes with the aid of Excel and analysed.

TS AND DISCUSSION

4.1. Density of *Prunus africana,* in the forest and on plantations

Figure 1 below shows the population density structure of Prunus population in the research zone

Figure 1: population density structure of Prunus population in the research zone



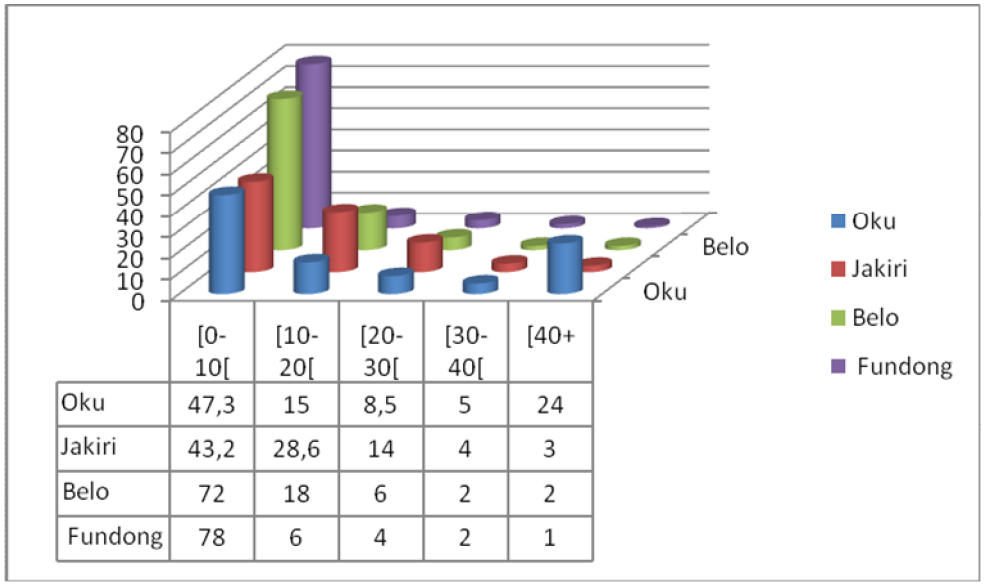
As observed in the above figure, the population density of *Prunus africana* in the research site varies considerably in the different study localities. The figure illustrates a higher *Prunus* average population density in the Jakiri locality followed by that of Oku, Belo and Fundong respectively. When considering the *Prunus* population density in the Kilum and the Ijim sites we observed that a covariance value of (-0.105.) indicating a reasonable difference in population density in the two major research zones. This results ties with studies carried out by Foaham et al., 2008 and Tah , 2009 in the research site. This result could be explianed by the quality of forest management structures that exist in the different zones.

Map of *Prunus africana* Population distribution in the Kilumï Ijim mountain Forest.

...*icana* on the Kilum-Ijim mountain forest

The different diameter classes of *Prunus africana* are represented in the research zone. The representation of young plants of the diameter class between 0 to 40 cm stands at 75.95%, 96.77%, 98% and 98.9% in Oku, Jakiri, Belo and Fundong respectively.

Figure 2: diameter class distribution in the research zone



	[0-10[	[10-20[	[20-30[	[30-40[	[40+
Oku	47,3	15	8,5	5	24
Jakiri	43,2	28,6	14	4	3
Belo	72	18	6	2	2
Fundong	78	6	4	2	1

This describes the montane forest as a regenerating forest. All the same this study shows that there is equally an exploitable potential in the forest with Oku having the highest followed by Jakiri, Belo and then Fundong.

From the field observations, it is clear that most of the inventoried plants fall in the [0-10[diameter class group, characterising the forest as a forest under high regeneration. This was explained by the Cf management to be as the result of in planting and the progressing control of human and animal access into forest lands.

