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An economic evaluation of medicinal tree cultivation

Prunus africana in Cameroon

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AN ECONOMIC EVALUATION OF MEDICINAL TREE CULTIVATION: *Prunus africana* in Cameroon

Abstract

Wild populations of the Afromontane forest tree *Prunus africana* (Rosaceae), known as the African Cherry or Red Stinkwood (sometimes called *Pygeum africanum*) are currently the sole source of bark and bark extract exported from Africa and Madagascar to Europe. This trade has taken place for nearly 30 years, for production of at least 19 different herbal preparations sold by 23 companies based primarily in Europe, but also in North and South America. These are used to treat benign prostatic hypertrophy (BPH), a common disease in older men. This account provides an interesting case-study of a medicinal species which is in transition from wild harvest to cultivated sources of supply. It also illustrates the 'ecological footprint' of Europe on African forests, and upon a medicinal resource within them.

Bark exploitation has caused serious damage to wild populations of *Prunus africana*, including trees inside forests of high conservation value in Madagascar and Cameroon. Because of the difficulty of implementing and enforcing conservation measures or developing local institutions to do so, sustainable bark harvesting of remaining wild stocks by local communities is considered unlikely in Cameroon and in Madagascar. For these reasons, cultivation has been suggested as an alternative source of bark production.

This study investigated the economic feasibility of different planting systems (enrichment planting, small-scale farming and plantations) for *Prunus africana* cultivation. As part of this process, we investigated *Prunus africana* bark production and growth rates, finding statistically significant correlations between bark thickness, diameter at breast height (dbh) and tree height. *Prunus africana* showed rapid growth, reaching 14m high and 37cm dbh in 18 years. Results of a comparison between the flow of costs and benefits from small-scale production of *Prunus africana* and *Eucalyptus camaldulensis* show that *Eucalyptus camaldulensis* cultivation is 30% more profitable than *Prunus africana* production. But there are reasons why farmers might rather invest in *Prunus africana* instead of, or in addition to, *Eucalyptus* trees: *Prunus africana* is highly valued as an ingredient in many local medicinal treatments, it is used in making tools such as hoes and axes, and it is a good source of poles and firewood. Moreover, farmers and field observation indicated that with the possible exception of maize, crop yield is not much affected by the presence of *Prunus africana* in the fields. This contrasts with the depressive effect of *Eucalyptus* trees on crop yields. In North West Province, Cameroon, at least 3,500 farmers are already planting *Prunus africana*.

Bark price is affected by moisture content, distance from the factory and the monopoly, which the company has had on export of bark and bark extract. This study determined bark moisture content to be 42-50%. In rural Cameroon, intermediaries only pay 70 FCFA (0.14 US$) per kg of *Prunus africana* bark, equivalent to about US$ 142 per ton of fresh bark. At the factory gate, bark sells for 104-270 FCFA francs per kg (in 1994, 1 US$ = 490 CFA), depending on bark moisture content and quality, equivalent to US$ 212 - 551 per ton. Higher prices were paid for bark in Cameroon in 1994, when an Italian company paid 250 FCFA francs/kg, regardless of bark moisture content (US$510 per ton of fresh bark). In Kenya, the price paid to the exporter was considerably higher (11 French francs (US$ 2) per kg). This is equivalent to a price of US$ 2,000 per ton of fresh bark. By comparison, the price for fresh bark of the black wattle, *Acacia mearnsii*, which is cultivated for its tannin-rich bark, was US$ 94 per ton.

On the basis of this study, we recommend clarification of Cameroon forestry law to enable farmers to sell bark from *Prunus africana* trees they cultivate, that information on the best methods for *Prunus africana* cultivation from seed be provided to farmers, more competitive bark prices that reflect the international market value of this product, and the initiation of an out-grower scheme with the involvement of the pharmaceutical company that buys the bark and has a monopoly on the export of bark extract.

Contents

Introduction

Traded internationally, and harvested from the wild, *Prunus africana* is hardly a 'minor forest product'. The quantity of bark (dried or extract) that is exploited annually for export to Europe ranges between 3,200-4,900 tons. This is the largest volume of any African medicinal plant in international trade, and provides a case-study with practical implications for policy on harvesting and sale of forest products. Neither the uncontrolled harvesting of wild *Prunus africana* populations, nor tree cultivation as one alternative to wild harvest are easy problems to resolve.

From the early 1970s, bark or bark extract of the Afromontane forest tree *Prunus africana* [formerly *Pygeum africanum*] has been exported from Africa (Cameroon, Madagascar, the Democratic Republic of Congo (DRC, the former Zaire), Kenya, Uganda (until 1992) (Cunningham *et al*., 1997). More recently, export started from Bioko (Equatorial Guinea) (Sunderland and Tako, 1999) to Europe (France, Italy, Spain). Bark or partly-processed bark extract is used either to produce herbal preparations or is re-exported to other companies in Europe, North or South America (Cunningham *et al*., 1997). These products are sold to treat benign prostatic hypertrophy (BPH), a debilitating ailment common in older men which is eased through the anti-inflammatory effect of *Prunus africana* extract on prostatic tissue and inhibition of bladder hyperactivity (Breza *et al*., 1998; Chatelain, Autet and Brackman, 1999; Paubert-Braquet *et al.*, 1994).

Current international export demand for *Prunus africana* bark, primarily to Europe, is over 3,000 tons per year. Nearly two-thirds of this is harvested in Cameroon (Cunningham and Mbenkum, 1993). Although a small proportion of unprocessed, dried bark is exported from Cameroon, most bark exploited in Cameroon and Madagascar is processed locally to produce an extract, which is then exported to Italy and France. By contrast, only unprocessed, dried bark is exported from Kenya and the DRC to Belgium and France.

Although this trade is a useful source of foreign exchange to these African countries, it has had a devastating effect on the wild populations that are the sole source of *Prunus africana* bark (Cunningham and Mbenkum, 1993; Walter and Rakotonirina, 1995). The limited distribution of *Prunus africana* also means that demand for bark is focussed on a limited area of forest. The species is restricted to Afromontane forest 'islands' which are generally above 1,500 - 2,000 m altitude. The small size of these 'islands' has been further reduced by agricultural clearing, which is the major threat to Afromontane forests. It is these remaining Afromontane forests that are the current focus of *Prunus africana* bark exploitation. As a result, already isolated populations on montane islands are becoming further isolated due to the destruction of almost all large, reproductively mature trees from intervening 'islands'. The worst affected are also the most genetically unusual - for example the Madagascan *Prunus africana* populations (Dawson and Powell, 1999). As a result, this species was listed in Appendix II of the the Convention on International Trade in Endangered Species (CITES), which requires monitoring of *Prunus africana* bark exports.

Sustainable harvest of *Prunus africana* bark was attempted by Plantecam in Cameroon, particularly between 1972 and 1987. This was based on a system of bark removal from opposing quarters of the tree trunk. Although this reduces the rate of tree mortality, field observation and a recent quantitative study show that this method frequently causes crown death. In practice, poor bark regrowth in dry sites leads to wood-borer and fungal attack on these trees. In moist sites, bark regrowth is better, but crown death of *Prunus africana* trees still occurs. At a local level, *Prunus africana* is a multiple-use species commonly used by local people for axe and hoe-handles, for traditional medicinal purposes or, more recently, as seed source for cultivation. In Cameroon, *Prunus africana* bark exploitation is focussed, despite their 'protected' status, on the three forests rated by Collar and Stuart (1988) as most important for bird conservation (Mt. Oku, Mt. Cameroon and Mt. Kupe). Felling or debarking and die-off of trees is therefore an issue of local, national and international concern (Cunningham and Mbenkum, 1993; Walter and Rakotonirina, 1995).

Several recent reports have drawn attention to these conservation problems and suggested cultivation as a possible solution in order to take harvesting pressure off wild stocks (Besong et al., 1991; Cunningham and Mbenkum, 1993). Whether this is a practical option or not depends on the economic viability of *Prunus africana* cultivation.

The aim of this study was to investigate the economic feasibility of different planting systems (enrichment planting, small-scale farming and plantations) for *Prunus africana* as an alternative to the current overexploitation of wild populations.

Methodology

felling, debarking ...

... and weighing bark mass of *Prunus africana*

The assessment of *Prunus africana* growth rates and bark mass production involved the measurement of tree height, diameter at breast height (DBH) and bark thickness for *Prunus africana* trees: firstly, where there was a known date of planting; secondly, measuring bark thickness for wild growing trees of known height and DBH; and thirdly, destructive sampling of bark mass.

Due to the widespread debarking of wild and cultivated *Prunus africana* trees and the political sensitivities regarding felling of *Prunus africana* trees, we were only able to fell and weigh bark mass from seven trees of differing diameter. All bark was stripped from the main trunks of these trees until the trunk tapered to 5cm diameter, or to a major fork. Wet bark mass was then weighed using a Salter 25 kg hanging scale. Undried field mass of bark was determined in the field using a battery-powered electronic balance. Bark samples were then dried at 600 °C for 72 hours. In our results we use fresh bark mass, following Schönau's (1972) recognition for *Acacia mearnsii* that this was a more useful independent variable than oven-dry bark mass.

Bark thickness was measured using a Swedish bark gauge, taking the average of 4 measurements made at breast height (1.3 m) as Schönau (1972) did in determining metric bark mass tables for *Acacia mearnsii*. Tree height was measured using a PM5/1520PS Suunto direct-reading hypsometer. Data were gathered on the heights, diameters and bark thickness of *Prunus africana* trees in five sites. Four of these sites were selected as they had trees of known age. Two of these were close to Ntingue village near Dschang, West Province, one was at Vekovi near Jakiri, North West Province, one at Buea on the slopes of Mt. Cameroon, South West Province, and the last was a wild *Prunus africana* population at Mt. Kilum, North West Province (Figure 1).

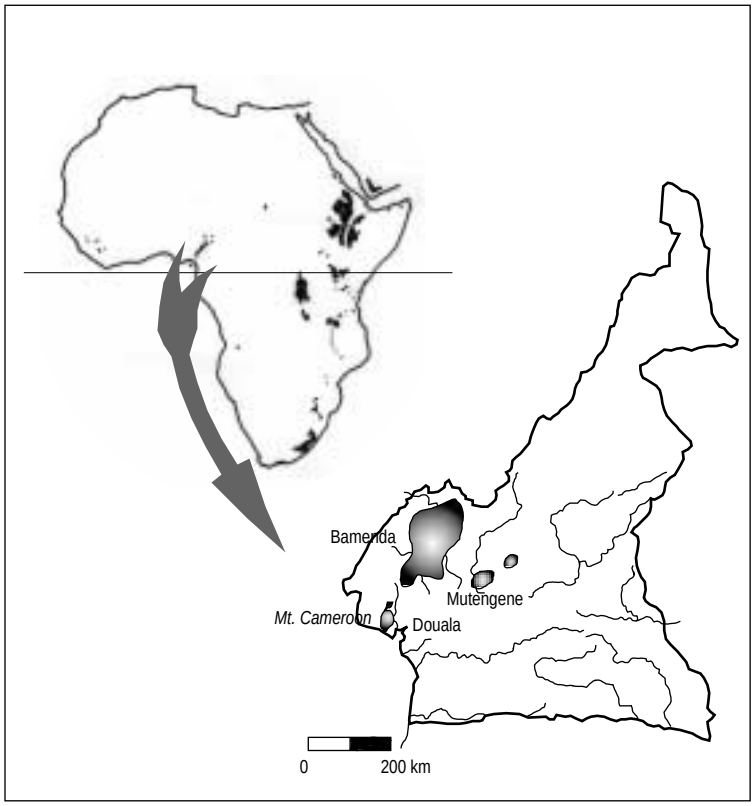


Figure 1: Map showing location of study sites in relation to location of *Prunus africana* in Cameroon. Inset shows distribution of the Afromontane centre of endemism in Africa where *Prunus africana* is located.

Trial plantation of c. 40 years old *Prunus africana* trees planted in western Kenya.

The field work for this study was conducted in 1995. Details of the five sites are given below:

(i) An enrichment planting in the forest (c.1,600-1,700 m asl): Due to illegal debarking of the majority of trees in this enrichment planting over the past 9 - 12 months, this research visit provided probably the last opportunity for evaluation of this 20 yr old enrichment planting. In accordance with permission received for bark removal as part of this study, it was in this site that 7 trees ranging from 7 - 26 cm DBH were felled for assessment of bark mass. In addition, 72 trees were measured for DBH and bark thickness at this site, with 30 trees measured for height as well as DBH and bark thickness. Bark samples of 200 - 400 g were taken and weighed with an electronic balance to determine wet bark mass prior to drying and determination of dry bark mass.

(ii) Trees planted near the old nursery at Ntingue (c.1,500 m asl): Twenty-four trees were measured for height, DBH and bark thickness at this site. Most trees had been recently illegally debarked.

(iii) Trees planted by a farmer Shey Lukong Charles Lankar at Vekovi outside Kumbo (60° 12' 90° 25'), North West Province, Cameroon (2,025 m asl): Planting of *Prunus africana* trees by Shey Charles Lukong over the past 18 years are testimony both to his foresight and to the agroforestry potential of this tree species. Seedlings were planted in 1977, 1979 and 1987. As a former worker for Plantecam from the Vekovi area near Jakiri in NW Cameroon, he has been planting trees amongst coffee, avocado, coco-yam and potato cultivation with great success. The largest of these trees at 18 yr old is 37.6c m DBH and 13.5 m high with bark 14 mm thick. Forty trees were measured on this farm for DBH, height and bark thickness, with a statistically significant sample of trees from the 1987 planting.

(iv) A small plantation trial at Buea (60° 12' 90° 25'), South West Province (900 m asl): This planting, of approx. 2 ha, was made by Plantecam on land provided by the 'Office National des Eauxs et des Forets' (ONADEF) as part of the Special Licence requirement for Plantecam to plant 5 ha per year of their licence agreement. Although this requirement was not fulfilled, this 1987 planting provides a useful comparison with other sites of known date of planting. This planting is in a field where local farmers cultivate cassava, coco-yam, beans, maize, *Dioscorea* yam and bananas. *Prunus africana* trees upslope of this field have clearly been affected by competition with elephant grass. Twenty-two trees were measured for DBH, height and bark thickness.

(v) Wild trees, Mt Kilum, North West Province, Cameroon (60° 15' 100° 26') (2,275-2,380 m asl): Fifty-two trees were measured for DBH and bark thickness, with height measurements possible for 24 trees. The clear crown die-off predominant even in trees which had been 'correctly' debarked by Plantecam staff about eight years earlier and which had fully regrown their bark, gives additional cause to doubt the long-term sustainability of wild harvest of bark.

The mean annual rainfall at the Oku, Vekovi and Dschang sites is 2,000-2,500 mm per year, considerably lower than the forested base of Mt. Cameroon, which falls within the narrow band of high rainfall adjacent to the Gulf of Biafra, where annual rainfall exceeds 8,000 mm per year. Soils on the Bamenda highlands, and the Oku area are derived from recent volcanic deposits (andesitic basalts and trachyte rhyolites) and older, less fertile crystalline basement rocks. Mt. Cameroon, which is still an active volcano, is surrounded by fertile soils derived from volcanic activity.

Land use and socio-economic systems in the study sites

The cool, mountain highlands where *Prunus africana* occurs in Cameroon are all densely populated. The three study areas, Oku/Mt. Kilum, Ntingue/Dschang and Buea/Mt. Cameroon, all have similar biophysical features. However, the areas are very different in terms of their 'traditional' political systems, culture, history and infrastructure. These are represented by the *fons* of the Tikar and Bamileke peoples, respectively found in the Mt. Kilum and Dschang study areas, and the Bakweri people living around Mt. Cameroon.

