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Winners and losers in forest product commercialisation

Final Report R7795 (May 2003)

Volume 1
Overview

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Executive Summary

The *Winners and Losers in Forest Product Commercialisation* project brings together the work of 24 researchers, investigating two different species (*Sclerocarya birrea* and *Carapa guianensis*) in South Africa, Namibia and Guyana. The research was carried out largely by local researchers in the study countries, and the findings provide some generic insights into NTFP market chains. Topics covered during this study range from an evaluation of basic ecological requirements for the two species, and how this knowledge can be used to increase yields, right through to a consideration of the intellectual property rights associated with their use, and the economic potential of income generation and benefit sharing.

During the project, households in over 30 communities in three countries were involved in participatory assessment of the resource itself, and in identifying how much of it is used for domestic and commercial purposes. The data generated from this household assessment was strengthened by additional information collected through group meetings at each site. Further information was collected about commercial activities from different sources, reflecting the situation in a number of different commercial chains. With a view to addressing poverty, we have examined how different types of livelihood capital entitlements are likely to be influenced by the commercialisation process.

As a result of this work, we have been able to address five research hypotheses, and, in answering these, we are able to conclude that in NTFP market chains, like many others, the major share of financial benefits from commercialisation is often captured by wholesalers, retailers and middlemen. Financial capital is an essential component in the chain, if human and social capital is to be integrated with natural capital to generate productive outputs. Failure to achieve this is often the result of inefficiencies in marketing chains, where the full value of all of the types of capital involved are not recognised or rewarded. In this study, we have also shown that it is possible for these difficulties to be overcome, if there is a cooperative spirit in the community, shared knowledge of resources, and adequate institutional strengths which can be mobilised for an equitable outcome for the community. For this to be realised, efforts would need to be made to ensure that the resource base, on which the commercial chain is built, is maintained and nurtured, and where necessary, appropriate tenure arrangements are put in place and enforced. At present, in the examples included here, there is no absolute threat to resources of marula and crabwood. It does seem likely, however, in some areas, that current depletion trends will need to be addressed by better management, and possibly domestication, if stocks of marula and crabwood resources are going to be available on a sustainable basis for future generations.

Overall, our work has led to the conclusion that both winners and losers do exist in NTFP marketing chains, but higher levels of pareto optimality/equity can be generated if communities work together and use their own strengths to manage and use their resources effectively. Specific characteristics have been identified which give rise to wining outcomes, and recommendations on how to achieve these have been disseminated through many different media. As a result, it is hoped that this work can contribute to a better understanding of how the benefits from NTFPs can be realised for poor people, on an ecologically, economically and socially sustainable basis. From these findings, we have also highlighted some issues relating to NTFP use which can contribute to more effective realisation of some of the Millennium Development Goals.

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1. Background

The contents of this report are drawn directly from the project reports produced by team members. This overview attempts to link together the results of this work to provide a comprehensive summary of all the work carried out during this project. A complete list of all of the outputs produced is attached to this report, and the detail of the information included here can be examined in the appendices provided on the attached CD.

Research on the commercialisation of non-timber forest products (NTFPs) has traditionally adopted a sectoral approach, focused within individual disciplines such as ecology, economics, sociology, anthropology, and forestry. It is now recognised that the use of NTFPs can make a significant contribution to household income, and that the potential from their commercialisation may be significant. If that commercialisation process is to be beneficial, especially for the most valued or ecologically most vulnerable types of NTFPs, it must be carried out with an adequate understanding of:

- whether NTFP commercial harvesting will be ecologically sustainable;
- the particular socio-economic, ecological or political circumstances where commercialisation is planned and carried out, and
- the effective distribution of financial benefits from trade, and the constraints on generated monetary income reaching poorer households.

There are many cases where commercialisation, rather than benefiting local communities in the long term, can lead to resource depletion, cultural disruption or reduced local self-sufficiency. Examples are the felling of entire populations of female *Mauritia flexuosa* (aguaje) palms for their fruits (Peruvian Amazon), loss of a popular edible fruit resource (*Berchemia discolor*) due to commercial debarking for basketry dyes (Botswana) or negative effects on local culture through marketing of carved wood drums (Brazilian Amazon). It is with these issues in mind that this project attempts to address the commercialisation of NTFPs in an integrated manner, reflecting how people are influenced along the whole production chain. From the lessons learned from this study of *Sclerocarya birrea* and *Carapa guianensis*, we can gain some insights into how the commercialisation process may be best managed to ensure equitable and sustainable use.

1.1 A summary of literature on marula and crabwood

Already much literature has been generated on these two species (especially marula), and one aspect of this project is to assemble it in a cohesive manner. The value of bringing the literature together in this way is demonstrated by the fact that two journal papers have already been generated from the background review done for marula (Shackleton et al. 2002, and Wynberg et al. 2002). In the review of the two species being considered here, we have examined literature from many different perspectives, and these are discussed under separate headings, and each species is considered in turn. For the full literature review carried out in the study, and the relevant bibliography see Appendices 3.1; 4.1; 4.2 and 4.8.

1.2 The marula, *Sclerocarya birrea* (A. Rich.), taxonomy and species description

The *Sclerocarya birrea* subsp. *caffra* (Sond.) subspecies is the most ubiquitous and occurs in east tropical Africa (Kenya, Tanzania), south tropical Africa (Angola, Malawi, Mozambique, Zambia and Zimbabwe) and southern Africa (Botswana, Namibia, South Africa and Swaziland) and is also recorded from Madagascar (Flora Zambesiaca 1960, Fox and Norwood Young 1982, Arnold and de Wet 1993, SEPASAL 2001). *Sclerocarya birrea* subsp. *birrea* occurs through west, north-east and east tropical Africa across a range of vegetation types, principally mixed deciduous woodland, wooded grassland and through the open dry savannas of northern tropical Africa and the Sahelian region. The trees are deciduous, reaching 7 – 17 m in height, and are usually considered a dioecious species, although occasional trees with male flowers may

bear a few female flowers. In keeping with the widespread cultural use of the species, the species name *birrea* is derived from *birr*, a local West African name for the tree (Palmer and Pitman 1972). Like *S. gillettii* (Beentje 1994) and some well-known crop plants in the Anacardiaceae, such as the mango (*Mangifera indica*) and mombin (*Spondias*), marula fruit pulp is edible. In addition, like fellow Anacardiaceae, such as the cashew (*Anacardium occidentale*) and pistachio (*Pistacia vera*), *S. birrea* produces edible nuts.

1.2.1 Ecology and productivity

There has been surprising little autecological research on *S. birrea,* in particular *S. birrea* subsp. *caffra,* in southern Africa considering its ubiquitous distribution and household and commercial importance. Some of the work that has been done on the ecology of *S. birrea* focuses on aspects relevant to the use of this species as a NTFP. Much of the data presented here draws on results from a much broader, in-depth study on the productivity of savanna species in South Africa (Shackleton 1998, Shackleton in press).

1.2.2 Habitat requirements

No specific studies have been done on the precise habitat requirements of *Sclerocarya birrea*, except in the Kruger National Park (Jacobs 2001). Instead, what exists is simply a collection of observations. In terms of soils, *S. birrea* is reported from a wide variety of soils from deep sands on granite, to basaltic clays, although a preference for well-drained soils has been commented upon (Lewis 1987). A key factor limiting its distribution appears to be its sensitivity to frost (von Breitenbach 1965, Palmer and Pitman 1972, Johnson and Johnson 1993). Altitudinal range is from sea-level to 1 800 m. Mean annual rainfall (MAR) ranges from 200 to 1 500 mm (Peters 1988), but more typically between 400 and approximately 1 000 mm per annum (Shone 1979, Shackleton 1997, Peters 1988, Bandeira *et al*. 1999).

1.2.3 Densities

The data that exist on species density result from other work recording densities of all woody species for vegetation mapping or characterisation purposes. A detailed inventory of woody biomass has been carried out (Shackleton, 1997) based on random replicated transects in three protected areas along a rainfall gradient in the central lowveld South Africa. This identified the highest absolute and relative abundance of *S. birrea* occurring at intermediate rainfall (500 – 850 mm).In comparison, the density of mature trees in Timbavati communal lands in the same region was reported by Shackleton (1996) to be 7.5 per hectare, whereas the density of all stems (not just adults) was 41.9 per ha. This is similar to the 8 trees (> 2 m tall) per hectare reported by Lombard *et al*. (2000) for Gottenburg communal lands in the Bushbuckridge region. In Mozambique, Bandeira *et al*. (1999) reported a density of 37.5 stems per hectare for individuals greater than 1.5 m tall, while in Zambia, Lewis (1987) undertook a complete population inventory and found a mean density of 14.8 trees per hectare, with a mean height of 7.6 m.

1.2.4 Growth rates

According to Johnson and Johnson (1993), height growth of newly germinated stems is approximately 70 cm per year, and that flowering occurs after four years. Shone (1979) reported that trees increase in height by approximately 1 m per year, while Shackleton (1997) monitored 44 individuals across 16 localities for five years, finding a strong positive relationship ($r^2 = 0.206$; $p < 0.01$; $n = 44$) between mean diameter increment and stem diameter. Citing figures from Israel, Van Wyk and Gericke (2000) and Nerd and Mizrahi (1993) claim fruit production rates ranging from 27 – 500 kg. of fruit per year.

1.2.5 Fruit production

Fruit production data for wild trees is scanty and often anecdotal. Some reports of numbers of fruits per tree include the work of Quin 1959; Palmer and Pitman 1972; Shone 1979; Arnold *et al.* 1985 Lewis 1987; Peters 1988; Roodt 1988; Taylor *et al.* 1996, and SEPASAL 2000. The average level of fruit production varies according to season and conditions, it is generally agreed that most female trees produce tens of thousands of fruits per season, with a weight of over 500kgs yielded per tree, and a wide range of estimates of the ratio of number of fruits to mass of fruits. The observed wide inter-annual variation in the production of marula fruits represents a challenge to sustainable commercialisation initiatives, as has been commented on for other non-timber forest products from semi-arid lands (Boffa *et al*. 1996).

1.2.6 Ecosystem functions

S. birrea is important to the ecology of other plants and animals. Because of its large size, it produces a large area with a cool sub-canopy environment, which are key resource areas in arid and semi-arid areas. These trees provide habitats for sub-canopy woody plants, grasses, forbs, parasitic plants such as woodroses (Dzerefos 1996), and for small vertebrates and invertebrates. Fruits are consumed by elephant, rhinoceros, warthog, kudu, baboon, vervet monkeys, zebra, porcupine, and millipedes, and foliage is browsed by elephant, kudu, giraffe, nyala and domestic cattle (Palmer and Pitman 1972), as well as by at least eight species of butterfly and moth larvae (Pooley 1993, Jacana 1997). Palmer and Pitman (1972) state that water-filled holes in the trunks of *S. birrea* are important breeding grounds for mosquitoes, more so than any other tree species in the two million hectare Kruger National Park.

1.2.7 Potential ecological impacts of use

The many and varied uses of *S. birrea* complicates identification and estimation of potential impacts of harvesting, because of potential synergistic effects. Since there has been no study of impacts resulting from increased human population densities, or commercialisation, it is only possible to identify potential areas for concern that require systematic assessment. In providing a baseline for such assessment in some areas, this study will contribute to more effective management of the species in the future.

1.2.8 Harvesting of fruits

Lombard *et al*. (2000) stated that “harvesting of fruit from marula does not present any direct environmental risk”. This may be the case, but needs further examination since fruit collection for human use could potentially impact on the regeneration rate of the species. The fact that *S. birrea* germinates readily and can also be propagated via truncheons means that it should be possible to readily replace stocks if fruit harvesting reduces recruitment in the long term, although care should be taken to ensure the maintenance of genetic diversity by using materials of very different origins. However, it is necessary that an ‘early-warning’ system is in place to detect such shifts and implement appropriate interventions before fruit supplies are reduced, with negative impacts on local rural livelihoods and incomes. Thus, in areas where increasing commercialisation is occurring or envisaged, it is necessary to implement (i) a simple and replicable monitoring system of plant densities, recruitment and size profile, and (ii) a rational harvesting strategy that ensures an acceptable proportion of fruits remain unharvested each year as a means of promoting recruitment.

1.2.9 Harvesting of other components

The real impacts of bark harvesting for medicines, and trunks and branches for carving, will vary according to the frequency, intensity and extent of harvesting, at both the level of an individual tree, and each population. Marula is a renewable resource, and consequently it is possible that some proportion of the population, however large or small, can be harvested on a sustainable basis indefinitely. Whether or not this can be achieved in practice depends upon a multitude of factors, including social, economic and well as ecological. In situations where harvesting is unsustainable at the local scale, there will be a decline in the size, structure and density of trees over a period of time. Action needs to be taken in areas where this may occur, to pre-empt the loss of benefits from this valuable resource.

1.2.10 Properties of the fruits, kernels, oil and other plant parts

Research into the traditional uses of marula oil in southern Africa clearly indicate that the properties of marula oil have been appreciated and exploited by local populations for possibly thousands of years (Junod 1927, Krige 1937, Quin 1959, Palmer and Pitman 1972-1974).In particular, the oxidative stability of marula oil appears to have been utilised in the preservation of meat (A. le R.van der Merwe cited by Palmer and Pitman 1972, L du Plessis pers. comm.). The bark of marula contains tannins and traces of alkaloids and therefore acts as an astringent and coagulant (Shone 1979). The average tannin content is about 3.5 % but may rise as high as 20.5% in October, before the leaves emerge (Watt and Breyer-Brandwijk 1962, Shone 1979). It is these properties that account for it use as a medicine. Tannins and flavonoids are present in the leaves, but alkaloids, steroids or triterpenoids have not been detected (Hutchings *et al.* 1996). Extracts from dry stembark have shown antibacterial activity (Hutchings *et al.* 1996).

Marula kernels are rich in protein (28 – 31 % or 30.9 g/100 g), oil (56 – 61 % or 57.0 g/100 g), magnesium (467 mg/100 g), phosphorus (836 mg/100 g) and potassium (677 mg/100 g) (Shone 1979, Arnold *et al.* 1985), and these qualities make it an important contributor to the diets of many rural communities, and especially for poor people. Marula fruit and juice is extremely high in Vitamin C providing about 2 mg of Vitamin C per gram of fresh juice. This is approximately four times the Vitamin C content of the average orange juice (Fox and Stone 1938, Shone 1979). In addition, it is the high anti-scorbutic value of the fresh fruit that makes it so important nutritionally, and accounts for early observations of the ability of marula fruit to combat scurvy (Shone 1979). Cold pressed marula oil has a light nutty flavour, and a fatty acid composition that can be compared to olive oil (Burger *et al*. 1987). Burger *et al.* (1987) ascribed marula oil's resistance to oxidation to its fatty acid composition, and this quality is one of the things that gives it good market potential. Information from the literature is provided in Appendices 3.1 and 4.8 on:

- the fatty acid composition of marula kernel oil,
- the oil and kernel content of marula nuts,
- the sterol and tocopherol content of marula oil,
- total protein content of marula meal and kernels,
- the amino acid content of marula kernel meal.
- comparison of the average fatty acid content of marula kernel with that of olive oil,
- the oxidative stability of marula oil is examined in comparison with olive, sunflower cotton and palm oils.
- analysis of the medicinal properties of various plant parts.

(Ingle 1906-07 cited in Quin 1959, Krige 1937, Fox and Stone 1938, Carr 1957, Quin 1959, Wehmeyer 1966, Wehmeyer 1967, Engelter and Wehmeyer 1970, Burger *et al.* 1987, Weinert *et al.*1990, Leakey 1999, Zharare & Dhlamini 2000; Galvez *et al.* 1991, Galvez *et al.* 1992, Galvez *et al.* 1993, Hutchings *et al.* 1996, Kubo and Kinst-Hori 1999).

1.2.11 Uses and contributions to rural livelihoods

Sclerocarya birrea trees and products have long formed an integral part of the lives, food security and spirituality of indigenous communities living within the distribution range of this highly valued and versatile species (e.g. Krige 1937, Quin 1959, Fox and Norwood Young 1983, Gomez 1988, SIDA 1992, Shackleton *et al.* 2000). It is of note that, despite extensive anecdotal and descriptive information on the use of *S. birrea* products, there is very little quantitative data on household consumption rates and informal trade in this species, but a summary of both the consumptive and non-consumptive uses of *S. birrea* are provided in Table 1.

Table 1. Summary of consumptive and non-consumptive uses of *S. birrea*

PLANT PART	USE	REFERENCES
FOOD AND BEVERAGES		
Fresh fruit	Eaten whole, particularly by children. Skin and nuts discarded, although the nuts may be stored for later extraction of the kernels.	SEPASAL 2001, ANU 1999
Beer/wine/distilled spirits	Fruits without seeds and skins mixed with water to make an intoxicating beer; also used to make wine (Zimbabwe) and distilled spirits.	SEPASAL 2001, ANU 1999, Mugochi *et al.* 1999
Jams and jellies	The fruits make a good table jelly.	Von Breitenbach 1965
Nuts (kernels)	Compartmentalised kernels can be eaten as they are or ground up to make porridge, condiments, pseudocereals and seed oil, or mixed with other foodstuffs to make relishes and chutneys.	SEPASAL database 2001, Roodt 1988
Oil from kernels	Seed oils are used as preservatives and for cooking.	SEPASAL 2001, ANU 1999
Roots	Roots are crushed and water is squeezed out to produce potable water.	SEPASAL 2001

PLANT PART	USE	REFERENCES
Leaves	Leaves are used as a relish.	SEPASAL 2001, Watt and Breyer-Brandwijk 1962
Exudates	The resin is eaten by the Moshaweng Tlokwa of Botswana.	SEPASAL 2001,
Larvae	Host to a variety of butterflies, moths and borer beetles which produce edible caterpillars and larvae.	Dalziel 1948, Pooley 1993
ANIMAL FOOD		
Aerial parts: stems, leaves from trees, fallen leaves, seeds	Cattle and game mammals eat fresh and fallen leaves as well as young stems. Elephant break branches off the tree and eat the leaves. The branches are often cut in winter and provided to livestock as feed.	Dalziel 1948, SEPASAL 2001, Pooley 1993
Fruits	Fruits are eaten by cattle, goats, game mammals, elephants, etc.	SEPASAL database 2001, also see ecological section
Nectar	Bees enjoy the nectar from marula flowers.	SEPASAL 2001
OTHER SUBSTANCES AND USES		
Seed oil	Used as cosmetics (skin moisturiser and soap) - the stable out performs all other known natural liquid oils. There is an ongoing research to find out if oil residue can be marketed as sunscreen.	Cosmetic Science & Business 2000, SEPASAL 2001
Bark and wood	Used for beehives and firewood.	Mbuya *et al.* 1994
Kernels	Kernels burn with a bright flame and are used as candle substitute (illuminants).	Coates Palgrave 1972
Wood	Wood is used to make floors, boxes, tool handles, boats/canoes, furniture, joinery, tools, yokes, plates/bowls, mortars, stools, beehives, toys, ornaments, drums and curios. The woody growth produced by parasitic mistletoes is sold as a curio.	SEPASAL 2001, Steenkamp 1999, Dzerefos 1996, Immelman *et al.* 1973
Tannins/resin	Red/brown dye and inks from the bark and resin.	Van Wyk and Gericke 2000, ANU 1999, SEPASAL 2001, Dalziel 1948, Perrier de la Bathie 1946
Fruit skins	The skins used as fertiliser in Pearl Millet fields in Namibia.	ANU 1999
Truncheons/ plants	Live fences.	SEPASAL 2001
SOCIAL AND CULTURAL USES		
Antifertility agents	Seeds are used for birth control.	SEPASAL 2001
Bark	Bark is used for ritual, religion, magic: a decoction is taken by some African tribes to remove defilement caused by eating food in the relatives' house where there has been death without the performance of necessary purification rites; Venda people administer powdered bark to expectant mothers to regulate the sex of the child (bark from male tree for a boy and that from female tree for a girl); Zulus and Thongas use a decoction of a bark as ritual cleansing emetic before marriage. Zulu healers bathe in a decoction of the bark prior to treating a patient suffering from gangrenous rectitis. Newly-	SEPASAL 2001, Hutchings *et al.* 1996, Watt and Breyer-Brandwijk 1962

PLANT PART	USE	REFERENCES
	born girls and their mothers are washed on a fire heated by marula twigs so that the baby may be endued with fertility, softness, tenderness and early maturity.	
Fruits/kernels	The fruit juice is used in certain Shangaan and Thonga religious ceremonies; kernels given as a gift is a great mark of friendship since the fruit is much prized.	SEPASAL 2001
Fermented fruit	Sharing of beer is important in cementing social relationships.	Shackleton *et al.* 1995
Roots	In Zimbabwe the roots are used to arouse or prevent possession from spirits.	Hutchings *et al.* 1996
NON-VERTEBRATE POISONS		
Fruits	Zulus regard fruits as a potent insecticide, this is used to destroy ticks.	Watt and Breyer-Brandwijk 1962
Bark	A decoction of bark is sometimes used as an insecticide.	Khan and Nlanga 1990
MEDICINE		
Bark	The bark contains antihistamines and is used for cleansing by inhaling the steam. A decoction of bark is used to treat human circulatory system (haemorrhoids) disorders; as well as digestive disorders and diarrhoea (crushed bark is used with boiled water), liver problems, fever, venereal diseases, malaria (malaria prophylactic), inflammation, rheumatism, painful teeth, and warts. Grounded bark mixed with soft porridge is used to help wean and strengthen babies. In East Africa the bark is used for toothache, constipation and stomach disorders.	http://www.knet.co.za/herbs/maralu, SEPASAL 2001, ANU 1999, Hutchings *et al.* 1996, Netshiluvhi 1996, Morris 1996, Kokwaro 1993, Descheemaeker 1979, Jenkins 1987, Watt and Breyer-Brandwijk 1962
Roots	Roots are used for many purposes in Zimbabwe, including menorrhagia, bilhazia, sore eyes, weakness and heart pain. In East Africa roots are used with other species in an alcoholic medicine to treat an internal ailment known as *kati.* In Senegal root bark and leaves are used with other plants for snake bite and other venoms.	Hutchings *et al.* 1996, Kokwaro 1993, Gelfand *et al.* 1985
Leaves	Leaf decoctions inhaled for malaria in Madagascar. Leaves may be used as dressings for burns	SEPASAL 2001, Hutchings 1996,

1.2.12 Tenure, access, management and policy

The equitable and sustainable use of NTFPs, especially important species such as *S. birrea*, for both subsistence and cash purposes is strongly influenced by tenure and regulatory controls and norms at a local level, as well as national policies and legislation at a higher level. Frequently, the two systems operate independently from one another, and may even be incompatible. Tenure arrangements and local formal and informal regulations are important in providing the rules for governing who can harvest a resource, where they can harvest, how much they harvest and for whose benefit (Neumann and Hirsch 2000).

The importance of *S. birrea* to rural people is reflected in the selective removal of non-fruiting male trees from arable lands, but the retention of fruit producing female trees (Brigham *et al.* 1996). Trees in home plots are also retained and seedlings are frequently nurtured (High and Shackleton 2000). Traditionally, the felling of marula trees, in particular female trees, was strictly taboo amongst most rural societies where this species occurs (Cunningham 1989). In other cases, marula trees could only be cut with the permission of the chief. In southern Africa, marula fruits are generally a common property or open access resource (Lombard *et al*. 2000) except where the trees occur on individual plots or fields, or near to homesteads. In these

situations private rights are accorded to the tree and its fruits (Shone 1979, Cunningham 1997). Quin (1959) observed a similar enclosure of trees with fences. Some stakeholders are concerned that commercialisation will result in increased privatisation of trees and loss of access by current users to trees on neighbours plots as the incentive for owners to make use of their own resource increases (Lombard *et al*. 2000).

Presently, a host of confusing and sometimes conflicting legislation exists to protect *S. birrea* in South Africa. Various provincial Ordinances and Acts afford protection to the tree, although these are generally inconsistent and outdated. Through the Forest Act 84 of 1998 it is intended that a more coherent approach to tree protection in South Africa be adopted. This Act afforded protection to certain trees found on private land, including *S. birrea*. The Act allows for the Minister to declare a tree species as protected, and marula is included in the draft list of protected tree species prepared in terms of this legislation.

1.2.13 Small-scale farmers and cultivation

The role of these trees in agroforestry systems has been identified, and demonstration of their good performance when cultivated has been made (Kwesiga *et al*. 1994). Farmers surveys have been carried out to determine priority species (Minae *et al*. 1995, Kwesiga and Mwanza 1995, Clarke 1995, Buwalda *et al*. 1996). Using participatory priority setting procedures (Jaenicke *et al*. 1995, Franzel *et al*. 1996), research priorities have been identified (Maghembe *et al*. 1995, 1998). Evidence from other indigenous African fruit trees (Leakey *et al*. in prep) indicates that such influences increase the range of phenotypic variation in fruit traits, offering enhanced opportunities for cultivar development. Genetic variation in fruit characteristics have been observed in indigenous fruits from southern Africa (Mwamba 1995); while Maghembe *et al.* (1994) and Maghembe (1995) have reported the benefits of cultivation, finding that trees planted in farmland have faster growth, earlier flowering and larger fruits than found on wild trees. To domesticate marula, on-going BMZ-funded domestication activities, coordinated by ICRAF, aim to bring indigenous fruits into cultivation by multiplying the superior trees, which produce large and sweet fruits while still small young trees. Vegetative propagation methods for marula were first developed by Holtzhausen *et al.* (1990). As with other sections in this summary, more detail is provided in Appendices 1 to 5.

1.2.14 Intellectual property rights and benefit-sharing

S. birrea is one of the edible fruit bearing species recorded from an excavation at Shongweni-South cave, South Africa (Cunningham 1988, Davies 1975). The early steps towards domestication of marula by local people, and selection of desirable traits, is well documented. Local knowledge about marula has also guided the work of a South African horticulturalist, Professor Kas Holtzhausen, who has over the past 20 years developed a number of cultivars through selection of several thousand wild trees. Three issues are pertinent in the context of intellectual property rights and benefit sharing:

1. The extent to which local knowledge has been used in the development of commercial cultivars of *S. birrea* and options for equitably compensating original holders of such knowledge.
2. The impact that Plant Breeder's Rights might have on communities that use and depend on marula.
3. The extent to which domestication and commercialisation of marula might impact upon communities currently harvesting or using the resource.

Plant exchanges in the 1980s between Botswana and Israel purportedly resulted in Israel receiving the marula tree from Botswana in exchange for Botswana obtaining the date and pomegranate from Israel (Hadassah 2001). Alternative information (Mizrahi pers. comm.) suggests that fruit-bearing cacti were introduced to Botswana by Israel, in exchange for marula and as part of a new crop development programme of the University of Ben-Gurion. Kibbutz Ketura in Israel's Arava region reportedly has up to 25 acres of marula growing, and significant fruit production (Ben Gurion University 2000). Fruit is sold to the regional council which produces and sells a kosher liqueur named "Marula", based upon a "secret recipe". Investigations are currently underway with regard to the options available to groups of primary and traditional producers in Namibia and southern Africa, to protect their traditional knowledge of marula-based products (Lombard pers. comm.). This project is also investigating ways in

which benefits could be shared among community-based groups in the region who have traditionally used the resource. One type of IPR that requires further investigation concerns the use of Geographical Indications, thus far confined to certain beverages and foodstuffs, but perhaps could be a potential tool to protect certain traditional know-how and promote distinctive local and regional products (Dutfield 2000). There are several other issues pertaining to intellectual property rights that have relevance to marula, and no doubt future fieldwork will suggest further areas warranting investigation. This project is contributing to this area of knowledge through a systematic examination of how benefit sharing relates to marula use in a number of communities in South Africa and Namibia. It is hoped that this information will be helpful in formulating appropriate policies for benefit sharing in other areas of the world, and guidelines on how this may apply in Guyana have been produced.

1.3 Crabwood in Guyana

As in the case of marula, crabwood is an important species in rural communities, and one that offers potential for income generation through value added at the household level. Crabwood is prized not only for the production of a high grade timber but also a number of NTFPs such as natural oil is extracted from the large seeds. In Guyana and Brazil this oil is utilised for skin care and as a natural insect repellent. Crabwood oil can be used in the production of soaps, candles, shampoos and other body care products. The seeds are also an important food source for some animals such as the agouti (*Dasyprocta leporina*), acouchy (*Myoprocta acouchy*) wild hogs (*Pecari tajacu & Tayassu pecari*), deer (*Mazama spp*), tapir (*Tapirus terrestris*) and also some birds who feed on the immature fruits (Iwokrama 2002; Forget 1999). The agouti and acouchy also serve as seed dispersal agents by their habit of scatterhoarding of the seeds (Forget 1996).

1.3.1 General Distribution

Crabwood (*Carapa guianensis*) (Brazil: andiroba) is an important tropical hardwood. It forms part of the timber trade of Guyana and other countries of the region. Two species of crabwood trees occur in Guyana – *Carapa guianensis* Aublet and *Carapa procera* A. DC (family - Meliaceae). *C. guianensis* is found throughout eastern Amazon, the Guianas, Trinidad, and Central America up to Nicaragua. *C. procera* has a more restricted distribution occurring in Central Guyana, throughout Suriname and French Guiana and in some locations for Brazil. *C. procera* also occurs in Africa but it is uncertain whether it is the same species as found in this area (Forget 2002, pers. comm.). These two species are very similar in appearance and are very difficult to distinguish if not in flower or fruit. Due to the unwitting similarity, *C. procera* has certainly been frequently misdiagnosed as *C. guianensis* in many studies and inventories.