4.3. Characterisation of *Prunus africana* exploitation techniques in the research zone

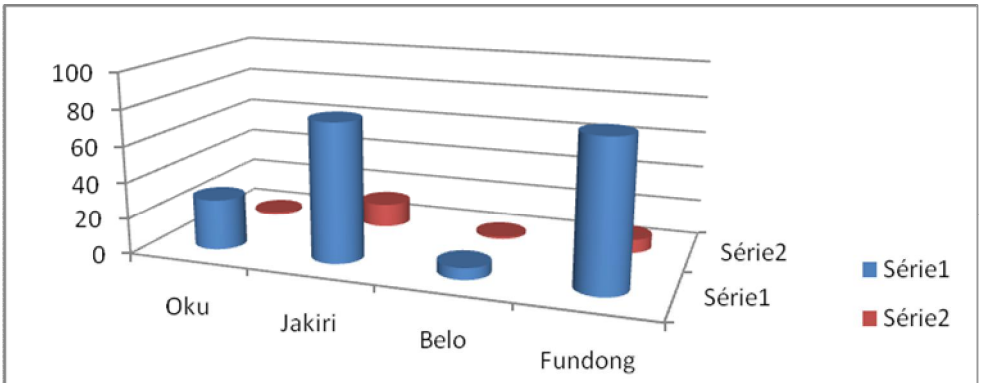
4.3.1. Percentage of *Prunus africana* plant exploited in the Study zone

The research team carried out an inventory of the different exploitation techniques used in the study zone. Below is a representation of the different percentages of exploited plants in the different research sites and the exploitation techniques used.

The figure below illustrates the different percentages of *Prunus* exploited in the Kilum-Ijim forest(serie 1) and the number of stems exploited per hectare(serie 2). This figure

ts total *Prunus* population inventoried exploited, 28.3% and then Belo 6.4%.

Figure 3: Percentage of Prunus plants exploited in the research zone



	Oku	Jakiri	Belo	Fundong
Série1	28,3	77	6,4	80,8
Série2	1,3	13,4	1,2	7,43

These figures are represented by a 7.43, 13.4, 1.3 and a 1.2 number of stems exploited per hectare respectively on these sites. These figures obtained in Fundong and Jakiri concords with the results presented by Ewusi et al.,(1996) from studies carried out in mount Cameroon, which illustrated that 87.6% of the inventoried Prunus population had been exploited, showing unsustainable exploitation rates. Guedje(2002) also made a similar observation after carrying out a study on exploited populations of *Garcinia lucida* in the Akom-Bipindi area and proposed that exploitation rates should drop to 25-50 % to be sustainable. Such measures should equally be proposed for *Prunus africana* exploitation.

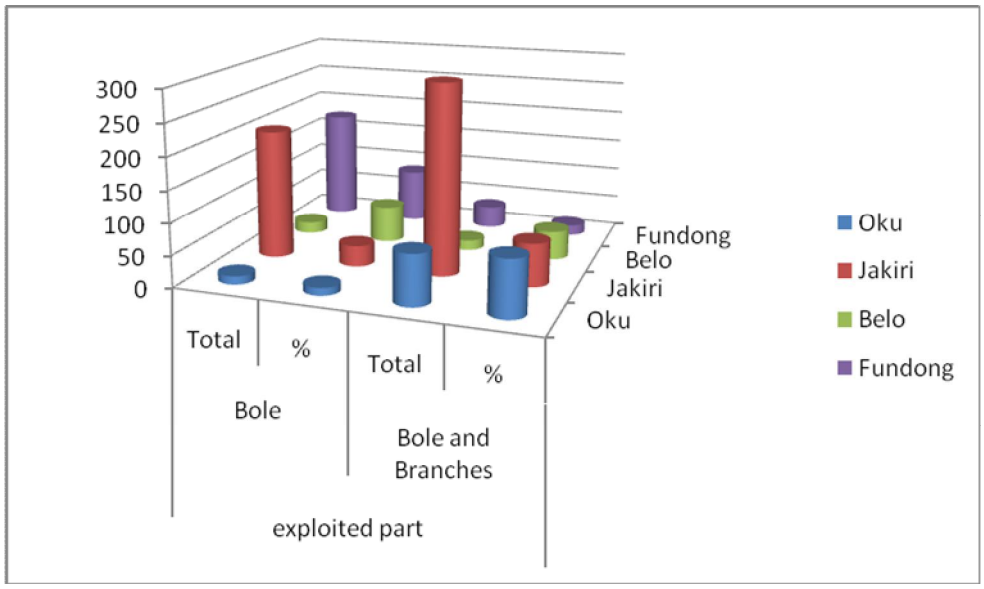
4.3.2. Number of *Prunus* plant exploited with respect to the exploited part.