Tikar people dominate the Bui division, which includes Oku and western Nso. They consider themselves to be ancestors of the Bamum and other peoples of the Bamenda highlands. Both the Tikar and the Bamileke (who dominate the Dschang study area) are organised into chiefdoms (*fondoms*), ranging from single villages to areas covering many villages. Chieftainships are hereditary, with local *fons* ruling their communities in collaboration with traditional councils. In general, the chiefs and councils have much more power and authority in dealing with local issues, such as minor criminal offences and land disputes, than do civil authorities. Traditional community leadership is stronger and communities more homogenous in the Oku-western Nso area than in the Dschang area, and is weakest around Mt Cameroon. By contrast with the long history of hereditary Tikar, Bamum and Bamileke *fons* with authority over large communities, the Bakweri had a segmentary social organisation, comprising small family villages under the authority of a few elders ('chiefs') until the start of the colonial period. It was only during British rule, in 1914, that a chieftaincy was instituted for all the Bakweri, with the title granted to the Endeley family of Buea under the British system of indirect rule (Geschiere, 1993). These differences in institutional structure have important implications for the community-based natural resource management programmes discussed later in this paper. Two other factors are important in this regard. First, large-scale oil palm and rubber plantations were rapidly established on the fertile volcanic plain between Mt. Cameroon and the sea by the German and later, by the British administration, displacing the Bakweri community around the base of Mt. Cameroon. Secondly, the influx of 'strangers' into the Bakweri community, even before 1900, also had an effect on natural resource management.

The main objective of the households in the rural areas of this study is to obtain a reliable supply of preferred foods throughout the year. The next most important objective is to earn cash. Maize is the principle food staple. Other important food crops include potato (*Solanum tuberosum*), beans (*Phaseolus vulgaris*), huckleberry (*Solanum nigrum*), coco-yam (*Colocasia esculenta*), cowpeas (*Vigna unguiculata*), sweet potato (*Ipomoea batatas*), and sugar cane (*Saccharum officinarum*). Coffee (*Coffea arabica*) is the primary cash crop; many farmers also grow *Eucalyptus* in woodlots. Food crops are also sold. Livestock are few and are usually limited to chickens and goats, kept mostly for security (selling to meet urgent cash needs) or for ceremonial purposes. Women provide the bulk of agricultural labour and are generally responsible for the cultivation of annual food crops. They also assist in the growing of tree crops, which is mainly done by men. Families generally live in villages, cultivating small plots around their homesteads and larger plots some distance away. Permanent crops, such as coffee, tend to be grown in fields near to the homestead, with strict tenure exerted over them by the farming family. Annual food crops are mostly grown on the further away fields, which are communally owned and which are administered by the chief and council. Rights to use these lands may be temporary or permanent. Cultivable land is extremely scarce in most parts of the study area. As a result, fields are cropped continuously, and soil fertility is reported to be declining. Planting and growing of trees is a common practice and is much more common around the homesteads, where tenure is secure, than in fields further away. Overall, insecure land tenure is not an important constraint preventing farmers from planting trees. Nevertheless, land disputes are common, and insecure land tenure does constrain certain individuals from planting trees in certain fields.

Market infrastructure in the Oku area is weak, and roads are extremely poor. The supply of inputs is highly variable and markets for farm products are unreliable. For example, farmers often suffer long delays, up to two years, in receiving payments for coffee supplied to cooperatives. Marketing risks thus contribute to the strong subsistence orientation of the household. From a socioeconomic perspective, the Dschang area differs from the Mt. Cameroon and Oku-western Nso areas in several ways. First, the Dschang area has better infrastructure, including roads, communications, and market services. Second, more residents of the community are employed outside the area. Therefore, remittances to the area from outside are higher. Thirdly, as a result of the above two points, incomes are higher in the Dschang area than in the Oku-western Nso area.

Socio-economic evaluation: Survey methods, data collection and analysis

This study assessed the practicality and local costs and benefits of *Prunus africana* cultivation by small-scale farmers and the advantages and practical problems experienced in current cultivation. Individual and group discussions, together with field observations, were used to collect relevant information concerning socio-economic aspects of farmer production of *Prunus africana*. A broad range of people were involved. They included small-scale farmers, middlemen or permittees trading on the medicinal plants, top management of the pharmaceutical subsidiary (Plantecam) exporting *Prunus africana* bark extract, Ministry of Environment and Forestry officials, and various non-governmental organisations. The small-scale farmers interviewed were selected from four main production areas at Mt. Ijim, Vekovi, Mt. Kilum/Oku and Mt. Cameroon. Staff of on-going projects involved in *Prunus africana* planting identified most of these farmers. Other farmers not associated with *Prunus africana* related projects were also interviewed.

Discussions were informal and in some cases a check-list of topics was used. The main purpose was to gain insight into key issues associated with *Prunus africana* production and related alternative enterprises. At the small-scale production level data were collected on:

1. nursery operations and costs - including year first started, number of seedlings produced, mortality rates and causes, sources of seed, costs of seeds;
2. projected uses, quantities produced, and prices for *Prunus africana* products;
3. production constraints.

Middlemen, otherwise known as permittees, are the only ones authorised to collect bark from assigned locations. For this reason they play an important role in the harvest of *Prunus africana* bark and in determining farm-gate prices. Data were collected on number of tons they were authorised to harvest, regions they had permission to harvest from, quantity they sold to Plantecam (the main buyer of *Prunus africana* bark), the existence of other buyers, prices they received, prices they paid to farmers, cost of transportation to the principal buyers, perceived constraints, and their perceptions of the sustainability of *Prunus africana* collection.

At the enrichment planting site at Ntingue, Dschang, a group discussion was organised with members of the community to assess their perception of the forest reserve and enrichment activity, their degree of involvement, and the sustainability of the system. Ministry of Environment and Forestry officials provided relevant data on number of permittees, current process of granting permits to middlemen, availability of seeds, and their perception of the sustainability of the system and probable strategies to correct the existing situation. Data were also collected from non-governmental organisations with respect to their activities promoting Prunus africana in relation to their own goals, seed availability, planting activities, and perceived production constraints. Information was also collected from senior management of Plantecam on a broad range of issues. Key points included collection activities, number of permittees with whom they have contact, and their relationship with these middlemen, production, demand situation in Europe, including market expansion opportunities and effect of possible development of substitutes and synthetics, ratio of bark to extract, supply stock and strategies for a sustainable management of *Prunus africana*.

In order to undertake some comparative analysis, information was also gathered from farmers on alternative enterprises such as *Eucalyptus* woodlots. The decision to use *Eucalyptus* to compare with *Prunus africana* was motivated by field observations which suggested that both enterprises are undertaken on comparable land types, under similar spatial arrangements and with comparable objectives.

The conventional costs-benefit analysis technique was used to calculate the costs and returns over a 30-year period. Discounted net returns were used to determine the net present value (NPV) of investment strategies.

Results

Tree height, diameter, bark thickness and mass

Variation in diameter and height of *Prunus africana* trees of the same age in the same locality was high. Variation among trees of the same age was particularly high in the enrichment planting at Dschang. Diameter at breast height and tree height significantly correlated, however, as shown by data from Vikovi (Figure 2). There was also a close correlation between dbh and bark thickness (Figure 3) and from the small sample of felled trees, between dbh and bark volume and between dbh and bark mass (Figures 4a and b).

Shey Charles Lukong (left): former commercial bark harvester and pioneer farmer of *Prunus africana* in NW Cameroon with forester Christian Asanga (right) next to a *Prunus africana* tree he planted from seed.

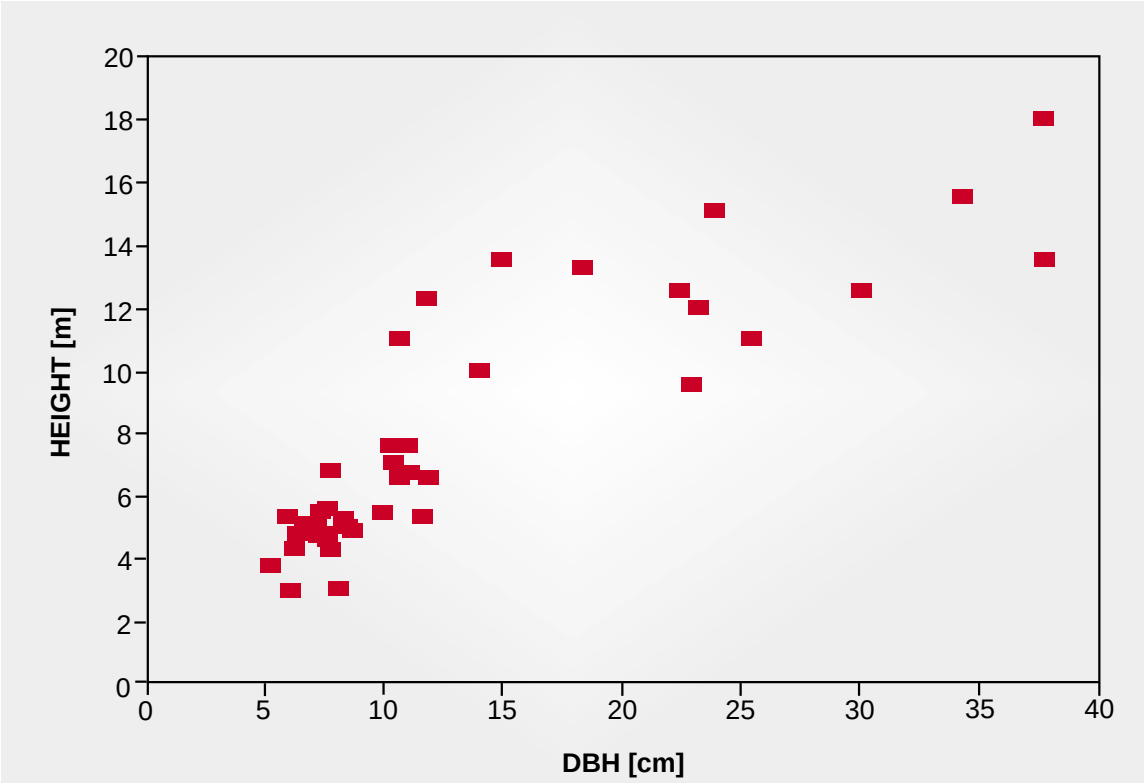


Figure 2. The relationship between diameter at breast height (dbh) and height of *Prunus africana* trees grown together with coffee, bananas, potatoes and beans by Shey Charles Lukong (Vekovi, NW Cameroon).

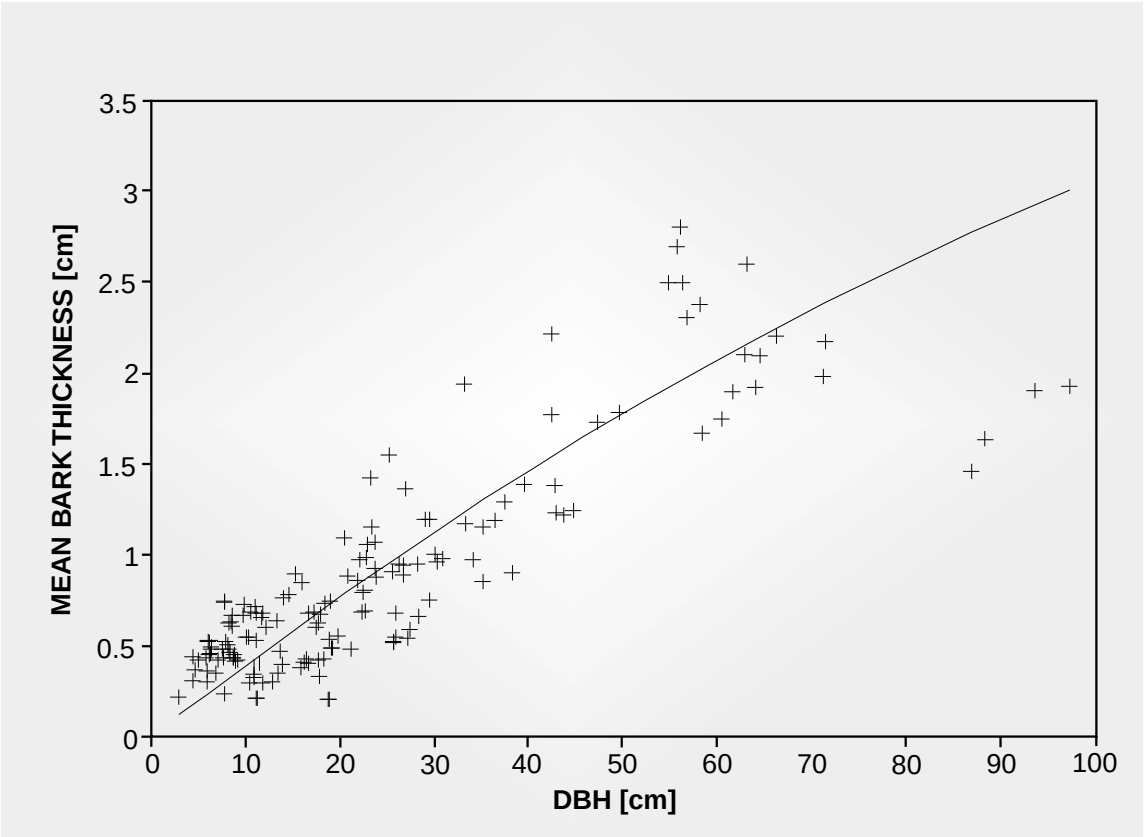
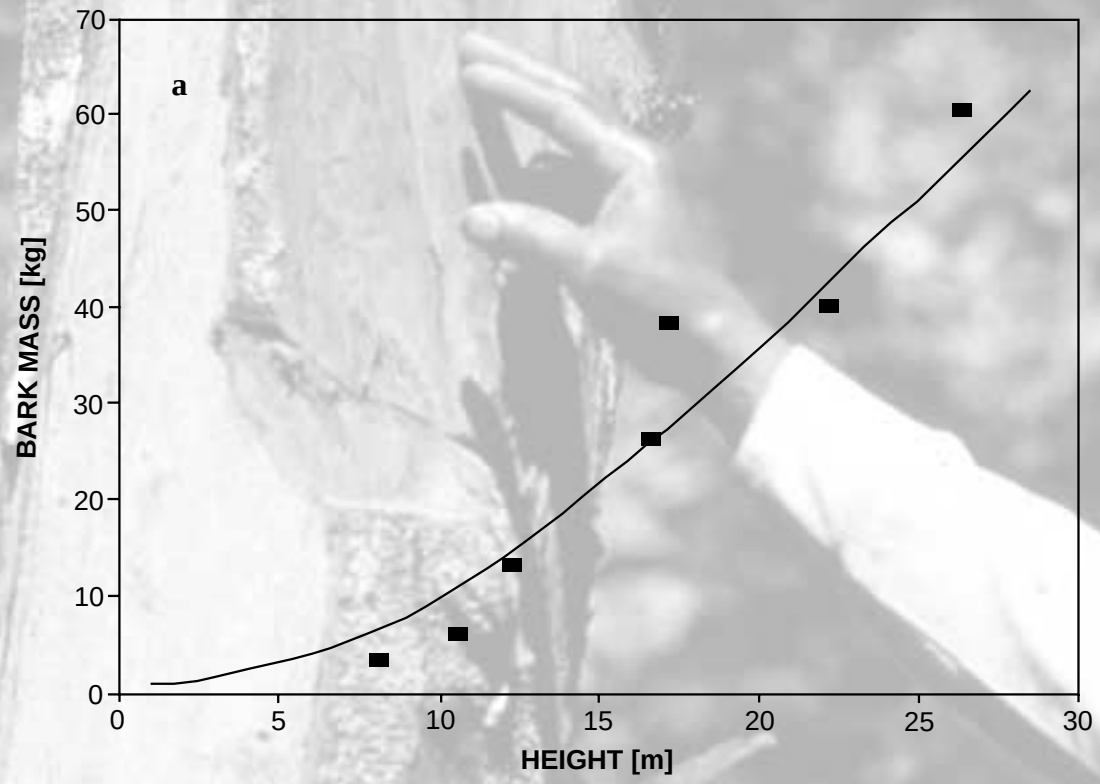


Figure 3. A quadratic regression showing the relationship between diameter at breast height (dbh) and mean bark thickness of *Prunus africana* trees in Cameroon (n= 170 trees).