1.3.2. Species description

Both species of crabwood are canopy species, growing to about 30-35 metres in height. Many have buttresses or are swollen at the base. Leaves are very large, alternate and compound (consisting of many sub-leaves called leaflets). The leaflet blades are leathery, smooth and shiny from above. The flowers are very small (3-5 mm), creamy white, sub-sessile on inflorescences. The fruit is a large woody capsule, which dehisces into valves (4-5), 5-15 cm long and 6-10 cm wide (Polak 1992; R. Thomas, pers. obs.). Seeds vary from 8-13 per pod and 1-2 per valve (Payne 2001). The sap wood is pink to brown, heartwood light to dark brown. The crown is large with very dense spreading or erect branches (Polak 1992). The species are relatively fast growing and from some accounts start fruiting at about 10 cm dbh. Documented size for fruiting at a minimum diameter are 16, 17 and 18 cm at Iwokrama, French Guiana and Guyana's North West District, respectively (Payne 2001, Forget, pers. comm., van Andel 2000). The tree grows to a diameter of 72 inches and a height of 170 feet (Fanshawe 1961); and those of 60-100 cm dbh yield between 2000 and 4000 seeds (Janzen el al 1983). Fanshawe (1961) estimated the Cuyuni-Mazaruni areas to be the richest crabwood areas. Later work confirms this, as shown in Table 2.

Table 2. Average densities of Carapa from large scale forest inventories in Guyana (trees/100 ha >40 cm dbh)

River basin areas of Guyana where Carapa is found									
Essequibo-Demerara	Demerara Mahaicony	Berbice-Courantyne	NorthWest District	Cuyuni Supernaan	Cuyuni-Mazaruni	Mazaruni-Essequibo	Pakaraima Highland area	South Guyana Dry	South Guyana Wet
63	1	50	86	33	133	31	118	4	20

Source: ter Steege & Zondervon 2000

A recent inventory for the Conservation International concession (80,000 ha) in central Guyana shows that an average of less than one tree >35 cm dbh occurs per hectare (100 metres x 100 metres) in mixed forests on flat and undulating terrain. However, trees ranging from 10-35 cm dbh average 6-13 trees per hectare (R. Thomas 2001).

1.3.3 Phenology

Flowering generally occurs annually between November and February. *C. procera* was observed to be in flower at Pibiri (central Guyana) in December 2002 (R. Thomas, pers. obs.). Flowering has also been observed August-September in North West Guyana (Orlando Fraser, pers. comm.). Fruiting is annual, generally occurring between April and July (Polak 1992, R. Thomas, unpublished data). The fruiting peak season for Iwokrama in 2000 was from March to June (Payne 2001). In the North West District fruiting occurs at the end of October-November (van Andel 2000).

The variation in crop size has effects on seed dispersal and consequential recruitment (Forget *et al* 1998). Crop size varies between trees, and would have implications for the production of crabwood oil. In Noragues, French Guiana, from 41 trees, crop size varied from 14-2497 seeds per tree (Forget, pers. comm.). The crop size for trees found in Brazil range from 50-200 seeds per year (Shanley *et al,* 1998).

The amount of oil produced from seeds also varies quite substantially (see Table 3). Whether this is a result of the type of extraction method, the soil type on which the crabwood trees grow, size of seeds or the crabwood species used, all warrant further investigation, and it is clear that much more research is needed before a full understanding of this species is achieved.

Table 3. Variation in amount of oil produced from 100 kg of seeds in different areas

Seeds weight	Amount oil produced (litres)	Reference
100 kg	2.3	Van Andel 2000, North West Guyana
100 kg	3.1	Colis pers comm.. Kimbia, Guyana
100 kg	18	Stanley *et al (*1998, Brazil)

1.3.4 Timber

Crabwood has familial associations with the true neotropical (*Swietenia* spp.) and African (*Entandrophragma* spp.) mahoganies (Thomas and Hammond 2000). Considered a hardwood, it is of medium to course texture, usually with straight grains, with a nominal density of 0.67 g cm^{-3} (Thomas and Hammond 2000; Brunner *et al* 1994). The wood varies in colour along the spectrum of pale pink to dark brown with black streaks with the sapwood falling at the lighter end of the spectrum and the heartwood at the darker (Fanshawe 1961; Polak 1992; Brunner *et al* 1994). It is termite and fire resistant (Fanshawe 1961).

Crabwood exploitation in Guyana dates back to the 19th century. The Guyana Forestry Commission (GFC) Market & Production Report of 1998 recorded that up until 1990 its lumber production was surpassed only by that of greenheart and mora (*Mora excelsa*). Straight grains

result in an excellent finish which is partly why the wood is used for interior joinery. van Andel (1998) opined that though local and foreign demand for the wood are high, volume losses due to moisture stress and frequent end checking may render *in situ* milling uneconomical. Prices of crabwood range from 100-115 US$ m^{-3} roundwood and in 1998 it ranked 5th in timber production within Guyana (Thomas and Hammond 2000). Stabroek News of May 9th 2000 reported that there are log export restrictions on the species due to shortage on the local market (Payne 2001).

1.3.5 Physical and chemical properties of crabwood oil

Due to the variation in its extraction method, the appearance of crabwood oil varies from producer to producer. Its colour at ambient temperature is known to range from cream (Fanshawe, 1950), to yellow-orange to red. The more consistent properties include a high viscosity and bitter taste (Fanshawe 1950; Abulet 1775; Plotkin MJ *et al.,* 1991).The oil may solidify at temperatures below 20 °C. The freezing point range is 19-5 °C (Pinto 1963, Sampaio 1993). The melting point of the solidified oil or fat is 22-43 °C (Pinto 1963, Sampaio 1993). Crabwood oil has a specific odour when freshly prepared but rapidly acquires a rancid odour with time. Other pertinent physical properties include: density at 15°C, 0.923-0.934 gmL^{-1}; at 25 °C, 0.930-0.931 gmL^{-1}; refractive index at 40 °C, 1.452-1.459 (Pinto 1963, Sampaio 1993).

The physical as well as medicinal properties of the oil are influenced by the chemical characteristics. Crabwood oil comprises two main components: a saponifiable or soap forming portion also called triglycerides (95-98% of the oil) and a non-saponifiable or non-soap forming component (2-5% of the oil) (Taylor 1998). Triglycerides that are liquid at room temperature are called oils whereas triglycerides that are solid at room temperature are called fats. The saponifiable portion or the triglycerides is made up of an alcohol called glycerol or glycerine in combination with saturated and unsaturated fatty acids. Fatty acids have long saturated or unsaturated hydrocarbon chains usually of 16 carbon atoms e.g. palmitic acid; 18 carbon atoms e.g. stearic acid, oleic acid, linoleic acid; and 20 carbon atoms e.g. arachidic acid. Oils and fats have a pleasant smell. The solid that precipitates out below 20 °C contains mainly the fats olein and palmitin the major triglycerides present in the oil. The non-saponifiable component is a mixture of bioactive organic compounds comprising tannins, triterpenes, flavonoids and limonoids (also called meliacins). These chemicals, held in the unsaponifiable portion of the oil, are responsible for its anti-inflammatory property. Crabwood oil also possesses the properties of an antiseptic, antiparasitic, emollient and cicatrizant .These have given rise to the immeasurable curative value of the oil. The limonoids andirobin and gedunin derivatives are the major limonoids identified in the oil, and these are responsible for the bitter taste of the oil.

The colour of the oil varies according to the quantity of plant pigments called tannins present in the oil. Tannins are derived from the skin of the seeds. The colour of the oil is also dependent on the amount of charring that takes place when the oil is heated during extraction from the seeds. The presence of moisture and precipitation of fats in the oil give the oil a cloudy appearance. Emollient properties of the oil have been attributed to the linoleic acid content. Hydrolysis of the triglycerides releases the free fatty acids causing the oil to go rancid and to acquire an unpleasant odour.

1.3.6 Crabwood oil extraction

Irrespective of where it is studied, or which tribe or group of persons is involved in its production, the method of extraction of crabwood oil is noticeably primitive and similar. The seeds are collected, boiled in a pot of water and left for several days to decompose. They are then individually cut and their endocarp or kernels removed. The kernels are then crushed and moulded into a paste, placed in a container and left in the sun. The sun's heat melts the paste to the extent that it oozes its oil content (Abulet 1775; Fanshawe 1950; Plotkin *et al.* 1991; van Andel 2000). The estimated time the boiled seeds are left to decompose ranges from 2 to 8 weeks (Fanshawe 1950, van Andel 2000). The paste can also be squeezed by a *matapi* (Reinders 1993; van Andel 2000). An alternative approach employed in the production of crabwood oil involves the drying and peeling of the seeds that are then grated and soaked in boiling water. The boiled seeds are squeezed with the bare hands or in a piece of cloth and the remaining oily liquid is then boiled for approximately two hours. The oil, which floats to the top, is scooped off and bottled (Reinders 1993; van Andel 2000).

In Brazil, upon completion of the two-week decomposition phase, the entire crabwood seed is crushed, skin and all. The grinding of the seed skin accounts for the red colouring in the oil. The elimination of the pulp-removal stage renders this method less painstaking and time-consuming. Instruments employed to crush the kernels vary from stones, to a pestle and mortar (Abulet 1775; Plotkin MJ *et al.* 1991) to a *tipiti* (www.rain-tree.com/andiroba.htm). In the absence of the sun, there is also the option of using a small furnace to heat the paste (Abulet 1775; Plotkin *et al*. 1991). At this stage, the Galibis of French Guiana place the kernel paste on flat stones hallowed to form a gutter to facilitate the outflow of oil, while the Wayapis use inclined trunks of palm.

1.3.7 Medicinal uses of crabwood oil

In the North West district of Guyana, *Carapa guianensis* is among the most "widely used" of the medicinal plants and is employed to cure as many as 15 ailments. Included in these are *coughs and colds, whooping cough, groin rupture, haemorrhoids, skin problems (i.e. insect bites, sores. thrush in babies, wounds and bruises, dry cracked skin, itching, skin diseases and painful swellings), malaria, pneumonia and asthma;* it is also used as an *insect repellent (for mosquitoes, beet rouge, ticks etc)* (van Andel 2000; Sullivan 1999). Additional reports have expanded this list to include *internal cancers, lice and tick infestation of the hair, muscle pain, psoriasis, sore feet, arthritis, flu, fever, leprosy, herpes, ulcers, tetanus* with general uses as a *parasiticide, pedeculicide, vermifuge, insecticide, insectifuge* and *allergesic*. Though not backed up by any other writing covered by this review, A 'Natu.Science Fitorepelentes' report has stated that crabwood oil (andiroba oil) is also "effective" in combating *protozoan, hepatitis, liver infection, kidney infection, tapeworm, jaundice, mycosis and dyspepsia* (www.andiroba.com.br/ingles.html). Krompegel (2000), in her paper "*Ethnobotany of Two Contrasting Ecosystems: Amazonia and Sonoran Deserts'*, identified additional "ethno medical" uses: remedying *throat inflammation, ear infection and vaginal pain*; Sullivan (1999) has noted its anti-diarrhoeal employment. The studies of Reinders (1993), Abulet (1775), Lachman-White (1992) and 'L'Ami des ingredients Naturel', all endorse these claims to varying degrees.

1.3.8 Cosmetic use of crabwood oil

Investigations into the cosmetic value or usefulness of crabwood oil is based on the high presence of linoleic and oleic acids in the seed of the crabwood tree. Linoleic acid is the main fatty acid involved in maintaining epidermis integrity. It can thus be used in all skin care products, anti-wrinkle products; skin restructuring emulsions and body lotions. In April 1998 a US patent was filed for an "invention" (a lipid extracted from the seed of crabwood tree) for the preventative treatment of cellulite. More precisely, the inventors Rouillard, Crepin and Saintigny, claimed that they held, among other things, "a method for inhibiting glucose 6-phosphate dehydrogenase in adipocytes, which comprises: applying to a skin a cosmetic or pharmaceutical composition comprising 0.01-100% by weight of a lipid extract of Andiroba." (US Patent and Trademark Office: Full Patent Text and Database, 1999). Possible compositions for an aqueous gel, body oil, lotion, etc. have been presented. Locally, crabwood oil is applied to the hair to add lustre and sheen. It is also used in scar reduction and as an astringent.

1.3.9 Other uses

Apart from the medicinal and cosmetic uses, crabwood oil is employed as furniture oil as well as a solvent for the extraction of plant colourants. The Munduruku Amerindians of Brazil used the oil to preserve human heads taken in war

2. Demand for the research

There is much evidence for the demand for this research. Within South Africa, several government departments and ministries have prioritized the commercialisation of biodiversity – through policy commitments, programmes and projects - as a key area requiring further attention. The Department of Water Affairs and Forestry, through the National Forest Act (84 of 1998) enables the development of community forestry agreements for the commercialisation of forest produce, provided that yields are shown to be sustainable. South Africa's National Research Foundation has identified the commercial use of biodiversity by communities and the protection of traditional knowledge about biodiversity as key research priorities within its focus areas on (1) the conservation and management of biodiversity; (2) sustainable livelihoods and poverty eradication; and (3) indigenous knowledge systems.

In Guyana, national forest policy identifies the promotion of '*sustainable and efficient forest activities, which utilize the broad range of forest resources and contribute to national development while allowing returns to local and foreign entrepreneurs*', as one of its three specific objectives (Guyana's National Forest Policy Statement of 1997). Policy makers have adopted the strategy of issuing concessions for '*forest uses other than timber extraction*' in a new initiative for Guyana (National Development Strategy 2001-2010). The Iwokrama programme itself has direct oversight of 360,000 hectares of forest, which allow for active NTFP project development, potentially including crabwood oil production in collaboration with local communities. More recently, Conservation International has acquired a large area of Guyana forest, and findings from this work will be of use to them in its management. At the regional level, there is a well recognised need (for example within the Organisation for African Unity (OAU), the Southern African Development Community (SADC) and COICA - the Coordinating Body for the Indigenous Organizations of the Amazon Basin) of the importance of regional strategies for commercialisation, especially with respect to shared biological resources, and associated benefit-sharing and intellectual property considerations.

In both southern Africa and the Guyana Shield, this project has contributed to the knowledge-base on which such strategies can be designed. Through the participation of people from other countries in these regions in the dissemination workshops, information from this project has already received wide attention.

3. Project Purpose

The project purpose is *to identify the economic and social impacts of commercialising non-timber forest products on resource poor farmers, landless people, artisans, traders and small-scale entrepreneurs, as well as the ecological impacts on the forest resource base*. To address the diverse yet integrated issues embodied in this purpose, activities were carried out by interdisciplinary teams from local institutions in South Africa, Namibia and Guyana. Activities were designed to produce consistent and streamlined outputs at each location. Ecological monitoring of both *Sclerocarya birrea* subsp. *caffra* (marula) and *Carapa guianensis* (crabwood) were carried out, providing a baseline dataset for the two species.

How human communities make use of both species was studied by conducting comprehensive household surveys in each country. In South Africa, 6 communities were involved in 2 regions, and in Namibia, 3 communities in the North Central region took part. In Guyana, household surveys were carried out in 20 villages in regions 7, 8, 9 and 10 (see map, Figure 1). In each country, further investigation was made of different agencies along market chains, and this served to provide insights into the impacts the commercialisation process is having on the various groups involved. Five key research hypotheses have been tested, and these are shown in Box 1.

Box 1. Key hypotheses addressed by this research

The key hypotheses addressed by this research are:

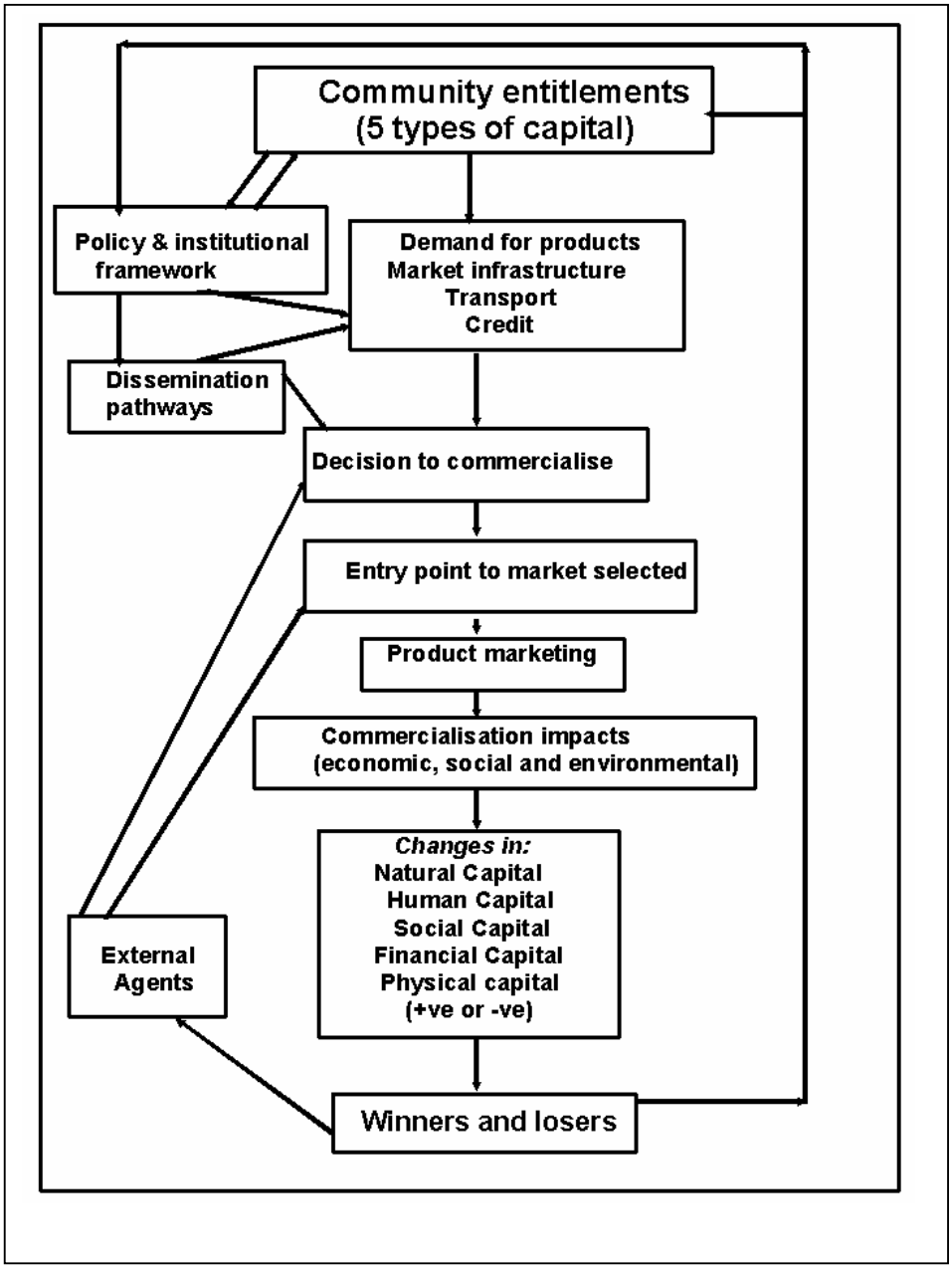
1. Wholesalers, retailers and middlemen often capture the major share of the financial benefits of the commercialisation process, and this can devalue the social, human and natural capital at the local community level.
2. The availability of financial capital and market driven demand can lead to an export of financial and other benefits away from rural communities, leading to a degradation of human and natural capital.
3. Inefficiencies of the product chain can also give rise to this export of financial and other benefits from local communities.
4. The financial benefits of commercialisation can be achieved by the community, if the process is made more equitable, and recognises and enhances the values of the other forms of capital.
5. The threshold off-take is a limiting factor to the sustainable commercialisation of both marula and crabwood unless the resource is enhanced by domestication.

Findings relating to each of these will be discussed in the final section of this report.

4. Research Activities

The research activities carried out in this project were comprehensive and coordinated to produce similar outputs from each study country. Each of these activities will be dealt with in turn. Due to the nature of the differences between the two species, results from crabwood shall be considered separately from those on marula. In each of the following sections, a summary is provided based on the research reports produced during the project. A list of the relevant reports is provided at the beginning of each section, and the full text is provided in the appendices as indicated. The framework on which the research activities are based is illustrated in Box 2.

Box 2. Research framework



4.1 Household & market survey/analysis

Box 3. Relevant project reports: Household & market survey/analysis

See Appendices 1 to 4, specifically:

Martinborough, T. 2002a. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Preliminary Report of the Family Level Survey. Iwokrama International Centre, Guyana.

Martinborough, T. 2002d. The Crabwood Oil Market in Guyana: Increasing Household Income. Dissertation for MSc in Environmental Economics, University of York. U.K.

McHardy, T. 2002b. Use of marula products for domestic and commercial purposes by households in the Ophande district, Maputaland, South Africa. Institute of Natural Resources, South Africa.

Ousman, S., Martinborough, T., Forte, J. and Hammond, D. 2002. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Community Level Survey. Iwokrama International Centre, Guyana.

Forte, J., Ousman, S. and Radzik, R. (eds.) Proceedings of the International Technical Workshop on Sustainable and Equitable Marketing of Crabwood Oil in Guyana, November 23-24, 2002, Lake Mainstay Resort, Region 2, Guyana. Iwokrama International Centre, Guyana.

Shackleton, S.E. and Shackleton C.M. 2002. Use of marula products for domestic and commercial purposes by households in the Bushbuckridge district, Limpopo Province, South Africa. Rhodes University, South Africa.

Shackleton, S.E., den Adel, S., McHardy, T. and Shackleton C.M. 2002. Use of marula products for domestic and commercial purposes: Synthesis of key findings from three sites in southern Africa. Rhodes University, South Africa.

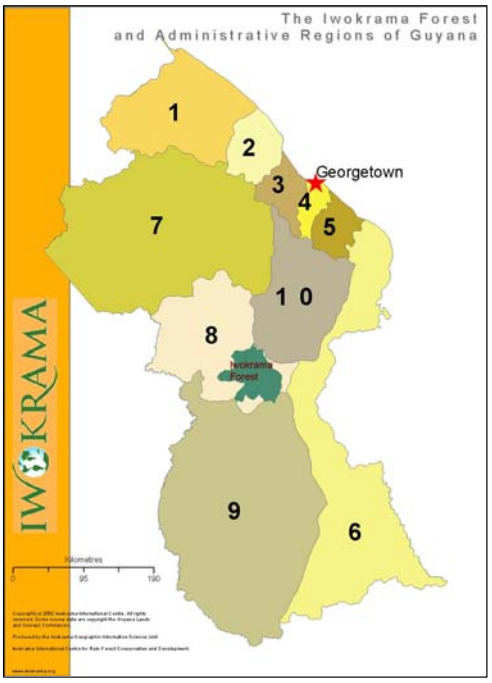
4.1.1 Summary

In order to assess the use and importance of marula and crabwood products to households and communities, representative samples of households were surveyed in locations where the products were known to be important. Due to budgetary limitations, it was decided that only communities where marula and crabwood were relevant were to be examined. While in some ways this may mean that the sample is truncated and not representative of all households in the respective countries, it does, however, mean that, of those communities where these species are relevant, the sample collected during the research does provide an insight into the areas and populations relevant to this study.

All surveys carried out in this project were conducted by trained enumerators, and carried out in a sensitive and considerate manner. In Namibia and Makhatini (Maputaland), a minimum of 60 households were randomly interviewed, whereas the sample size for Bushbuckridge was 142 households in four villages (Hokwe, Rolle, Edinburgh and Allandale). A common interview schedule was used in all the southern African locations, and where possible, the surveys carried out in Guyana targeted the same issues. The interviews, of between one and two hours in length, were conducted in the vernacular with the assistance of local interpreters where needed. In all cases, the field sites were visited during the fruiting season (marula: December to March, crabwood, March to May), although, in the case of southern Africa, due to the need to collect other data during the fruiting period, the surveys had to be carried out prior to fruit fall and ripening. Households were therefore requested to report on the previous two season's use of marula.

In Guyana, this research draws on studies of crabwood oil producers carried out in 2001, in Administrative Regions 7, 8, 9 and 10 of Guyana by Iwokrama International Centre staff collaborating in the CEH 'Winners and Losers' Project. (See Figure 1.) 23 Communities within these regions are known to be producers of 'crab oil' – the colloquial name for the oil in Guyana, and these participated in surveys and community level meetings.

Figure 1. Map of Guyana showing administrative regions



Some features of Guyana and Iwokrama

The population of Guyana, as of 1999, stood at an estimated 721,831, with 51% female. The proportions of the Guyana population living in absolute and critical poverty in 1999 were estimated to be 36.3% and 19.1% respectively, with the highest concentration in the Rural Interior (estimated at 78%) and on the Rural Coast (40%). The Rural Interior of Guyana, is an area with only 9% of the country's population but 70% of all who are living under the poverty line in the country.

Iwokrama is an area of 3,600 km^2 of primary rainforest in central Guyana which has been designated as a area for international research into forest conservation and development. It promotes research and training for scientists from Guyana and elsewhere.

During this project, a total of 20 community-level surveys were completed, mainly with Village Leaders and Councils. Each community profile assessment aimed at gathering data on a collective number of households. The community level survey mainly focused on assessing:

- access rights to resource sites by crabwood seed collectors
- land tenure issues
- production levels of crabwood oil in communities with access to resources and in those with restricted access
- shifts in the number of crabwood oil producers
- abundance and availability of the resource – crabwood trees
- energy requirements of the conversion process and the status of crabwood seed supply
- number of producers in comparison with the scale of crabwood oil production

At the household level, 131 households were included in the survey, and additional qualitative material was collected from interviews with key informants – village leaders, crabwood traders, chainsaw operators, pharmacy operators in Georgetown, government officials, etc.

In South Africa, Namibia and Guyana, the household questionnaire used was complex and comprehensive, and covered:

- the uses of marula and crabwood;
- quantities used/made of each tree-based product (e.g. fresh fruit, beer/wine, jam, kernels, wood, medicine, oil, bark, leaves etc.);
- sales and income;
- cultural value;
- access, management and tenure issues;
- resource availability; and
- household socio-economic characteristics.

The same approach, questionnaire and data summaries were used in Makhatini and northern KwaZulu-Natal, South Africa and in North Central Namibia (formally Ovomboland) (see McHardy 2002, den Adel 2002). In both South Africa and Namibia, two group meetings were held to clarify a range of themes identified during the household survey as needing further elaboration and clarification. Themes explored included: traditional recipes and uses of marula, resource access and management issues, attitudes towards commercialisation, and cultural practices associated with marula (such as presenting the *induna* with beer - *xikuha*). Over 20 participants attended each meeting, mostly women.

Data were captured in Excel spreadsheets and analysed for each village individually and the whole dataset. For the southern African data, estimates of quantities of outputs produced per season were calculated from the data on amounts collected or made each time, the frequency of collection or production, and the length of the season. The gross direct use value of the different marula products to households was obtained by multiplying the amount used in the season by the local 'farmgate' price. All data were averaged across households. Where there was wide variation in the data, ranges as well as means are reported. In this summary report the results across individual villages/households were pooled for each area to provide averages representative of the particular study area as a whole, and to facilitate comparison between sites. Summary details of household surveys in the three study sites in southern Africa are provided in Table 4, and for Guyana in Table 5, and details of these surveys, including the survey instruments, are provided in Appendices 1, 2, 3, and 4.

Table 4. Key socio-economic characteristics of households interviewed in each of the study sites in southern Africa *(Means and Standard Deviations)*

Variable measured	Bushbuckridge	Maputaland	Namibia
Average residency period (years)	31 ± 0.2	16 ± 1.4	40 ± 2.6
% female headed hh	34.5	25.4	33
Average hh size	7.5 ± 0.3	7.2 ± 0.3	11.9 ± 0.8
Average number of jobs per hh	1.01 ± 0.1	0.62 ± 0.1	1.3
% of hh with one or more jobs	66	49	62
% of hh with pensions	35	27	10
% of hh with no regular income from jobs or grants	15	38	12
Average hh income from resident earners (Rands/hh/month)* **	731 ± 85	335 ± 58	799 ± 319
Average remittances from migrants and non-resident contributors (Rands/hh/month)	195 ± 42	113 ± 48	Difficult to obtain - often in kind payments
% of hh earning <R250/month	25	37	48
% of hh earning between R251 – R1000/month	47	44	35

* Monthly incomes were not easy to obtain as some households were reluctant to divulge their incomes, whilst others found this variable difficult to estimate, either because they did not know what the income earner earned or because they were self-employed and income varied widely from month to month. We believe that there was a tendency to over-estimate income from self-employment. However, the values obtained were comparable to existing estimates for the study sites.

** The Namibian Dollar (N$) and South African Rand (SA R) are linked and directly equivalent to each other. See Box 4 for exchange rates.