The research team also inventoried the total number of *Prunus africana* exploited in function to the part exploited.

An evaluation of the debarking technique in the area shows that, all exploited trees have their bole heights debarked. 0.1% of the debarked trees where debarked using the ¼ technique and the rest that is 99.9% through a complete stripping of the vegetative parts of the plants. This type of exploitation technique will affect sustainability of the product. Guedje (2002) in his studies on *Garcinia lucida* show that bark regeneration is positively correlated to the debarking technique used. Though *Prunus africana* show a remarkable degree of bark reconsitution(Cunningham and Mbenkum, 1993), it has been observed that

s exposes the stems to stem borers and phytophtora

Figure 4: Number of Prunus plant exploited with respect to the exploited part



From the above figure, bole is the most exploited tree part observed in the study zone. About 100 % of exploited trees in the wild had their Bole completely debarked. This situation was more aggravated in Fundong (83.93%) and Belo (55.55%) villages where most of the exploited trees had all their bole removed. This peculiarity was also observed in other studied villages and mainly affected trees with dbh superior to 20cm. From the figure above, the percentage of trees exploited from bole through to the branches varied from 88.1% , in Oku , 67.1%, 44.4% and 16.1% in Jakiri, Belo and Fundong respectively.

Oku shows a very low exploitation of tree boles only but with the highest number of stems with the bole and branches debarked.

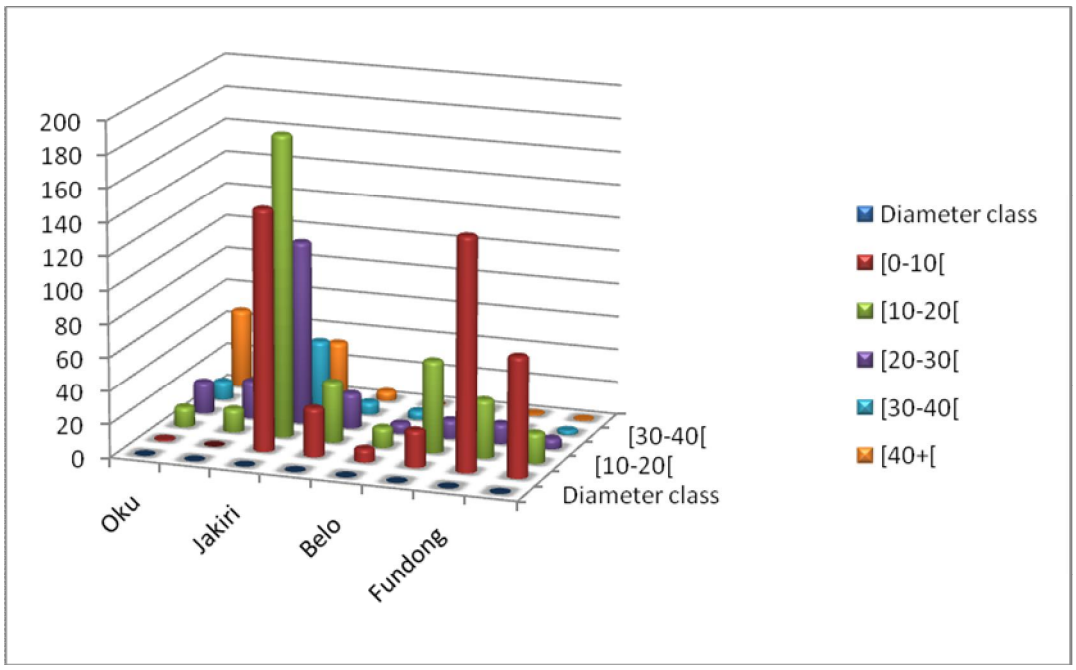
According to Ndam and Yogo(1999), the debarking of a tree is to be done only on the bole as from 1.30 m above the ground and up to the first main branch. With regards to the research zone, the applied debarking techniques are not durable and not in conformity to the recommended techniques by Ndam and Yogo(1999).