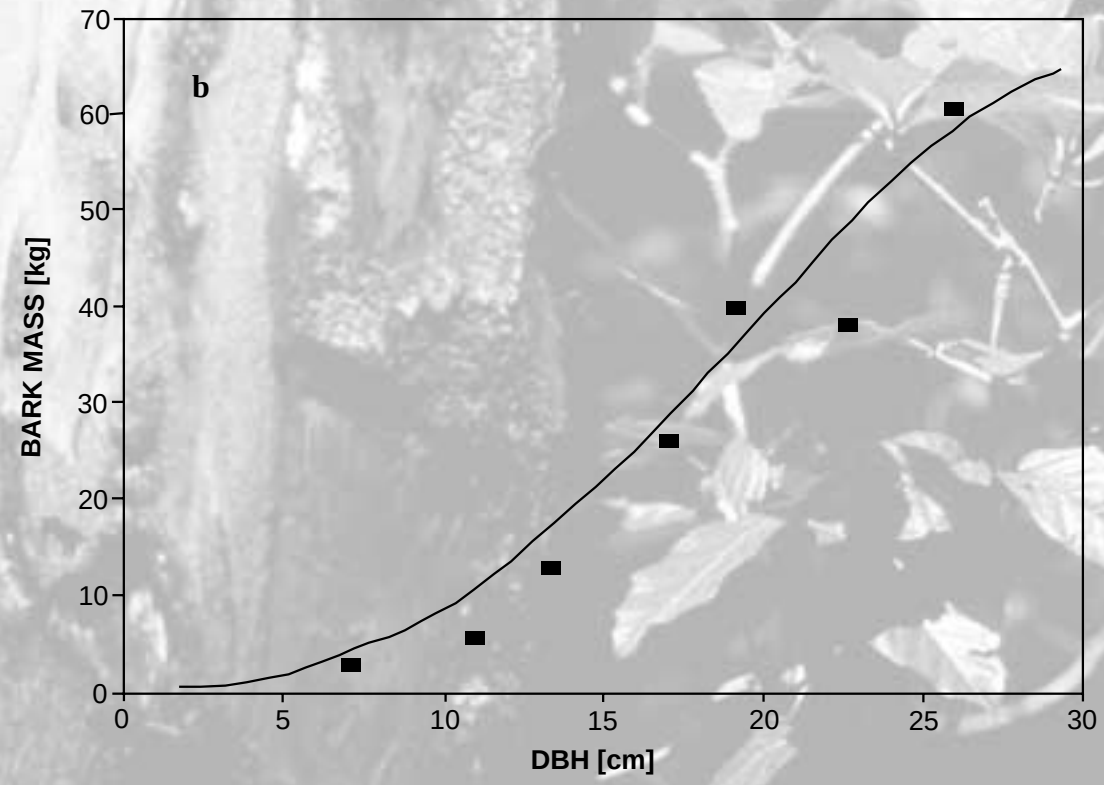


Figure 4. Bark mass from seven felled Prunus africana trees of different diameters at Ntigue, Cameroon,showing the relationship between (a) bark mass and height, and (b) bark mass and DBH.

Table 1. Prices paid for bark by Plantecam at the factory in Mutengene, Cameroon, based on two factors : (a) bark moisture content and (b) a correction factor based on bark quality, as of 1 April 1994 when the spate of uncontrolled harvest occurred on Mt. Cameroon (1 US$ = 490 FCFA).

Bark moisture content	Price paid (FCFA francs/kg)	Equivalent value (US$/kg)	(US$/ton)
Up to 12%	250	0.51	510
From 12.1% to 20.0%	220	0.45	480
From 20.1% to 24.9%	200	0.41	408
From 25.0% to 30.0%	170	0.35	346
Above 30%	130	0.27	265

Bark quality	Correction coefficient
Mediocre	0.8
Passable	0.9
Standard	1.0
High	1.1

Economic analyses

Economic returns to farmers clearly are a key factor determining whether they will cultivate Prunus africana. Two of the factors affecting this are Prunus africana bark and timber quality.

BARK PRICES

Until recently, Plantecam has held a monopoly export of bark or bark extract, and has been able to determine the price paid for bark. At the time of this study, the price paid for bark depended on bark moisture content and bark quality, Plantecam pays 104-270 FCFA/kg bark (Table 1).

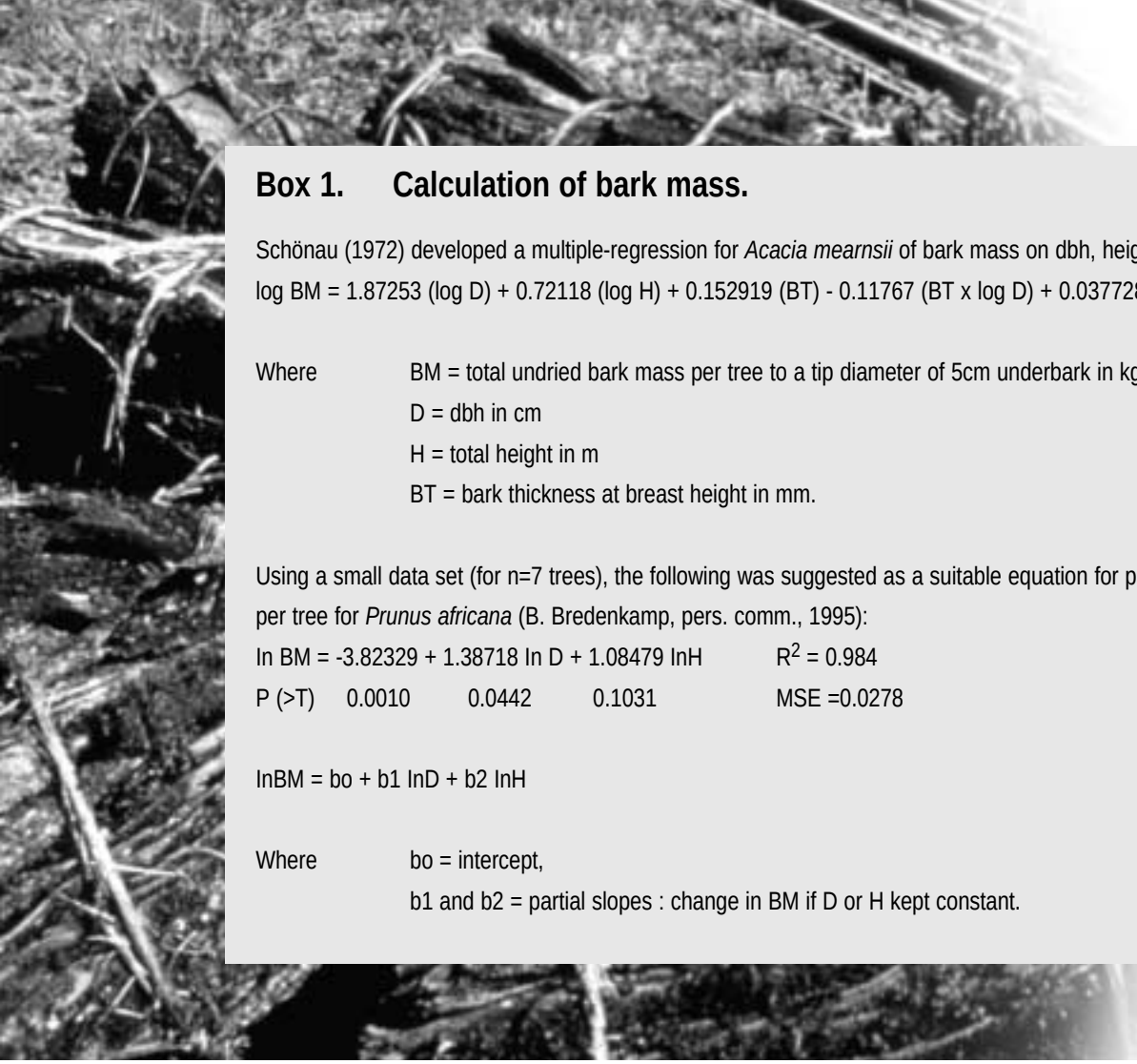
WOOD-BORER EFFECTS ON TIMBER QUALITY

High levels of *Prunus africana* stem infestation by wood-boring beetle larvae (probably in the family Cerambycidae) were recorded at sites below 1,500 m asl during this study. Although there were no signs of wood-borer in late 1992, all of the *Prunus africana* trees planted in Limbe Botanical Garden (15 m asl) were severely affected by wood-borer by 1995. In common with trees planted at lower altitude, the majority of live trees (87.5% (21)) planted near the old nursery at Ntingue (c.1,500m asl) had been attacked by wood-borer. By contrast with trees at lower altitudes, only 9.6% (five) of wild trees in the forest at Mt. Kilum (2,275 - 2,380 m asl) showed signs of borer attack. This is an important factor that will undoubtedly reduce the timber value of *Prunus africana* cultivated on either a small or large scale at lower altitudes.

COMPARATIVE ANALYSIS OF SMALL-SCALE PRODUCTION OF *PRUNUS AFRICANA* AND *EUCALYPTUS CAMALDULENSIS*

Results of the flow of costs and benefits for small-scale production of *Prunus africana* and *Eucalyptus camaldulensis* in the Oku area are shown in Tables 3 and 4, respectively. Each is assumed to be produced in a 0.16 ha woodlot. For *Prunus africana* production (Table 2), the major costs were incurred on seedlings, land preparation, planting and weeding. Benefits were obtained from the sales of construction poles (8th year), bark (13th year), hoe and axe handles (18th year) and salvage value (end of the rotation). The net present value (NPV) of benefits for the production of *Prunus africana* at the farm-level is 29,010 FCFA francs (US$ 60) using 10% discount rate over the 30-year period. The flow of discounted net returns shows that the farmer loses in the first three years. Positive net returns are realised beginning in year eight. By the 18th year, the entire investment is repaid.

The NPV for a comparable *Eucalyptus* enterprise is shown in Table 5. Expenses on seedlings, land preparation and planting, weeding and prun-



Box 1. Calculation of bark mass.

Schönau (1972) developed a multiple-regression for *Acacia mearnsii* of bark mass on dbh, height, bark thickness :

log BM = 1.87253 (log D) + 0.72118 (log H) + 0.152919 (BT) - 0.11767 (BT x log D) + 0.037728 (BT x log H) - 2.04586

Where BM = total undried bark mass per tree to a tip diameter of 5cm underbark in kg;
D = dbh in cm
H = total height in m
BT = bark thickness at breast height in mm.

Using a small data set (for n=7 trees), the following was suggested as a suitable equation for prediction of bark mass per tree for *Prunus africana* (B. Bredenkamp, pers. comm., 1995):

ln BM = -3.82329 + 1.38718 ln D + 1.08479 lnH R^2 = 0.984

P (>T) 0.0010 0.0442 0.1031 MSE =0.0278

lnBM = bo + b1 lnD + b2 lnH

Where bo = intercept,
b1 and b2 = partial slopes : change in BM if D or H kept constant.

ing, and crop loss constitute the main components of the costs side. Benefits are largely attributable to construction poles, fuelwood from construction poles, fuelwood poles, electricity poles and sawing logs. Over a 30 year period the NPV is 37,885 FCFA. This figure is 30% higher than that of *Prunus africana*. An examination of the flow of discounted net returns shows that the net gains and losses alternate at the rate of one to three. That is, three years of loss are followed by a year of net gain. Nevertheless, for the *Eucalyptus* enterprise the investment is repaid by the fourth year.

This analysis indicates that although *Eucalyptus* enterprise NPV exceeds the NPV for the *Prunus africana* investment, there is a profit for investing in *Prunus africana*. There are also reasons why one might rather invest in *Prunus africana* than in *Eucalyptus* trees. Farmers indicated that crop yield is not affected by the presence of *Prunus africana* in the fields. Field observations indeed support this assertion, with the exception of maize, which did not perform well in the presence of *Prunus africana*. *Eucalyptus*, on the other hand, depresses crop growth far more severely. Secondly, the medicinal value of *Prunus africana* was subsumed in the bark sales value to avoid double-counting. Although this is proper, this may in fact lead to an under-estimation of the value of the species for rural households as a medicinal plant.

In fact, small-scale farmers prefer to diversify their farming operations; that is why a single household generally manages a dozen or more farm enterprises. They are thus likely to want to plant both *Prunus africana* and *Eucalyptus* because each provides different products and helps the household to manage risk. An important advantage of *Prunus africana* over *Eucalyptus* is that it does not depress crop growth; farmers may thus prefer to grow it in association with crops, along internal and external farm boundaries. *Eucalyptus*, on the other hand, can only be grown in woodlots because it interferes too much with crop growth.

A sensitivity analysis was undertaken to determine how the NPV is affected given changes in key parameters such as bark price, pole price, labour cost, and the discount rate. Table 5 shows the NPVs thus calculated.