Box 4. Currency exchange rates at the time of the surveys

Currency, 2002	US dollar rate	UK £ rate
South African Rand, and Namibian dollar	10	16
Guyanese dollar	185	230

Table 5. Some summary results of household surveys in Guyana

Household responses to questions on crabwood production, (%), 2001			
1. Experience of the producers	1 to 5 years (49.2%)	5 – 15 years (20.9%)	Over 15 years (29.8%)
2. Magnitude of production, lts. /season	0 - 45 (67.4%)	46 – 135 (25.2%)	136 – 180 (7.6%) *
3. Quantity of seeds required to produce 5 litres of oil (kg)**	Up to 200 (38.5%)	200 – 350 (19.2 %)	Over 350 (3.8%)
4. Crab oil Selling Prices, (G$ per litre)	Less than 300 (16.3%)	300 - 600 (38.7%)	0ver 600 (44.8)
5. Production cost, (G$ per litre) ***	Less than 750 (57.9%)	750 – 1500 (5.4%)	Over 1500 (8.6%)
6. Income generation, (G$ per annum) ****	Up to 6000 (34.2%)	6000 – 14,000 (6.1%)	Over 14,000 (23.7%)
7. Trading links External – outside of the village	All external (76.9%)	All internal (4.4%)	Mixed (18.5%)

Notes: * 2.5% of households reported producing over 300 litres of oil per season;
** Great inconsistency was recorded in estimations of seed requirements, and 38.5% of respondents gave no answer.
*** Responses only given by 72% of respondents
**** Responses only given by 56% of respondents

4.1.2 Use of resources

Both the crabwood and marula trees provide many uses for people, including in both cases, its use as timber. The crabwood tree is used very differently from the marula, as the fruits are not seen as a direct source of food for humans. Summary details of how crabwood is used are shown in Table 6, and a summary of the uses made of marula trees in the 3 study locations in southern Africa are shown in Table 7.

Table 6. Uses of crabwood timber as reported by chainsaw operators

% Responses of chainsaw operators on use of crabwood	%
1. Used to construct buildings; interior finishing in houses;	45.9
2. Making boats, furniture, birdcage and paddles	6.7
3. Lumber used for building boats and houses	19.3
4. Making various types of boats, canoes, prams, paddles	15.8
5. Making furniture	12.3

In addition to its use as an important source of timber, crabwood is an important source of oil extracted from its seeds, as well as other parts such as bark being used for medicinal purposes.

Table 7. Use of marula products by households (% hh) in the different study sites

% of households using		Bushbuckridge	Makhatini	Namibia
Fruit	Eating	94	57	97
	Beer/wine	75	71	100
	Juice	13	0	100
	Jam	31	0	3
	Other (fodder, sell, manure)	16	2	-
Kernels	Whole	88	81	98
	Oil (cooking)	0.7	0	100
	Oil (cosmetic)	1.4 (obtained from MDC)	2	28
	Add to food	61	68	100
	Eat 'cake' (residue after oil extraction)	0	0	100
	Cake as animal feed	0	0	68
Wood	Carving	5	8	0
	Utensils	10	11	52
	Firewood	94	60	97
	Other (cattle yoke, fencing, furniture)	7	0	78 (poles)
Medicine	Bark	39	80	2
	Roots	8	14	5
	Leaves	4	24	52
Caterpillars		54	39	30
Larvae		2	14	3
Game pieces		60	0	73
Other (e.g. burn shells, veterinary use, leaf skirts, fodder, rattles and necklaces, fencing, diviners dice)		15	4	100 (burn shells)

How this information has been used to address the research hypotheses is discussed in Sections 5 and 6.

4.2. Interviews with key informants in commercial chains

Box 5. Relevant project reports: Interviews with key informants in commercial chains

See Appendices 1 to 4, specifically:

den Adel, S. 2002. Use of marula products for domestic and commercial purposes by households in North-Central Namibia. CRIAA SA-DC, Namibia.

du Plessis, P., Lombard, C. and den Adel, S. 2002. Marula in Namibia: Commercial Chain Analysis. CRIAA SA-DC, Namibia.

Shackleton, S.E. 2002. The informal marula beer traders of Bushbuckridge, Limpopo Province, South Africa. Rhodes University, South Africa.

Shackleton, S.E., Wynberg, R.P., Sullivan, C.A., Shackleton, C.M., Leakey, R.R.B., Mander, M., McHardy, T., den Adel, S., Botelle, A., du Plessis, P., Lombard, C., Laird, S.A., Cunningham, A.B., Combrinck, A. and O'Regan, D.P. 2002. Marula commercialisation for sustainable and equitable livelihoods: Synthesis of a southern African case study.

Forte, J., Ousman, S. and Radzik, R. (eds.) Proceedings of the International Technical Workshop on Sustainable and Equitable Marketing of Crabwood Oil in Guyana, November 23-24, 2002, Lake Mainstay Resort, Region 2, Guyana. Iwokrama International Centre, Guyana.

Mander, M., Cribbins, J., Shackleton, S.E. and Lewis, F. 2002. The Commercial Marula Industry in South Africa: A sub-sector analysis. Institute of Natural Resources, South Africa.

Martinborough, T., Forte, J. and Hammond, D. 2002. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Preliminary Report of the Chainsaw Operator Survey. Iwokrama International Centre, Guyana.

Martinborough, T. 2002b. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Preliminary Report of the Pharmaceutical Dealers Survey. Iwokrama International Centre, Guyana.

4.2.1 Summary

Various market chains were investigated during this project. In South Africa, five different market options were examined, while in Namibia, marketing of marula fruit, kernels and oil was investigated. In Guyana, the markets for crabwood oil and timber were examined through information from household surveys, pharmaceutical businesses and chainsaw operators.

4.2.2 The marula fruit sales marketing chain (to MDC and Distell)

To investigate the commercial marula market chain, a telephone and e-mail survey was first conducted to engage several commercial role players within the marula industry, to identify operational commercial chains. In addition to a few small local producers and several women brewing and selling beer, two primary large scale role players were identified in South Africa:

- Distell
- Mhala Development Center (MDC)

In terms of marula commercialisation, five viable and active market channels were identified, including:

- Amarula Cream liquor channel
- Marula juice channel
- Marula oil channel
- Kernel channel
- Marula beer channel

To investigate these various channels, a more extensive survey was conducted with these role players involving field visits, interviews, and individual and group surveys in the Phalaborwa and

Bushbuckridge areas in South Africa – an area with relatively high densities of marula trees, and in the north central regions of Namibia, where resources are more scarce. In Namibia, several key informants were interviewed, and community discussion groups were held. In South Africa, preliminary interviews with Distell and MDC revealed that the production and processing activities involved extensive community participation, as the harvesters of the fruit and nuts. These communities were therefore also included in the survey on marula harvesting and processing activities.

Questions included data on quantities and type of marula resource collected, information on collection operations, and, where possible, the costs of marula collection, processing and sales, as well as information on household characteristics. Two local community members were employed and trained to conduct the survey interviews, with guidance from the project team.

Figure 2. Group interview at Edinburgh under a marula tree

The data collected relates to the 2001/2002 fruiting season. Forty-one individuals supplying to Distell were interviewed at the Distell Factory site in Phalaborwa and one group interview (consisting of nine people) was conducted with collectors at Edinburgh in the Bushbuckridge area. Several individual and group interviews were also conducted with representatives from management of Distell and Mirma at Stellenbosch and Phalaborwa. For the MDC chain, a total of 93 people involved in supply and processing marulas were interviewed. Fifty were involved in the collection of fruit and the remaining 43 were involved with nut extraction. Interviews and group discussions were also held with MDC management.

4.2.3 Limitations of the survey into large scale commercialisation

While the survey was relatively successful in producing qualitative information, it did not provide conclusive quantitative data. The commercial enterprises either did not have the relevant data as there were incomplete marketing chains, or they were not willing to supply data required due to the fear of compromising their market position. Community surveys did not always provide accurate data due either to a lack of understanding between harvesters and interviewers, or inability of some harvesters to recall information. Some individual interviews had to be shortened due to time constraints, but overall, the work has been sufficient to generate improved understanding of marula commercial chains.

4.2.4 The marula beer[2] marketing chain

Forty-five beer traders were randomly interviewed in the five main towns in the Bushbuckridge district where marula beer is sold, namely Acornhoek, Thulamahashe, Bushbuckridge, Mkhuhlu, and Hazyview. Between ten and eleven traders were interviewed in each market, except for Mkhuhlu, where only two traders were encountered. In addition, six roadside traders selling along the main road were interviewed. The total sample size was thus 51 traders. The survey was conducted at the beginning of the fruiting season, in late January and early February and represents the markets during this period. The markets were revisited in early March and fewer traders were found.

A structured interview dealing with the characteristics of traders, characteristics of the market, production and income, sources of fruit, and problems and constraints was administered in the local language (*Tsonga* or *Pedi*) through an interpreter. Each interview took about half to one hour to complete, depending whether the traders were trading for the first time or not. In addition, a full count of all traders in each market, where they came from and when they had

[2] Some researchers and stakeholders use the term 'cider' in place of 'beer'

started selling marula beer, was carried out each time one of the markets was visited. Most markets were visited two or three times. Data from a comprehensive household survey of four villages in the region were also used to complement the findings from the trader survey (see Shackleton and Shackleton 2002). The contribution that marula beer makes to household income in the area is shown in Table 8.

Table 8. Average contribution of beer sales to household income and livelihoods, Bushbuckridge, South Africa, 2002

Length of selling season (weeks) (based on traders estimates) (mean ± SE)	6.5 ± 0.3
Gross income (R) per season (mean ± SE)	687.31 ± 66.85
Costs (R) per season (transport, lunch, bottles) (mean ± SE)	192.56 ± 23.74
Net (cash) income per season (mean ± SE)	500.25 ± 74.07
Labour inputs per season (hours) (mean ± SE): Beer production Selling Total	 73.67 ± 9.12 168.05 ± 15.46 241.72

From the data collected, it has been calculated that the returns to labour for marula beer sales were R2 (South African Rand) per hour or R16 per day, which is above the minimum wage for the area of R10 per day. Respondents also mentioned that selling beer was much more profitable than selling fruit to MDC or Distell who were "robbing them". This is supported by the household data which demonstrate average net incomes of between R194 and R335 for fruit sales. It must be noted, however, that the above analysis does not take account of the value of labour inputs, and when this is factored in, the returns to beer production and sales are lower (for full details, see Shackleton et al. South African Synthesis report, Appendix 3.5). In addition to sales of beer, selling of marula kernels is also important. Some details of the production levels in 3 areas of southern Africa are shown in Table 9.

Table 9. Production of the two most popular marula products in southern Africa, 2002

	% of households producing	Average amounts produced (litres per producer household per season); range in parentheses
Beer/wine*		
Namibia	100	195 (5 - 1200)
Bushbuckridge	75	311 (10 - 3360)
Makhatini	71	253 (25 - 400)
Kernels		
Namibia **	100	72 (2 - 250)
Bushbuckridge	88	10 (1 - 100)
Makhatini	81	12 (3 - 84)

* Wine in Namibia is an undiluted, fermented marula drink, whilst South African marula beer is generally diluted with water.

** Most kernels in Namibia are used for the production of a traditional cooking oil, whereas in South Africa they are eaten.

4.2.5 Marula market chains in Namibia

Traditional marula use in Namibia is very culture-specific, and consequently varies between regions. For example, in the North Central Region of the country, marula is so important, and its use so universal, that traditional laws and customs have evolved around it, while in the north-eastern Kavango and Caprivi regions, marula is traditionally not even used to any significant extent. Our study has concentrated in those high use areas in the north Central part of the country, in the Oshana, Oshikoto, Ohangwena, and Omusati Regions. This whole area is home to almost half of Namibia's population, with an estimated 800, 000 people living in the area. Although subsistence farming is the main activity for most households, due to poor soil quality and uncertain climatic conditions, this represents a poor and sometimes insufficient means of survival. All households interviewed have an arable field and cultivate it, and the average size of

the fields is 4.3 hectares. The average annual income from agricultural sales for these subsistence households is only N$ 100, highlighting the value of financial capital generated from marula product sales.

The surveys and other research techniques used in Namibia followed the same design as those used in South Africa, with minor changes being made for local conditions. The following commercial chains for marula were identified as operating actively in 2001/2002:

- Manual juice extraction and cider production for sale in local and national markets
- Juice extraction with small hydraulic presses and cider production for sale in local and national markets
- Manual kernel extraction for sale in local and national markets
- Manual kernel extraction and traditional oil production for sale in local and national markets
- Manual kernel extraction and cold-pressed oil production for the international cosmetics markets

Fruit collection is an activity which is carried out mainly by women, but there are many different uses which are made from the tree. These are shown in Table 10.

Table 10. Percentage of households using marula products

Marula Use	% of HH		Marula use	% of HH
Eating fruits	97%		Wood carving	0%
Wine (omaongo)	100%		Wood for utensils	52%
Juice (oshinwa)	100%		Firewood	97%
Porridge from fruits	78%		Housing/fencing poles	78%
Jam	3%		Bark as a medicine	2%
Eating kernels	98%		Roots as a medicine	5%
Cooking oil (ondjove)	100%		Leaves/branches as medicine	52%
Cosmetic oil	28%		Edible caterpillars	30%
Use kernels in recipes	100%		Edible larvae	3%
Eat the cake	98%		Hair relaxer	37%
Cake as an animal feed	68%		Nuts for game pieces	73%
'Soup' from kernels	100%		Empty nuts as firewood	100%

All households sometimes extract kernels, but those that had more female labour available and were more involved in kernel sales did so more often, and in larger quantities. Among the households surveyed by den Adel (2002), the average quantity extracted per household was 36 kg (SD+/- 26 kg). 14% of households sold kernels only from home, and 37% sold only in local markets – in both instances the price is fixed (by local custom) at about N$8/kg. In a controlled test to determine the productivity of the traditional extraction methods, six women were asked to decorticate 5 kg of marula nuts each. The results are shown in Table 11, and on average, the time to extract 1 kg of kernels in Namibia is found to be 8hrs 12 minutes. These figures suggest that the return to labour from kernel sale is rather low, at N$1 per hour.

Table 11. Kernel extraction in Namibia

Name	Time to cut 5 kg nuts	Time to take out kernels	Total time to extract kernels from 5 kg nuts	Kg of kernels from 5 kg nuts	time to extract 1 kg of kernels
Johanna	1h45	2h24	4h09	0.528	7h51
Selma	2h00	2h15	4h15	0.512	8h18
Aino	2h19	2h41	5h00	0.597	8h22
Otilie	2h27	2h14	4h41	0.554	8h27
Ina	2h05	2h31	4h36	0.576	7h59
Leticia	2h22	2h39	5h01	0.609	8h14
Average	**2h10**	**2h27**	**4h37**	**0.563**	**8h12**

Marula oil is extracted from kernels, and a relatively experienced oil extractor can usually get about 200 ml of oil from 1 kg of good kernels in one hour, but the yield can be substantially lower. This suggests that the most productive oil producers will take at least five hours to produce 1 litre of oil from 5 kg of kernels. Since each kilogram of kernels has taken some 8 hours to produce, the total labour input to produce one litre of marula oil in the traditional way is 45 hours.

Most people in the region are very poor, and make their own oil. There are, however, some sales in local markets, but it is never sold in large quantities. The price is set at N$15 per 200 ml, giving a market price of N$75 per litre when sold locally. This indicates a greater rate of return to labour, at N$1.6 per hour, demonstrating the importance of adding value to NTFP products. These figures, however, are still very low, but, nevertheless, indicate that the people in this region do benefit financially from marula utilisation. For more details on this work see den Adel (2002), and du Plessis et al. (2002) in Appendix 2.

4.2.6 A commercial market chain: crabwood timber production

Crabwood is an important timber species in Guyana, and its market chain runs from forest areas to the international export market. To assess the significance of this to crabwood resources in Iwokrama, a survey of chainsaw operators was undertaken through questionnaires to determine:

- scale of chainsaw operation
- scales of production of crabwood timber
- present market value
- selling prices of crabwood timber in various sizes and forms
- uses of the crabwood timber
- ranking of sales of crabwood timber in comparison to other main timber species
- production costs e.g. transportation
- existing markets
- sustainability of resource

A total of 57 chainsaw operators were surveyed in 15 villages in Region 10. Their responses are shown in Table 12.

Table 12. Sample responses of chain saw operators

Chainsaw operators responses (% total)	Weroni district (20%)	Ituni, Sand Hills, MH (36%)	Other areas (45%)
% operators reporting markets for timber sales *	sales to local communities (21%)	sales to Georgetown (32%)	sales to New Amsterdam (75%)
Chainsaw operators involved in crabwood seed use	collect seeds (35%)	relatives involved in oil production (42%)	make crabwood oil in their own households (20%)
Length of employment as a chainsaw operator	Over five years (50%)	3 – 5 years (33%)	Less than 3 years (18%)

* more than one selling location reported by operators

The survey reported that crabwood timber is sold in two forms – logs and rough sawn lumber - by the chainsaw operators. The uses of the wood have been shown in Table 6. The undressed crabwood lumber is being sold for an average of GY$31.00 per board foot (bm) by the surveyed chainsaw operators involved in sawing crabwood lumber. However, some of the respondents are only selling the crabwood in the log or raw form for an average of GY$1.67 per board foot. None of the operators were producing dressed crabwood lumber since all of the respondents indicated that there was no equipment (plane/edger) to dress the lumber in the area of operation.

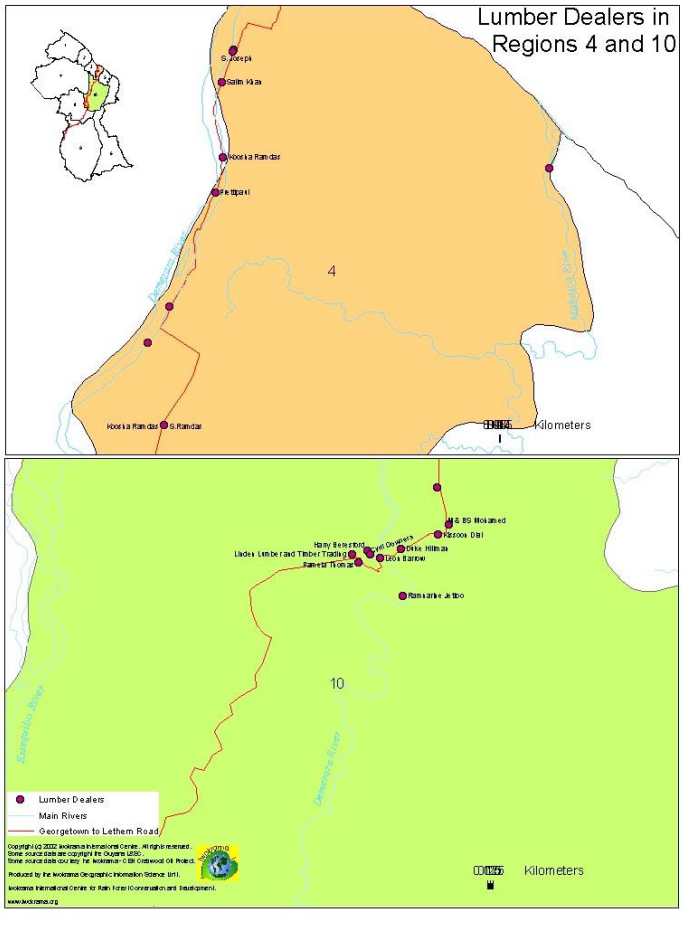
A number of reasons have been given by chainsaw operators and others for the decline in the number of crabwood oil producers in the region. These reasons are listed in Table 13, and one

of the major reasons given is the increase in logging over the last 20 years. These figures suggest that much of the benefit of crabwood logging is going out of the community, both in financial terms, and due to the subsequent depletion of natural capita in the form of crabwood seeds.

Table 13. Common factors identified for the decrease in the number of crabwood oil makers in the surveyed villages of Region 3 and 10

Reasons for decline in crabwood oil Producers	Ranking (1 being the most common factor)
1. Logging over the last 20 years	1
2. Low availability of crabwood trees and travelling long distances to obtain seeds	2
3. Crabwood oil is slow to sell	3
4. Time and labour intensive	4
5. Migration of youths from village seeking alternative jobs	4
6. Price does not compensate for time and energy	5
7. Lack of steady market and low price	5

Figure 3. Where crabwood timber is sold in central Guyana



4.2.7 Crabwood oil market chain – interviews with producers and commercial oil buyers in Guyana

In a survey across three administrative regions of Guyana (10, 9 and 8) 131 commercial crabwood oil-producing households were identified. Of these, 116 were located in Region 10, although since not all villages in that region were covered, the data is unlikely to have captured all producers of that region. A total of 34 oil producing households were selected for detailed study to investigate factors influencing crabwood oil production. Details of producers in 3 communities are shown in Table 14.

In an earlier national study in 1999, 75 pharmacies/drugstores were surveyed, and 73.3% were involved in the crabwood oil trade. In 2000, a sample of 15 of these pharmacies was again surveyed to ascertain price changes. Visits were also made to market vendors who sell crabwood oil. The survey instrument used can be found in Appendix 4.

Table 14. Crabwood oil Producing Population (1999-2000 and 2002)

Community	1999-2000 crabwood oil producing population (households)	2002 crabwood oil producing population (households)	Percentage of households sampled in 2002
Ebini	22	15	73
Ituni	8	8	75
Wiruni	15	11	73

As a result of the study, a number of issues relating to the various market chains for crabwood and marula were revealed, and these are discussed in more detail in subsequent sections of this report.

4.3 Commercial chain analysis

Box 6. Relevant project reports: Commercial chain analysis

See Appendices 1 to 4, specifically:
du Plessis, P., Lombard, C. and den Adel, S. 2002. Marula in Namibia: Commercial Chain Analysis. CRIAA SA-DC, Namibia.

Grimmond, J., Joseph, I. and Datadin, V. 2002. A spatial assessment of Crabwood Oil production in Regions 9 & 10 of Guyana. Iwokrama International Centre, Guyana, Technical Report No. 2002/1.

Martinborough, T. 2002b. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Pharmaceutical Dealers Survey. Iwokrama International Centre, Guyana.

Martinborough, T. 2002d. The Crabwood Oil Market in Guyana: Increasing Household Income. Dissertation for MSc in Environmental Economics, University of York. U.K.

Mander, M. (2002) Lessons from Commercialising Natural Products in Southern Africa In: Forte, J., Ousman, S. and Radzik, R. (eds.) *Proceedings of the International Technical Workshop on Sustainable and Equitable Marketing of Crabwood Oil in Guyana,* November 23-24, 2002, Lake Mainstay Resort, Region 2, Guyana. Iwokrama International Centre, Guyana.

Mander, M., Cribbins, J., Shackleton, S.E. and Lewis, F. 2002. The Commercial Marula Industry in South Africa: A sub-sector analysis. Institute of Natural Resources, South Africa.

Martinborough, T., Forte, J. and Hammond, D. 2002. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Chainsaw Operator Survey. Iwokrama International Centre, Guyana.

Poulson, U. 2001. International Market Survey Report for Marula and Crabwood Products. CEH Wallingford, U.K.

4.3.1 Summary

Marula resources are widely used throughout southern Africa, and various scales of commercialisation can be observed. In this region, markets for these resources range from relatively large-scale formal markets, to individual traders in informal operations, carried out on an ad-hoc basis. Crabwood, on the other hand, is widely used in a number of countries around the Guiana Shield, and in Guyana, it is used commercially for timber, and to a much lesser extent, for crabwood oil. In Brazil, the use of crabwood oil is becoming more widespread, sold under the name of *'andiroba'*, now recognised for its insecticidal properties. This section examines some aspects of commercial market chains for marula and crabwood, but full details can be found in the research reports listed above.

4.3.2 Commercial enterprises and formal markets in South Africa and Namibia

There are five organisations in South Africa involved in marula use. Distell (a new company recently formed from a merger of Cape Distillers and Stellenbosch Farmers' Wineries) is the largest consumer of marula fruits and pulp in South Africa. It is also the longest existing commercial initiative based on *S. birrea* in the region having started in 1981. The company processes approximately 700 tons of pulp or 2000 tons of fruit into Amarula Cream annually. The other large commercial company with an interest in marula is Northern Canners Limited – NORJAX. At present, the company is not yet marketing marula oil products, but has been experimenting and producing a limited amount of marula oil.

A recent, but innovative, project is the Marula Project of the national Mine Workers Development Agency (a Section 21 Company). Three main products are being developed, a marula beer mainly for the local tourism market, a nectar or juice, and an oil for export. The potential of other marula-based products such as soap and massage oil is being investigated. In January 2001 alone, over 300 individuals and 54 employees from 27 communities around the Mhala Development Centre in Thulamahashe, benefited financially from the Marula Project (MDC project outline, undated). Each season the Mhala Development Centre processes about 80 – 100 tonnes of marula fruit to produce approximately 8 tonnes of pulp. Marula Committees at village level control the quantity and quality of fruit supplied, with each of the 27 committees being supplied by about 10-30 collectors, primarily women. The Mhala Development Centre is working hand-in-hand with another community development project, the DANCED/Department of Water Affairs and Forestry Community Forestry Project, to ensure sustainable use and management of the marula resource and to promote on-farm planting.

Lisbon Estates is a parastatal citrus and mango estate located near the Kruger Gate of Kruger National Park. They commenced producing marula jelly in 1983, but have recently closed this enterprise. Approximately 12 000 bottles of marula jelly were processed annually, some of which was supplied to Kruger National Park. Due to limited profit margins and a small market, the marula jelly enterprise showed little growth, ultimately resulting in its demise in 2001. Like Lisbon Estates, Ina Lessing Jams produce a wide variety of fruit jams, jellies and chutneys using both commercial grown and indigenous fruits. Unlike the other commercial producers described above, none of their fruit for marula products comes from communal lands. The products are mainly sold within South Africa.

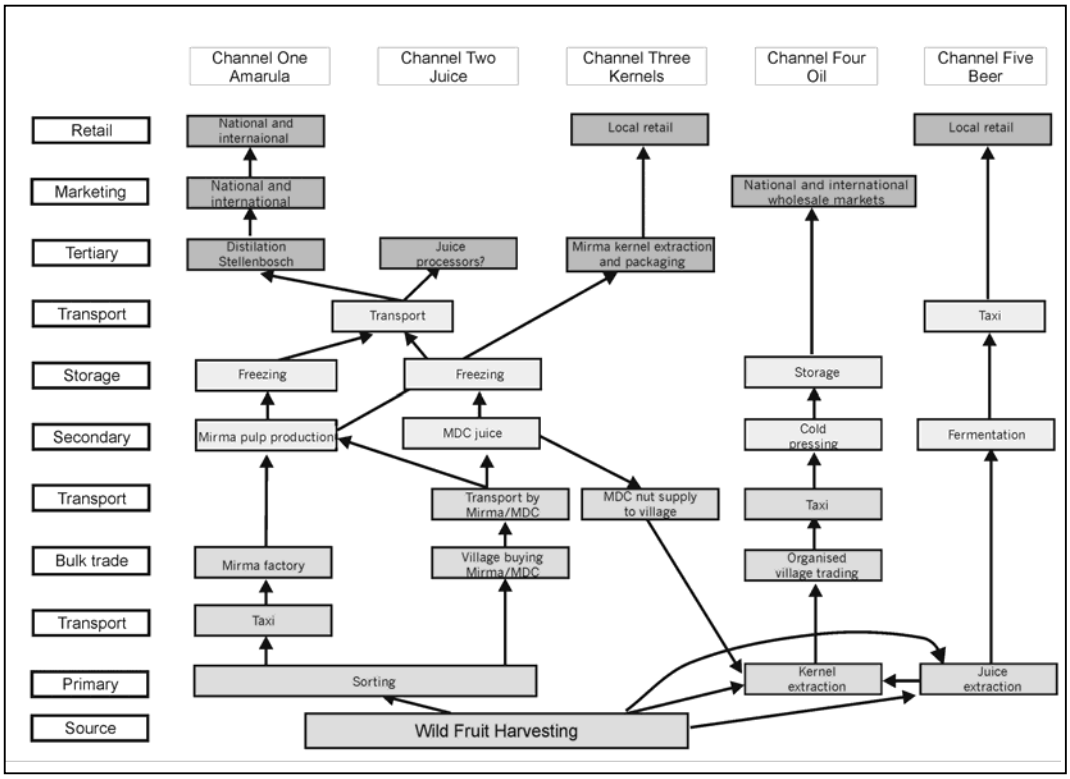
In Namibia, CRIAA SA-DC has been largely responsible for expanding the market in marula products for rural producers. The marula products involved include kernels, oil and oil-based products (e.g. soap) for local and export markets, and fruit-based products presently for informal markets. Fruit juice products are hand and machine processed. Marula commercialisation in Botswana is now negligible although Veld Products Research and Development have initiated some trial marketing of marula 'chunks' and jam.

In terms of how marula resources are currently used commercially, five different commercial market chains have been examined in South Africa and Namibia during this project. These include:

- Amarula cream production by Distell;
- Marula fruit sales for juice production;
- Sale of kernels;
- Sale of marula oil;
- Sale of marula beer.

How these five commercial chains operate is shown in Figure 4.

Figure 4. Generalised commercial market channels in the marula industry in Namibia and South Africa



Source: Mander et al. 2002

In each case, the chain has been traced from source of raw materials through to sale and use by consumers. Both costs and benefits have been examined, and these are discussed in Section 5.