ts exploited with respect to diameter class

with respect to diameter class

Sites								
	Oku		Jakiri		Belo		Fundong	
Diameter class	Total	%	Total	%	Total	%	Total	%
[0-10[	1	0,01	145	29,3	8	22,2	140	72,5
[10-20[	12	13,99	182	36,4	12	55,5	35	18,1
[20-30[	19	22,5	110	21,2	6	11,1	12	6,2
[30-40[	11	11,5	42	7,4	5	11,1	5	2,6
[40+ [	47	52	33	5,6	0	0	1	0,5
Total	90	100	512	100	31	100	193	100

Figure 5: exploitation pattern of Prunus in the research site



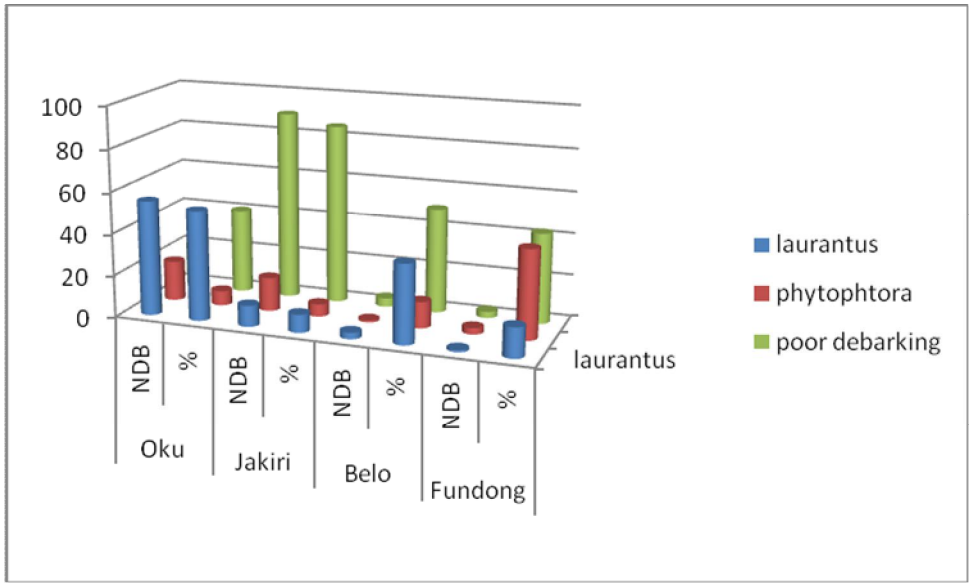
The above figure describes the exploitation pattern of *Prunus* in the research site within the different diameter classes. It is observed that, all diameter classes explored in this study have atleast one of the stems exploited. However, the exploitation percentages seem to increase with the in diameter of stems. Almost all trees with a dbh higher than 10 cm have been debarked in all the sites, with Oku, Belo and Jakiri showing very high percentages of 99.99%, 78.8 and 70.7% respectively. Fundong shows the lowest percentage of plants with dbh above 20 cm that has been exploited. The exploitation percentage in the forest is high and unsustainable due to illegal exploitation through theft after the ban. Ndam and Yogo (1999) prescribed that the minimum exploitable diameter for *Prunus africana* should be

d bark regeneration and sustainable management of tation activity carried out in this area is not quite in conformity to the prescribed methods.

4.3.4. Effects of poor debarking techniques of *Prunus africana*

A study on the different pest that attack the *Prunus* plant was also carried out. This was through the observation of the tree crown and the counting of the number of dead branches on each plant. A correlation on the number of dead branches due to pest attack and poor debarking was also carried out.

Figure 6: effects of debarking techniques on *Prunus* plants



It was observed that the percentage of poor debarking techniques in the research zone is very significant with Jakiri, Belo and Fundong showing a very high figures up to 90%, 50%, and 42.8% respectively. Oku had the lowest percentage of poor debarking techniques that could be explained by the long existence of the Kilum mountain forest project in the area to promote the conservation of the montane forest (complete stripping, 100% debarking, debarking of the bole, buttresses and branches) its was realised that it showed a higher percentage of pest (6.9%) and laurantus (52.5%) attacks due to the very recent harvesting of *Prunus* in the zone. Jakiri with the highest percentage of poor debarking techniques due to theft and lack of resources to promote monitoring by the forest management structure, contrarily showed a lower percentage of pest and laurantus attacks. This could be explained by the fact that community forest management in the Bihkov area is advanced and the last date of debarking in the area.

t pest and poor debarking techniques influenced the ark green and a majority with yellowish colorations were observed. This high value of yellowish coloration of leaves in Jakiri (82.4%) and Fundong (96.3%) can be described as resulting from trauma caused by poor debarking techniques and debarking of stems even smaller than 20 cm. It was equally observed that the areas with dark green leaf aspect could be attributed to the presence of young *Prunus* plants with dbh less than 10 cm.