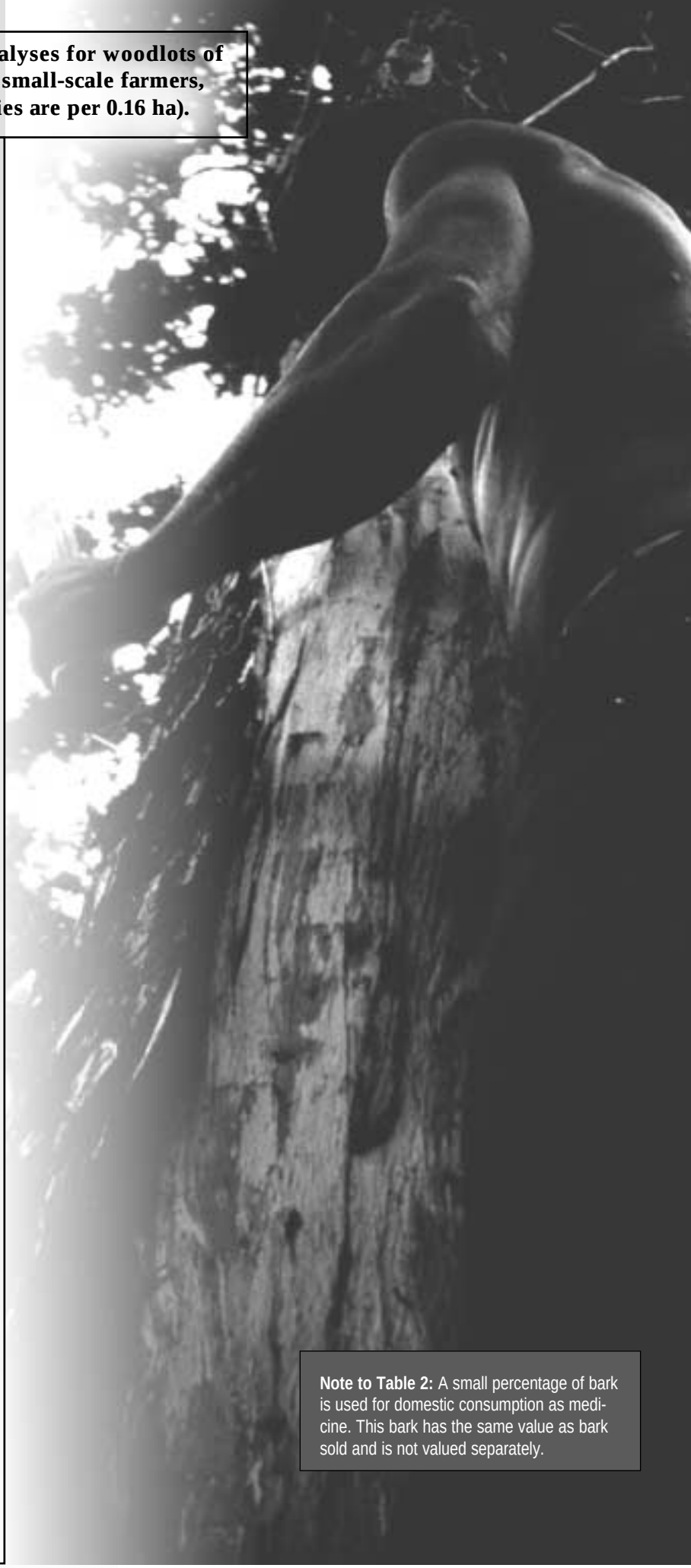
Table 2. Data used in cost and benefit analyses for woodlots of *Eucalyptus* and *Prunus africana*, small-scale farmers, Oku (values are in CFA; quantities are per 0.16 ha).

A. *Eucalyptus*

Price for a construction pole	150
Value of branches per tree for fuelwood	50
Price for electricity pole	1,500
Price of sawing log	3,500
Price of fuelwood pole	100
Discount rate	10%
No. of construction poles (yrs 1-12)	122
No of fuelwood poles (yrs 1-12)	31
No of construction poles (yrs 13-23)	113
No. of fuelwood poles (yrs 13-23)	28
No of construction poles (yrs 24-30)	103
No of fuelwood poles (yrs 24-30)	26
No of sawing logs	28
No of electricity poles	3
% coppices good for poles	80
% coppice good for fuelwood	20
% of 20-year trees used	10
Cost per 100 seedlings	200
Labour cost/day	500
No of packages of 100-seedlings	2
No of days for land preperation, 0.16 ha	1.5
No of days weeding & planting, 0.16 ha	1
Yield per hectare (kg maize)	1,000
Area of crop loss	520
Estimated crop loss	33%
Quantity of maize loss	17.16
Price of maize	67

B . *Prunus africana*

Quantity of bark harvested/tree (kg in yr 13)	6
Quantity of bark harvested/tree (kg in yr 18)	8.5
Quantity of bark harvested/tree (kg in yr 23)	11
Quantity of bark harvested/tree (kg in yr 28)	13.5
Quantity of bark harvested(yr 30)	100
No of axe handles/yr/tree (before yr 18)	1
No. of axe handles/yr/tre (yr 18 and after)	3
No. of hoe handles/yr/tree (yr 18 and after)	5
No of hoe handles (before yr 18)	2
No of trees/ha	2,500
No of trees/0.18 ha (yrs 1-8)	45
No of trees/0.18 ha (yrs 9-30)	22
Price of poles yr 30	12,000
Price of poles obtained after thinning	300
Bark price/kg	100
Price of Hoe handle	250
Price of Axe handle	400
Cost/seedling	50
Survival rate	65%
Labour cost/day	500
Land prep. and planting (hrs)	2
Weeding and pruning (hrs)	3
Debarking time(days)/tree - to year 18	0.16
Debarking time(days)/tree - after year 18	0.25
Debarking time year 30	0.5
Handle preparation time/tree	0.25
Salvage value/tree	5,000



Note to Table 2: A small percentage of bark is used for domestic consumption as medicine. This bark has the same value as bark sold and is not valued separately.

Table 3. *Prunus africana* woodlot costs and returns: small-scale farmer, Oku.

	COSTS (FCFA/hectare)						RETURNS (FCFA/hectare)						
Time Period (YEAR)	Seedlings	Land prep. & planting	Weeding & prunning	Debarking costs	Handles preparation	Total	Bark sales	Hoe handle sales	Axe handle sales	Poles sales after thinning	Salvage value	Total	Discounted Net Returns (FCFA)
1	2,250	1,000	1,500			4,750							-4,318
2	790		1,500			2,290							-1,890
3	515		1,500			2,015							-1,512
4													
5													
6													
7													
8										6,600		6,600	3,079
9													
10													
11													
12													
13				1,760		1,760	13,200					13,200	3,314
14													
15													
16													
17													
18				1,760	5,625	7,385	18,700	27,500	26,400			72,600	11,729
19													
20									8,800			8,800	1,308
21													
22								11,000	8,800			19,800	2,432
23				2,750		2,750	24,200					24,200	2,395
24									8,800			8,800	893
25													
26								11,000	8,800			19,800	1,661
27													
28				2,750		2,750	29,700		8,800			38,500	2,479
29													
30								11,000	8,800		110,000	129,800	7,439
											NPV [10%]		29,010

A number of remarks can be made from the results presented in Table 5 (page 16). First, both *Eucalyptus* and *Prunus africana* have positive net present values (NPVs) at 20% discount rate; at 30% however, the NPV for the medicinal plant is negative, whereas for *Eucalyptus* it is still positive. Secondly, except for *Eucalyptus* (labour cost) where the change in NPVs are very small across all three discount rates, there is a considerable change in NPV if the direction of change of a key variable is reversed. Third, the results are not very sensitive to changes in bark prices. Finally, the most remarkable change in NPV occurs when the pole price of *Eucalyptus* is changed.

ENRICHMENT PLANTING

Enrichment planting, especially of forest reserve areas, has been used as a strategy to ensure that the resource base is renewed. In Mt. Oku, for instance, the Mount Kilum Forest Project is currently undertaking enrichment of the mountain with *Prunus africana*. In Dschang a forest was planted with *Prunus africana* in 1972 by the Office National des Eaux et Forets (ONADEF) at Ntingue village. These enriched forest reserves can be a source for harvesting *Prunus africana* bark. There are, however, a number of critical issues concerning the exploitation and management of these, as will be shown in the next section.

An economic analysis of enrichment planting was conducted using data from the Ntingue forest reserve as already described above in the methodology section. Table 6 depicts the flow of costs and benefits of this enterprise. On a hectare basis, the NPV using a discount rate of 10% is 1,428,486 FCFA francs (US$ 2,915 per ha). The discounted net returns are negative for the first three years. At the 13th year after the first bark sales, the total investment is repaid. The peak net returns are observed in the 18th year with discounted net returns of 643,805 FCFA (US$ 1,314 per ha).

Table 4. *Eucalyptus* woodlot costs and returns: small-scale farmer, Oku

	COSTS (FCFA/hectare)					RETURNS (FCFA/hectare)						
Time Period (YEAR)	Seedlings	Land prep. & planting	Weeding & prunning	Crop loss value	Total	Construction	Fuelwood poles	Fuelwood from constr. poles	Electricity poles	Sawing logs	Total	Discounted Net Returns (FCFA)
1	400	750	500		1,650						0	-1,500
2			500		500						0	-413
3				575	575						0	-432
4				575	575	18,360	1,530	3,060			22,950	15,283
5				575	575							-357
6				1,150	1,150							-649
7				1,150	1,150							-590
8				1,150	1,150	18,360	1,530	3,060			22,950	10,170
9				1,150	1,150							-488
10				1,150	1,150							-443
11				1,150	1,150							-403
12				1,150	1,150	18,360	1,530	3,060			22,950	6,946
13				1,150	1,150							-333
14				1,150	1,150							-303
15				1,150	1,150							-275
16				1,150	1,150	16,920	1,410	2,820			21,150	4,353
17				1,150	1,150							-227
18				1,150	1,150							-207
19				1,150	1,150							-188
20				1,150	1,150	16,920	1,410	2,820	4,650		25,800	3,664
21				1,150	1,150							-155
22				1,150	1,150							-141
23				1,150	1,150					10,850	10,850	1,083
24				1,150	1,150	16,920	1,410	2,820	4,650		25,800	2,503
25				1,150	1,150							-106
26				1,150	1,150							-97
27				1,150	1,150							-88
28				1,150	1,150	15,480	1,290	2,790			19,560	1,277
29				1,150	1,150							
30				1,150	1,150							
										NPV [10%]		37,883

To gain better insight on the stability of NPV with respect to changes in key variables, a sensitivity analysis was performed (Table 5, page 16). Regardless of substantial reductions in bark price or labour costs, NPVs remain positive at discount rates of 10%. Changes in labour costs do not have as significant effect as do changes in the bark price. The internal rate of return is 28.8%, which indicates that this enterprise is profitable.

ACACIA MEARNSII: A MODEL FOR PRODUCTION OF *PRUNUS AFRICANA*?

One option for *Prunus africana* bark production would be to follow a similar system to that used for *Acacia mearnsii* bark production, where successive plantings of trees are felled and totally stripped of their bark (for tannin production). Timber is then sold as fuelwood. It may also be possible to manage bark production from *Prunus africana* on a coppice rotation. Although we were only able to fell seven *Prunus africana* trees at Ntingue, and any extrapolations from these data are speculative, bark mass data from these *Prunus africana* trees are similar to those from Schönau's (1973) metric bark mass tables for *Acacia mearnsii* with bark 8mm thick at breast height bark (Table 7). By contrast to our small sample size, Schönau (1973) determined his bark mass tables from data on a sample of 1,379 *Acacia mearnsii* trees.

Black wattle (*Acacia mearnsii*) bark production from 12 yr old stands with a mean density of 1,363 trees/ha (551.7 trees/acre) is 28.1 tons/ha (11.37 tons/acre) (Schönau, 1973, 1974). Mean bark thickness at breast height in these *Acacia mearnsii* trees was 5.46 mm, with a mean DBH of 14.4 cm and a mean height of 16.4 m at 12 yr (Schönau, 1973, 1974). Although *Prunus africana* growth rates are lower than those of *Acacia mearnsii*, this is compensated by the higher price per ton of bark and presumably, higher bark yields per ha due to thicker bark.

In South Africa, the price for wet *Acacia mearnsii* bark at the time of our *Prunus africana*

Table 5. Sensitivity analysis of changes of key variables on net present value (NPV) for both enterprises (1 US$ = 490 FCFA).

VARIABLE/ENTERPRISE	NPV (FCFA)		
Discount rate	**10%**	**20%**	**30%**
Prunus africana:	29,010	302	-3,887
Eucalyptus:	37,885	16,565	9,161
Bark price			
Prunus africana:			
50% increase	34,985	1,543	-3,547
50% decrease	23,036	-939	-4,226
Construction Pole Price			
Eucalyptus:			
50% increase	55,855	24,988	14,087
50% decrease	19,911	8,141	4,235
Labour Cost			
Prunus africana:			
50% increase	25,523	-1945	-5,699
50% decrease	32,498	2,548	-2,074
Eucalyptus:			
50% increase	37,108	15,870	8,532
50% decrease	38,658	17,259	9,790

study was R 340 (US$ 94) per ton (comprising a basic price of R 228 per ton and an after sales rebate of R 112 per ton, 1 US$ = 3.63 R in 1994). Harvest costs, mainly bark stripping and bundling, were R 65 per ton and transport costs, which clearly vary with distance, on average are R 25 per ton, giving a net price of R 250 (US$ 69) per ton of wet bark (D. Dobson, pers. comm., 1995). By comparison, Plantecam pays between 104 - 270 FCFA per kg (490 FCFA = 1 US$), depending on bark moisture content and quality (see Table 2), or US$ 212 - 551 per ton.

In rural Cameroon, intermediaries pay 70 FCFA (0.14 US$) per kg of *Prunus africana* bark. This bark would translate to a net price of around US$ 142 per ton of wet bark. This is less than a third of the price for wet bark paid by the Italian company which in 1994 bought bark from Special Permit holders at 250 FCFA per kg (regardless of moisture content) which would yield a gross price of US$ 500 per ton. In Kenya, a far higher price is paid to the exporter for *Prunus africana* bark. In 1992, the exporter was paid 11 French francs/kg (US$ 1 per kg) for dry bark (or US$ 2,000 per ton). This would be the equivalent of US$ 1,000 per ton of wet bark, and nearly four times that paid at the factory gate by Plantecam.

The mean quantity of *Prunus africana* bark processed annually from 1986-1991 by Plantecam was 1,923 metric tons/yr (Cunningham and Mbenkum, 1993). Assuming that bark production and growth rates in *Acacia mearnsii* plantations would be the same as that for *Prunus africana*, this quantity of bark would be produced by 68.4 ha of trees felled and totally stripped of bark each year. These would be 12 year old stands with 1,363 trees/ha, total annual demand thus representing 93,229 trees/yr. A 12 year rotation would therefore require 820.8 ha.

Table 6. *Prunus africana* costs and returns: enrichment planting, Ntingue, Dschang.

	COSTS (FCFA/hectare)						RETURNS (FCFA/hectare)						
Time Period (YEAR)	Seedlings	Land prep. & planting	Weeding & prunning	Debarking costs	Handles preparation	Total	Bark sales	Hoe handle sales	Axe handle sales	Poles sales after thinning	Salvage value	Total	Discounted Net Returns (FCFA)
1	50,000	22,500	1,500			74,000							-67,273
2	17,500		1,500			19,000							-15,702
3	11,375		1,500			12,875							-9,673
4													
5													
6													
7													
8													
9													
10													
11													
12													
13				80,000		80,000	600,000					600,000	150,625
14													
15													
16													
17													
18			8,000		12,500	20,500	850,00	750,000	2,000,000			3,600,000	11,729
19													
20									800,000			800,000	1,308
21													
22					12,500			250,000	800,000			1,050,000	2,432
23			125,000			125,000	1,100,000					1,100,000	2,395
24									800,000			800,000	893
25													
26								250,000	800,000			1,050,000	1,661
27													
28			125,000			125,000	1,350,000		800,000			2,150,000	2,479
29													
30					12,500			250,000	800,000			1,050,000	7,439
											NPV [10%]		29,010

Notes
a) Quantity of bark harvested: 6kg/tree (yr. 13), 8.5kg/tree (yr 18), 11kg/tree (yr 23), and 13.5kg/tree (yr 28).
b)Bark price/kg = 100FCFA.
c)Labour cost/day= 1,000FCFA.
d) # of axe handles: 1/tree (yrs 22, 24, 26,28); 3/tree (yr. 18).
e) # of hoe handles: 5/tree(yr 18); 2/tree (yrs. 22, 26, 30).
f) Price of axe handle: 400 FCFA.
g) Price of hoe handle: 250 FCFA.
h) Cost/seedling: 50 FCFA.

PLANTATION PLANTING IN TROPICAL LOWLANDS

Cunningham and Mbenkun (1993) suggested the possibility of establishing *Prunus africana* plantations in low altitude sites of SW Cameroon for three reasons. Firstly, land in high altitude sites was scarce as a result of high human population densities. Secondly, it was suggested that land planted with oil palms might become available, due to decreasing economic viability of oil palm (*Elaeis guineensis*) plantations with competition from higher yielding and increasingly extensive oil palm plantations in South-east Asia. Thirdly, due to the high growth rates and apparent good health at that time (November 1992) of a small number of young *Prunus africana* trees planted at Limbe Botanical Garden (40° 0' 90° 03') at 15 m asl.