4.3.3 The market for crabwood products

The market for crabwood oil is quite informal, although timber markets are more organized. Oil tends to be made in the home of forest dwellers, and they may sell it to their neighbours or to speculative traders who buy it from them at a low price. Most oil supplies sold in Georgetown originate from the Berbice River communities (Region 10), but a network of distribution allows traders to purchase the oil in wholesale and retail quantities, without any dealing with producers. A small number of middlemen provide the link between them.

Quality is considered important and only 30.9% of the traders were able to give an idea of where their oil was being produced. The oil's availability is shown to be much greater in Georgetown than anywhere else. For every 6 traders found in Georgetown, there were 4 on the main access roads of East Bank of Demerara and 1 on those of the West Coast of Demerara. The most striking, however, was the Georgetown/East Coast Demerara ratio of approximately 32:1. Three traders were involved in the bottling, labeling and distribution of the oil. It is noteworthy that though it is in Georgetown and its environs that crabwood oil is most accessible, the population of this area appears least knowledgeable of the oil and its uses both traditional and innovative. Prices for crabwood oil at different stages of the market chain are shown in Table 15, and it clearly demonstrates that the majority of money to be made from the oil does not tend to accrue to producers at the household level.

Table 15. Crabwood oil prices in Guyana, 2000.

Price in interior regions (G$/litre)	Price per litre on the coast (G$/litre)	Loose oil price (G$/oz)	Bottled oil price (G$/oz)	International price (US$ per kg)
G$630	G$1,260	G$50-185	G$13-35	US$15

Source: Martindale 2001; van Andel 2000.

In spite of the potential of its oil in candle and soap making, and as a phytorepellant, it is still the timber of the crabwood tree that is given attention by local policy makers, but given its potential on both the national and international markets, crabwood oil is a prime candidate for policy attention, and it hoped that this study and its dissemination outputs will be of use to policy makers. To examine some of the factors influencing the use and sale of crabwood, econometric techniques have been used to test two hypotheses:

Hypothesis 1: *Increase in market access increases household income* (from crabwood oil production)

To test this hypothesis, several regressions were run to ascertain the relationship between the average net incomes generated by crabwood oil sales (the dependent variable) and the independent variables. The function is as follows:

Average Net Income =ƒ (Road Access, Travel to Market, Travel to Middleman, Number of Producers in Community)

A log-linear function was used to test this hypothesis. Dummy variables were used for "Road Access", "Travel to Market" and "Travel to Middleman". The variable "Net Income" was divided by the "Production" to get the net income per gallon of oil produced ("Average Net Income"). This variable was transformed to the exponent e, i.e. the natural log of "Average Net Income". "Number of Producers in Community" was cubed and also naturally logged.

The resulting regression was log-linear and as follows:

Ln NetInc= 5.834 + 4.232*RA + 1.255 tr_mkt + 2.152 tr_mddm +0.191 (ln #Proders) + u

Standard error (0.783) (0.629) (0.772) (.085)

Where: NetInc is Average Net Income
RA is Road Access
Tr_mkt is the Travel to Market
Tr_mddm is Travel to Middleman
 # proders is Number of Producers in Community

RA, *Tr_mkt* and *Tr_mddm* were all dummy variables.

The explanatory power of the regressors with regard to the variability in average net income was 0.766 or 76.6% with a standard error of 0.9703.

Tests of significance - Joint Test of Significance

In spite of a very high P-value equivalent to 0.000 for the F-statistic, it was nevertheless tested to reinforce the significance of the regressors as a whole.

The hypotheses were as follows:
H_0 = coefficients of all independent variables in model = 0
H_1 = coefficients of all independent variables in model $\neq$ 0

F statistic from regression =12.298 while the F-critical at a 5% level of significance or $F_{0.05(4,15)}$ =3.06. The fact that the F statistic was greater that the F-critical, resulted in the failure to accept the null hypothesis of no joint significance of the independent variables (see Table 16).

Individual Significance

The hypotheses tested were as follows:

H_0 = variable coefficient = 0
H_1 = variable coefficient $\neq$ 0

Table 16. Variable Significance-Regression 1

Variables	β	Standard Error	T statistic	Significance	95% confidence interval	
					Lower bound	Upper bound
Constant	5.534	0.794	6.956	0.000	3.840	7.227
RA	4.232	0.783	5.402	0.000	2.565	5.900
Tr_mkt	1.255	0.629	1.955	0.065	-0.086	2.596
Tr_mddm	2.152	0.772	2.789	0.014	0.507	3.796
# proders	0.191	0.085	2.254	0.040	0.010	0.371

All variables except *Tr_mkt* were significant at a 5% level of significance.

The Critical-*t* statistic, at a 5% level of significance, and divided by $t_{(\alpha\ ,\ n-2)}$ (where α is the degrees of freedom (0.05) and n is the sample size (20)) was equal to 2.101. In each case, except for that of *Tr_mkt* the *t*-statistic surpassed the *t*-critical, causing a rejection of the null hypothesis of no significance. RA was by far the most significant variable with a t-statistic of 5.402.

These results show that with all variables held constant and at a 95% confidence level:

- The mean average net income of households with direct access to road transportation is 6785.5% greater than that of households without;
- The mean average net income of households that travel to the market is 250.9% higher than that of households who do not travel to market;
- The mean average net income of households that travel to middleman is 760.2% higher than those who do not;
- A 1% increase in the number of commercial producers a community will result in a 0.191% increase in the mean average net income earned by these producers.

This work clearly shows that there is a direct benefit to be made by crabwood oil producers if they can gain access to the market.

Hypothesis 2: *Increase in market access may lead to overexploitation of crabwood seeds in public forests.*

The function is as follows:

Over-exploitation = f(Average net household income from crabwood oil, household size, income from other sources, direct access to road)

The assumption is that the relationship between the probability to over-harvest and the independent variables will not be a linear one. A logistic function raised to the third power was used to analyse this relationship. Due to the assumption of underlying normality of the population distribution, Logit regression was used. All independent variables with the exception of road access was raised to the third power and naturally logged.

The resulting regression model is:

$$\ln \frac{Pr\ of\ Overexploitation}{Pr\ of\ no\ Overexploitation} = 12.388 - (0.899)\ 3\ lnPrice + (0.7)\ 3\ ln\ AvProd + u$$

Wald statistic: (3.012) (5.542)

Where: *Pr* represents Probability
Price is the price of crabwood oil; and
AvProd is average production of household

The overall explanatory power of the model has been found to be 86.2%. A number of variables which were expected to influence the odds of overploitation, (eg. transportation costs, number of producers within each community, family size and road access), were found to be insignificant. In all combinations of variables, the constant was insignificant. With the critical t-statistic at 95% level of significance and n-2 (29-2=17) degrees of freedom, was 2.052 Both variables included in the model surpassed this estimate. Income from other sources was highly insignificant with a Wald statistic of 0.277; Number of producers or *LnProder* had a Wald statistic of 1.509; while tansportation and input costs (*lnTranin*), of 1.547. Adding the latter did not, however, alter the predictive power of the model. The model implies that when all other variables are held constant, and with 95% certainty:

- A 1% increases in price is expected to result in the reduction of the odds of a household overexploiting becoming 0.407 times less than it was with no price change.
- On the flip side, we expect that a 1% decrease in price will result in these odds becoming 0.407 times greater.
- A I% increase in average production of households, over the two years would result in the odds of over-exploitation being 2.014 times greater than they are with no price change.

This analysis provides some indication of the factors which influence a household's ability to capitalize on its access to crabwood resources, and how the resource itself may be influenced by increased commercialisation. These issues are discussed further in Section 5.3.

4.4 Assessment of productive capacity

Box 7. Relevant project reports: Assessment of productive capacity

See Appendices 1 to 4, specifically:

Botelle, A., du Plessis, P., Pate, K. and Laamanen, R., (2002) *A Survey of Marula Fruit Yields in North-Central Namibia*. CRIAA SA-DC, Namibia.

Leakey, R., Shackleton, S.E., du Plessis, P., Pate, K. and Lombard, C. 2002. Characterization of phenotypic variation in marula (*Sclerocarya birrea*) fruits, nuts and kernels in South Africa and Namibia.

Leakey, R. (in press) Domestication potential of Marula (*Sclerocarya birrea* subsp. *caffra*) in South Africa and Namibia: 3. Multiple trait selection*. New Forests.*

Leakey R.R.B, Pate, K. and Lombard, C. (in press) Domestication potential of Marula (*Sclerocarya birrea* subsp *caffra*) in South Africa and Namibia: 2. Phenotypic variation in nut and kernel traits. *Agroforestry Systems.*

Leakey R.R.B, Shackleton, S.E. and du Plessis, P. (in press) Domestication potential of Marula (*Sclerocarya birrea* subsp *caffra*) in South Africa and Namibia: 1. Phenotypic variation in fruit traits. *Agroforestry Systems.*

McHardy, T. 2002a. Inventory of available marula resources on the Makhatini Flats, Maputaland, in the fruiting season of 2002. Institute of Natural Resources, South Africa.

Payne, K. 2001. The potential sustainable production of *Carapa guianensis* (Meliaceae) Abul. Oil in the Iwokrama Rainforest, Guyana. Dissertation for BSc in Environmental Science, University of West of England, U.K.

Shackleton, C.M., Botha, J., Emanuel, P.L. & Ndlovu, S. 2002. Inventory of Marula (*Sclerocarya birrea* subsp. *caffra*) Stocks and Fruit Yields in Communal and Protected Areas of the Bushbuckridge Lowveld, Limpopo Province, South Africa. Rhodes University, South Africa.

Shackleton, C.M., Botha, J. and Emanuel, P.L. (in press). Productivity and abundance of *Sclerocarya birrea* subsp. *caffra* in and around rural settlements and protected areas of the Bushbuckridge lowveld, South Africa. *Forests, Trees & Livelihoods.*

Thomas, R. 2002, Flowering, Fruiting and Abundance of Crabwood trees in Guyana. In: Forte, J., Ousman, S. and Radzik, R. (eds.) *Proceedings of the International Technical Workshop on Sustainable and Equitable Marketing of Crabwood Oil in Guyana*, November 23-24, 2002, Lake Mainstay Resort, Region 2, Guyana. Iwokrama International Centre, Guyana.

4.4.1 Summary

This section of the work involved a comprehensive assessment of resources from these species in a number of different locations, and under different land use conditions. This resource assessment involved estimates of tree density, fruit production rates, gender distributions, as well as phenotypic variation in the fruits, nuts and kernels. Marula and crabwood will be treated separately in this section.

4.4.2 Marula

This study found significant variation in the marulas of South Africa and Namibia. Full details of procedures and results are provided in the specific references given here, which can be found in Appendices 1, 2 and 3. Table 17 provides a brief summary of some of the activities carried out in the study locations.

Table 17. Locations for marula resource study, and sample activities

	South Africa: Bushbuckridge				**South Africa:** Maputaland		**Namibia:** North Central		
Site name	Allandale	Andover	Hokwe	Madile	Makhatini	Ubombo	Oshangwena	Omusati	Oshana
Number of trees surveyed at each site	582				74		104		
Sample size for fruit mass estimates (fruits)	443	588	340	360	920	560	1800	3300	3300
Sample size for fruit yield estimates (trees)	24	30	18	23	46	28	12	22	22
No of monitored trees in homesteads	24	30	18	23	10	10	n.a.	n.a.	n.a.
No of monitored trees in arable lands	20				22	7	n.a.	n.a.	n.a.
No of monitored trees in communal lands	29				14	11	n.a.	n.a.	n.a.
Number of homestead plots	99				31	32	n.a.	n.a.	n.a.
Number of arable field plots	30	30	30	30	19	11	n.a.	n.a.	n.a.
communal land (0.2 ha plots)	60				16	16	n.a.	n.a.	n.a.

4.4.2.1 Statistical analyses in the resource inventory

Differences between villages or land uses were examined via ANOVA after testing for normality. The number of fruits per tree was log transformed, and the tree basal area or canopy volume attributes were square root transformed. Pair-wise comparisons of significant parameters in the ANOVA were examined via the Least Significant Difference. A T-test was used to test differences between protected areas and village areas (pooled data for homestead plots, fields and rangelands). The size class profiles of adult stems in the communal lands and protected areas were compared via means of a Smirnov test. The relationship between fruit yield per stem and stem circumference was examined via linear regression. To assess the sustainable yield of *S. birrea* a deterministic population matrix model was used to generate eigenvectors that represent the proportion for a stable state profile that each class in the size class profile should constitute. The eigen value, λ, represents the state of the population. If λ is equal to one, then the population is stable, if λ is greater than one then the population is increasing and if λ is smaller than one then the population is declining. Transposing the matrix and then calculating the eigen values gives figures that are then used to calculate the sensitivity values, which show which of the parameters have the most effect on the model. The fecundity is then reduced to simulate the effect of fruit harvesting and λ is observed to estimate the highest sustainable yield.

A simple spreadsheet model was constructed to examine the balance between total supply and demand within each of the four villages. The number of people per village was taken from the projected 1998 figures of Pollard et al. (1998). Those for Rolle were divided into three since we surveyed Rolle A which is separated from Rolle B and C via the railway and river, hence there is limited overlap of collecting access. The proportion of land under different land uses (residential, fields, communal grazing) was taken as the mean across all villages in the Sand River catchment determined by Pollard et al. (1998). As no fruit yield data were available from Edinburgh, a mean value of the other three villages was used. Yield on communal land trees was taken as the mean determined for the two protected areas, since both represent 'wild' populations.

4.4.3 Crabwood in Iwokrama forest, Guyana

A forest inventory was conducted in Iwokrama, and the results of this are shown in Figure 5. This suggests that the area is well provided for with crabwood trees, and there is potential for oil extraction if these are well managed. In a similar area, a density of one tree >35 cm dbh per hectare was found in mixed forests on flat and undulating terrain. However, trees ranging from 10-35 cm dbh average 6-13 trees per hectare (Conservation International unpublished data, 2002).

Figure 5. Distribution of crabwood within the Iwokrama forest

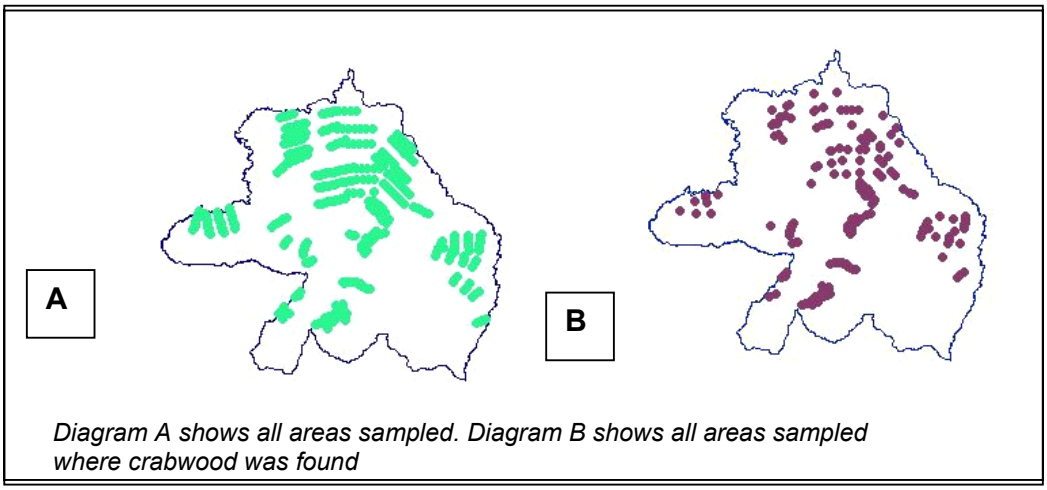


Diagram A shows all areas sampled. Diagram B shows all areas sampled where crabwood was found

A more detailed study on crabwood was carried out during 2001 (Payne, 2001, see Appendix 4) In this work, a total of 318 trees were surveyed, in three separate plots of 0.75 ha. 129 trees were studied in one of the lowland plots, 146 in another lowland plot in a more disturbed area, and 43 in an upland plot. All of these trees were measured and comparisons were made between the sites, with the findings indicating that the lowland sites contained significantly more trees than the upland area, at the 99% confidence level. While the number of trees varied widely from 10 to 2570 seeds per tree, the mean canopy size was relatively consistent. In terms of seed production, there was a difference between the trees at the different sites, once again significant at the 99% confidence level, with as much as four times as many seeds being produced from upland areas than in the lowlands.

4.5 Survey of traditional knowledge and IPR: local and producer issues and institutions, and industrial issues and institutions

Box 8. Relevant project reports: Survey of traditional knowledge and IPR

See Appendices 1 to 4, specifically:

Wynberg, R.P., Cribbins, J., Leakey, R.R.B., Lombard, C., Mander, M., Shackleton, S.E. and Sullivan, C. A. 2002. Knowledge on *Sclerocarya birrea* subsp. *caffra* with emphasis on its importance as a non-timber forest product in South and southern Africa: A summary. Part 2: Commercial use, tenure and policy, domestication, intellectual property rights and benefit-sharing. *Southern African Forestry Journal,* **196**: 67 – 77.

Wynberg, R.P. *et al* (in press) Marula commercialisation for sustainable and equitable livelihoods: A Policy Brief. *Forests, Trees & Livelihoods.*

Wynberg, R.P., Laird, S.A., Botha, J., den Adel, S. and McHardy, T. 2002. The Management, Use and Commercialisation of Marula: Policy Issues.

Laird, S.A. and Wynberg, R.P. 2003. Biodiversity Prospecting and Access And Benefit-Sharing: An Introductory Primer.

4.5.1 Summary

As is the case for all NTFPs, a range of laws and policies impact the management, use and commercialisation of marula. These include laws and policies that directly concern NTFPs, or marula, such as natural resource, agriculture, forestry, and environment laws; measures on land tenure and resource rights; and a range of economic and financial measures such as trade and taxation. Relevant laws and policies are manifested at the international, regional, national, provincial, and local level – the latter in southern Africa including customary laws and regulations. In some form or other, these regulations all try to promote conservation, increase economic welfare of households, or stimulate national economic growth. Information on the policy aspects of marula use and commercialisation was obtained in a number of ways, and these are summarised in Table 18.

Table 18. Approaches used to investigate commercial traditional knowledge and institutions details

Existing information surveyed	Numerous literature sources were consulted from both academic and 'grey literature'. These included the international patent databases for products or processes based on marula, searches on the UPOV database, archival material on marula, obtained from the National Archives in Pretoria, and in Guyana, and searches on the internet.
Information collection at household and commercial levels	Questions identified and included into both the household and commercial use surveys
Group consultation	A series of small meetings was held with marula producers in the Bushbuckridge villages of Rolle, Allandale and Hokwe in an attempt to identify key policy issues
Individual interviews conducted	A total of 33 interviews with held in 3 locations with (a) traditional authorities; (b) local conservation officers; (c) provincial conservation and forestry officers; (d) agricultural extension officers; and (e) local committees and institutions, and formal surveys were carried out.

For details of this work, see Appendix 3.4

The knowledge gained from this work focuses particularly on the links between customary law and government regulation. Information obtained was supplemented and triangulated with that received from the household surveys administered in each area, and in group interviews. This survey represents one of the most comprehensive and focused efforts to deepen understanding

of policy and regulatory issues affecting marula conservation and use in South Africa and Namibia. On the basis of lessons learned from this, guidance for other countries (including Guyana) has been developed, and forms the basis of policy briefs and guidance notes for benefit sharing from NTFPs (see Appendices 5.14 and 5.15). Many of the issues covered in this work consider how NTFP use relates to the Convention on Biological Diversity, summarised in Box 9.

Box 9. Non-Timber Forest Products and the Convention on Biological Diversity

NTFPs are becoming increasingly prominent within the Convention on Biological Diversity. For example:

- At the Fifth meeting of the Conference of Parties (Decision V/4) in 2000, a specific request was made to the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) to consider: "The impact of, and propose sustainable practices for, the harvesting of non-timber forest resources, including bush meat and living botanical resources (§14)".

- At the Sixth meeting of the Conference of Parties in 2002, a decision (VI/22) was taken to undertake an expanded programme of work on forest biodiversity which includes among its activities: (i) the development, support and promotion of programmes and initiatives that address the sustainable use of NTFPs; (ii) regional cooperation and work on NTFPs; (iii) the establishment of a liaison group to bring harvesting of NTFPs to sustainable levels; (iv) the development of necessary legislation for the sustainable management and harvest of NTFPs.

For further information see the CBD website: http://www.biodiv.org

4.6 Integration of national and international data & overall analysis of survey results

Box 10. Relevant project reports: Integration of national and international data & overall analysis of survey results

See Appendices 1 to 4, specifically:

Combrinck, A. and Muller, J. 2002. Modelling Marula Distribution in South Africa: A deterministic approach. Environmentek, CSIR, South Africa.

Forte, J., Ousman, S. and Radzik, R. (eds.) Proceedings of the International Technical Workshop on Sustainable and Equitable Marketing of Crabwood Oil in Guyana, November 23-24, 2002, Lake Mainstay Resort, Region 2, Guyana. Iwokrama International Centre, Guyana.

Grimmond, J., Joseph, I. and Datadin, V. 2002. A spatial assessment of Crabwood Oil production in Regions 9 & 10 of Guyana. Iwokrama International Centre, Guyana, Technical Report No. 2002/1.

Joseph, I. 2002. GIS Internship Final Report. Iwokrama International Centre, Guyana.

Shackleton, S.E., den Adel, S., McHardy, T. and Shackleton C.M. 2002. Use of marula products for domestic and commercial purposes: Synthesis of key findings from three sites in southern Africa. Rhodes University, South Africa.

Shackleton, S.E., Sullivan, C.A., Cunningham, A.B., Cribbins, J., Leakey, R., Laird, S., Lombard, C., Mander, M., Netshiluvhi, T.R., Shackleton, C.M., and Wynberg, R. 2001. *An overview of current knowledge on Sclerocarya birrea (A. Rich.) Hochst. subsp. caffra (Sond.) Kokwaro with particular reference to its importance as a non-timber forest product (NTFP) in southern Africa.*

Shackleton, S.E., Wynberg, R.P., Sullivan, C.A., Shackleton, C.M., Leakey, R.R.B., Mander, M., McHardy, T., den Adel, S., Botelle, A., du Plessis, P., Lombard, C., Laird, S.A., Cunningham, A.B., Combrinck, A. and O'Regan, D.P. 2002. *Marula commercialisation for sustainable and equitable livelihoods: Synthesis of a southern African case study.*

4.6.1 Summary

The work done in this study has covered a wide range of issues. In carrying out the work, we have endeavoured to link the activities and findings from the three countries by using the same research approaches and tools. Table 19 provides some comparison of data collected from the three study countries.

Table 19. A comparison of key variables relating to NTFP commercialisation in 2002

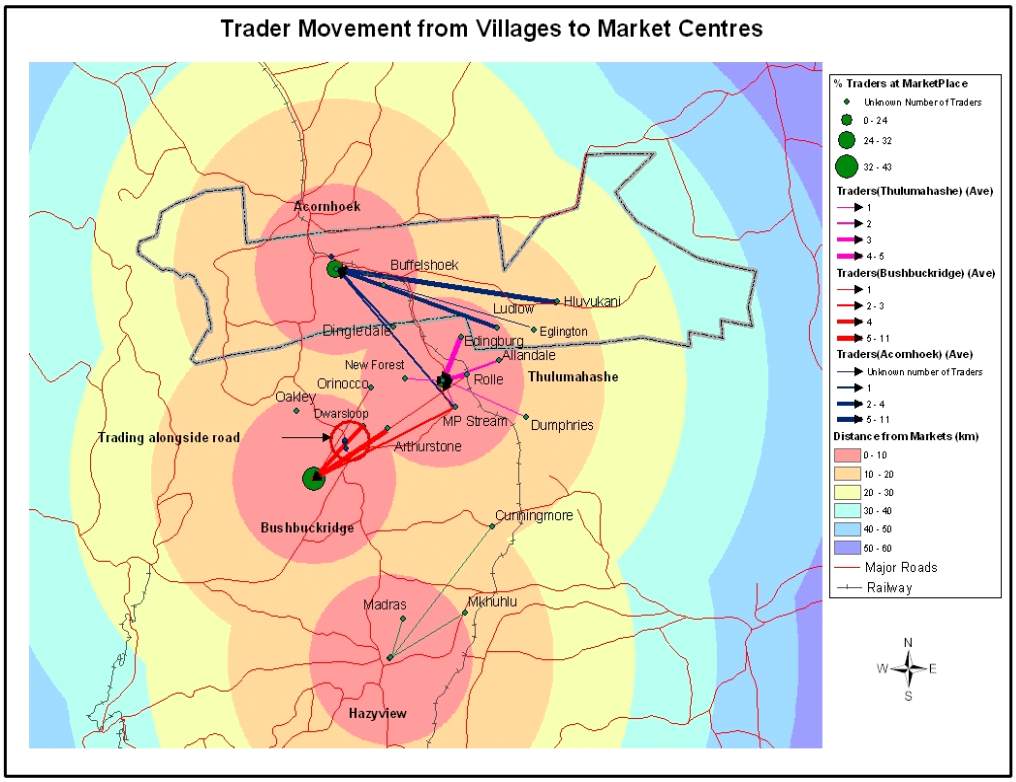
	South Africa	Namibia	Guyana
Density of trees/ha	7-15 trees/ha in homesteads, rising to 41-91 in communal lands (note some trees have more than one stem)	6-9 trees/ha in homesteads. Evidence of selection as a high proportion of these are fruit producing trees.	6-14 trees >10cms dbh. Per ha.
Yield of oil per 10kg of seeds	3.3 litres in large scale operation (MDC)	2 litres	0.23 – 0.7 litres
Returns to labour from fruit harvesting or oil production	The return to harvesting households contributing to large scale juice production is R578 per year. From the sale of kernels to MDC, collectors earn R156 per season. Selling marula beer in informal markets brings in R426-574 per season.(US$42-57)	N$1.6 per hour to produce oil. Individual traders earn an average of N$71 (US$7.1) per season contributing to CRIAA oil production.	Household incomes resulting from crabwood oil production tend to be in the region of G$10,000 per annum (US$54)
Shortage of resources found	Not in most areas	Yes, 75% of respondents reported a lack of marula trees in the area. Harvesting limited by agreements in some areas.	Yes in some areas, but there are many places where the seed bearing trees are farther away from communities than before, and there is some risk of long term depletion occurring as a result of logging.
Important for subsistence	Yes, fruits widely consumed, (children eat on average 2250 per season), and many other uses are made of the trees.	Yes, used in various ways by 100% of households surveyed	Yes, used by many for medicinal purposes as well as to generate cash.
Use of money generated from marula use	School fees and uniforms, medicine, food, building materials.	Average household annual income is N$250 per month, so any money generated by sales of marula is beneficial and is used for food, medicine, schooling and fuel.	Most people reported using money from crabwood oil to supplement family income and to pay school fees and other schooling costs.
Potential for domestication	Not necessary in most areas at present due to large wild populations, but can be done to increase yields. Some large scale operators may be interested to do this in the long term.	Tending self seeding marulas has long been observed here, and in many areas, seedlings from preferred trees have been nurtured (by 35% of households). Much potential for further domestication exists, but areas where this may be practical may be limited, and perhaps may not be accessible to the poorest members of the community. Commercialisation may stimulate more domestication at the household level.	Already observed on an informal basis, where householders may have planted trees for long term capital returns from the timber.

4.6.2 Trader Movement Analysis

Another way that data can be integrated is through the use of GIS. In this project, a small amount of resources was invested to explore the use of this, and in particular, this was used to examine links between sellers and buyers in the commercial chain for marula beer in South Africa. Forty-five beer traders were randomly interviewed in the five main towns in the Bushbuckridge district, namely, Acornhoek, Thulumahashe, Bushbuckridge, Mkhuhlu, and Hazyview (Shackleton, 2002). Between ten and eleven traders were interviewed in each marketplace except for Mkhuhlu, where only two traders were encountered. In addition, five roadside traders selling along the main road between Bushbuckridge and Acornhoek and one selling on the road between Thulumahashe and Dwarsloop were also interviewed.

A GIS was used to map the spatial distribution of beer traders in this area as well as to examine the number of traders selling beer at a specific market place. A distance grid was created to show the distance travelled by the beer traders to the marketplace. Existing town data were used to map the location of the different towns and markets. Five roadside traders were interviewed by Shackleton (2002) and their locations captured with the aid of a handheld GPS. The results of this is shown in Figure 6.

Figure 6. Map of marula trader location and movement



This example provides some insight into the use of GIS as a tool for analysis of natural resource management issues. By evaluating trader movement it seems that specific marketplaces are seen as being more favourable then others. The reasons for this have been identified by Shackleton (Appendix 1.4). The possibility of making extra income during times of financial stress is more of a driver for traders to travel the long distances to marketplaces.

4.6.3 International market surveys

During the project, surveys were carried out in the international market for natural products and cosmetic oils. Some results of this work are summarised in Table 20, and while this type of information is of use to players in the market, especially in Guyana, there is a lot more to be done to investigate potential markets for marula and crabwood oils and other products in other regions of the world.