Chapter 5: CONCLUSION AND RECOMMENDATION

This chapter draw a conclusion from the results of the study carried out in the research zone.

From the analysed data, it was concluded that, there is a high Prunus potential in the montane forest of Kilum-Ijim, with the northern zone(Jakiri) showing the highest Prunus potential(16 stems/ha) followed by the eastern and north-eastern zones of Belo(12.3 stems/ha). The Fundong (9 stems/ha) and the Oku (6.1 stems/ha) zones that are situated in the south-and north eastern regions respectively, have the lowest population percentage of Prunus in the study site. This concludes that there is a higher Prunus potential in the eastern and north eastern zones of the forest than the south eastern and southern zones regions of the forest.

The population structure is represented by a high potential for Prunus regeneration. This regeneration potential was observed in all the research sites. The eastern, north eastern and the south eastern regions of the forest show a very high (more than 70%) representation of juvenile population(stems less than 20 cm in dbh).

The diametric structure of the population shows an inverse J graph, with only the southern part of the forest(Oku) having a valuable representation of plants with dbh greater than 30 cm. All the diameter classes are represented in the research site.

Contrarily to the observed population density, in the south eastern zone of Fundong where 9 stems of Prunus are seen per hectare, as compared to those of the Jakiri and Belo zones, the debarking frequency show as much as 6.43 stems/ha representing 77.82%. Jakiri follows suit with 12.4 stems/ha debarked, then comes Oku and Belo with 1.4 stems/ha and 0.4 stems/ha respespectively being debarked in the research zone. These low debarking percentages could be defined by the influence of the community forest management structures in the zones.

It was also observed that almost all the Prunus plants in the Oku and Jakiri zones had been debarked from the bole through to the branches (88.1% and 67.1% respectively). Belo and Fundong had less than 50 percent of the stems debarked from bole through to the branches. This describes the exploitation techniques used in the Oku and Jakiri research zones as being unsustainable.

Prunus plant, it was observed that, there is higher
st (6.9%) attacks due to the very recent harvesting of *Prunus* in the zone. Jakiri showed a poor harvesting techniques than all the other research sites.

Though the Fundong and the Jakiri sites have the highest population of juveniles, the percentage of plants with yellowish and dead branches from pest and lauranthus attacks are very high. This has been linked to trauma caused by poor debarking techniques. This situation could also be attributed to the phenoligic status of the plants, since the study was carried out during the post fruiting season marked by the regeneration of leaves in *Prunus africana.*

The frequency of reduced tree crown caused by dead branches, is higher in Oku compared to the other sites due to the high representation of trees with large diameter. Meanwhile it is equally evident that all the trees exploited in the research zone showed a degree of stress.

From the results of this research we can conclude that though much has been done for the past years to ensure *Prunus africana* conservation, the population distribution of the plant is continuously dropping due to poor harvesting techniques in its natural milieu. With regards to the impact that can result from this practice on the plant population and on the ecosystem in which it exists, the following recommendations can be made:

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Forest

FICHE DE COMPTAGE

University of Yaounde I **Faculty of Sciences** **Department of Plant Biology**	**Team leader:é é é é é é é é é é é .** **Date é é é é é é é é é é é é é .....**
Foresté é é é é é é é é é é é é Transect n°é é é é é é é é é é é . **Altitudeé é é é é é Longitudeé é é é é é é latitudeé é é é é é é é é .**	**Particularities observed**

C<10cm	C>10cm	Bole Ht (m)	State of bark 1:exploited 0:not exploited	Quality of BH 0:0%regeneration 1:25% regeration 2:50%regeneration 3:75%regeneration 4:100%regeneration	Tree Health 0:dead 1:living	State of crown 0, 1, 2, 3	Forest strata