By early 1995, all of the young *Prunus africana* trees at Limbe Botanical Garden were however heavily infested by wood-borer, reducing the timber value of *Prunus africana* grown at low altitude to that suitable only for use as firewood. For this reason, the projected costs and returns of a *Prunus africana* plantation do not include timber values (Table 8).

Table 7. Bark mass comparisons for *Acacia mearnsii* trees with 8 mm thick bark at breast height (Schönau, 1973) and *Prunus africana* trees of similar height and dbh, showing similarities between predictions from *Acacia mearnsii* bark mass tables and medium sized (>13cm dbh), but not the smaller *Prunus africana* trees.

Acacia mearnsii			*Prunus africana*		
height (m)	dbh (cm)	wet bark mass (kg)	height (m)	dbh (cm)	wet bark mass (kg)
18.5	25.0	59.6	18.3	26.0	60.6
18.0	19.0	44.9	18.0	19.1	40.2
13.5	22.5	39.2	13.6	22.6	38.3
13.0	17.0	29.0	13.0	17.1	26.4
10.5	13.0	18.5	10.6	13.2	18.8
7.5	11.0	11.4	7.6	11.0	6.1
5.5	7.0	n/a	5.8	7.1	3.4

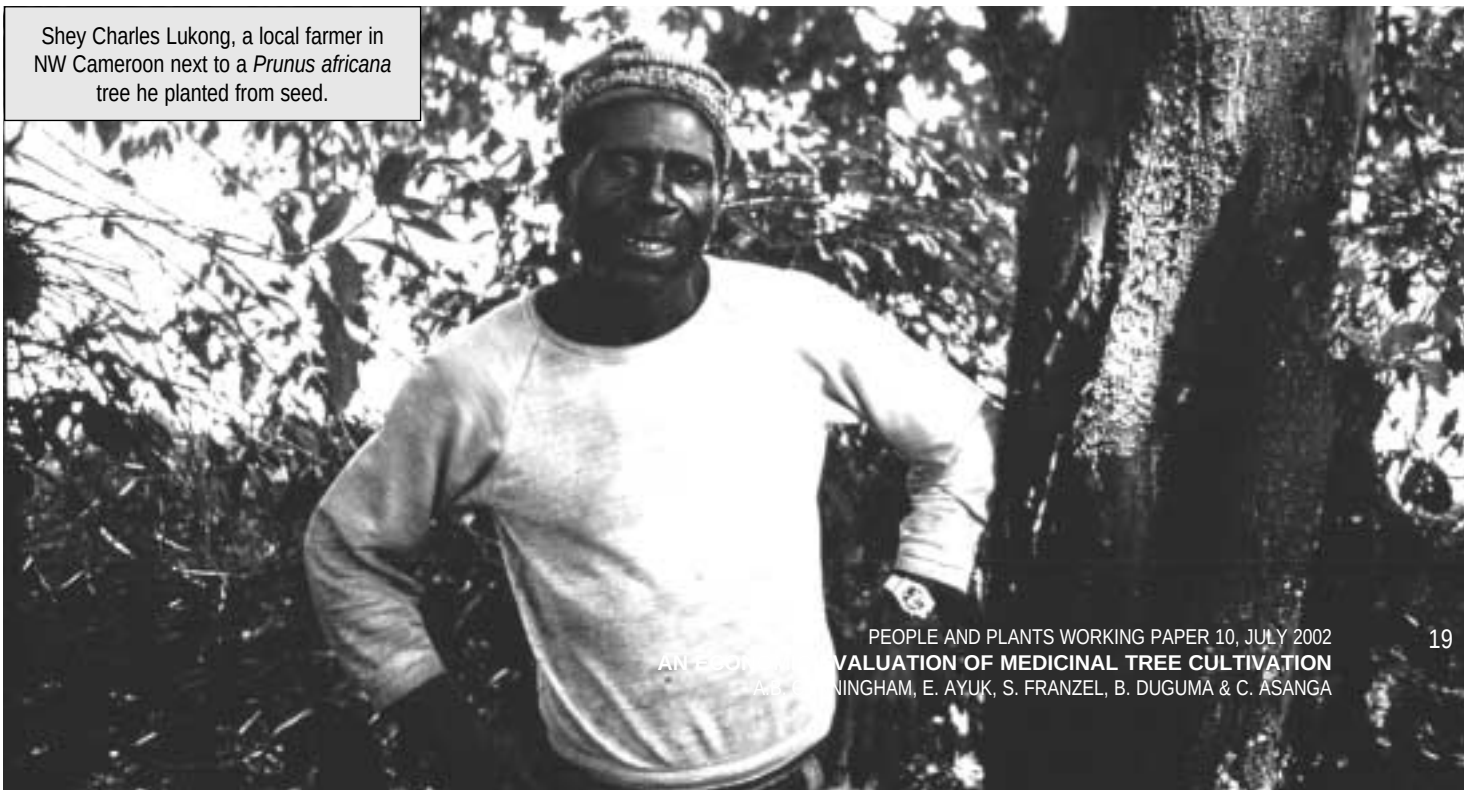
Dr. Fonki T. Mbenkum next to bundles of *Prunus africana* bark ready for processing at the Plantecam factory, Mutengene, Cameroon.

Table 8. ***Prunus africana*** **costs and returns: *ex-ante* analysis of a plantation in lowlands of South West Province.**

	COSTS (FCFA/hectare)						RETURNS (FCFA/hectare)						
Time Period (YEAR)	Seedlings	Land prep. & planting	Weeding & prunning	Debarking costs	Handles preparation	Total	Bark sales	Hoe handle sales	Axe handle sales	Poles sales after thinning	Salvage value	Total	Discounted Net Returns (FCFA)
1	31,530	69,160				100,690							-91,527
2			35,000			35,000							-28,910
3			22,400			22,400							-16,822
4			35,000			35,000							-23,905
5			21,000			21,000							-13,041
6			35,000			35,000							-19,740
7													
8			35,000			35,000							-16,,345
9													
10			5,600			5,600							-2,161
11													
12			5,600			5,600							-1,786
13													
14													
15				189,000		189,000	1,020,000					1,020,000	198,609
16													
17													
18													
19													
20				236,000		236,000	1,147,000					1,147,000	135,739
21													
22													
23													
24													
25				295,000		295,000	1,275,000					1,275,000	90,160
26													
27													
28													
29													
30				369,000		369,000	1,402,000					1,402,000	58,881
												NPV [10%]	**269,194**

Notes:
Data are from CEP/DIRFORESTS/MINEF Trees are planted at a density of 300 trees/ha. IRR = 15.5%
Cost/seedling: 100 FCFA.
Crops may be grown between the trees during the initial years. Costs and returns of crops are not included in this analysis.
Bark yields in year 15 are 20 kg/dry bark/tree, or 6000 kg of dry bark per ha, priced at 170 CFA/kg. Trees are harvested every five years after year 15. Yields assumed to increase by 0.5 kg/tree/year.
Labor is costed at 1,400 CFA/day, the cost including overhead, to the Cameroon Development Corporation, a manager of plantation crops in South West Province.

Shey Charles Lukong, a local farmer in NW Cameroon next to a *Prunus africana* tree he planted from seed.



Planting and support activities for *Prunus africana* as a small-holder crop

The economic potential for introducing the tree *Prunus africana* as a smallholder crop described in the previous section, is confirmed by the high level of enthusiasm for planting *Prunus africana* in North West Province, Cameroon. At least 3,500 farmers have planted in the last several years (Box 2). Bark collection in forest areas has greatly increased, and farmers have become aware of the opportunities of producing and selling bark. Most of the farmers planting *Prunus africana* receive support through development projects and NGOs, which often provide seed and subsidised inputs for nursery development. But in all cases, farmers contribute their own labour, which is the most important input in nursery production, indicating their strong interest. Moreover, much planting is taking place by farmers outside of projects.

Local and NGO initiatives in *Prunus africana* production

In the Oku area of Bui Division, the Kilum Mountain Forestry Project has been assisting farmers since 1989 to organise nurseries and plant *Prunus africana* and other species on their farms. In 1994, there were 35 functional group nurseries, ranging in size from five to over 100 farmers. Group members share the seedlings, planting most on their farms, selling some to other farmers and some to the project, which uses them for forest enrichment planting. Most farmers also give seedlings to relatives and neighbours. Initially, the project provided free seeds and polythene bags but has phased out these subsidies. The high prices for seed and seedlings in the Oku area are indicative of their high demand. The project purchases potted seedlings on contract at 25 FCFA/seedling, whereas farmers sell seedlings to local persons at 50 FCFA (bare-rooted) or to persons from outside Oku at 100 to 200 FCFA (potted). Demand generally outstrips supply in Oku, although in some instances the project has helped transport surplus seedlings to be sold in other areas, such as Bamenda. Seed sells for 250/kg to local persons and 500/kg to outsiders.

In 1993, *Prunus africana* was the most important species in the Oku nurseries, accounting for one-third of all the seedlings grown. In 1994, 23 of the 35 groups were producing *Prunus africana*; lack of seed was the most important reason some were not planting. The groups produced about 14,000 *Prunus africana* seedlings in 1994, half bare-root and half potted. The project purchased 5,348 seedlings for forest enrichment plantings; farmers planted most of the rest on their own farms. Some seedlings were sold.

In the Ijim Mountain Forestry Project in the Kom area of Boyo Division, about 60 nursery groups, composed of about ten farmers each, have produced and planted about 9,600 *Prunus africana* seedlings. In 1993, the project collected 200 kg of seed from farmers, paying 500 FCFA per kg. In 1994, 75 kg was collected. All seed was distributed among the nurseries, free of charge. In addition to planting seeds in nurseries, some farmers transplant wildings from forest areas. Helvitas, a non-governmental organisation, assists local communities to improve water supplies and management of watersheds in a number of areas in the North West Province, including Bambui, Guzang, Belo, Nso, and Biamey. One small component of these projects is the provision of *Prunus africana* seedlings to farmers for planting, mainly on communal areas. In Bambui, the project supports nine nurseries and has trained 120 farmers in nursery management.

Rural Training Centre, Mfonta, Bambui, receives financing from the Methodist Church, England, and provides training to farmers in short courses at its farm. The centre has collected *Prunus africana* seed since 1991 from various places in the province, distributes seed to its trainees (about 200 per year) and sells to development projects, including Helvitas, VCP, Bafut, and PAPSEC. The Centre has collected about ten kg of seed per year and reports that demand far outstrips supply.

The Trees for the Future project, based in Kumbo, Bui division, was started in 1991 and aims at reducing environmental degradation through tree planting projects with encouragement of, and assistance to village groups, families and institutions. The project includes 63 different groups in this area, with about 1,950 members. By 1994, some 275,000 trees were reported planted by these groups, the majority (65%) of these being *Leucaena*, the next most commonly planted being *Calliandra* (11%) and *Prunus africana* (9%).

Other groups reported to be assisting farmers in planting *Prunus africana* but which we did not

Box 2. Selected projects assisting farmers to plant *Prunus africana* and numbers of farmers planting, 1995. * = no estimates possible

AREA	*PROJECT or NGO WITH PROJECT*	*NO. FARMERS PLANTING*	*ESTIMATED NO. OF TREES*
Oku, western part of Nso, Bui division NW Cameroon	Kilum Mountain Forest Project	35 nursery groups (1994) with 350 members. Planting *Prunus* since 1989.	1,400
Kom area, Boyo division. NW Cameroon	Ijim Mountain Forest Project	60 nursery groups (1994) with 600 farmers.	1,200
Bambui, Belo, Guzang, Nso, Biamey, Besiavum. NW Cameroon	Watershed Conservation, Helvitas	9 nurseries in Bambui. Most planting in communal areas.	*
NW Cameroon	Rural Training Centre, Mfonta	200 farmers per year get *Prunus* seed since 1992	600
Nso, Bui Division, NW Cameroon	Trees for the Future	1,900 members, 470 planting *Prunus*	470 25,000 trees planted (1994).
Mendankwe, Mezam division, NW Cameroon	None	50 farmers	50
Bova, SW Cameroon	Greenfield Common Initiative Group	Started in 1993. Nursery with about 2000 Prunus seedlings (1994).	*

NOTES: The list is not exhaustive. other projects and NGOs are also assisting farmers to plant *Prunus africana*. Moreover, some planting is also taking place outside of projects. Notes on calculations of numbers of farmers planting *Prunus africana* are as follows:. Oku and parts of Nso: For every nursery member, it is estimated that an average of three other farmers have planted. Buying and selling of seedlings is extensive. Kom: For every nursery member, it is estimated that an average of one other farmer has planted. (Planting has begun more recently than in Oku). At the Rural Training Centre, Mfonta, it is estimated that an average of one person has planted for each person to whom seed was given. Estimates for Mendankwe stem from a local person.

contact include in NW Cameroon: MESG, Shishong; VCP, Bafut; PAPSEC, Bamenda, and in SW Cameroon: Greenfield Common Initiative Group, Bova and the Mosake Common Initiative Group, Buea. There are also many farmers planting *Prunus africana* independent of development projects. These farmers can be divided into two groups. First, are relatively high-income and 'progressive' farmers who have recently become aware of the market for *Prunus africana* bark. These farmers have bought seed, often from Nso or Oku, and have planted on a fairly large scale (200 trees or more). Of the 70 persons in North West Province who have permits for buying *Prunus africana* bark, about ten have planted. One farmer, Mr. Luta Albert in Santa, is reported to have planted 5,000 trees. Plantings have also been extensive in Mendankwe, a village adjacent to Bamenda, probably because farmers have better access to information on markets and prices than farmers in areas further away from Bamenda. Here, a farmer reported having pur-

chased seed from Nso for 4,000 FCFA/kg. A second and much smaller group is composed of pioneer farmers who planted *Prunus africana* many years ago, for several different reasons. For example, Shey Kinsam, in Tadu, Nso, planted about 21 trees in the late 1970s, primarily for firewood. Many farmers in the Oku area have *Prunus africana* trees that their fathers or grandfathers planted in their compounds, primarily for medicine. Charles Lukong, a retired *Prunus africana* bark collector for Plantecam, planted over 100 trees on his farm in Vekovi in the 1970s and 1980s.