Table 20. Some information about natural oil purchasing companies

Name of Company/Tel no. Internet address If Company/ Product Material is being sent	Which plant ingredients are used?	Which active plant ingredients are important?	Do you tell about them in your advertising?	Any important plants being researched at present?	What information would you need on Crabwood and Marula?	Do you normally buy from the producer or from a wholesaler?	Can we put you in contact with local suppliers?	Are you interested in fair trade issues?	Do you try to give your company a green profile?
Wala-Dr. Hauschka/ Dr. Reinhard Toedt Tel: +49 7164 930 258 http://www..wala.de Will send material about company and products	Tincture, Oil, Extract	Salvia, Camomile, Calendula	Yes, very often – both medicinal and cosmetic	No	From the producer: where and how is plant grown, extract and essential oil info	Both, but mostly producing on our own	Yes	Yes, no business with unethical producers	Yes
CPL Aromas Plc/ R&D Manager Tim Whiteley Tel: 01279 718 573 http://www.cplaromas.com	Extracts for fragrances and end products	Essential Oils for odour value and anti-ageing/anti-oxydant indications	Only for retailers	Yes, but through 3rd parties	Full specifications of extracts, attributes of extracts like if anti-oxydant or other properties	Combination of both, but often from the producer	Yes	Yes	Yes, for instance no use of animal tested fragrance
Potter and Moore/ Jennifer Bell Tel: 01733 281000 No website	Extracts	n/a	Only for retailers	None - Work with well known extracts	Specification and Certificate of Analysis	From wholesalers	Yes	Yes, if ingredient fit into their formulas and are specified	Yes, but difficult since many materials in that quality can be difficult to obtain
A & E Connock Ltd./ Alan J Connock Tel: 01425 653367 http://www.connock.co.uk Company/Product Material already received	Oil – Already promoting Marula in creams and lotion	n/a	n/a	For instance Marula Oil or Manketti Oil	Sample (250g), Material Data Safety Sheet, Botanic Info, Local (Native) Use over the years, Price CIF UK, Mode of packaging, Measure of e.g. gravity and acid values	Rarely from producers, but depends. Almond and Sunflower Oil through wholesalers	Yes	Agrees with fair trade – special interest in Papua New Guinea	Not heavily involved
Robert McBride Ltd./ June Graham Tel: 01274 844 844 http://www.mcbride.co.uk	Extracts	Variety of extracts – fashion-led, changes every year, at the moment Green Tea	Only private label to among others Tesco	Limited research on natural ingredients	Only interested if well-known	Most extracts come from wholesalers – otherwise mixed	Limited interest	Only in specific projects – business to business	No

4.7 Production of dissemination materials

Dissemination materials are essential to the delivery of scientific results to end users. In this project we have tried to ensure that materials are presented in ways that reach a wide range of stakeholders, and we have endeavoured to make the research findings from this work as generically applicable as possible.

4.7.1 Summary

A complete list of over 60 project outputs and dissemination materials is provided in Section 11 of this report. These cover all aspects of the work, and are supplied in various formats. Hard copies of most of these outputs are contained in Appendices 1 to 5, and are also available from the project website at http://www.ceh-wallingford.ac.uk/research/winners/.

4.7.2 Achievement of research activities

During the course of the project, all activities were carried out satisfactorily, and outputs were produced as anticipated. During the course of the work, however, there were a few issues which were more difficult than expected:

1. We were disappointed to be unable to collect a longer period of data for the resource inventory component. This was due to the delayed start date of the project which meant the first fruiting season was missed.

2. Another difficulty encountered when investigating commercial players in southern Africa was due to the concern expressed by some key informants over the issue of commercial confidentiality. This meant that some data was unavailable from some sources, and estimates had to be made.

3. In the case of the international market survey, responses from Japanese interviews were disappointingly low, this probably being explained by language difficulties in spite of survey documents being sent in Japanese. There is, however, little doubt that Japan remains a significant potential market for oils from both species.

4. In the case of the work carried out in Guyana, numerous staff changes within Iwokrama during the life of the project tended to make the work a little disjointed, and it was unfortunate that the funds requested by that organisation did not really cover the full value of their contributions. This was due to underestimates made by the then crabwood project leader at Iwokrama at the start of the project.

These difficulties were, in general, relatively minor, although it is important to recognise the last point when considering the level of outputs from Guyana compared to South Africa. During the course of the project, it was decided that it would be useful to involve a local environmental education consultant in South Africa so that an output on marula could be generated for inclusion in to national curricula where relevant. This was additional to all the planned activities and outputs, but it was felt worthwhile as a way of ensuring key issues being passed to future marula users.

Note: A complete list of all the tangible outputs generated by project activities is attached to this document, and the full text of each one can found in the appendices to this report, and also, in some cases, on the project website.

5 Outputs

In order to address the research hypotheses listed in the project purpose, this project has focussed on the development of improved understanding of several main themes. These involve:

- identification of the distribution of costs and benefits of actual or potential commercialisation of two species in 3 countries;
- examination of the five sustainable livelihoods capital types, and the relation between changes in these and the commercialisation process;
- identification of possible sources of inefficiencies in the market chains;

- the extent of potential sustainable exploitation of the natural capital stock of the 2 species;
- recognition of the importance of non-financial forms of capital to local communities;
- the development of appropriate IP and benefit sharing protocols which can be applied to the utilisation of the 2 tree species under consideration;
- the identification of factors determining 'winners and losers' in marketing chains;
- investigation of global market opportunities.

Each of these output themes will be considered in turn.

5.1 Distribution of commercialisation benefits and costs identified in terms of the 5 sustainable livelihood capital entitlements (physical, social, human, natural and financial).

In this project we have examined how different stages of the marketing chain for NTFPs impact on the livelihood opportunities and capitals of different groups within society. We have found that in southern Africa, in general, no one particular group is being disenfranchised at the current time, although there is a risk that women may lose some potential earnings if commercialisation involves machinery or institutions which are taken over by men. While in many areas marula resources are currently in excess of the level of demand, there is a possibility that in future this may not be the case, and there is a case to be made to develop a more recognised system of tree tenure, along the lines of that found in Namibia, where the situation is rather different, and women in particular have been involved in many efforts to commercialise marula resources. In Guyana, while extensive knowledge of crabwood and its processing and use exist, there is little organised marketing, and the returns to producers are rather low. There is great potential for better marketing schemes to be developed, and it is hoped that this may be achieved through Iwokrama or possibly community schemes.

We have also found that for a number of households within the study communities in all locations, utilisation of natural capital in the form of marula/crabwood products does generate financial capital. This enables financial payments to be made for education, thus facilitating the development of human capital. In addition, social capital has been built within these communities, through the greater awareness of NTFP values, and the evolution of 'marula producer groups' and 'crabwood user groups' which is promoting networking between different relevant communities. In terms of physical capital, the sale of both marula and, especially, crabwood products is reported as being a means by which households can develop their physical capital holdings. In Guyana, in the case of larger scale production (cottage industry scale), this is seen in the form of outboard engines, which can increase the household's potential production in a variety of ways. In the case of South Africa and Namibia, incomes from the sale of marula are seen to be an important contribution to household clothing and shoes as well as food. This is illustrated by the figures from Table 21, which demonstrates that marula is an important resource to local households in southern Africa.

Table 21. Percentage of households trading marula products in southern Africa

	Beer/wine	Fruit	Kernels
Namibia	0, 33%, 30%, 87%	0	62%
Bushbuckridge	8%, 19%, 10%, 18%	19%, 63%, 3%, 31%	25%, 46%, 55%, 87%
Makhatini	1 household	0	1 household

The proportion of households selling marula products varied widely both across study sites, and between different villages or areas within study sites.

It could be argued that some depletion in social capital may be occurring as the result of sale of marula beer in some areas, where previously exchange of beer has been part of traditional ritual practices associated with fertility and harvesting. Lessons may be learned from this, and some ways of protecting the social capital associated with crabwood oil production and commercialisation include:

- **Linkages are important: use international agreements for local ends**

Community-based forest management may well be critical at many levels but the forestry lobby outweighs it in clout at the policy-making level. Local communities have to counter their

hegemonic discourses at varying levels: for instance by recognising the potential use of the Ramsar Convention for protecting wetlands, and the potential advantages of ensuring a seat at the table when the National Protected Areas System is being formulated. In these counter-discourses, the 'swamps' of the foresters are recognised as biodiverse wetlands, and protected areas are valued for the multiple contributions made to the global ecosystem.

- **Gender issues**

In most areas, the task of seed collection is shared by the family group, although women play a lead role. In the Berbice River area – and this is probably true elsewhere - male hunters advise collectors on seed fall areas. Processors are female in the majority of instances and middlemen are male. Crabwood oil exploitation is a real opportunity for women to generate money for the household, and it is important that this remains the case if greater commercialisation takes place.

- **Re-instituting use of the word 'karaba' in place of 'crab oil'**

Crabwood oil is marketed in Brazil under the exotic Tupi-Guarani name 'andiroba' that means 'bitter taste.' In contrast, the connotations of 'crab oil' are unsavoury, evoking a mental image of oil being squeezed out of smelly crabs. There needs to be a movement to use the word karaba/ carapa and not the coastlander distortion 'crab oil.' We see the world through cultural lenses, never objectively. Marketing experts capitalize on this fact and they work at 'framing' the products they sell to hook the 'must have that' impulse of potential customers. Speaker after speaker at the crabwood workshop stressed the importance of 'branding' crabwood oil, particularly for the global market. Products in the growing natural products market stress qualities like '*contains no animal products'.* Crabwood oil has many qualities that can be successfully marketed: Amazonian and Guiana Shield forest product, ecologically important to animals, *NTFP sustainably produced at small scale household and community level.*

Box 11. Local attitudes towards marula commercialisation: A summary of discussions from group meetings in Allandale and Hokwe

ON BENEFITS: The sales of marula fruit and kernels provide cash for school fees, school books, school uniforms and food. This has been a positive development. However, sellers felt that the prices per unit they were receiving for both fruit and kernels were inadequate and did not reflect that time and effort that went into either collecting the fruit or extracting the kernels.
ON SOCIAL REPERCUSSIONS WITHIN AND BETWEEN VILLAGES: Participants did not feel that, at this stage, commercialisation had created social tensions or competition between users within villages. Producers were said to collect independently in their own time. The perception was that there is enough fruit for everyone, especially for those that are prepared to walk far. Participants in one group in Allandale felt that there were no tensions between themselves and neighbouring villages regarding the collection of marula fruit. Indeed, they often share with their neighbours. There have been no disagreements. However, in another group in Hokwe there were complaints that 'outsiders' (men) with 'bakkies' came to collect fruit in the communal lands surrounding Hokwe and chased local women away. These men purportedly were selling the fruit and had to come to the Hokwe area because all the marula trees had been cut out in the area from whence they came.
ON MEN'S ATTITUDES: In Allandale, it appears that the men have no objections to the selling of beer, fruit and kernels provided women made beer for their husbands first. In fact many were said to be encouraging their wives to participate in selling. In Hokwe, men, in particular the older generation, were not supportive of selling marula products. Selling beer or fruit is "against our customs". The attitudes of the *induna* (see below) had obviously influenced other people's attitudes.
ON ATTITUDES OF TRADITIONAL LEADERS: The *induna* in Allandale has no objections to people selling any marula products. He recognises the poverty around him, and the need for people to earn income. By contrast, the *induna* in Hokwe was opposed to the sale of fruits or beer as he felt that this would deprive local residents of a traditional product that had an important role in bringing people together – he also felt the price for the fruit (i.e. benefits) was too little to outweigh the social and cultural costs of commercialising it. Women in the village were, however, free to sell kernels.
ON EXPANSION OF COMMERCIAL ACTIVITIES: Participants felt that commercialisation can grow as there is still unused fruit available. They also felt that the commercial value of marula would help prevent chopping for firewood.
OTHER COMMENTS: The Hokwe group felt that the export of marula products overseas would "make people more aware of what we have here" and of people's circumstances. Participants did not believe that "external" commercialisation had impacted negatively on any local level trade in beer and kernels, or on the use of marula products for home consumption.

Table 22. South Africa and Namibia: Current effects and impacts of marula use and commercialisation on livelihood assets, and predicted future effects with further commercialisation. Impacts have been assessed on a scale of –2 to +2, using --, -, neutral, +, ++.

Livelihood capital asset	Current effect from subsistence domestic use	Current effect of commercialisation	Potential effects of increased commercialisation without intervention	Notes and Comments
1. HOUSEHOLD AND COMMUNITY LEVEL				
1.1 Human Capital				
1.1.1 Health and nutritional status	++ (Marula fruit products and kernels currently consumed by the majority of households)	+ (No affect as yet on domestic consumption)	+ (Potential that some of the resource may be diverted away from domestic use)	If the cash earned from selling fruit or kernels is used to buy nutritious food then impact may be positive.
1.1.2 Indigenous skills (Local knowledge)	++ (Much of the use of marula is based on local knowledge)	++	++ (Unlikely to have any negative impacts and may even enhance this if commercialisation efforts build on local knowledge)	Effects could be negative if there are no mechanisms in place to protect local knowledge (e.g. of high yielding trees). Our impression is that there is more awareness amongst community members of the cultural importance of marula and the need to minimise negative impacts as commercialisation increases.
1.1.3 Entrepreneurial and business skills	Not applicable	++ (Women entrepreneurs selling beer are expanding this to other products)	++ (Increased business skills, new processing skills, new products)	Any initiative should introduce new skills and ideas – e.g. women in both Bushbuckridge and Namibia mentioned the commercialisation processes gave them the idea to sell marula products locally.
1.1.4 Access to information re product	+	Neutral to -	+ (Some information being withheld, but stronger cooperatives will ensure access to more information)	Cooperatives tend to enhance access to information, but private sector operators, e.g. Distell, are often secretive about all aspects of their business.
1.1.5 Empowerment of women	++ (Women are primarily involved in processing marula products)	++ (Women primarily involved in selling marula products)	++ (Women are primarily involved in processing and selling marula products, but men may see this as an opportunity – see notes)	Women in Bushbuckridge complained that men with pick-ups were removing fruit to sell from the commonage. In Namibia, men were interested in the fruit presses sold to a women's group.
1.1.6 Equitable access to education	Not applicable	+	++ (More communities benefit)	Much of the income is used for school fees.
1.2 Social capital				
1.2.1 Traditions and culture and socio-cultural cohesion	++ (Urban-rural linkages, social networks, reciprocal obligations, marula gatherings, etc.)	+/- (Could go either way)	+/- (Could go either way)	Commercialisation could lead to the potential loss of social cohesion and benefits as traditions of sharing and giving fall away due to more sales of fruit, less beer making, and reduction of neighbourhood parties. Commercialisation of kernels may have less of a social impact than for fruit as kernels not used within a social context to the same extent. A positive effect of commercialisation could be through the reinvigoration of cultures and tradition.
1.2.2 Effective organisations and institutions (bargaining power,	Neutral	+ (Eudafano Women's Cooperative – Namibia, committees in Bushbuckridge)	+/- (Could go either way)	Cooperatives could be strengthened by the commercialisation process, or people, especially those with access to resources and assets, could become more individualistic and competitive in the trade.

Livelihood capital asset	Current effect from subsistence domestic use	Current effect of commercialisation	Potential effects of increased commercialisation without intervention	Notes and Comments
contacts, etc.)				
1.2.3 Leverage with outside agents (power)	Neutral	+ Namibia Neutral S. Africa	+/-	Commercial producers may be in a situation where there is little opportunity to use leverage (e.g. in South Africa where producers are price takers) or they could even be exploited by commercial companies. On the other hand, stronger cooperatives could turn this around.
1.3 Financial capital				
1.3.1 Household income level	+ (Costs savings but highly seasonal)	+ (Incomes presently low and highly seasonal)	+ (More households become involved)	Income unlikely to be enhanced substantially due to the highly seasonal nature of the resource and the act that traders are price takers due to an abundance of the resource.
1.3.2 Cash at crucial time	Not applicable	++	++	The income from marula comes at a crucial time in the household's calendar when they are short of cash after Christmas and when the new school year starts.
1.3.3 Access to credit	Neutral	Neutral	+	Evidence that people working together in cooperatives often use this to start rotating loan schemes. Groups may be able to purchase processing equipment on credit from the organisations they are supplying to (e.g. Namibia).
1.3.4 Access to markets	Not applicable	+	+	Evidence that traders are exploring new markets (e.g. in towns) for locally traded products.
1.3.5 Cash for investment	Not applicable	+	+	Some households are investing their earnings into other trading activities.
1.3.6 Household savings	Neutral, but cost savings on purchasing alternative.	Neutral	Neutral	Cash usually used immediately for school fees and food, as the people selling marula products are amongst the poorest (but some investment in other earning activities – see above).
1.3.7 Community resources (funds)	Not applicable	+ (e.g. Distell community fund, Eudafano lending scheme)	+	
1.3.8 Employment (salaried)	Not applicable	+	+ (Localised opportunities)	
1.4 Natural capital				
1.4.1Supply/stocks	Neutral (Wild resource depleting, planted resource increasing)	+ (Increased protection and propagation)	+ S Africa ++ Namibia (Increased protection and propagation)	Commercialisation will act as an incentive to plant and protect marula.
1.4.2 Equitable access to resource	++ (Shared resource - all household have access to marula products, even in Namibia where trees are tenured to individual households)	Neutral Namibia Neutral S Africa (Limited instances of negative impacts)	- Namibia - S Africa (Increased privatisation, reduced sharing, theft, enclosure of commons)	Early evidence of increased 'selfishness' with respect to the marula resource (e.g. Edinburgh village less households allowing other to harvest from their trees) and less sharing. Theft reported by 1/3 of households.
1.4.3 Management of resource	Neutral to + (Regulations prohibiting cutting not well enforced	Neutral	+ (Increased incentive to manage)	Additional value of the tree may increase incentives for better management of existing populations and re-institution of local regulations.

Livelihood capital asset	Current effect from subsistence domestic use	Current effect of commercialisation	Potential effects of increased commercialisation without intervention	Notes and Comments
	especially in S Africa)			
1.4.4 Selection of high yielding/ quality trees	+ (Evidence of some selection)	+	+ (Propagation of high yielding genotypes)	Domestication programmes could increase positive impact.
1.5 Physical Capital				
1.5.1 Shelter and household possessions	Neutral	Neutral	Neutral	Current and potential incomes too small to have a major impact. Mainly used immediately for day-to-day needs.
1.5.2 Ownership or access to production equipment	Neutral	+	++	Access to equipment through cooperatives and organisations, if necessary.
1.5.3 Transport, telecommunication, etc.	Neutral	Neutral	+	Access to communications through cooperatives and organisations may develop.
2. NATIONAL LEVEL				
2.1 Financial capital				
2.1.1 Export earnings (GDP)	Not applicable	+ (Amarula, marula oil))	+ (Amarula, marula oil)	Only kernels in Namibia, and only fruits in S Africa.
2.1.2 Employment generation beyond community level	Not applicable	+	+	Distell employs workers at both of their factories.
2.1.3 Tax revenue	Not applicable	+	+	
2.1.4 Import substitution	Not applicable	Neutral	Neutral	
2.1.5 Indirect benefits (e.g. tourism)	Not applicable	+	+	Preservation of local culture as a consequence of increased commercialisation due to increased awareness of this.
2.2 Social Capital				
2.2.1 IPR issues	Not applicable	Neutral	+/-	Could increase or diminish community rights over marula depending on the model adopted.
2.2.2.Support of R&D	Not applicable	+	+	There is already evidence of government and donor support for marula.
2.3 Natural Capital				
2.3.1 Biodiversity ecosystem function/services	+	+	+	Caterpillars, wood roses, habitat/niche.

This table has been adapted, with thanks, from the livelihood outcomes matrix developed for the CIFOR World Comparison of NTFPs Project.

Livelihood analysis for crabwood commercialisation

The same process of assessing potential livelihood impacts has been applied to the situation of crabwood commercialisation. Table 23 provides a summary of this analysis.

Table 23. Guyana: Current effects and impacts of crabwood use and commercialisation on livelihood assets, and predicted future effects with further commercialisation. Impacts have been assessed on a scale of –2 to +2, using --, -, neutral, +, ++.

Livelihood capital asset	Current effect from subsistence domestic use	Current effect of commercialisation	Potential effects of increased commercialisation without intervention	Notes and Comments
1. HOUSEHOLD AND COMMUNITY LEVEL				
1.1 Human Capital				
1.1.1 Health and nutritional status	++ Continued use of traditional remedies such as crabwood oil empowers value of local knowledge, and prevents/ treats some illnesses	+ No affect as yet on domestic consumption, perhaps some increase in urban areas as it becomes available	+ Potential that some of the resource may be diverted away from domestic use	If the cash earned from selling oil is used to buy nutritious food then impact may be positive.
1.1.2 Indigenous skills (Local knowledge)	++ Much of the use of crabwood is based on local knowledge	++	++ (Unlikely to have any negative impacts and may even enhance this if commercialisation efforts build on local knowledge)	Effects could be negative if there are no mechanisms in place to protect local skills base. If all crabwood oil production was carried out by a large commercial enterprise, local access to the market maybe lost. Some awareness amongst community members of the cultural importance of crabwood and the need to minimise negative impacts as commercialisation increases.
1.1.3 Entrepreneurial and business skills	Increased interest at present is stimulating interest in crabwood processing	++	++ Increased business skills, new processing skills, new products	Any initiative should introduce new skills and ideas – e.g. training in candle and soap making in crabwood producing communities.
1.1.4 Access to information re product	+	Neutral to -	+ stronger cooperation between producers will ensure access to more information	Cooperatives tend to enhance access to information, but private operators are often secretive about all aspects of their business.
1.1.5 Empowerment of women	++ Women are primarily involved in processing	++ Women primarily involved in processing seeds	++ Women are primarily involved in processing and selling products, but men may see this as an opportunity	Women are the main agents in the production of crabwood oil, although men are actively involved in seed collection.
1.1.6 Equitable access to education	Not applicable	+	++ (More communities benefit)	Much of the income is used for school fees.
1.2 Social capital				
1.2.1 Traditions and culture and socio-cultural cohesion	++ Urban-rural linkages, social networks	+/- (Could go either way)	+/- (Could go either way)	Commercialisation could lead to the potential loss of social cohesion and benefits as traditions of sharing and giving fall away due to higher crabwood oil values A positive effect of commercialisation could be through the reinvigoration of cultures and tradition.
1.2.2 Effective	Neutral or + if group efforts	+	+/- (Could go either way)	Cooperatives could be strengthened by the

Livelihood capital asset	Current effect from subsistence domestic use	Current effect of commercialisation	Potential effects of increased commercialisation without intervention	Notes and Comments
organisations and institutions (bargaining power, contacts, etc.)	are recognised			commercialisation process, or people, especially those with access to resources and assets, could become more individualistic and competitive in the trade.
1.2.3 Leverage with outside agents (power)	+	+	+/-	Commercial producers may be in a situation where there is little opportunity to use leverage (e.g. where producers are price takers) or they could even be exploited by commercial companies. On the other hand, stronger cooperatives could turn this around.
1.3 Financial capital				
1.3.1 Household income level	+ (Costs savings but highly seasonal)	+ (Incomes presently low and highly seasonal)	+ (More households become involved)	Income unlikely to be enhanced substantially due to the highly seasonal nature of the resource and the fact that traders are price takers due to an abundance of the resource.
1.3.2 Cash at crucial time	Not applicable	++	++	The income from crabwood comes at a crucial time in the household's calendar when they are short of cash and the new school year starts.
1.3.3 Access to credit	Neutral	Neutral	+	Evidence that people working together in cooperatives may often use this to start rotating loan schemes. Groups may be able to purchase processing equipment on credit from the organisations they supply to.
1.3.4 Access to markets	Not applicable	+	+	Evidence that traders are exploring new markets (e.g. in towns) for locally traded products.
1.3.5 Cash for investment	Not applicable	+	+	Some households are investing their earnings into other trading activities.
1.3.6 Household savings	Neutral, but cost savings on purchasing alternatives.	Neutral	Neutral	Cash usually used immediately for school fees and food, as the people selling crabwood products are sometimes the poorest.
1.3.7 Community resources (funds)	Not applicable	+	+	Local groups, especially churches may provide small loans for productive materials.
1.3.8 Employment (salaried)	Not applicable	+	+ (Localised opportunities)	Crabwood producers tend to be self motivated.
1.4 Natural capital				
1.4.1Supply / stocks	Neutral (Wild resource depleting, planted resource increasing)	+ (Increased protection and propagation)	+ Guyana (Increased protection and propagation)	Commercialisation will act as an incentive to plant and protect crabwood.
1.4.2 Equitable access to resource	++ Some shared resource - all household have defacto access to crabwood products	+ better recognition of indigenous rights etc will have a positive effect if it can be achieved	- More control of crabwood logging needed	Early evidence of increased distances to the crabwood resource. Many people report loss of important trees.
1.4.3 Manageme	Neutral to + (Regulations	Neutral	+ Increased incentive to	Additional value of the tree may increase incentives for better

Livelihood capital asset	Current effect from subsistence domestic use	Current effect of commercialisation	Potential effects of increased commercialisation without intervention	Notes and Comments
nt of resource	prohibiting cutting currently not well enforced)		manage	management of existing populations and re-institution of local regulations.
1.4.4 Selection of high yielding/quality trees	+ Evidence of some selection in home and farm plots	+	+ Propagation of high yielding genotypes – unlikely in the short term	Domestication programmes could increase positive impact – already some households plant crabwood trees as capital for their children's future.
1.5 Physical Capital				
1.5.1 Shelter and household possessions	Neutral	Neutral	Neutral	Current and potential incomes too small to have a major impact. Mainly used immediately for day-to-day needs.
1.5.2 Ownership or access to production equipment	Neutral	+	++	Households have own equipment, and access through cooperatives and organisations may be possible in some places.
1.5.3 Transport, telecommunication, etc.	Neutral	Neutral	+	Access to communications through cooperatives and organisations.
2. NATIONAL LEVEL				
2.1 Financial capital				
2.1.1 Export earnings (GDP)	Not applicable	+ crabwood oil	+ crabwood oil	Potential exists, especially in Japan and European natural products markets.
2.1.2 Employment generation beyond community level	Not applicable	+	+	Possible
2.1.3 Tax revenue	Not applicable	+	+	
2.1.4 Import substitution	Not applicable	Neutral	Neutral	
2.1.5 Indirect benefits (e.g. tourism)	Not applicable	+	+	Preservation of local culture as a consequence of increased commercialisation due to increased awareness of this.
2.2 Social Capital				
2.2.1 IPR issues	Not applicable	Neutral	+/-	Could increase or diminish community rights over crabwood depending on the model adopted.
2.2.2.Support of R&D	Not applicable	+	+	There is already evidence of government and donor support for crabwood.
2.3 Natural Capital				
2.3.1 Biodiversity, ecosystem function/services	+	+	+	habitat/niche.

This table has been adapted, with thanks, from the livelihood outcomes matrix developed for the CIFOR World Comparison of NTFPs Project.

In the case of crabwood, oil manufacture is not random. The fact that producers residing in areas with no direct access to regular road transportation, or any road transportation for that matter, have continued to produce in spite of exceptionally low prices, is an indication of some dependence on income generated from this product.

These seem to suggest that:

1. Crabwood oil, as a commercial product, serves to buffer household income from other sources. In other words, producers of these areas are seeking to make within a certain range of income from the sale of this product and not as much income as they can possibly make. The issue of commercial production of crabwood oil serving as safety-net, therefore comes to the fore;

2. Producers are sensitive to the supply demands of the market and/or middle-men and have, over the years, adjusted their production to meet those demands; and/or

3. For some producers, at that time of year, there is little or no viable alternative to crabwood oil production as a means of generating income.

For more detail on these findings see Appendices 1 to 5.

5.2 Sources of financial capital used in the commercialisation process identified, and direct and indirect links between these and the distribution of costs and benefits examined.

Financial capital plays an important role in market chains in general, and particularly for product suppliers. In the market chains examined in this study, financial capital is invested in various types of equipment required for the harvesting and processing of marula and crabwood. Capital investment along these chains ranges from the machete/cutlass and the baskets/buckets used at the household level, to large scale processing machinery such as that used to produce the pulp required by Distell in the production of Amarula liqueur. At the intermediate level, there are some specific items such as cold presses, kernel cutters etc., but these also have their traditional (widely used) equivalents.

At the household level, in all of the study areas of this project, there is a very low financial capital requirement. Freedom of entry and exit to the market exists, and product producers, as individuals, tend to be 'price takers', unable to influence market prices. Further up the market chain, at larger volumes, more capital is invested, not only in processing machinery but also in vehicles (S. Africa) and outboard engines (Guyana). In the case of those involved in beer making, there is a positive return on the investment of this capital, as the overall return to this activity is greater than simply collecting and selling fruit, but this is very much determined by the value placed on the time involved in beer production. In all cases, however, there is little doubt that some interaction of all the capital types is required for successful commercialisation to take place.

How different communities benefit from utilisation of marula in southern Africa is shown in Table 24. It is interesting to note that when all costs, including all labour is taken into account, the financial benefits accruing to individuals is highest if they sell their fruits directly to Distell, with that commercial chain generating significantly more for the whole community than any other chain.

Table 24. The financial benefits of marula trade to local economies in South Africa and Namibia, 2002

	Income to marula producing communities	Average annual profit per trader	Number of traders	Total investment into local economy
CRIAA SA-DC oil	R250 000		3 500	R250 000
MDC oil	R290 000	R150	1 100	R394 000
MDC juice	R64 000	R360	220	R140 000
Distell Amarula liquer	R1 100 000	R1 100 to R720	420	R1 532 000
Bushbuckridge community beer	R136 000	R500	200	R136 000
TOTAL	**R1 838 000**		**5 440**	**R 2 452 000**

In order to consider these issues more thoroughly, some analysis of the different costs of production for the two most commercialised chains for marula production in South Africa have been examined.