Farmers' reasons for planting

Farmer' reasons for planting and perceptions of benefits varied across the region. Three of the most common and most important reasons are the need for:

1. A cash-earning enterprise: When discussing reasons for planting, many farmers mentioned their disappointment with coffee, the main cash crop of North West Province, because of the marketing problems mentioned in the description of study sites. Farmers have also experienced problems marketing *Eucalyptus*, another important cash enterprise, as supply of poles has outstripped demand in some areas (IRA 1988). The issue is not so much whether *Prunus africana* is as profitable as coffee or *Eucalyptus*, but whether *Prunus africana* has a role as a supplementary cash-earning enterprise for farmers. As mentioned above, small-scale farmers operate a complex farming system composed of over a dozen different enterprises. The main reasons for having so many different activities is to meet household subsistence needs, to minimise risk and to reduce labour and cash bottlenecks throughout the year. Farmers are eager to invest in new enterprises that earn cash and fit their resource endowments. *Prunus africana* requires relatively low levels of land, cash and labour. Moreover, farmers find that it is relatively easy to establish, does not compete much with crops, and has multiple uses, aside from providing bark for sale.
2. An important medicine for home consumption: In Oku, Nso, and around Mt. Cameroon, *Prunus africana* bark is an important component for medicines. Traditional doctors use it, as well as individuals treating themselves or their family members. In Oku, traditional doctors use some *Prunus africana* bark in preparing nearly all traditional medicines; it is especially important in cures for stomach ailments ('belly bite'), fever, rheumatism, and gonorrhoea. It is never used alone, but rather is boiled together with other ingredients. In Kom and Mendankwe, some farmers were unaware of the use of *Prunus africana* bark in traditional medicines, although Nsom and Dick (1992) have recorded *Prunus africana* as an important medicine for treating malaria, stomach ache and fever in the Ijim/Kom area. Use of the bark to treat stomach ache is also recorded from East Africa (Kokwaro, 1976) and elsewhere in Cameroon (Letouzey, 1978).
3. The diversity of other uses. These include:
   - handles for axes and hoes: the strength of the wood was the main reason the species is suited for these tools. Farmers with adult trees were producing handles for both home use and sale;
   - mulch: three of the farmers with adult trees claimed that the leaves were a useful manure for crops. On their farms there appeared to be little if any competition between adult trees and crops (beans, coffee, and potatoes). On one other farm we noted considerable competition with crops, perhaps in part because the soil on this farm was less fertile than on the others. Farmers also noted that maize does not grow well near the tree.
   - firewood: women claimed it was an excellent firewood species, because the wood burns for long periods of time, at high intensity.
   - poles: none of the respondents had actually used *Prunus africana* for poles. But based on its straightness, taper, and strength, they felt that it would be superior to *Eucalyptus*, the most common pole species. There is a strong demand for construction poles in the areas we visited.
   - seed sales: only two of the five farmers having adult trees had trees that produced seed. Neither farmer was aware that there was a strong market for them. Thus they did not collect the seed. Other producers claimed that they hoped to sell seed when their trees matured.

On-farm tree management and problems encountered by farmers

Farmers with reproductively mature *Prunus africana* trees generally had established them from wildings that they had collected in the forest. Reproductively mature trees were generally scattered in crop land, including annual crops and coffee. Farmers mentioned that the trees were easy to establish and performed well even

on infertile soils. The only observed production problem on farms with mature trees was that of wood-borer on two of the five farms surveyed in Nso. In one of these cases, the farmer did not consider wood-borer as a problem, while on another it was constraining growth and had probably spoiled the wood for use in construction. Of the three farmers with mature trees who were not associated with a project, two were expanding their plantings using wildings from their own farm, and the other was using wildings from the forest.

Farmers associated with projects were establishing nurseries as project staff had shown them. Most of the nurseries were group nurseries, generally serving five to 15 members. Numbers of seedlings ranged from 300 to 3,000, and both potted and bare-rooted seedlings were being produced. Bare-rooted were primarily for planting by members, whereas potted seedlings were for sale to persons transporting the seedlings before planting them (bare-rooted seedlings need to be planted within a few hours after removal from the seed bed). In the Oku project, farmers also sold seedlings back to the project for enrichment plantings in the forest. Seedling management was generally high; no problems were reported concerning germination of seeds. However, in the Oku area, there were problems with aphids destroying seedlings in the dry season and survival rates varied between 20% and 90% (median = 60%). Problems reported in nurseries were:

1. the scarcity and high costs of polythene bags,
2. the high amount of labour required, especially for watering, and
3. theft of seedlings, reported in Mendankwe.

The Oku and Mt. Ijum projects had originally paid for all cash inputs (seed, bags, and spray) but were in the process of phasing out subsidies. In all cases, farmers supplied all labour in nursery development, the biggest cost in nursery production.

The high demand for *Prunus africana* seed and seedlings is reflected by their high market prices. Prices for *Prunus africana* seed ranged from 250 FCFA/kg to 4,000/kg, however markets are highly imperfect. As mentioned above, farmers in some areas where seed was available were unaware that there was a market for seed. At the same time, organisations and individuals in Bamenda were unable to acquire the quantities of seed they needed. Seedling prices also varied, from 25 FCFA to 250 FCFA, depending on the location and whether the seedlings were potted or bare-rooted. In some places, such as Njinikijem, farmers were also buying and selling wildings.

Planting niches also varied widely. *Prunus africana* was commonly mixed with other species in woodlots (four of 10 farmers) on land where crops had not performed well. Other common niches, each planted by four of 10 farmers, included in coffee plantations, on boundaries, and scattered in food crops. Most farmers had planted 100 to 200 trees and all but one were still interested in expanding. Survival rates in the field ranged from 20% to 100% (median was 80%). The most important problem was browsing by goats; drought at the time of planting was also mentioned. Farmers were generally impressed with the growth of the trees in their fields; trees reached three to five meters in height after four years.

Farmers with mature trees managed them in several ways. Some were cutting branches for axe and hoe handles from trees of about 18 years or older. One farmer pruned his trees frequently, claiming that frequent pruning promoted growth of branches and increased the number of hoe and axe handles available. Only one of six farmers with mature trees had harvested bark, although all intended to. Several farmers were uncertain about their rights to harvest bark from their own trees. They were not clear on whether or not they needed permission before harvesting. In fact, Cameroonian law is somewhat ambiguous about farmer rights. Although people have the right to harvest products from any tree they or their family have planted on their own farm, it is not clear how they prove that they or their parents or grandparents had planted a particular tree.

Two farmers, one from Vekovi and one from Mendankwe, had had bark exploited from their trees without their permission. In one case, a son had sold the bark without his father's permission and in the other case, thieves had stripped bark from trees at night. One farmer had given bark to a traditional doctor in exchange for a chicken. This same farmer had also allowed bark collectors to strip bark from his trees in exchange for money. But the collectors had stripped over 3/4 of the bark off the tree and it was not clear that the tree would survive. The farmers did not have information about how much bark should be removed or how to do so. Nor did they have adequate information about prices. The farmer who had sold his bark obtained about 30 FCFA/kg. Farm gate prices varied between 30 and 70 FCFA in the North West Province during 1994-1995. Plantecam pays between 104 and 270 FCFA/kg at the factory, depending on the moisture content and quality of the bark.

In summary, farmers are highly enthusiastic about *Prunus africana* and have been successful in planting the tree on their farms. Several thousand have done so. The principal problems farmers are experiencing with the tree include stem borer, especially in lower altitudes, aphids on seedlings in nurseries, theft of bark and seedlings, the high cost and scarcity of polythene bags, browsing of newly planted seedlings by goats, and lack of information about rights to remove bark and prices of bark and seeds.

Social aspects of enrichment planting

Discussions with the inhabitants of Ntingue village identified some of the problems associated with non-community participation in enrichment planting activities. Villagers claimed that, unlike during the period when Plantecam harvested bark from wild populations of *Prunus africana*, they did not benefit from the enrichment activities since ONADEF brought its own workers. Other concerns included their belief that *Prunus africana* competes with crops, uncertainty about their rights to harvest the trees if they had them in their fields, and their lack of knowledge about the species itself. The younger villagers said that if they knew how to integrate the species in their cropped fields (in an agroforestry system), they would be happy to adopt it. They cited examples of how coffee and cocoa farms are cultivated together with other crops.

It was evident from the discussions that because the farmers were not involved with or did not fully understand the objectives of enrichment planting, they lost interest and took an antagonistic position, especially in recent years when the demographic pressure on land has increased tremendously. The alarming rate of debarking in recent years is proof that the villagers do not consider themselves as part of this undertaking. Had the community been fully involved in this activity they could have controlled the illegal debarking going on in the reserve areas. Lessons from this experience suggest that the community should be fully involved and be encouraged to participate in and receive benefits from any enrichment planting.

Local and international trade and the future bark market

Institutional arrangements, including the national policies, local social systems, and arrangements amongst firms and entrepreneurs, have an important influence on whether the bark resource is 'mined' or managed. Marketing systems for *Prunus africana* bark in Cameroon have ranged from a monopoly, in which Plantecam had complete control over the entire marketing chain from collection through export, to free market, when numerous buyers could harvest, transport, and export the bark. There is also a great variation in the composition and local influence of traditional institutions in control over forest use.

Internal trade in Cameroon

Prior to 1972, only small-scale harvest of *Prunus africana* bark occurred for local medicinal use. This changed dramatically in 1972 when Plantecam, a subsidiary of the French company Laboratoires Debat, obtained a monopoly over the commercial trade in *Prunus africana* bark. Although commercial harvesting started to take place, a system of controlled harvest by teams of Plantecam workers was maintained. This worked relatively well until 1985 when the Government of Cameroon issued additional licences for *Prunus africana* bark exploitation to 50 entrepreneurs (Cunningham and Mbenkum, 1993). At no stage during this process were quotas based on any forest inventories or assessments of sustainable harvest.

From 1985 to 1992, most of the bark sold to Plantecam was from the Bamenda Highlands in North West Province, Cameroon (Cunningham and Mbenkum, 1993). According to information obtained in this study, there were 70 permittees in the province in 1994. Each was allowed to transport 100 tons of *Prunus africana* bark. Special permit holders were supposed to have a monopoly over bark harvesting in a designated area, but these boundaries are ignored. This benefits the farmers, in that there are several different persons they can sell to, each buyer then has to compete for a farmers' bark and pay higher prices. But on the other hand, the disadvantage of this system is that there is no incentive for a permittee to seek to maintain stocks in his area. It is effectively an open-access situation. As one permittee told us, it is in the interests of each permittee to fell trees because if he doesn't fell a tree, someone else will come along and fell it. In North West Province, there was a big increase in bark exploitation. In addition, theft of bark from trees on private land also increased.

In rural areas, farmers are paid 30-70 FCFA per kg of bark. At Plantecam, bark prices range from 104 FCFA/kg for poor quality, high moisture content bark to 270 FCFA/kg for dry, high quality bark (US$ 0.2 - 0.6 per kg). This is based on the pricing structure shown in Table 9. Net returns earned by permittees buying and selling bark are substantial but are probably not inordinately high, given the high risks they face and the

Table 9. Costs and returns for a Special Permit holder trading in *Prunus africana* from Bamenda, North West Province, Cameroon.

COSTS	
Buys 16.5 tons wet bark at 70 FCFA/kg	1,155,000
Collection costs	
2 laborers for 1 month 500 FCFA/day	30,000
Transport to organise collection (500 km at 200 FCFA/km)	100,000
Transport Banso-Bamenda (50,000/11 Tons)	75,000
Drying costs (1 labourer for 1 month 500 FCFA/day)	15,000
Transport Bamenda-Mutengene 250,000/11 Tons)	250,000
Tax (2 shs/kg)	22,000
Miscellaneous (10%)	165,000
Interest on capital (10% for 3 months)	181,000
SUB-TOTAL	**1,993,000**
RETURNS	
Scenario a) Revenue earned from sale of 11 tons (250 FCFA/kg dry bark)	2,750,000
NET RETURNS (Revenue minus costs)	757,000
Net returns as percentage of capital invested	42%
Scenario b) Revenue earned from sale of 11 tons (200 FCFA/kg dry bark)	2,200,000
NET RETURNS (Revenue minus costs)	**270,000**
Net returns as percentage of capital invested	**13.5%**

scarcity of capital. In the model in Table 9, the permittee earns a 42% rate if return on his investment if he can sell bark at a high price but only 13% rate of return, if he sells at a lower price. Competition among permittees probably results in higher prices paid to farmers and lower profit margins than would occur in the absence of competition.

Mt. Cameroon (4° 12'N 9° 10'E) is now the national focus of bark exploitation, due to the depletion of *Prunus africana* populations in West and North West Provinces. This over-exploitation became especially serious in May 1994 when the Cameroonian government ended Plantecom's monopoly over bark harvest on Mt. Cameroon and on bark export. The government issued export licences to three Cameroonian entrepreneurs, reportedly in response to an order they had received for 2,000 tons of bark from an Italian company who were prepared to pay 250 FCFA/kg regardless of bark moisture content. The result was a spate of uncontrolled bark exploitation, particularly by young men, which focussed on the major remaining source of *Prunus africana* bark in the forests of Mt. Cameroon.

International trade and the future market for *Prunus africana* bark

At least 23 different companies sell brand name herbal preparations made from *Prunus africana* bark. Most of these are based in Europe, with others located in North America (at least two companies) and Latin America (three) (Cuningham et al., 1997). Bark processing and the export of bark extract are dominated however by a few main companies. Firstly, the French company Groupe Fourniere (France), which bought Laboratoires Debat and its Cameroonian subsidiary, Plantecam. Their bark harvests represent over 70% of the international trade and the basis of the most widely marketed product, 'Tadenan'. Secondly, the Italian companies

Indena Spa. and Inverni della Beffa, which produces ''igenil' , sourcing most of its *Prunus africana* bark from Madagascar (Walter and Rakotonirina, 1995).

Initially, Plantecam exported unprocessed *Prunus africana* bark, but later invested in equipment to produce chloroform bark extracts at their factory at Mutengene, which was established there over 20 years ago. In 1993, the Mutengene factory was included in an industrial free zone. By this stage, in addition to the export of plant products (*Pausinystalia johimbe* bark, *Voacanga africana* seed, *Strophanthus* seed and *Prunus africana* bark), Plantecam had expanded into manufacturing products, such as anti-malarials, aspirins and glucose. In 1995, Plantecam was reported to have an annual turnover of FCFA 2,000 million (US$ 4 million) per year and employed over 200 permanent and temporary workers (Akwa, 1995).

Given this process of change, depletion and product diversification it is important to consider whether *Prunus africana* cultivation is worthwhile, particularly given the relatively long (12-18 year) period before commercial harvest of bark is advisable. Future trends in the international market for *Prunus africana* bark are an important component to this question. If farmers start cultivating *Prunus africana* trees now, do we know whether a market will exist in 20 years from now? Like many future markets, sales of *Prunus africana* products cannot be predicted with any certainty 20 years into the future. There are several factors which should give reassurance to current and potential growers, however.

As a multiple-use species, *Prunus africana* has several factors in its favour. Firstly, there are several indications that a worst-case situation where the international bark market might collapse is unlikely. The opposite may in fact, occur, with an increase in the market for *Prunus africana* bark. This is suggested for the following reasons:

- as prostate gland hypertrophy and benign prostatic hyperplasia (BPH) become more common among men in western Europe and the USA, so will the market demand for treatment of this problem. The projected increase in market demand for herbal preparations for the period 1993-1998 is 8-15% per year (Grunwald and Buttel, 1996);
- phytotherapeutic treatments for prostate gland hypertrophy and benign prostatic hyperplasia (BPH) are popular and provide a lucrative market that is unlikely to diminish. In Germany, for example, *Serenoa repens* herbal preparations were among the top ten most frequently prescribed herbal monopreparations, with an annual retail sales value of DM 30 million (Grunwald and Buttel, 1996). Similarly, in the USA, a recent survey in selected health food stores showed that *Serenoa repens* was the sixth best selling herbal preparation, representing 4.4% of total individual herb sales from selected health food stores in the USA (Brevoort, 1995).
- most *Prunus africana* based products are currently produced and sold within the European Union (EU), and not in the potentially large and lucrative markets of North America and Japan. *Prunus africana* extract is also sold in Australia (Commonwealth of Australia, 1995). With the combination of its rapidly growing, lucrative market for herbal preparations to treat prostate problems without surgery, North America could be considered a major potential market for herbal preparations from *Prunus africana*. Several companies advertise *Prunus africana* products (or a mixture of *Serenoa repens*, pumpkin seeds, *Prunus africana* extract and other ingredients) for sale on the Internet. This is a particularly rapidly growing trend in the USA. If the Food and Drug Administration (FDA) regulations in the USA and Canada approve *Prunus africana* products for sale, then an increase in demand for *Prunus africana* bark can be expected.
- Recent patent applications for uses of *Prunus africana* bark extract in addition to their use to treat BPH. The patent application by Chizick and Delorscio (1999) for the use of herbal formulations including *Prunus africana* extract to control male baldness is a good example (Proguard, US Patent 5,972,345 issued October 26, 1999);
- all source countries for *Prunus africana* bark or bark extract have increasingly weak economies. This can make bark and bark extract export more attractive as a source of foreign exchange.

Secondly, if we assume the worst, and the international market for Prunus africana bark collapses, then farmers will still have a local market for the many other products that this tree produces, including axe and hoe handles, firewood and timber. Thirdly, local cultivation of Prunus africana means local self-sufficiency in a popular traditional medicine which has been severely depleted from the wild.

What we can be sure of is that unless cultivation takes place, demand will continue to focus on diminishing wild populations of this species.

Sustainable wild harvest in theory and practice

In theory, a sustainable commercial harvest of *Prunus africana* bark is possible due to the remarkable resilience of the cambium and bark regrowth. In practice, this does not take place in Zaire, Madagascar or Kenya, where a high proportion of trees are either felled or so heavily debarked that the trees die. The failure of managed sustainable harvest is evident from field observation of tree and crown die-off in forests of West, North West and South West Provinces, Cameroon, widespread acknowledgment of bark shortages from North West Province and the results of a recent quantitative study by Tako et al. (1996), who surveyed five sites around Mt. Cameroon. Their study showed that 61% of trees were totally debarked, an additional 25% of tree trunks had been girdled and 1.6% had been felled. Only 10% of trees had not been exploited out of a sample of 127 trees. In practice, sustainable use of wild populations is limited by several factors:

1. The high stress of bark removal on the trees: Despite the resilience of *Prunus africana* to debarking, bark regrowth is limited in dry sites and even when complete regrowth occurs, large scale removal of bark severely stresses the trees. This is clearly evident in the poor tree crown health of debarked trees. In Cameroon, sustainable bark harvesting was attempted between 1972 and 1987, when the company Plantecam had a monopoly on bark exploitation. Trained teams of harvesters employed by the company removed opposing quarters of the trunk bark up to the first branch rather than girdling the trees. The intention was then to return after 4-5 years to remove the undamaged trunk bark and after another 4-5 years, the regrowth. Although this practice limited tree die-off resulting from bark damage, crown die-back still occurs in some trees and bark regrowth is very poor on trees in open, dry sites.
2. Low tree density and low bark prices reduce incentives and opportunity for monitoring and community control: The combination of low *Prunus africana* density and low bark prices greatly reduces the incentive to limit debarking only to the opposing quarters of the trunk. *Prunus africana* trees occur at a relatively low density (an average of 5.5 tree per ha (Eben Ebai *et al*., 1992). In many sites, tree densities are far lower than this. In addition, the costs of collection are high, due to low tree density and rugged terrain. Under these circumstances, sustainable harvest is not considered to be a commercial proposition.
3. Poor regeneration: The resulting low level of recruitment of young trees into the *Prunus africana* populations reduces options for future sustainable harvests.
4. Forest department controls are limited by difficult terrain and low numbers of forest guards: Patrolling by forest guards generally requires two forest guards per 500 ha of reserve (Hall, 1983). This level of staffing is rarely available for Afromontane forest reserves, where patrolling is made doubly difficult by rugged terrain and poorly paid and equipped forest guards. Despite the commendable efforts of Plantecam at sustainable bark harvesting, bark overexploitation and tree die-off has got progressively worse.

Local institutional controls

In order to fulfil conservation objectives and simplify management of wild *Prunus* stocks and conservation areas, the long-term objective should be either to :

- ensure that remaining wild stocks in conserved forests are used as a seed source for on-farm production and that bark stripping of these trees ceases; or
- cease bark exploitation until stocks recover, then shift to quota based harvesting on a 5-8 year rotation, with no harvest during the interim period.

Neither of these objectives can be achieved without effective control. Options for control are either through government forestry organisations, through community participation, or a combination of the two.

The first of these options is difficult to achieve with the limited manpower and money within MINEF or ONADEF for enforcement, monitoring or management. Examples of this are first, the failure of MINEF to either establish quotas or control of overexploitation; and second, the failure of ONADEF to protect planted trees in the enrichment planting at Dschang.

Community forests are a key component of recent Cameroon forestry legislation, which includes two main categories of forests. Firstly, what are termed 'permanent Forests' which includes *Forêts domaniales* (State Forest) and *Forêts communales, ou des collectivités publique* (Public or local government forests) and secondly, 'non-permanent forests', which includes *forêts du domaine national* (national domain forests) and *forêts communantaires* (community forests) (Republic of Cameroon, 1994). This follows a worldwide shift away from government control of forests and forest resources to one of collaborative forest management, as recently reviewed by Fisher (1995). Although this is highly politically correct, it is only under very specific circumstances that community-based forest management will succeed. In the case of *Prunus africana*, many of the requirements for successful community-based management (see Wade, 1987) are missing. Rather than being in a clearly defined area, for example, *Prunus africana* trees are dispersed and occur at low density. Local communities are divided and heterogenous, rather than being homogenous and cohesive on the issue of bark harvesting, particularly around Mt. Cameroon, where many 'strangers' are involved in the commercial trade. It is also difficult to detect 'free-riders' exploiting *Prunus africana* bark in dense forest.

Community-based management of *Prunus africana* bark resources has however been suggested for some villages around Mt. Cameroon by Eben-Ebai *et al*. (1994) and has been suggested for Mt. Kilum (Nurse *et al*., 1994). Recommendations by Eben-Ebai *et al*. (1994) centred around two key considerations. Firstly, an increase in the price paid to local people for *Prunus africana* bark. Secondly, for the role and obligations of the government, the local community and Plantecam to be clearly defined in terms of the price paid for bark in relation to bark moisture content and quality, the timing of bark harvest and collection and the allocation of quotas. In making recommendations for community-based management around Mt. Cameroon, many villages were excluded by Eben-Ebai *et al*. (1994) as they had cosmopolitan populations with a low proportion of local people. An example of this was Kuke village, where there were two local people and 45 'strangers' resident in the village. Geschiere (1993) points out that the influx of 'strangers' into Bakweri villages around Mt. Cameroon dates back to pre-1900. It also poses a major problem for any community-based conservation proposals for this area. An additional problem is the diminished authority of village leaders whose power is increasingly being challenged by young men. As we were told by a Bakweri village chief during this study:

"The Bonakanda boys, they want wealth immediately. That is why they destroy all those trees. Control by chiefs is not possible. Many don't care. They like only to say to those boys, go.....and give me my own money from the sale of Prunus africana *bark to drink. That is where they are.....with our children as leaders"*.

In this case, the chief took the opposite view to the process of community involvement being so widely promoted. In a frank discussion with the provincial Chief of Forestry, he openly admitted that he, and other chiefs, would be unable to control the young men in surrounding villages or 'strangers' taking bark and requested that forestry staff be directly involved in control.

The situation is less complex and more hopeful in North West Province, Cameroon, where local communities are more 'traditional' and culturally homogenous. In Oku and Banso, for example, leadership is through a traditional hierarchy, the Kwifon society, lead by the Fon of Oku or Nso. At Oku, for example, the community proposed a new rule to fine a person cutting down a *Prunus africana* tree (Nurse *et al*., 1994). Rule breakers, if detected, would be subject to a fine of 3,000 FCFA. This is the equivalent of six days local wage equivalent (about US$ 5 at that time). Even in this area, however, the traditional systems of control have started to break down (Nurse *et al*., 1994). The local commercial market for *Prunus africana* seed among local farmers also offers an opportunity for expanding local incentives for protecting remaining tree stocks.

Seed harvesting as a community incentive

Uncontrolled exploitation has vastly reduced the wild populations of most reproductively mature *Prunus africana* trees in the West and North West Provinces, Cameroon. These trees need to be protected for two main reasons: first, due to their conservation importance in maintaining forest structure and as a fruit food source and habitat for birds and mammals. Secondly, they represent a genetically diverse source of seed for on-farm production and provenance selection.

As trees mature, seed yields increase. Prices for *Prunus africana* seed were highest in North West Cameroon due to demand for farmers and where wild populations have been heavily depleted. Prices were very variable, ranging from 250 FCFA/kg to 4,000/kg of seed. Seedlings are also sold, at 25 FCFA to 250 FCFA each. Only two farmers encountered during this survey had reproductively mature trees, which had been cultivated on-farm. One of these farmers, Mr. Wajira Binkar of the Oku area had four trees (>35 cm DBH) producing seed that were an important source of seed and wildings for other local farmers and the Kilum Mountain Forest

project. This offers an excellent opportunity linking seed and seedling sales with community involvement in protection of remaining wild trees. Although seed yields vary from year to year, average yields of 6-10 kg seed per tree are considered likely. At a density of 4.4 mature trees/ha, this represents an income of 6,000-176,000 FCFA/ha/yr. This could be increased further from the sale of seedlings.

One option in the Oku and Banso areas would be to follow a similar system of control applied through customary law to sacred forests (such as those set aside as burial places for the *fons*). Only the 'nchindah', who are members of the Kwifon society, are allowed to enter these forests. Discussions at a community level may lead to a system of tighter control over seed (and income) producing trees.

Domestication of *Prunus africana*

'Conservation through cultivation', whereby cultivated sources of medicinal plants are produced to take pressure off wild stocks, is often promoted but rarely implemented on a large scale in Africa. *Prunus africana* could prove to be an exception to this situation, for at least three reasons:

1. cultivation of this multiple-use species is an economic proposition, unlike many slower-growing and more habitat-specific medicinal plant species destructively harvested for bark, roots or the whole plant.
2. *Prunus africana* is already a popular tree for indigenous agroforestry in Cameroon, and a multiple-use species with similar potential elsewhere in montane Africa.
3. phenotypic, genotypic and chemical variation between (and possibly within) populations offers scope for selection and domestication.

At present however, no selection of genotypes with desired qualities such as straight growth form, fast growth rate or high active ingredient yields has been carried out, although this was recommended by Cunningham and Mbenkum (1992) and a *Prunus africana* domestication project is planned by ICRAF (Leakey, 1993). Several approaches for selection are possible and are discussed below.

The use of local knowledge in *Prunus africana* selection

The insights of local harvesters' knowledge in the selecting of desirable qualities for domestication of wild plants has been suggested for *Hyphaene petersiana* palms (Cunnningham, 1994) and may also have application to *Prunus africana*, where easier bark removal would reduce labour costs. Commercial *Prunus africana* bark harvesters in Cameroon recognise three 'types' of *Prunus africana* ('*Pygeum*'). A key issue in this local classification is the ease with which bark is peeled from the trunk:

- '*Pygeum blanc*', where the bark is easily stripped off, exposing the white timber under the bark;
- '*Pygeum rouge*', where the bark is difficult to remove, with inner bark sticking to the tree trunk and giving it a red appearance;
- and a second 'rouge' variety, which is easier to debark.

According to harvesters, these differences do not appear to be seasonal. It is possible that they may be due to differences in soil moisture balance between sites, or alternatively, may reflect genotypic differences between *Prunus africana* trees. Bark harvesters in Cameroon (Dschang and Mt. Cameroon areas) said that '*Pygeum blanc*' and '*Pygeum rouge*' trees were not respectively restricted to moist or well-drained sites, but had a scattered distribution, and neither were there seasonal factors. Seasonal factors are relevant in the timing of bark removal from *Brachystegia* trees for bee-hive construction in Mozambique, but other factors can also be involved. In Zambia, for example, beekeepers cut small test blocks from miombo woodland trees prior to bark removal, selecting for 10-60% (mean = 34%) of *Brachystegia*, *Julbernardia* and *Cryptocephalum* trees with cross-grained inner bark (Clauss, 1992).

Chemical differences in bark extracts

Phytochemical analysis of *Prunus africana* bark extract has shown the presence of sterols, pentacyclic triterpenoids, several lipid soluble substances, including fatty acids (C12 to C24) and two linear alcohols, n-tetracosanl and n-docosanol (Longo and Tira, 1981; Martinelli, Seraglis and Pifferi, 1986).

Chemists working for the two major companies processing *Prunus africana* bark have both confirmed that it is possible to distinguish

between *Prunus africana* bark sourced from different localities in Africa and Madagascar (R Oudot pers. comm., 1992; Martinelli, Seraglis and Pifferi, 1986 (see Figure 5)). Using high resolution gas chromatographic (HRGC) analysis, Martinelli *et al*. (1986) showed that *Prunus africana* bark extracts from different sources in Africa had characteristic HRGC profiles, and that it was possible to distinguish between these using principal components analysis (Figure 5). Bark extracts from *Prunus africana* in Madagascar were distinguished from *Prunus africana* bark extracts from Zaire, Cameroon and Kenya by their high 3-0-acetyl oleaolic acid content. *Prunus africana* bark extracts from Cameroon and Zaire were far more difficult to differentiate, but were considered to differ due to variations in ursolic acid, B-sitosterol and 3-0-glucoside content.9.3 Genotypic differences

High levels of endemism occur in plant groups with short seed dispersal distances due to very large fruits and/or short distance dispersal agents such as ants. *Prunus africana*, which has relatively small fruits dispersed by birds and mammals, does not fall into these categories and presumably has relatively long dispersal distances. The location of isolated *Prunus africana* populations on montane 'islands' dotted over virtually the entire length of sub-Saharan Africa and a few isolated mountains in Madagascar has probably been a key factor in genotypic and chemical differences expected between populations. This offers wider scope for selection of characteristics for domestication. It is also a point of concern that already isolated populations on montane islands are becoming further isolated due to the destruction of almost all large, reproductively mature trees from intervening 'islands'.

Barker et al. (1994) and more recently and in more detail, Dawson and Powell (1999), used Random Amplified Polymorphic DNA (RAPD) analysis of leaf chloroplast DNA to show distinct differences between isolated *Prunus africana* populations from different parts of the range of this species, with less variation between populations from more closely situated montane 'islands'. The most unusual populations are those in Madagscar (Dawson and Powell, 1999).