5.2.1 Summary of incomes and costs for major commercial enterprises

A summary of revenues and costs for two major commercialised marula operations is provided in Table 25. From these figures, we can see that in 2001, MDC purchased marula kernels to the value of R290 000, and marula fruit to the value of R38 000. In 2002 it was estimated that Distell purchased fruits to the value of R450 000 from local communities. Between MDC and Distell, an estimated 2 200 tonnes of marula fruit was bought for the production of juice and pulp in 2002. Both MDC and Distell estimate that there is a 10% wastage in their processing, with a total volume of 210 tonnes fruit wasted. It is estimated that MDC bought 12 tonnes of processed marula kernels in 2001. The wastage within the marula oil extraction process has not been estimated, but there is likely to be a significant wastage with the hand-powered presses currently employed.

Table 25. Summary of incomes and costs for commercial enterprises

Company			**MDC**	**MDC**	**Distell**	**MDC**
Product			**Fruit**	**Fruit**	**Fruit**	**Kernels**
Year			2001	2002	2002	2001
Total volumes bought	**tonnes**		**150**	**100**	**2000**	**12**
Sold			-	15	-	-
Wastage			50	10	200	
On hand			-	5	-	-
Processed			**100**	**70**	**1800**	**12**
Tons produced			**10**	**6**	**800**	**4**
Yield			**10.0%**	**8.6%**	**44.4%**	**33.3%**
Liters produced - oil	**1 tonne=**	**1000**				**4000**
Costs						
Purchasing Costs		Fruit / Nuts	R 37,500	R 25,000	R 450,000	R 290,000
		Transport	R 20,000	R 10,000	R 40,000	
		Labour		R 5,000	R 77,000	
Sub Total			**R 57,500**	**R 40,000**	**R 567,000**	**R 290,000**
Processing Costs		Labour	R 98,880	R 87,000	R 500,000	R 95,200
		Materials	R 2,000	R 1,200		R 4,000
		Capital Costs	R 11,500	R 11,500	R 453,333	R 4,800
		Other - Electricity	R 4,400	R 400	R 12,000	
Sub Total			**R 116,780**	**R 100,100**	**R 965,333**	**R 104,000**
Total Costs						
Cost per tonne			**R 174,280**	**R 140,100**	**R 1,532,333**	**R 394,000**
Cost per liter			**R 17,428**	**R 23,350**	**R 1,915**	**R 98,500**
						R 99
Price per tonne			R 8,000	R 8,000	R 2,400	R 112,971
Total (Potential) Income			**R 80,000**	**R 48,000**	**R 1,920,000**	**R 451,884**
Profit / Loss per tonne			**-R 9,428**	**-R 15,350**	**R 485**	**R 14,471**
Total Profit/Loss			**-R 94,280**	**-R 92,100**	**R 387,667**	**R 57,884**

Source: Mander et al. 2002

Since the quantities of end products considered here were not disclosed to the study team, estimates had to be made, and on this basis, it is estimated that Distell produces 800 tonnes of pulp, with MDC producing up to 10 tonnes of juice and 4 tonnes of oil per annum. In terms of investment, due to the high level of capital inputs in Amarula production, the formal marula industry (excluding traditional beer) is likely to have contributed to a total investment of at least R2.2 million within the South African economy, with R1.1 million (or 50%) accruing to rural suppliers. Included in this is some R700, 000 invested in the local economy by MDC in 2001.

Costs of production appear to vary considerably, with Distell producing pulp at an estimated R1 500 per tonne in 2002, and MDC producing juice (not pulp) at R17 000 per tonne. In 2001 MDC produced marula oil at an estimated R99 000 per tonne. In terms of profit and loss, it is difficult to get exact figures, as key information was not supplied to the study. On the basis of speculative calculations made by the researchers, the levels of profit and loss in these two

operations are likely to be in the region of R388 000 profit per annum for Distell, and for MDC, the oil operation ran at a profit of R58 000 in 2001 season, while their juice operation in 2002 is estimated to have made a loss of R94 000.

5.2.2 Guyana

In an analysis of costs along the product chains, it is clear that there is much variability in the costs faced by different producers both within and between communities, as shown in Table 26. When these are all taken into account, it appears that incomes are not always positive for primary producers, and this supports the idea that middlemen make most of the profits to be made from crabwood oil commercialisation.

Table 26. Costs and benefits of crabwood production in communities in Guyana

Community	Descriptive statistic	Net income G$	Income other sources, G$	Price G$	Total cost G$	Transportation and input cost G$	Time cost G$
Ebini	Range	-182,719 to 51,068	24,000 to 126,000	1,750 to 3,175	6,725 to 346,792	3,252 to 51,802	3,700 to 294,980
	Mean	-8,014	76,820	2,678	7,2247	13,343	58,905
	Stdev ±	6,9534	32,730	453	9,6246	15,132.06	83,340
Weruni	Range	-24,815 to 25,900	36,000 to 432,000	3,125 to 5,000	2,767 to 37,940	100 to 6,467	1,380 to 33,525
	Mean	3,379	185,410	4,296	12,558	3,331	9,746
	Stdev ±	16,758	189,440	970	11,952	2,525	10,337
Ituni	Range	-39,213 to 2,327	36,000 to 81,000	3,125 to 6,250	2,568 to 64,213	435 to 3,433	1,105 to 62,436
	Mean	-6,383	48,830	5,000	16,747	1,647	15,100
	Stdev ±	16,326	20,340	1,425	23,666	1,056	23,462
Kwakwani	Range	14,500 to 41,563	62,000 to 218,000	6,250 to 8,125	20,938 to 35,885	3,475 to 11,645	11,688 to 26,125
	Mean	31,725	137,330	6,875	27,649	8,123	2,0684
	Stdev ±	14,968	121,920	1,082	7,589	4,199	7,848
Aroaima	Range	220,265 to 234,375	50,000 to 100,000	8,125	41,875 to 145,360	4,375 to 6,090	37,500 to 139,270
	Mean	227,320	75,000	8,125	93,617	5,233	88,385
	Stdev ±	9,977	35,360	0.00	73,174	1,212	71,962

Source: Martinborough, 2002

These figures show how the value of human capital in the form of labour varies considerably, with the labour inputs in Aroaima accounting for as much as 95% of total costs. Analysis seems to suggest that this high degree of labour costs is due to the long distances required to travel to a selling point, and this indicates that if these labour costs are included, those households located furthest away from a road (or river) link, will in fact experience a negative net income from crabwood oil production. In this analysis, labour inputs are based on its opportunity cost in the region.

5.2.3 Maximising benefits from NTFP commercialisation

From the results of this research, it is possible to identify some ways in which the economic impacts of NTFP commercialisation can be maximised. Some of the ways in which benefits from crabwood can be developed include:

- **Small producers can increase bargaining power through consolidation**

Producers need to network in and across villages, form cartels or co-operatives to market their products. The traditional Amerindian social structure is egalitarian and does not favour entrepreneurial behaviour. Households are expected to meet their own subsistence needs and sales of excess produce are to supplement the household economy, not for conspicuous consumption or hoarding. A household is an independent economic unit, and there is generally no developed tradition of communal marketing of trade goods. Hucksters and middlemen exploit this situation by dealing with Amerindian producers one-on-one and driving the price down. In

the modern context, local producers need to reflect on this cultural trait and find ways to network among themselves so as to improve their own bargaining power.

- **Standardise production process and monitor product quality**

The onus will be on networks of producers themselves to aim to consistently produce a high quality oil. They will have to work with new producers in particular to guarantee a uniform standard. Practices that promote rancidity – like that of adding water or cane juice to crabwood oil have to be stamped out.

- **Start with national markets, then branch out**

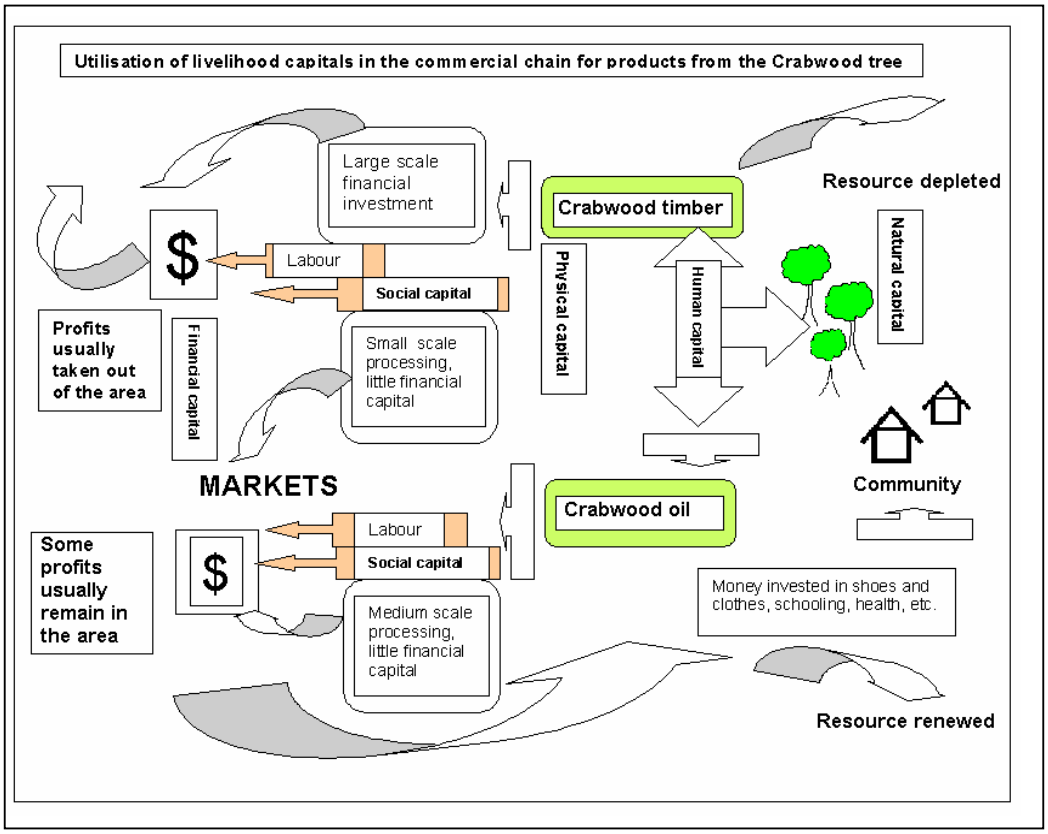
The local market for crabwood oil is not saturated and prices are good. Producers should aim to satisfy that market, particularly if there is no price advantage for the export market. This route will help producers to work on product standardization and quality before expansion. Sometimes the biggest markets are at home but sufficient attention is not paid to developing it or satisfying local demand.

For more detail on these findings see Appendices 1.6; 2.3; 4.8 and others.

5.3 Inefficiencies in the market chain quantified.

Figure 7 provides an illustration of two branches of crabwood commercialisation: timber and oil production, and as is illustrated, the utilization of the species for timber means that future opportunities to harvest seeds is removed, and profits tend to go mostly to the entrepreneurs who have access to the financial capital needed for machinery. The role played in the commercial chain by the various livelihood capital types is indicated, and it seems likely that large scale commercialisation is likely to have a more detrimental effect on these capitals than would be the case in small scale commercialisation, where more value added can be retained by the producer.

Figure 7. Commercial market chains for crabwood products



Inefficiencies can be best identified if the factors which influence marketing decisions are known. In Guyana, standard econometric approaches have been used to analyse the factors influencing market behaviour of crabwood producers, and this has shown that access to transport and the market are vital if householders are to gain the benefits from crabwood oil production (see Section 4.3). This analysis also shows that changes in price for crabwood oil are likely to increase use of the resource, and there is some risk that this could lead to over-exploitation. This is particularly true of the crabwood timber market, as harvesting of the whole tree reduces potential future resources. If this occurs, there would possibly be a reduction in benefits for the poorest members of the community who may depend on crabwood seeds, drawing on these common property resources to be used in times of need. In the case of crabwood oil, overcollection of seeds could have the same effect. This finding does suggest that there is a risk that commercialisation of crabwood may have a negative effect on crabwood resources, and if there is an expected rise in crabwood prices, and increased use, it would be a wise precaution to examine ways in which the resource base can be maintained.

These results clearly show that one of the major inefficiencies in the market chain is transport and access to market. This was found to be the case in all study areas. In the case of South Africa, transport is costly and can be erratic, and in a number of cases product was lost through spoilage directly as a result of transport and coordination problems. In Namibia, more cooperative approaches are producing higher returns, and some successful attempts at shared marketing have been made. In Guyana, sales are very haphazard, and often producers sell the product directly from their homes, simply because the journey to market is arduous and costly. As a result, for many producers, the return on crabwood oil production is low, and the market is quite inactive. Potential exists for more streamlined marketing of crabwood oil in Guyana, and an institution to address this, such as the nutmeg producers association of Grenada, could be taken as a model for the development of such a body in Guyana. Indeed, at the final workshop in Guyana, crabwood oil producers pledged to develop a producer's network, linking people from different production areas of the country. Such a model is in existence in South Africa and Namibia, and there is a clear indication that such development would be beneficial to those involved in crabwood oil production. Some of the information required for successful commercialisation would involve knowledge of how NTFPs can be prepared for national and international markets. This is discussed in the following section, and a summary of the winning and losing qualities of traders and businesses are shown in Table 27.

Table 27. Winner and loser qualities of individuals, households and enterprises involved in NTFP commercialisation

WINNER QUALITIES	LOSER QUALITIES
• Individuals organised as a group	• Un-organised individuals
• Well informed of markets	• Poorly informed of markets
• Access to transport	• Poor access to transport
• Coordinated production	• Un-coordinated production
• Small input cost to revenue received ratio	• Large input cost to revenue received ratio
• Consistently good quality products	• Variable quality products
• Skilled in bargaining	• Unskilled in bargaining
• Well 'networked' – good partnerships and many linkages	• Poorly 'networked' – poor partnerships and few linkages
• Easy and equitable access to resource	• Uncertain and restricted access to resource
• Fits with other livelihood strategies and socio-cultural norms	• Competes with other livelihood strategies and socio-cultural norms

5.3.1 General requirements for export of crabwood oil

Western regulations limit the amount of detectable additives such as extractive solvents and adulterants or additives to the oil. The standardised oil (Chung 2000) must contain a specified

minimum level of one or more plant constituents and standard amount of active chemical(s) e.g. gedunin derivatives, andirobin. The oil must therefore be standardized to specific constituent(s) or marker compounds as accepted by industry as most important. This standard serves as a basis for verification. Standardisation ensures that sufficient amounts of the active plant constituents are present to give an effective product for industry and consumer protection. The best way to communicate to the consumer is by quantifying (standardising) to the most broadly reported marker compounds. In the case of crabwood oil the marker compounds should be andirobin and gedunin derivatives as well as oleic acid and palmitic acid in the form of their triglycerides olein as palmitin for medicinal properties.

5.3.2 Physical and chemical export requirements for crabwood oil

For commercialisation purposes the oil must be of consistent quality and standard. Standardising the oil ensures that the best price is obtained for the oil each time. Extraction methods should be standardised to give the best quality oil. Extraction of the oil from the seeds should be performed as soon as the seeds are collected. Rotten seeds should not be used for oil extraction. Cold press extraction is one of the best extraction methods to use as it minimizes decomposition of the oil.

Physical properties that need to be standardised are colour, clarity, viscosity and odour. Choice of colour is subjective and consumer dependent. Some consumers may prefer the darker coloured oil whereas others may prefer the pale yellow oil. Clarity and viscosity are dependent on temperature as well as fat and moisture content. The oil should be clear at room temperature, 25 °C. So the amount of moisture in the oil should be kept at the minimum allowable value. Minimising the amount of moisture present in the oil also reduces the rate of hydrolysis and decomposition (rancidity) of the oil by microorganisms and increases the shelf life of the oil.

The free fatty acid content increases as the oil goes rancid. Crabwood oil of good quality has low acid content, less than 1%. Keeping the free fatty acid content below 1% is essential for pleasant odour. The oil gradually acquires a stronger unpleasant odour as the free fatty acid content increases. Density, melting and freezing points and refractive index of the oil gives an indication of the quality of the oil e.g. percentage of triglycerides. Chemical properties that need to be determined for the oil include: acid, saponification and iodine values. Acid value indicates the quantity of free fatty acid present in one gram of oil or fat. The saponification value gives the quantity of caustic potash required to saponify the oil or fat. The iodine value gives the degree of unsaturation of the fatty acids in the oil or fat.

The oil should contain at least 95% triglycerides to have good emollient properties. It should also have between 1 and 3% limonoids and triterpenes for effective insect repellent and insecticidal properties. Analysis of the oil is best carried out using Gas Liquid Chromatography that serves to quantify the amount of different triglycerides present in the oil and establishes the presence of contaminants e.g. solvents and certain adulterants. The chromatograph or “fingerprint” obtained from Gas Liquid Chromatography is used to verify the quality of the oil and can be used to establish both price and comparability.

To minimize decomposition of the oil and improve the shelf life, the oil should be protected from light, high temperatures, air, moisture, microorganisms and metals through proper handling and packaging. The oil should be stored between 20 and 25 °C in dark or amber glass bottles. Toxicity hazards and expiry date must be stated for the oil. These variables can only be established through carefully conducted short and long term laboratory tests.

For more detail on these findings see Appendices 1 to 4.

5.4 Threshold off-takes for sustainable production of marula and crabwood identified

The objective to identify threshold off-takes for sustainable production really require data from a longer time period than that provided by this study, but by providing a baseline for assessment of marula, this work has contributed significantly to this goal. For example, by providing a better understanding of factors influencing the supply of resources from a tree species like marula, we are in a better position to understand the role it may play in supporting livelihoods for poor people in semi-arid zones. In Guyana, a general investigation of crabwood trees has been

made, along with tree use, oil production and trade. Information on crabwood is separated from that on marula, as the alternative land use types have not been relevant in the Iwokrama context. Data relating to crabwood are presented in Section 5.4.2.

5.4.1 Marula

The resource inventory relating to marula reveals that trees found in homestead plots and fields tend to bear more, better quality fruits than those found in the wild, although there is likely to be a much greater density of stems there. There is a statistically significant relationship between canopy size and fruit yield. Significant individual differences exist within the population as a whole, and also between trees found in areas of different land uses. Certain individuals produced both more and larger fruits and, in particular cases in Namibia, the fruits were often more than twice the average size, giving rise to the name '*Namibian wonder*'. It is also clear from this work that larger size fruits don't necessarily produce more or bigger kernels.

It is apparent both in Bushbuckridge and Namibia that householders have tended to selectively nurture those trees which are both abundant in fruit yield, and are sweeter than those found in populations in areas less influenced by humans. In the case of the Muputaland study sites, the characteristics of the local marulas does tend to reflect the fact that the area has only recently been settled, and there has been little influence by humans in the area. At the moment, in all areas, according to data from the season of the survey, there appears to be a supply of marula fruits in excess of the amount demanded by humans. It was, however, reported in Maputaland, that the age distribution of the marula population suggests that not enough young trees are currently being recruited to ensure a sustainable offtake in the future. In addition, some 35% of those questioned in Bushbuckridge reported the occurrence of theft of marula fruits, something which was reported to have not occurred before. While over half of all householders questioned during this study reported the nurturing of any self-seeding marulas, a much lower number (25-44%) reported actually cultivating the trees themselves.

Table 28. Summary productive capacity data for marula

	South Africa- *marula* Bushbuckridge	**South Africa-** *marula* Maputaland	**Namibia –** *marula* North Central
Stem Density (stem/ha)			
In homestead plots	10.8	6.35	1-6
In arable fields	5.7	2.63	
In communal lands	61.3	6.0	
In the wild	102.1	63.75	
Female Density (trees/ha)		**	1-4
In homestead plots	4.5	3.36	
In arable fields	2.0	0.91	
In communal lands	2.3	2.69	
In the wild	4.5	7.25	
Mean fruit mass, gms	23.6	23.92	26.68*
Mean fruits per tree	30,773	5,051	19,866
Mean mass of fruits per tree	65-1092		25-2055
Kernel size, gms	0.34		0.36
% kernel oil content	44.7 – 72.3		50.2 - 63.8
Sample size	148	134	104

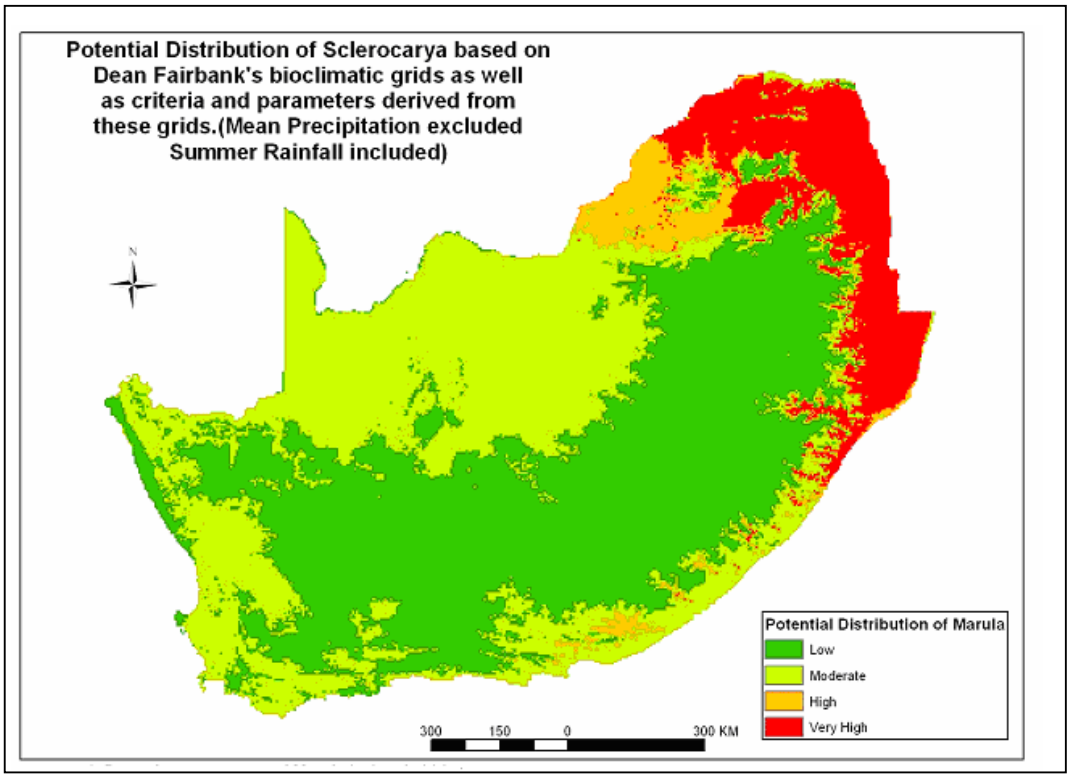
* value includes the 'Namibian wonder, with an average fruit mass of 69.9 gms.
** data relates to 'fruiting trees' rather than simply by gender.

There appears to be evidence from this research that the current supplies of marula fruits in South Africa are adequate to meet demand, due to the great abundance of both the trees and their fruit production. There is the potential for further development or increased utilisation, but this may give rise to localised conflicts over resource use when lack of tree tenure exists. There is also the possibility of the natural productivity of the marula being increased through improved

cultivars and selection, and the *Namibian Wonder* would be ideal for such an endeavour. In that particular case, there may be some grounds for patenting or other IP registration.

In terms of national potentials, by looking at the biophysical conditions which are a prerequisite for successful marula recruitment, we can use GIS to predict those areas in which marula production can possibly be viable. This can be done by identifying those places which meet all the requirements of likely marula success. This is shown in Figure 8.

Figure 8. How GIS can be used to investigate the potential viability of marula trees in South Africa



Due to the scale of this work, much more detailed investigation would be required to confirm the viability of any specific locations, and more detailed analysis using GIS is recommended.

5.4.2 Crabwood

In any situation where a resource is becoming commercialised, it is possible that the stock of that resource can become depleted through over-use. In the case of crabwood, the risk of depletion is more likely to be caused through timber harvesting than it would be from crabwood oil production. Much has been written about logging of crabwood trees, and this is not the major issue for this research, so our efforts have been more specifically directed towards the impacts that may result from over-harvesting of crabwood seeds.

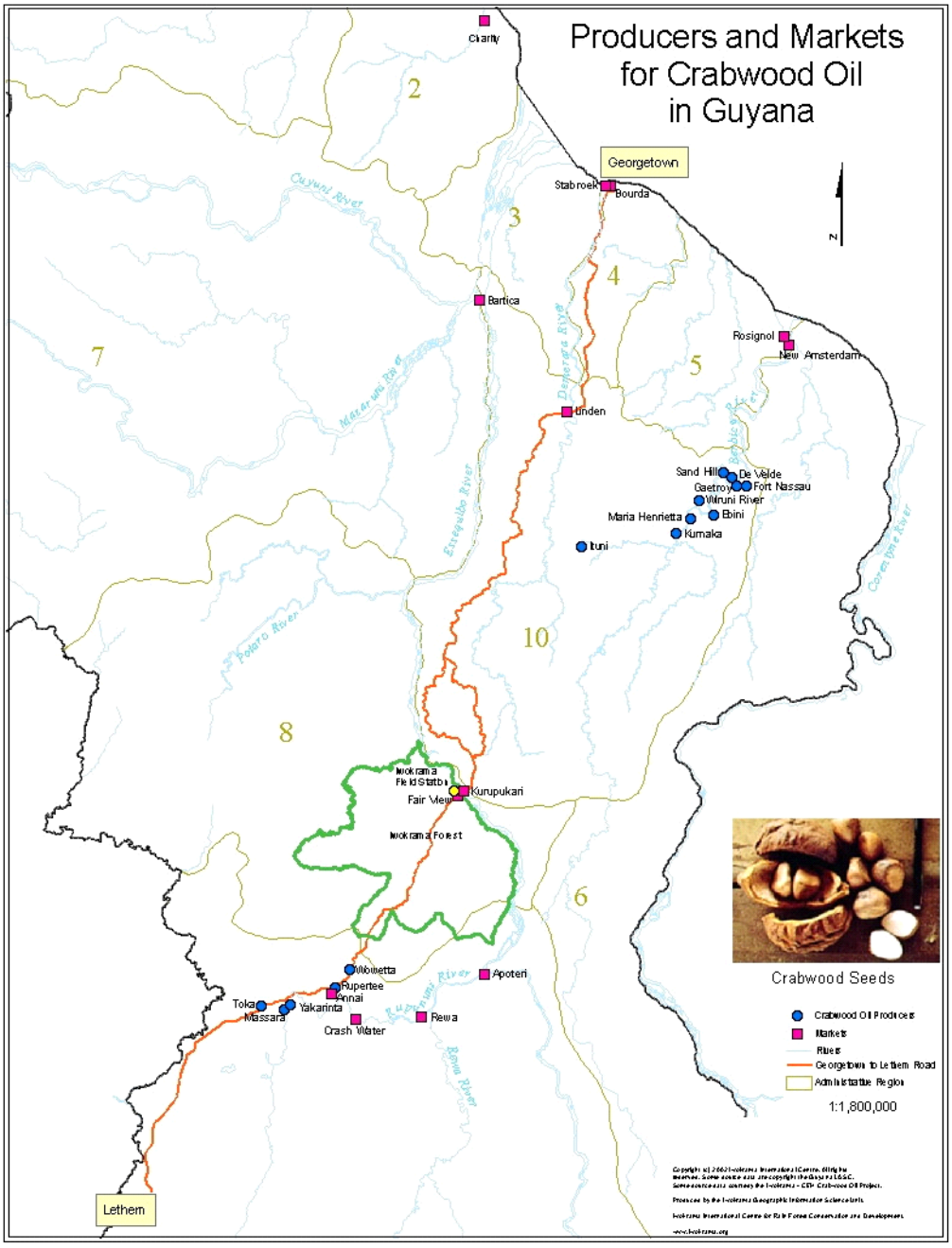
5.4.2.1 Crabwood supply stock and estimates of sustainable seed off-take

Crabwood abundance estimates were taken from published records of inventory conducted in 1961 and 2000. The tree inventory estimates of 2000 were taken to be a reflection of present crabwood supply stock. Sustainable seed off-take levels have been adopted from research done in the Iwokrama Reserve. Seed yields of trees of varying sizes on three 0.75ha plots were examined from March to May of 2000. With the use of regression analysis, the correlation between tree seed production and stem size was tested and a sustainable off-take of seeds identified. According to this estimate, 50% of seeds are required to be left for regeneration, with 50% removal possible, but this has been reduced to 40% to ensure that any additional shock of isolated cases of timber harvesting can be absorbed.