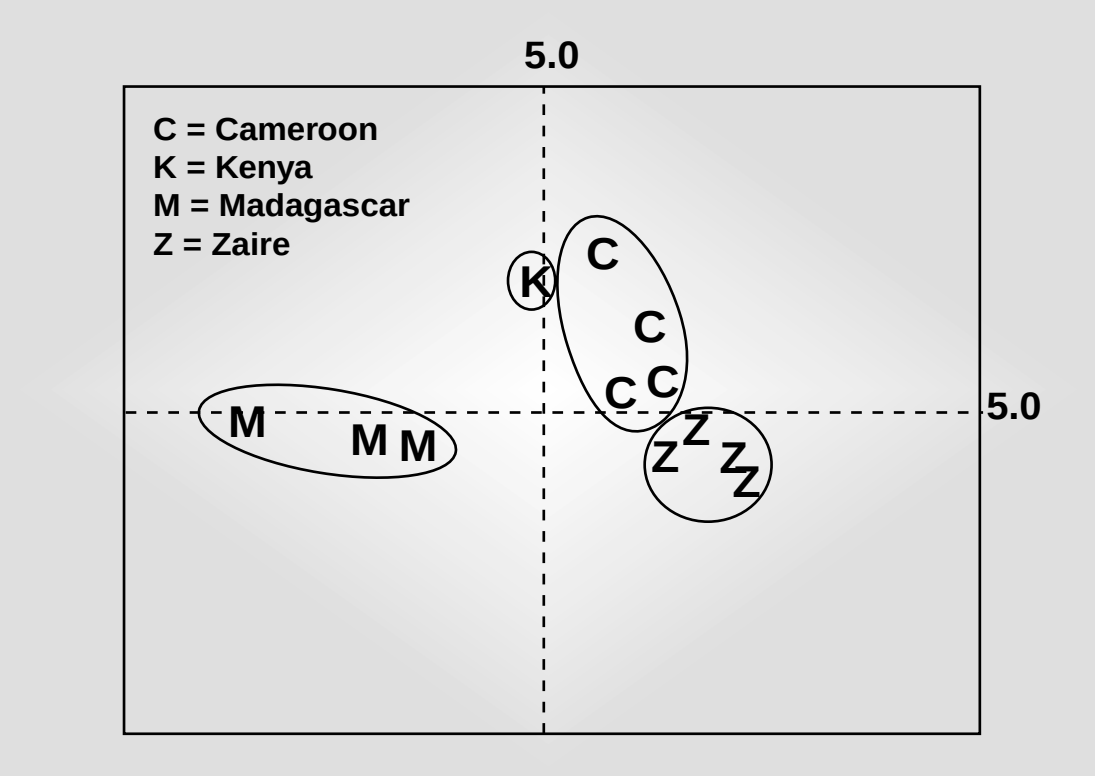


Figure 5. Chemical differences between *Prunus africana* bark extracts from Zaire, Kenya, Cameroon and Madagascar based on principal components analysis (redrawn from Martinelli, Seraglis and Pifferi, 1986).

Selection for *Prunus africana* growth form

Prunus africana trees have been planted a few meters apart as boundary markers for several kilometres around the Mt. Kilum forest. These trees are now 5-6 years old. As vegetative propagation is possible, these offer a good opportunity for selection of cuttings of trees with desirable qualities of growth form. Selections made from trees in the wild could be added to this as well.

Conclusions and recommendations

The change in the population structure of *Prunus africana* populations in Cameroon due to debarking and die-off of large trees poses a problem for forest conservation, local people and ultimately, to the management of Plantecam, who have invested a considerable amount of money in equipment to enable production of bark extract in Cameroon. *Prunus africana* production is more suited to higher altitude sites above 1,500 m asl. One of the constraints on plantation production of *Prunus africana* bark in Cameroon is that small-scale farmers densely populate these montane highlands. On their own initiative, farmers in this region of Cameroon have done more to cultivate *Prunus africana* trees than any international pharmaceutical companies or rural development agencies. In many ways, small-scale farmers hold the key to a shift in sourcing bark from wild harvest to cultivated supplies.

Although plantations may be appropriate in other parts of Africa, an out-grower scheme which involves and expands from the estimated 3,500 farmers already cultivating small numbers of *Prunus africana* trees is considered to be most appropriate in Cameroon. For this to work requires clarification of Cameroon forestry law to enable farmers to sell the bark from the trees they grow. At the same time, remaining wild populations need to be conserved through a combination of government and community control. It also needs committed support from the pharmaceutical industry, rather than their demand for bark merely being shifted to exploit wild *Prunus* populations elsewhere.

In order to fulfil conservation objectives and simplify management of wild *Prunus* stocks and conservation areas, the long-term objective should be either to:

- ensure that remaining wild stocks in conserved forests are used as a seed source for on-farm production and that bark stripping of these trees ceases; or
- cease bark exploitation until stocks recover, then shift to quota-based harvesting on a 5-8 year rotation, with no harvest during the interim period.

Neither objective is possible, because a ban on bark exploitation would involve the political impossibility of throwing thousands of Cameroonians out of work. A "second best" strategy is needed, focusing on conservation of wild stocks and sustainable bark stripping, but progress can only be achieved with effective control, and the support of government forestry organisations, the pharmaceutical industry (particularly Plantecam) and community participation. At the moment, it is local farmers who have achieved the most towards a shift to *Prunus africana* cultivation. In this study, however, we identified three key needs where outside support can build on these local initiatives:

1. Production of a guide to *Prunus africana* production from seed: Many farmers are unaware that *Prunus africana* seed rapidly loses viability if stored at room temperature. Seeds need to be planted within six weeks of collection. Production of a step-by-step guide to planting *Prunus africana* from seed would save farmers time and money, and boost tree production.
2. Clarification of forestry legislation on the sale of bark from cultivated trees: At present, many farmers believe that they are not allowed to sell bark or other products from *Prunus africana* trees that they have cultivated. This discourages farmers from cultivating trees on their farms. Legislation is unclear and needs clarification to enable farmers to sell products from cultivated indigenous trees such as *Prunus africana*. This could link with the recommendation that a register of growers is kept.
3. Low technology propagators: Construction of low technology propagators at field sites such as Mt. Kilum would boost the number of young trees being produced, as it enables year-round production to take place, rather than seasonal production from seed.

Although several of the recommendations made by Cunningham and Mbenkum (1993) have been implemented, even more have not. The most important advice we can give is that there needs to be a commitment to implement the recommendations made by Besong *et al*. (1991), Cunningham and Mbenkum (1993), Eben Ebai *et al*., (1994) and Ewusi *et al*., (1996). Rather than repeat these in detail, they are summarised here:

Box 4. Recommendations for conservation

1. CONSERVATION THROUGH CULTIVATION

Objective: Local production of *Prunus africana* to provide an alternative to the destructive harvesting of wild stocks

- Plantecam Medicam and other Special Permit holders assisting in establishment of large enough *Prunus africana* populations to replace harvesting of wild stocks (Besong *et al*., 1991; Cunningham and Mbenkum, 1993); This assistance should focus on helping smallholders to grow the tree on their farms.
- Research needs to be conducted for selection of fast-growing, high active-ingredient yielding *Prunus africana* cultivars (Cunningham and Mbenkum, 1993). This is currently underway through ICRAF (Leakey, 1993; Tchoundjeu *et al.*, 2002).
- Small-holder farmers need to play a greater role in *Prunus africana* cultivation, including agroforestry/permaculture systems on steep slopes (Cunningham and Mbenkum, 1993).
- *Prunus africana* cultivation using selected high active-ingredient yielding varieties (rather than from wild collected seed/cuttings) should only be undertaken if this poses no threat to the genetic integrity of wild populations in core conservation sites.
- Extension support is needed to assist small-holder farmers to establish nurseries, following the Kilum Mountain Forest (ICBP) example (Besong *et al.*, 1991).
- Community involvement in seed collection and seedling production as an economic incentive for conservation of remaining mature wild trees. Outside organizations need to ensure that a wide range of planting material is collected from the wild and made available to farmers, in order to preserve the genetic diversity of the species.

2. *IN-SITU* CONSERVATION OF REPRESENTATIVE VIABLE POPULATIONS

Objective: Maintenance of representative viable populations of *Prunus africana* in Afromontane forests

- Core conservation areas should be recognized as control sites for comparison to forests where bark exploitation on wild populations continues to take place, or if already disturbed, to monitor forest recovery and *Prunus africana* regeneration. It is recommended that no *Prunus africana* harvesting should take place within these areas set aside for Afromontane forest conservation (see Gartlan, 1989). There should be an immediate withdrawal of bark harvesters working within these high conservation priority sites.
- Local communities should be involved in the process of conservation (Nurse *et al*., 1994; Eben Ebai *et al*., 1994).

3. *EX-SITU* CONSERVATION

Objective: Establishment of field gene banks for *ex situ* conservation of this apparently recalcitrant seeded species

- Provenance collections in secure field gene-banks should be established for *Prunus africana* genotypes. The same should apply to provenance collections for *Prunus africana* and *Prunus crassifolia* from other sites, particularly those where commercial bark harvesting is taking place. Where these field banks occur outside the countries of origin of the material, it must be accompanied by legal agreements that cover control and compensation for the use of the material.

4. BARK HARVESTING FROM WILD POPULATIONS

Objective: To set sustainable limits and manage bark harvesting over a set period until *Prunus africana* plantations and enrichment plantings are established

- Current Special Permits should be revoked and reissued after comprehensive inventories have been established prior to further bark exploitation from the wild and that strong support should be given to the following recommendations made by Besong *et al*. (1991), Cunningham and Mbenkum (1993) and Ewusi *et al*. (1996):
  - to reduce quotas and limit the number of permits given out. Ewusi *et al*. (1996) also make specific recommendations for inventory work and development of yield tables as a basis for granting quotas. This is an important alternative to *ad hoc* quotas granted in Yaounde without prior inventory;
  - to develop accurate maps of the distribution and density of *Prunus africana*;
  - to restrict the activities of permit holders to the forest zones allocated to them;
  - that permit holders should be held responsible for the damage caused to the trees. Bark harvesting techniques need to be respected (ie: bark removal from opposing quarters of the trunk, up to the first branch);
  - the minimum exploitable diameter should be increased to 40 cm DBH;
  - forest regeneration taxes need to be raised and linked to this exploitation in order to finance a silviculture programme.

5. MONITORING

Objective: To monitor the effectiveness of these and other recommendations, as well as the status and recovery of *Prunus africana* populations

- Permanent plots or transect lines need to be set up outside and within core conservation areas to monitor tree growth, population dynamics and recovery (or not) of exploited trees (Cunningham and Mbenkum, 1993; Ewusi *et al*., 1996).
- A timetable needs to be set by the Forestry Department for the implementation of cultivation, and a register needs to be kept of the area that this involves, with more practical spacings between trees than those implemented at Buea.

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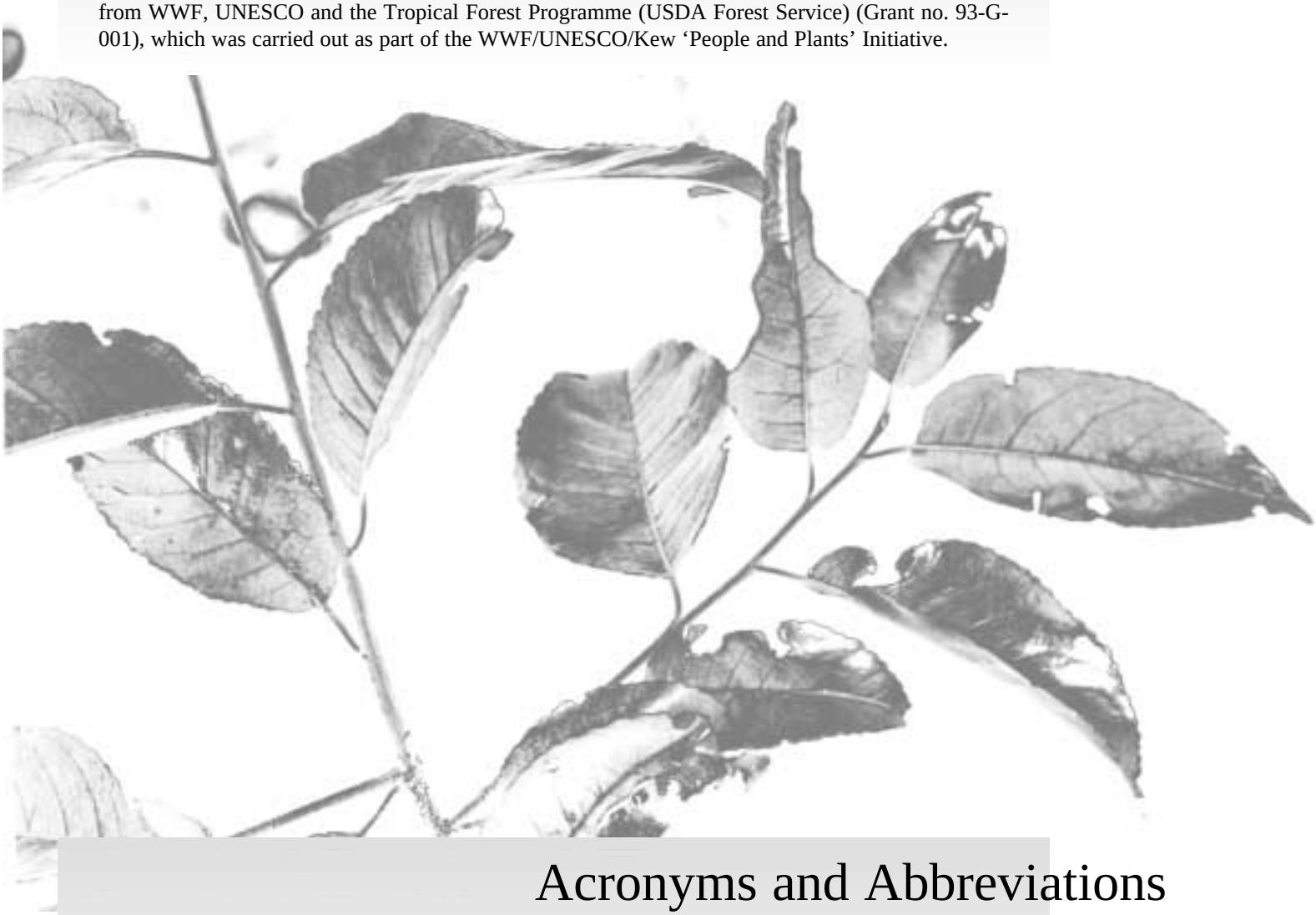

Acronyms and Abbreviations

DIR/FORESTS	Direction des Forêts (DF)
FCFA	Franc de la Confederation Française Africaine
HELVITAS	Swiss Association on International Cooperation
IRA	Institut de la Recherche Agronomique
ICRAF	World Agroforestry Centre (formerly International Centre for Reserach in Agroforestry)
MINEF	Ministère de l'Environnement et des Forêts
NPV	Net Present Value
ONADEF	Office National des Eaux et des Forêts
UNESCO	United Nations Educational, Scientific and Cultural Organization
USDA	United States Department of Agriculture
WWF	World Wide Fund for Nature

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The People and Plants Initiative

was started in July 1992 by WWF, UNESCO and the Royal Botanic Gardens, Kew to promote the sustainable and equitable use of plant resources through providing support to ethnobotanists from developing countries.

The initiative stems from the recognition that people in rural communities often have detailed and profound knowledge of the properties and ecology of locally occurring plants, and rely on them for many of their foods, medicines, fuel, building materials and other products. However, much of this knowledge is being lost with the transformation of local ecosystems and local cultures. Over-harvesting of non cultivated plants is increasingly common, caused by loss of habitat, increase in local use and the growing demands of trade. Long-term conservation of plant resources and the knowledge associated with them is needed for the benefit of the local people and for their potential use to local communities in other places.

The diversity of traditional plant-resource management practices runs through a spectrum from "cultivation" through to gathering "wild" plants, all of which are included in the People and Plants approach.

Ethnobotanists can work together with local people to study and record the uses of plant resources, identify cases of over-harvesting of non-cultivated plants, find sustainable harvesting methods and investigate alternatives such as cultivation.

The People and Plants initiative is building support for ethnobotanists from developing countries who work with local people on issues related to the conservation of both plant resources and traditional ecological knowledge. Key participants organize participatory workshops, undertake discussion and advisory visits to field projects and provide literature on ethnobotany, traditional ecological knowledge and sustainable plant resource use. It is hoped that a network of ethnobotanists working on these issues in different countries and regions can be developed to exchange information, share experience and collaborate on field projects.

Please visit our website at:
http://www.rbgkew.org.uk/peopleplants

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