5.4.2.2 Using GIS to link producers and consumers of crabwood oil

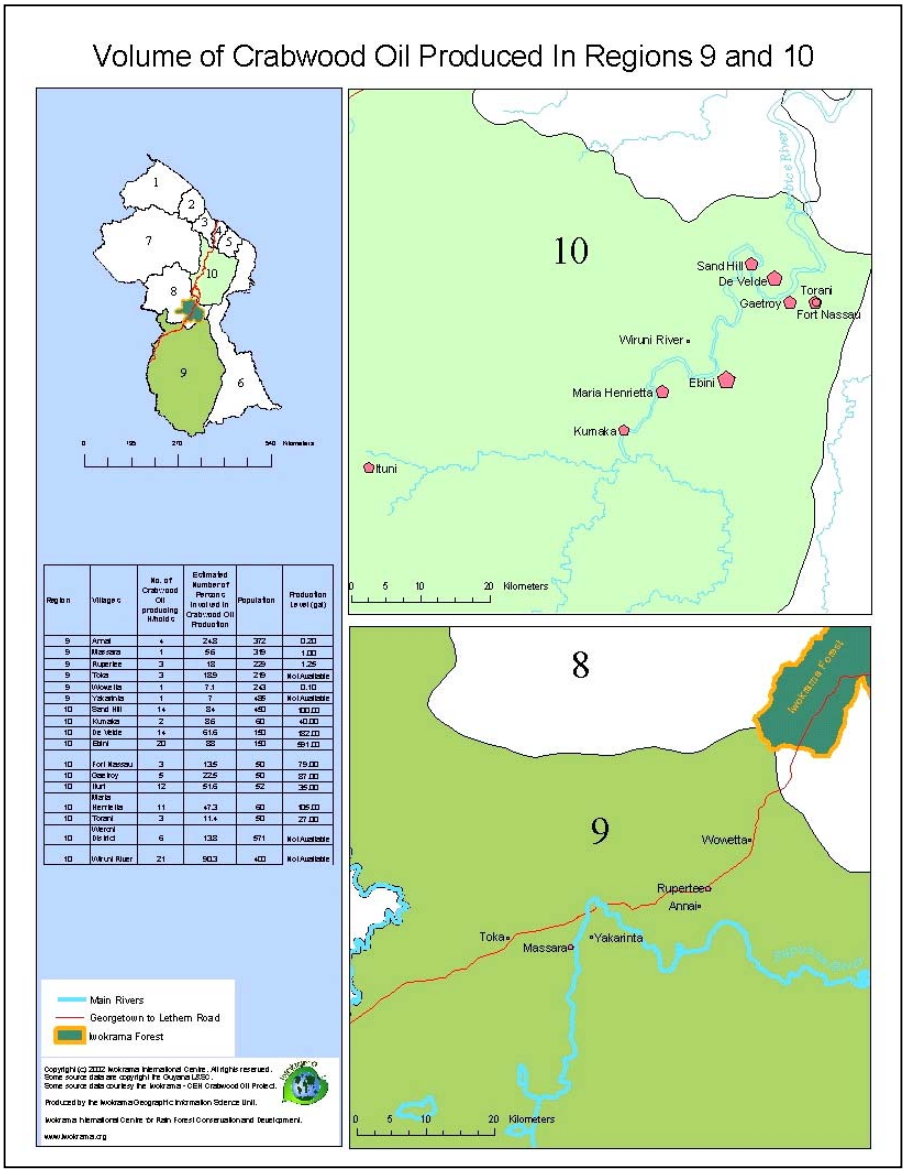
The data used in this study is part of a general investigation of crabwood oil production and trade in Guyana. With more comprehensive data, it is likely that GIS could have a wide application in linking sources of crabwood tress to potential oil producers. An example of how this may be of use is shown in Figure 9.

Figure 9. Using GIS to link data from different sources



For the purpose of spatial analysis, six areas from Region 9 and eleven areas from Region 10 were involved in crabwood oil production. Details of the areas covered are shown in Table 29 and illustrated in Figure 10. While surveys were done in other villages, only these 17 locations had enough information to be spatially represented/analysed. The population totals by region were 1867 persons and 2043 persons for Regions 9 and 10, respectively. Whilst this represents a difference of only 176 persons, there exists a marked difference in both output and involvement in production between the two regions.

Figure 10. The application of GIS in Iwokrama



Region	Villages	No. of Crabwood Oil producing Hhlds	Estimated Number of Persons Involved in Crabwood Oil Production	Population	Production Level (gal)
9	Annai	4	24.8	372	0.20
9	Massara	1	5.6	316	1.00
9	Ruperteo	3	18	229	1.25
9	Toka	3	18.9	219	Not Available
9	Wowetta	1	7.1	243	0.10
9	Yakarinta	1	7	435	Not Available
10	Sand Hill	14	84	450	100.00
10	Kumaka	2	8.6	60	40.00
10	De Velde	14	61.6	160	522.00
10	Ebini	20	88	160	691.00
10	Fort Nassau	3	13.5	50	79.00
10	Gaetroy	5	22.5	50	87.00
10	Ituni	12	51.6	52	35.00
10	Maria Henrietta	11	47.3	60	105.00
10	Torani	3	11.4	50	27.00
10	Wiruni District	6	13.8	571	Not Available
10	Wiruni River	21	90.3	400	Not Available

Table 29. The extent of crabwood oil production in 2 regions of Guyana

Region	Villages	# of Crabwood Oil producing HH	Estimated No. of Actual HH per Village	Population	% of Population producing Crabwood Oil	Production Level (gal)
9	Annai	4	60	372	1.08%	0.20
9	Massara	1	57	319	0.31%	1.00
9	Rupertee	3	38	229	1.31%	1.25
9	Toka	3	35	219	1.37%	Not Available
9	Wowetta	1	34	243	0.41%	0.10
9	Yakarinta	1	69	485	0.21%	Not Available
		13		**1867**	**0.70%**	2.55
10	Sand Hill	14	103	450	3.11%	100.00
10	Kumaka	2	14	60	3.33%	40.00
10	De Velde	14	34	150	9.33%	182.00
10	Ebini	20	34	150	13.33%	591.00
10	Fort Nassau	3	11	50	6.00%	79.00
10	Gaetroy	5	11	50	10.00%	87.00
10	Ituni	12	12	52	23.08%	35.00
10	Maria Henrietta	11	14	60	18.33%	105.00
10	Torani	3	13	50	6.00%	27.00
10	Weroni District	6	131	571	1.05%	Not Available
10	Wiruni River	21	92	400	5.25%	Not Available
		111		**2043**	**5.43%**	1246.00

5.4.3 Maintaining and enhancing the resource base through better management and domestication

While it is clear from the results of this study that many marula areas are currently in a situation of surplus supply, there are others where there is much potential for intervention. This is also true of crabwood and, since both species provide valuable benefits, the opportunities to increase yield is worthy of attention.

5.4.3.1 Potential interventions and recommendations for marula

In the case of marula, some progress has been made in the quantification of species productivity, and the identification of winning and losing qualities, but this is based on a short season, and this may not be representative. More monitoring of this for a longer period would be beneficial, but we now present some observations on how the resource base can be strengthened for future use.

Opportunities:

- Huge genetic variation and therefore opportunity to make a quantum leap in yield and quality. Broad genetic base also gives an opportunity for minimisation of risk.
- Marked phenological variation in fruiting across and within regions allows for future selection to increase length of fruiting season.
- Multipurpose species, with an opportunity to do single purpose selection within this.
- Relatively high abundance of trees in the landscape, and the wide distribution of the species. In Namibia, a growing population and distribution of marula and also few alternatives.
- Easily propagated, hardy, high germination success, and reasonably fast growing.
- Compatibility with human dominated land uses (therefore can increase densities).
- High fruit yields per tree.
- Traditional interest in bees and honey can address constraint of low pollination success.
- The fact that supply currently exceeds demand allows an opportunity for commercialisation, and for time to improve the resource before faced by too high a demand.
- Presence of forestry/agricultural extension officer services in the regions.
- Strong cultural value and high nutritional qualities.

- Commercialisation and increased awareness as to the importance of marula has led to a positive incentive to manage the tree effectively, and to uphold customs and traditions.
- Decentralisation of marula management provides opportunities for community-based monitoring systems to ensure the enforcement of customary rules and regulations.
- Farmers have an interest and knowledge of the species, the desired traits and products.
- In Namibia there is respect and protection of the marula resource, also in S. Africa, but less so.

Constraints:
- Limited knowledge of domestication techniques in rural communities including amongst extension officers.
- Without selection, genetic diversity results in a non-uniform product, which complicates trying to maintain quality, especially in international markets.
- In South Africa, the monitoring and enforcement of rules and regulations for marula are weak.
- Insufficient male trees to maximise kernel number and an absence of pollinators.

5.4.3.2 Recommendations for marula

Selection
- Initiate a participatory domestication programme using a wide strategy to maintain genetic diversity.
- Select for low nut:kernel ratio.
- Select for maximum numbers of kernel per nut.
- Select for thin shells, easily popped operculum.
- Select for early and late fruiting cultivars to extend productive season.

Management and domestication
- Develop strategy for improved pollination to maximise numbers of kernel per nut (e.g. hives in trees – need to ensure that cross-pollination promoted, male:female optimised; spatial arrangement of males and females, spatial arrangement of hives).
- Increase proportion of male trees in the population.
- Optimise sex ratio and stem densities within existing farmer-driven land use systems.
- Promote education and training in SME and horticulture techniques.

5.4.3.3 Potential interventions and recommendations for maintaining the crabwood resource base

In the case of crabwood, there is still much to be learnt. There is little doubt that in some areas, the resource is under threat through logging activities, and this is reducing people's access to the seeds to produce crabwood oil. Action must be taken to address this. There is also important information to be gained relating to the proportion of crabwood seeds required for the ecosystem itself, as crabwood logging is depleting the species functionality associated with both habitat and food provision for other species.

Table 30. Opportunities and constraints for crabwood commercialisation

Benefits	Constraints
Human Capital / Labour	
1. Provide income 2. Family labour 3. Potential to collect seeds on hunting, fishing or farming trips 4. Children assist in the collection and processing stages during school holidays 5. Knowledge of crabwood oil making is still widely known in some regions 6. Entire chain of stakeholders benefit directly from the oil trade	• Migration to Brazil and to the logging and mining industries to seek work limits labour availability in some cases • An average of one day is spent collecting seeds • Travel further and further to access resources in some areas due to logging out of crabwood trees by logging companies • Low prices paid for labour considering labour costs. • Small scale production of oil in isolated communities due to logging
Social Capital	
1. Women identified as important in the local trade with the unique technique to process the oil 2. Excellent medicinal uses of the oil 3. Oil uses should be promoted locally to encourage use of local medicines rather than spending money on imported drugs for same treatment	• Knowledge of crabwood oil making is no longer widely known in some communities • Substitutes for crabwood oil are being used e.g. imported Baby Oil • Younger generation no longer interested in the traditional oil-making process (becoming westernised) • Networking – the local producers are not organised in any association to supply to markets
Natural Capital – Resources	
1. Availability of resources in some regions 2. Seasonal harvesting of seeds 3. Family sometimes spend weeks on the farm to process the oil instead of returning to the village 4. Widespread recognition of the need for management system to protect the resource base	• Lack secure land tenure and land rights • Sometimes there is a small crop season in August to September (not every year) • Resources no longer available for community uses on some community lands and State Forest due to logging out of crabwood trees • Wastage of wood (left to rot if some logs are rejected by outsiders) • Local producers compete with animals for seeds in some seasons. Also trees do not fruit every season affecting livelihoods in some seasons
Financial Capital	
1. Lack of market access for most communities 2. Depend on traders considered to be savvy to market the oil. Have access and links to markets 3. Women are given responsibility to market the oil since they are at home during the day 4. The timber is a highly prized wood for the furniture industry 5. Need for networking of local producers to prevent exploitation by middlemen 6. Use of 'Karaba' instead of crab oil as an indigenous word to promote forest product 7. Techniques for reforestation of crabwood trees tried and tested 8. Crabwood trees have a wide range within the Guianas	• Local producers give the oil on credit to the local traders • Local producers sometimes have to wait until the next season to receive payment from the traders • The traders set the price which they are willing to pay for the oil • Women often have to directly interface with the traders who are better at negotiating • Poor linkages to markets and lack of knowledge of potential global markets • Absence of ready market
Physical Capital	
1. Some materials are unavailable e.g. zinc sheets to assist with the processing stages	• Competition from logging in many areas since there are no existing legislation to guarantee local access to NTFPs • Information on resource management

5.4.3.4 Recommendations for local policy decisions relating to crabwood in Guyana

A number of suggestions have been developed following participatory consultation with crabwood producers

5.4.3.5 Manage and/or protect crabwood trees

The 75 titled Amerindian villages can formulate local by-laws to manage and/or protect crabwood trees or other key natural resources found on their lands. Copies of by-laws are supposed to be given to the Regional Democratic Council (in the local government system) and the Ministry of Amerindian Affairs. Communities in State Forests or State Lands that lack title cannot protect their forest resources in a similar way, but can make representation to the Guyana Forestry Commission to ensure protection for crabwood seed-bearing trees.

5.4.3.6 Consider issue of sustainable off-take of crabwood seeds

Management plans for crabwood trees must factor in the needs of animals like akuri and peccary that depend on the seeds for food. These animals play a role also in propagation of the species. A community might decide to rotate seed collection from different stands or trees from year to year, rather than taking seeds from all areas, or it might limit off-take of seeds per acre or hectare, until such time as precise off-take rates are established. More detailed investigation over a longer number of seasons is needed to establish a more exact estimate of seed requirements for ecological thresholds.

5.4.3.7 Propagating crabwood trees

The evidence from scientific experiments and community experience is that it is possible to grow crabwood trees. Trees also begin to fruit between 7 and 10 years, and younger trees are said to produce greater quantities of seeds than older trees. Planting and nurturing crabwood trees near homesteads, in farms and in forest areas will not only aid sustainable livelihoods but environmental conservation also. Some anecdotal evidence exists which confirms that this is already occurring in some areas.

Table 31. Winner and Loser qualities of the tree resource itself

WINNER QUALITIES	LOSER QUALITIES
• Abundant resource	• Rare resource
• Plant part used readily renewable	• Replacement of harvested part slow
• Non-destructive harvesting – little influence on regeneration	• Destructive and damaging harvesting – affects regeneration
• Easily propagated	• Difficult to propagate
• Genetically diverse with potential for selection and domestication	• Genetically uniform with little potential for selection
• Multiple uses	• Narrow use options
• High yielding and of high product quality	• Low yielding and of poor product quality
• Consistent and reliable yield from year to year	• Inconsistent and unpredictable yield from year to year
• Already cultivated within farming systems/early phases of domestication done by traditional farmers	• Wild resource which would be difficult to cultivate
• Fast growing and short time to production of harvestable product	• Slow growing and long time to production of harvestable product
• Compatible with agroforestry land uses	• Competitive with crops, harvest at season with labour deficit, etc.
• Hardy	• Sensitive to adverse environmental conditions
• Wide distribution	• Narrow distribution

In the case of both marula and crabwood, many of the winning qualities apply. For more detail on these findings see Appendices 1 to 5.

5.5 Greater awareness of the role of non-financial forms of capital achieved in local communities.

Natural, social and human capital are all important in subsistence communities, and people are aware of this. The project did however raise the profile of the natural capital element of the NTFP marketing chains, and it is hoped that the disseminated outputs will have the impact of building greater consciousness about the need to nurture these types of trees for future generations. The value of cooperation and community management of the resources was promoted at the workshops, along with the idea of adding value to household incomes, by exploiting these non-monetary livelihood capital types.

In order to promote awareness of all of the issues associated with the project, a number of tangible outputs have been produced, and a summary of these are shown in Table 32. For the full list of project outputs see Section 11 and Appendices 1 to 5.

Table 32. Methods used to build awareness about livelihood capitals and NTFP use

Type of material	Southern Africa	Guyana	International
Journal papers	7 various on marula	In prep.	1 generic in prep.
Leaflets	2 on marula	2 on crabwood	1 generic
Stakeholder workshops held, number attended	Regional Dissemination Workshop, March 2003, 80 attendees, including participants from non-project countries	Regional Dissemination Workshop, November 2002 80+ participants, including participants from non-project countries	Papers delivered at the International Rangelands Congress, 2003; and the ICRAF Agroforestry Conference 2002, plus attendance and output dissemination at the International NTFP meeting in Bonn, 2003, and World Forestry Congress, 2003
Benefit sharing document produced	Benefit sharing primer published Marula policy report produced	Benefit sharing primer prepared for distribution	Potential for international distribution being investigated
Video production	'Trees of Life' video production. Available for free broadcast	'Trees of Life' video to be shown on GTV. Short version for use in wildlife training course, Guyana Zoo.	Available for free broadcast, copies being circulated. To be broadcast at World Forestry Congress, 2003
Posters	*Marula - a tree for everyone!* *Why are trees important for our lives?*	*Crabwood Oil: a source of income from the forest*. *Why are trees important for our lives?*	*Winners and Losers* theme poster delivered Johannesburg World Summit on Sustainable Development, 2002
Training booklet	*My friend the marula* In prep. English, Tsonga and Zulu, 500 copies	-	-
Newspaper, popular press, TV/Radio	Interviews with project personnel, and excerpts of video, shown on SABC news, and full programme on NBC. Newspaper and magazine coverage	Interviews with project personnel on GTV	Articles in popular magazines in UK, South Africa, and for publications from the FAO and CIFOR

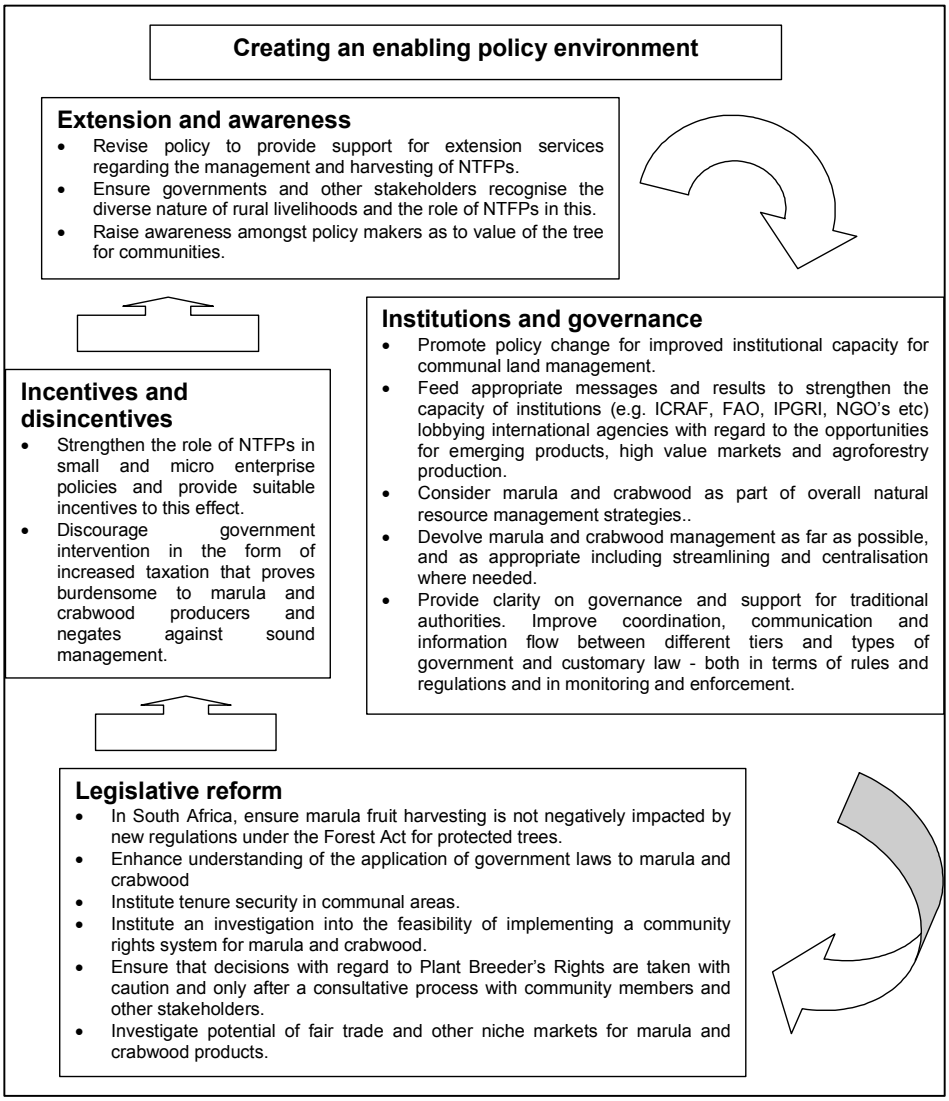
5.6 Appropriate IP and benefit sharing protocols developed

Guidelines on these issues relating to NTFP exploitation have been produced in this project, and additional financial support from IUCN and GTZ has enabled publication of these in South Africa. Copies of the guidelines are to be delivered to relevant authorities in Guyana, but it is recommended that further work should be done to tailor this specifically for the local conditions. This will empower communities to have a better understanding of how they can best make use of any commercial opportunities from non-timber forest resources. Generic issues are shown in Figure 11, but for more detail see Appendices A3.4; A5.14 and A5.15.

5.6.1 Enabling policy

There are a number of stages involved in the development of a positive policy for NTFP commercialisation. As in any policy, involvement of a range of stakeholders and policy makers will produce better results, and to implement new policies, legislative reform will be needed. Certain types of incentives and disincentives can be used, especially those to promote small scale household production. By raising awareness in extension officers and in different government departments, greater support for NTFP utilisation will be achieved. This is summarised in Figure 11.

Figure 11. Recommendations for creating an enabling policy environment



In addition to the generic issues shown above, some specific recommendations relating to crabwood have also been made, and these are now discussed.

5.6.2 Recover and promote traditional uses of crabwood/karaba oil
The therapeutic and medicinal properties of crabwood oil are increasingly being capitalized upon in global markets. Topical applications range from use as insect repellent to aid to hair growth and anti-cellulitis properties. The local market has also been responding favourably to information on the potential uses of crabwood oil. To capitalise on this, it is necessary to recover traditional knowledge and adapt it to the new situation, while promoting equitable participation, particularly in decision-making, by the community as a whole.

5.6.3 Respect local knowledge
Communities must take on board how to interest local women and men in crabwood oil processing and sale. Education in the efficacy of crabwood oil and training in its processing are key. In addition, people will learn to process the oil if they think there is a market and the price is right. Local communities should respond to the requests for action expressed by women collectors and processors, as and when necessary. This might be, as in the testimony of Mrs Gomes of Batavia, when seed bearing trees harvested by a community are cut down by concessionaires.

5.6.4 Start locally, the knowledge is within
A major setback to local Amerindian entrepreneurship is the attitude of Amerindians who may wait for outsiders to place an order before making a product, or worse, wait for outsiders to organise the production and sale. It is important to take pride in what they have, not see those products as a symbol of backwardness. Many products, including crabwood oil, have qualities that lend themselves to be marketed: organic, pesticide-free, relatively long shelf life, proven and tested over centuries. The challenge now is to turn these advantages to local benefit. 'Local communities must value what is around them, including the potential of crabwood oil'. (J.Forte, Crabwood Oil Workshop, Mainstay, Guyana, 2002

For more detail on these findings see Appendices 1 to 5.

5.7 Factors determining winners and losers in commercialisation identified along the product chain, and global market opportunities examined
Traditionally, people in Southern Africa are aware of the importance of marula trees, but it is clear that the products from them are becoming more financially valuable. There is a need in some areas for institutional strengthening, to enable communities to develop greater control of these resources, to protect their future needs. Specific 'winning' characteristics have been identified for anyone involved in the market chain, providing the basis from which greater capacity to benefit from NTFP use can be developed. Greater awareness has been built on how returns to NTFP use can be increased.

An example of how poor households in particular can benefit from NTFP use can be indicated by an assessment of the value of marula use in Bushbuckridge, South Africa. This is shown in Table 33. It is important that this unaccounted value of informal marula use is not neglected when decisions are made on future commercialisation issues.

Table 33. Economic value of domestic consumption of marula in Bushbuckridge

Fresh fruit:	R314
Beer:	R567
Jam:	R16
Kernels:	R184
Total gross annual direct use value of marula in Bushbuckridge (based on fruit): R18 million	

Source: Shackleton and Shackleton 2002 (Appendix 1.3)

The international market for essential and cosmetic oils is dominated by a few countries, but there is a huge potential for marketing both crabwood and marula oils due to a strong demand for natural, organic and fair trade products from consumers in rich industrial nations. The value of indigenous knowledge about crabwood, marula and other NTFPs will be lost if we fail to address issues such as intellectual property rights of forest dwellers, the easing of trade barriers and product marketing campaigns that educate consumers.

The opportunities for global marketing of marula and crabwood products have been investigated. This work has focused on the UK and Japan, both countries being major users of natural health and cosmetic products. Japan is the world's largest consumer of cosmetic and skin care products. For the purpose of the survey, companies were identified from the lists of Japanese Manufacturers and Exporters obtained through JETRO (The Japan External Trade Organisation). We also contacted the JICA (Japan International Cooperation Agency). Introductory letters were sent out to the companies in Japan, the UK, and parts of Europe, accompanied by a preliminary questionnaire. For those which responded positively, this was followed up by a telephone interview for more detailed information. 15 companies were interviewed by phone.

About 70% of those interviewed by phone were interested to be put in contact with suppliers, although they generally preferred to deal with an organisation rather than individuals. In spite of translating the letters and questionnaires into Japanese, we received a very low response rate from Japanese companies. Nevertheless, two of them were interested to know more specifically about crabwood. Of the companies which responded to the survey, only one had heard of crabwood before, and 73% said they wanted to hear more about it, and 72% said that they were interested in 'fair trade' issues.

A total of 15 additional companies were identified as being currently involved in selling crabwood or marula oil. These were interviewed to find out the types of products they sell, and these tended to be hair care products, moisturising cream, insecticide products etc. They all exhibited some degree of protection of information relating to their sources of raw materials and other commercial issues. This preliminary investigation suggests that there is a potential market for crabwood oil which could be exploited in the future, and in the case of marula, there is great potential to capitalise on the high level of marketing which has been carried out by Distell to market 'Amarula Cream' liquor. Significant progress has already been achieved in the sale of marula oil from Namibia, to the 'Body Shop', a success story facilitated by CRIAA.

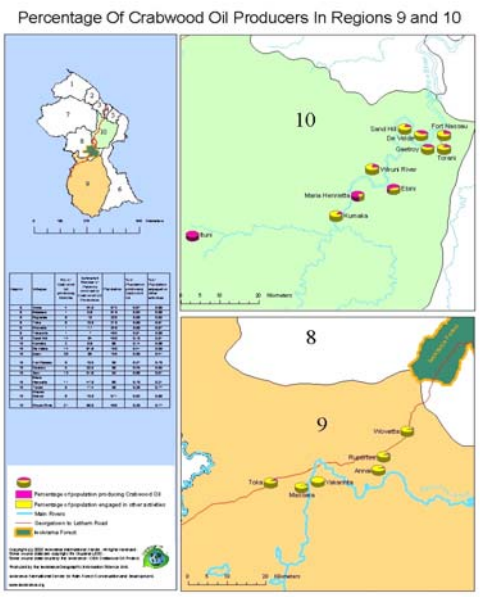
This very small-scale survey into international markets for NTFP oils like marula and crabwood has shown that there is a clear interest in these products, and in the case of crabwood, little is currently known. Both for marula and crabwood, great potential exists for larger scale marketing, and it is likely that if properly managed, this could bring long term benefits to local communities. In the case of crabwood oil, efforts to develop local marketing would be a good start on which a larger trade volume could be built, with a view to developing an export market. This would particularly apply to the development of products such as insect repellent soap and candles, which could generate added value for cottage industry enterprises. There is also much potential for the active ingredients of crabwood oil to be investigated.
Information about NTFPs such as marula and crabwood is needed before large scale commercialisation can take place. Such data is summarized in Table 34.

Table 34. Information needed for commercialisation to progress

Information about properties of NTFPs needed by potential buyers:	
A sample (250g)	 What is needed to show what products like these have to offer?
Material Data Safety Sheet	
Botanic Information	
Local (Native) Use over the years	
Price CIF UK	
Mode of packaging	
Measure of gravity and acid values	
Background information, from former studies if possible	
Cosmetic in-vitro data	
Standard safety statement	

There is immense potential to develop resource management tools using GIS techniques. This provides the means by which many different types of data can be combined, including both qualitative and quantitative data. In this project, a small amount of project resources were used to demonstrate how GIS can be used, and a simple example of this is provided in Figure 12.

Figure 12. The application of GIS in Iwokrama



This kind of information can provide the means by which links along the market chains can be identified. While some information has been treated in this way, there have not been enough resources in this study to take this further. In future, it is hoped that figures like this can be linked with more details such as transport links, labour supply and markets for products.

On the basis of what we have identified in the crabwood market chain, there is a large discrepancy between the location of crabwood oil producers and the markets where that product can be sold. This study has revealed that the (usually) small scale producers are often at the mercy of the entrepreneurs who provide the transport link to buyers.

In the case of the marula marketing chain, GIS has been used to investigate the areas of South Africa where marula trees can be grown (see Figure 8). Further study is needed to determine whether a single variable (for instance groundwater or soils), or a combination of variables, have more significant effect on the distribution of marula in South Africa. The use of GIS in mapping natural resources and, more importantly, in mapping the movement of resources through value chains, is becoming more reliable for answering complex questions. In this case, by mapping the potential distribution of marula and crabwood resources, and linking these to relevant socio-economic data, it will become possible to provide accurate information for the use of potential commercial interests. This is an area of research which can be further developed in future work.

The characteristics of successful markets are shown in Table 35, and this highlights the winner and loser qualities for markets themselves.

Table 35. Winner and loser qualities of the product in relation to markets

WINNER QUALITIES	LOSER QUALITIES
• Commercial opportunities	• Undeveloped/poor market interest
• Diversity of end markets – from local to international markets	• Limited markets
• Diversity of end products – from traditional to sophisticated	• Fad or single niche products
• Positive marketing image that can assist entry into high value markets (cultural significance, history, community based harvesting and processing, organic, ecologically sustainable, etc.)	• No or negative marketing image (ecologically destructive, exploitation of Many other substitutes primary producers, etc.)
• Unique qualities of ingredients	
• Qualities of the raw product well matched to market needs	• Many other substitutes
• Many buyers of raw material	• A monopsony - only one buyer of raw materials
• Many sellers of raw materials and end products	• A monopoly – only one seller of raw materials or end products
• Buyers aware of product or brand	• Buyers ignorant of product or brand

This study has focussed on two species only, and while many other plants are important NTFPs, little is known about many of them. This suggests that more marketing for a number of these could be useful, but it would need to be recognised that the resource would have to be properly managed if it were to succeed.

For more detail on these findings see Appendices 1.6; 2.7; 4,7; 4.9.

6. Contribution of Outputs

This project has made a significant contribution to our understanding of how local communities operate along a well developed market chain. This has been developed through extensive analysis of such chains for marula in South Africa and in Namibia. Our work shows that it is a combination of attributes which determine the success of players along that market chain, and these 'winning attributes' can apply to any individuals or groups at any stage of the chain. At present, there is little indication that any groups are losing out from the commercialisation process, but it must be noted that this is a situation which may change in the future, if the scale of commercialisation of both marula and crabwood were to become more widespread. The results of this study do serve to provide indications of what could become a problem in the future, and we hope that we have indicated how communities can best benefit from the use of their NTFP resources, while at the same time managing them for the benefit of future generations. The outputs and activities of this project have all been designed to address the five research hypotheses identified in the project purpose. The findings relating to these hypotheses are summarised in Table 36. (For more detail on Project Outputs see sections 5.1 to 5.7.)

Table 36. Project research hypotheses and findings

Research Hypothesis	Research Findings	Reject or accept hypothesis
Wholesalers, retailers and middlemen often capture the major share of the financial benefits of the commercialisation process, and this can devalue the social, human and natural capital at the local community level.	*Addressed by Output 1 and 7* When producers are isolated and have to act as price takers, this hypothesis is found to hold in all sites. In places where people work together, as in the Namibian marula cooperative, this is much less likely to be the case.	**Accept**
The availability of financial capital and market driven demand can lead to an export of financial and other benefits away from rural communities, leading to a degradation of human and natural capital.	*Addressed by Output 2 and 7* While this is seen to be the case in some places (especially poor isolated communities), it appears that it is not always true, as in some cases, these external forces can create benefits for local communities. For example, in the case of marula use, the return to labour from selling fruit to wholesale buyers can be more than it is from selling it as processed beer, due to inefficiencies in the market, and wastage.	***Reject, Reformulate, and Retest***
Inefficiencies of the product chain can also give rise to the export of financial and other benefits from local communities.	*Addressed by Output 3 and 7* This is certainly found to be true in almost every case, and it is only by reducing such efficiencies that benefits to communities can be maximised.	**Accept**
The financial benefits of commercialisation can be achieved by the community, if the process is made more equitable and recognises and enhances the values of the other forms of capital.	*Addressed by Output 5, 6 and 7* Measures to ensure equitable access to resources is just one of the factors which will influence how well financial benefits can be generated. Without the inputs of the human, physical and social capital, benefits from use of natural capital cannot be realised, as it is mostly through the addition of value added that financial benefits can be realised.	**Accept**
The threshold off-take is a limiting factor to the sustainable commercialisation of both marula and crabwood, unless the resource is enhanced by domestication.	*Addressed by Output 4 and 7* At present there is little evidence in South Africa that commercialisation of marula is limited by lack of resources. In Namibia, however, there is some evidence of this, and in Guyana, there are some concerns that this is indeed the case following large scale harvesting of crabwood for timber.	**Accept in some places but reject in others**

7. Contribution to the Millennium Development Goals

Through the testing of these research hypotheses, this project is providing a scientific basis for policy making relating to the management of non-timber forest products. In so doing, it is making a contribution to the achievement of the Millennium Development Goals 1, 3, 4 and 7. By developing a better understanding of the relationship between the ecologically sustainable supply of environmental goods and services provided by the two study species, and the demand for those goods and services from local populations, our work will help policy makers to design better management strategies for them, thus contributing to goal number 7 - *ensuring environmental sustainability*.

By highlighting the issue of access to common property resources such as marula fruits and crabwood seeds, the work is raising awareness of the importance of NTFPs in the livelihood strategies of poor people. Developing better management of such resources ensures that people continue to have access to this important form of food or income generation. Both of these contribute to the achievement of goal number 1 - *the eradication of extreme poverty and hunger,* and number 4 - *the reduction of child mortality.*

Similarly, through the investigations made here of how the tree products from marula and crabwood are actually used, we are highlighting the contributions made by women in generating benefits from this use. This, and the policies of resource management which may arise from applications of the findings, will contribute to goal number 3 - *promoting gender equality and female empowerment*.

8. Reaching the target institutions and beneficiaries

For research to have a meaningful impact, it is important that the results are communicated to the user community. In this case, this includes government departments, training, agricultural and forestry institutions, NGOs, and the private sector. Many efforts on different levels have been made to communicate the research results to this audience. In the project we have conducted final regional dissemination workshops which were attended by representatives of all major stakeholder groups. Details of these workshops are shown in Appendices 5.30 and 5.31. Policy briefing notes have been produced (Appendices 5.13; 5.14 and 5.15), scientific journal papers and articles in the popular press including TV and Radio interviews (Appendix 5) have been delivered. Guidance notes on IP and benefit sharing have been produced, and a '*My Friend the Marula'* story booklet is in preparation in South Africa. (A full list of all outputs is provided in Section 11).

Four posters have been produced on both species, and distributed to training institutions (Appendices A5.7; A5.8; A5.9 and A5.10), and five different leaflets have been distributed in a number of different international meetings (Appendices A5.1 to A5.5). A comprehensive website is available at www.ceh-wallingford.ac.uk/research/winners which is being continuously updated as new outputs are generated. For widespread dissemination of the outputs more globally, a 28 minute video has been produced entitled *'Trees of Life: 10 lessons from the marula and crabwood trees'*, and this has already been shown on national television in Namibia (6.30pm 8/5/03), and it is to be shown in Guyana and South Africa in the near future. Details of this are shown in Appendix 5.11. An additional and unplanned dissemination tool was produced and delivered to Guyana Zoo, in the form of a 12 minute training video, *'Fruits and Foragers: tree regeneration in Guyana's forests'*, for use in wildlife ranger training sessions.

In South Africa, beneficiaries of these tangible outputs include the Dept. of Water Affairs and Forestry (DWAF); Community Forestry Project of DWAF/DANCED; Mineworkers Development Agency/Mhala Development Centre; Mpumalanga and Northern Province communities and Departments of Agriculture and Environmental Affairs; NAFCOC; Macoda Project; Makulele CPA; Southern Africa Wildlife College; Mpumalanga Parks Board; National Research Foundation; CP Wild project; DACST Innovation Fund Project Commercial products from the wild; Kwa-Zulu Natal Nature Conservation Services; National Botanical Institute; Self-employed Women's Union; Cape Distillers (RSA); and the Mirma Company (RSA).

In Namibia, the Eudafano Women Co-operative Ltd; Katutura Artisans' Project and the Community Forestry Extension and Development Project of DoF/DANCED have all been

recipients of materials from the project, and members of the Southern Alliance For Indigenous Resources (SAFIRE) in Zimbabwe have also been beneficiaries of the project.

In Guyana, the Guyana Forestry Commission; Forest Products Association; the North Rupununi District Development Board; the Area council of village chiefs, Region 8; the Ministry of Amerindian Affairs; the Environmental Protection Agency; the Amerindian Research Unit; the Amerindian People's Association; Guyana Nature Foundation, Conservation International; Ministry of Fisheries, Crops and Livestock; the Small Business Association; and some of the Regional Democratic Councils have all been involved in the project at some level and will benefit from its outputs.

Internationally, many different organisations have made use of the project outputs, both through the website, and through ICRAF and the FAO (NTFP group). Potential involvement with CIFOR and UNEP are anticipated as a means of further dissemination of outputs. In late 2003, presentations will be made by team members at the World Forestry Congress meeting in Canada. The 'Trees of Life' video will also be shown at that meeting. For the scientific community, a total of 7 papers are either already published or in press, and it is also anticipated that a future journal publications will be generated to integrate all the results from the project in due course, including a paper to be submitted for the 2004 forthcoming special issue for the journal *Forests, Trees and Livelihoods*.

9. Developing the potential of marula and crabwood in the future

For the further promotion of sales of non-timber products from both marula and crabwood, efforts are needed in terms of:

- Refinement of methods of oil production including quality control to international commercial standards;
- Improved packaging to meet freight requirements and long shelf life (quality of labels, ink, materials etc.);
- Improved forms of communication between international buyers and suppliers – potential for development of cooperatives along the lines achieved in Namibia;
- Improved forms of larger scale conversion of materials from a raw state to a marketable commodity;
- Better transport opportunities for some communities, especially in Guyana;
- Cooperative efforts by local producers to provide a consistent supply and quality of product to wholesale buyers
- Better links between local production groups and international buyers.

As part of the empowerment process for local communities in the product chain, it is important to recognise that:

1. Knowledge of how NTFPs can be used is a form of social capital, which can generate monetary and other benefits for user communities
Adding value locally, for example, through soap making with crabwood oil, has multiple benefits: for health, on account of its insect repellent qualities, and as an income generating option. Communities can build on knowledge gained by standardising crabwood oil processing to meet export standards.

2. There is likely to be a need to implement institutional changes
At the local level, the real challenge is to solve a series of fundamental issues relating to the organization and administration of crabwood or marula commercialisation, in order to ensure democratic, participatory and transparent management of community-managed resources. In many cases, communities will need to recover traditional knowledge and/or adapt it to the new situation, while promoting equitable participation --in particular in decision-making-- by the community as a whole.

In addition to these specific marketing issues, there would be significant benefit to continue with the resource inventory component of the monitoring of the marula species, as this was not

conducted within the short life of the project, and so the reliability of our findings are limited by this fact. We would like to recommend that this component be carried out further. We would also recommend that much more could be done to encourage a reduction of logging of crabwood trees in the Guianas. We would also particularly like to see more work done on the commercialisation potential for medicinal plants in both countries, with a view to securing better distribution of benefits within such market chains. Any of these further research needs into the commercial process could be funded by DFID, GTZ or other donor agencies. On the biophysical side, CIFOR or ICRAF or UNDP may be appropriate to take this work forward.

10. Conclusions

This project has been designed to develop an improved understanding of how NTFP commercialisation influences both people and the environment. In order to ensure that the benefits from NTFPs remain available for local communities who use them, a number of issues have been examined, and some conclusions can be drawn and recommendations made.

NTFPs provide benefits to rural households in the form of food, medicines and other resources, and as components of traditional culture. The knowledge of how they can be used forms part of the social assets of a community, and their exploitation provides a source of financial capital which often provides a lifeline in times of real need. As long as access rights are maintained, they provide an important opportunity for gender equity. In order to ensure that the benefits of NTFPs remain available for rural households, resources must be efficiently used without threatening the resource base, and with minimal wastage. Local ownership helps to ensure a fair and equitable share of benefits from commercialisation, and if there is a large and sustained demand for NTFPs, both nationally and internationally, and if NTFP user groups are informed and organised, they can maximise benefits by adding value to their products. To ensure that the natural advantages of NTFP utilisation are maintained for local people, politicians and relevant institutions must support all aspects of the NTFP industry, from household producers to large scale international organisations. These issues are summarised in Table 37.

Table 37. Means of improving benefits from marula and crabwood use

Improve post-harvest technology and efficiency	Improving marketing and commercialisation processes
• For marula, develop nut-cracker for speeding up nut decortication. For crabwood, promote awareness of quality standards • Develop better storage and processing, while maintaining 'low technology' household extraction techniques. • Seek to identify opportunities for improved returns to labour through tree selection for yield and ease of extraction. • Improve quality and uniformity of products through selection, dissemination of improved planting stock, post harvest technologies and processing skills.	• Promote health and nutritional benefits within marketing strategy. • Create a marketing image. Invest in marketing campaigns – particularly for community initiatives. • Diversify markets for existing and new products. • Promote supply contracts for equitable distribution of benefits (e.g. with fair trade organizations, SANProTA – a regional trade association, etc.). • Build on the existing indigenous practices and knowledge and promote the existing cultural heritage. • Ensure commercialisation pathways that enhance the role of women at the village level, whilst also creating new commercial trade at national and international level. • For marula, promote traditional food and beverages and opportunities to use marula in national and international cuisine (recipe book and public awareness of potential marula products, kernels on Air Namibia/SAA flights). • For crabwood and marula, investigate ways in which the aroma of the oil can be improved and maintained over its shelf life. • Promote and provide financial support to NGOs as 'honest brokers', but exit strategies with sustainability plans crucial. • Develop partnerships with NGO and the private sector to provide sustainable trading opportunities (using the CRIAA SA-DC model). Partner with private sector donors and investors, for the establishment of local businesses. • Focus more on the development of businesses, with investments made in all aspects of the market channel.

There is little doubt that more marginalised households rely most heavily on wild harvested resources. To ensure that commercialisation of NTFPs results in an equitable distribution of costs and benefits between and within communities, certain conditions must be maintained. These include paying careful attention to possible socio-cultural impacts of any developments in the market, and avoiding sudden large-scale commercialisation interventions. Grassroots community organisations (cooperatives) can be set up to ensure equity, price security and information dissemination. If the ability of communities to engage in discussions with a wide range of market players and service suppliers can be encouraged, cooperative trading groups can be established to reduce destructive competition.

Improving local benefits from marula and crabwood use

In order to capitalise on the benefits of commercialisation, rural households must be informed of opportunities for marula and crabwood products trade. Efforts should be made to include a wide spectrum of products, and research should be supported to develop new marula and crabwood products. For products for which there is already a demonstrated demand – such as marula beer, crabwood based insecticides, etc., efforts should be made to improve product quality, including extending shelf life. Established community structures can be developed to organise trader groups to engage with partners and service organisations. These can form the basis of forums to negotiate operating procedures such as price setting, cooperative marketing strategies, and the development of effective information channels.

Training programmes for marula and crabwood traders can be devised to enhance their business skills, and the establishment of joint saving and investment schemes can help to mobilise financial capital. In the case of Guyana, a major problem facing crabwood oil producers is that of transportation. By improving river and road communications, and by promoting a more cooperative approach to marketing, increasing incomes are likely to accrue to oil producers. If this is consolidated by a commitment from the government to support a stronger moratorium on crabwood timber extraction, crabwood oil is more likely to be able to provide a sustainable stream of benefits for future generations of people living in the interior of Guyana. While this work has focussed on two important tree species, there are a number of lessons which can be learned from this, and applied to other NTFPs. These are summarised in Box 12.

Box 12. Lessons for NTFP commercialisation

- NTFPs are most important for the poor and marginalised members of communities;
- NTFPs make up income shortfalls, but in most cases, they cannot significantly alleviate poverty in the long term;
- Engagement in NTFP commercialisation and its benefits is variable even amongst the poorest households;
- Benefits of NTFP commercialisation must be weighed against the negative social and cultural costs of commercialisation, but these can be moderated by local agreements;
- Land and usufruct rights must be clear, government intervention pitched at the appropriate level, and political support for the NTFP industry secured;
- NTFP commercialisation can lead to improved management and conservation of the resource in certain circumstances, but requires oversight and intervention;
- An abundance of positive or 'winner' qualities need to be in place, or developed amongst the participants in the trade, and across the resource and markets;
- NTFP cultivation needs to be community-owned and driven if it is to succeed;
- Benefits from NTFP commercialisation can be realised at a local level;
- Communities are generally ill placed to benefit from intellectual property rights;
- Models of commercialisation based on partnerships between producer communities, NGOs and the private sector, are most likely to succeed;
- Product diversification is important to reduce dependence on a single product;
- Scaling up and introducing new technologies can shift benefits away from women and the most marginalised producers;
- NTFPs form only part of a far broader ecological, economic, social and political landscape;
- NTFP trade and industries are dynamic in space and time, and distribution of benefits will change under changing circumstances.

Finally, we can conclude from this study that in terms of 'winners and losers' in forest product commercialisation, there are almost always both winners and losers. By helping local communities to develop better marketing techniques, improved knowledge and business skills, they are more likely to become winners, gaining a more equitable share of the benefits generated from NTFP trade.

11. Project output list by output type

Academic Dissertation

Martinborough, T. 2002. **The Crabwood Oil Market in Guyana: Increasing Household Income.** Dissertation for MSc in Environmental Economics, University of York. U.K. 67pp

Payne, K. 2001. **The potential sustainable production of *Carapa guianensis* (Meliaceae) Abul. Oil in the Iwokrama Rainforest, Guyana.** Dissertation for BSc in Environmental Science, University of West of England, U.K. 48pp.

Book Contribution

Sullivan, C.A. 2003. **Marula Article** in *Riches from the Forest: food, crafts, spices and medicines*. (working title). CIFOR.

Briefing Notes

CEH Wallingford. 2003. **Winners and Losers in Forest Product Commercialisation: The importance of forest products for poverty alleviation.** CEH Wallingford. U.K.

Conference/Workshop

'Sustainable and Equitable Marketing of Crabwood Oil in Guyana', *International Technical Workshop, Lake Mainstay, Region 2, Guyana,* **November 23-24, 2002.** 84 participants. Iwokrama International Centre, Guyana.

'Marula Commercialisation for Sustainable Livelihoods', *Feedback and discussion on findings and recommendations from a two-year research project on the use, trade and processing of marula in South Africa and Namibia*, Nelspruit, South Africa, February 19, 2003. 60+ participants. INR/Rhodes University, South Africa.

Conference Paper

Shackleton, C.M. 2002. **Use and selection of *Sclerocarya birrea* (marula) in the Bushbuckridge Lowveld, South Africa.** *ICRAF Regional Agroforestry Conference: agroforestry impacts on livelihoods in southern Africa, putting research into practice.* 20-24 May, 2002, Warmbaths, South Africa.

Shackleton, S.E., Shackleton, C.M., Mander, M., Wynberg, R., Sullivan, C.A. and Leakey, R. 2002. Diversifying **Communal Rangeland Use and Benefits: The Case of Marula (Sclerocarya birrea) in Bushbuckridge, South Africa.** *Proceedings of the International Rangeland Congress,* Durban, South Africa, July 2003.

Educational Textbook

'My Friend the Marula': A foundation phase learning support material based on the research outcomes of the 'Winners and Losers' Project. English, Tsonga and Zulu versions. T. Sguazzin & D. du Toit, South Africa. 16pp (in prep). 500 copies.

Factsheet/Leaflet

'Crabwood Oil (Karaba Oil): A non-timber forest product - sustaining community crabwood oil cottage industry, Guyana, South America', Iwokrama International Centre, Guyana, 2002. 8pp.

'Marula Commercialisation for sustainable livelihoods', Rhodes University, South Africa, 2001. 4pp.

'Marketing Potential of Crabwood Oil in Guyana', Iwokrama International Centre, Guyana, 2001. 1pp.

'Making the most of your marula trees'. Recipe leaflet. CEH Wallingford, 2003. 4pp.

'Winners and losers in forest product commercialisation', CEH Wallingford, UK, 2001. 4pp.

'Winners and losers in forest product commercialisation', CEH Wallingford, UK, 2003. 4pp.

Handbook/Manual

Laird, S.A. and Wynberg, R.P. 2003. **Biodiversity prospecting & access And benefit-sharing: An introductory primer.** IUCN, Pretoria, South Africa. 33pp.

Internal Project Report

Botelle, A., du Plessis, P., Pate, K. and Laamanen, R. 2002. **A Survey of Marula Fruit Yields in North-Central Namibia.** CRIAA SA-DC, Namibia. 22pp (+ Appendices and photographs).

Combrinck, A. and Muller, J. 2002. **Modelling Marula Distribution in South Africa: A deterministic approach.** Environmentek, CSIR, South Africa. 12pp.

den Adel, S. 2002. **Use of marula products for domestic and commercial purposes by households in North-Central Namibia.** CRIAA SA-DC, Namibia. 35pp.

du Plessis, P., Lombard, C. and den Adel, S. 2002. **Marula in Namibia: Commercial Chain Analysis.** CRIAA SA-DC, Namibia. 28pp.

Forte, J., Ousman, S. and Radzik, R. (eds.) **Proceedings of the International Technical Workshop on Sustainable and Equitable Marketing of Crabwood Oil in Guyana, November 23-24, 2002, Lake Mainstay Resort, Region 2, Guyana.** Iwokrama International Centre, Guyana. 50+pp.

Grimmond, J., Joseph, I. and Datadin, V. 2002. **A spatial assessment of Crabwood Oil production in Regions 9 & 10 of Guyana.** Iwokrama International Centre, Guyana, Technical Report No. 2002/1. 6pp.

Joseph, I. 2002. **GIS Internship Final Report.** Iwokrama International Centre, Guyana. 9pp.

Leakey, R., Shackleton, S.E., du Plessis, P., Pate, K. and Lombard, C. 2002. **Characterization of phenotypic variation in marula (Sclerocarya birrea) fruits, nuts and kernels in South Africa and Namibia.** 17pp (+ Figures and Appendices).

Mander, M., Cribbins, J., Shackleton, S.E. and Lewis, F. 2002. **The Commercial Marula Industry in South Africa: A sub-sector analysis.** Institute of Natural Resources, South Africa. 71pp.

Martinborough, T., Forte, J. and Hammond, D. 2002. **Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Chainsaw Operator Survey.** Iwokrama International Centre, Guyana. 6pp.

Martinborough, T. 2002. **Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Family Level Survey.** Iwokrama International Centre, Guyana. 10pp.

Martinborough, T. 2002. **Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Pharmaceutical Dealers Survey.** Iwokrama International Centre, Guyana. 10pp.

Martinborough, T. 2002. **Karaba oil (Crabwood oil): a literature review.** Iwokrama International Centre, Guyana. 6pp.

McHardy, T. 2002. **Inventory of available marula resources on the Makhatini Flats, Maputaland, in the fruiting season of 2002.** Institute of Natural Resources, South Africa. 15pp.

McHardy, T. 2002. **Use of marula products for domestic and commercial purposes by households in the Ophande district, Maputaland, South Africa.** Institute of Natural Resources, South Africa. 29pp.

Ousman, S., Martinborough, T., Forte, J. and Hammond, D. 2002. **Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Community Level Survey.** Iwokrama International Centre, Guyana. 10pp.

Poulson, U. 2001. **International Market Survey Report for Marula and Crabwood Products.** CEH Wallingford, U.K. 51pp.

Shackleton, C.M., Botha, J., Emanuel, P.L. & Ndlovu, S. 2002**. Inventory of Marula (*Sclerocarya birrea* subsp. *caffra*) Stocks and Fruit Yields in Communal and Protected Areas of the Bushbuckridge Lowveld, Limpopo Province, South Africa.** Rhodes University, South Africa. 17pp.

Shackleton, S.E. 2002. The **informal marula beer traders of Bushbuckridge, Limpopo Province, South Africa.** Rhodes University, South Africa. 25pp.

Shackleton, S.E., den Adel, S., McHardy, T. and Shackleton C.M. 2002. **Use of marula products for domestic and commercial purposes: Synthesis of key findings from three sites in southern Africa.** Rhodes University, South Africa. 57pp.

Shackleton, S.E. and Shackleton C.M. 2002**. Use of marula products for domestic and commercial purposes by households in the Bushbuckridge district, Limpopo Province, South Africa**. Rhodes University, South Africa. 61pp.

Shackleton, S.E., Sullivan, C.A., Cunningham, A.B., Cribbins, J., Leakey, R., Laird, S., Lombard, C., Mander, M., Netshiluvhi, T.R., Shackleton, C.M., and Wynberg, R. 2001. **An overview of current knowledge on *Sclerocarya birrea* (A. Rich.) Hochst. subsp. caffra (Sond.) Kokwaro with particular reference to its importance as a non-timber forest product (NTFP) in southern Africa.** CEH Wallingford, U.K. 58pp.

Shackleton, S.E., Wynberg, R.P., Sullivan, C.A., Shackleton, C.M., Leakey, R.R.B., Mander, M., McHardy, T., den Adel, S., Botelle, A., du Plessis, P., Lombard, C., Laird, S.A., Cunningham, A.B., Combrinck, A. and O'Regan, D.P. 2002. **Marula commercialisation for sustainable and equitable livelihoods: Synthesis of a southern African case study.** CEH Wallingford, U.K. 51pp.

Strong, J. 2002. **Methods for the Use of Camera Traps and Thread Trails to Monitor Wildlife Use of Crabwood (C*arapa guianensis*) Seeds in the Iwokrama Forest.** Iwokrama International Centre, Guyana. 12pp (+ data sheets).

Wynberg, R.P., Laird, S.A., Shackleton, S., Mander, M., Shackleton, C., du Plessis, P., den Adel, S., Leakey, R.R.B., Botelle, A., Lombard, C., Sullivan, C., Cunningham T. and O'Regan, D.P. 2002. **Marula commercialisation for sustainable and equitable livelihoods: A Policy Brief.** CEH Wallingford, U.K. 9pp

Wynberg, R.P., Laird, S.A., Botha, J., den Adel, S. and McHardy, T. 2002. **The Management, Use and Commercialisation of Marula: Policy Issues.** 62pp.

Journal Paper

Leakey, R. (in press) Domestication **potential of Marula (*Sclerocarya birrea* subsp. *caffra*) in South Africa and Namibia: 3. Multiple trait selection.** *New Forests*.

Leakey R.R.B, Pate, K. and Lombard, C. (in press) **Domestication potential of Marula (*Sclerocarya birrea* subsp. *caffra*) in South Africa and Namibia: 2. Phenotypic variation in nut and kernel traits.** *Agroforestry Systems*.

Leakey R.R.B, Shackleton, S.E. and du Plessis, P. (in press) **Domestication potential of Marula (*Sclerocarya birrea* subsp. *caffra*) in South Africa and Namibia: 1. Phenotypic variation in fruit traits.** *Agroforestry Systems*.

Shackleton, C.M., Botha, J. and Emanuel, P.L. (in press). **Productivity and abundance of *Sclerocarya birrea* subsp. *caffra* in and around rural settlements and protected areas of the Bushbuckridge lowveld, South Africa.** *Forests, Trees & Livelihoods*.

Shackleton, S.E., Shackleton, C.M., Cunningham, A.B., Lombard, C., Sullivan, C.A. and Netshiluvhi, T.R. 2002. **A summary of knowledge on *Sclerocarya birrea* subsp. *caffra* with emphasis on its importance as a non-timber forest product in South and southern Africa. Part 1: Taxonomy, ecology, traditional uses and role in rural livelihoods.** *Southern African Forestry Journal*, 194: 27 – 41.

Wynberg, R.P., Cribbins, J., Leakey, R.R.B., Lombard, C., Mander, M., Shackleton, S.E. and Sullivan, C. A. 2002. **Knowledge on *Sclerocarya birrea* subsp. *caffra* with emphasis on its importance as a non-timber forest product in South and southern Africa: A summary. Part 2: Commercial use, tenure and policy, domestication, intellectual property rights and benefit-sharing.** *Southern African Forestry Journal*, 196: 67 – 77.

Wynberg, R.P. et al (in press) **Marula commercialisation for sustainable and equitable livelihoods: A Policy Brief.** *Forests, Trees & Livelihoods*. (Sept 2003)

Magazine Article

O'Regan, D.P. 2003. **Non-timber forest products: a sustainable income**. *Appropriate Technology*, June 2003.

O'Regan, D.P. 2003. **Profit without Plunder**. *Planet Earth*, Spring 2003, NERC Publications, UK.

Newsletter Article

Leakey, R. 2002 **Marula Article** in Limpopo Province's *New Farmer and Entrepreneur*.

O'Regan, D.P. 2003. **Identifying the 'Winners & Losers' in the commercialisation of non-timber forest products (NTFPs)**. *NWFP-Digest-L* No. 3/03. e-mail journal of Non Wood Forest Products Programme, Forestry Department, FAO. FAO, Rome.

Shackleton, S.E. 2001. **Marula Commercialisation for Sustainable Livelihoods.** *Southern Africa Ethnobotany*. Vol. 1./No. 4. Official newsletter of the Indigenous Plant Use Forum, Pretoria, South Africa.

Newspaper Article

Sizwe samaYende, 2003. **Report on Marula Workshop**, Nelspruit, February 2003. *City Press*, 02 March 2003.

Popular Poster

'Are Local People Winners or Losers from Forest-Based Products? A Study in Ethics, Equity and the Market based on two NTFPs: Crabwood Oil in Guyana & Marula in Southern Africa'. 2001. Iwokrama International Centre, Guyana. Presented by Vanda Radzik at the World Summit on Sustainable Development, July-August 2001.

'Crabwood Oil: a source of income from the forest'. 2002. CEH Wallingford. Presented at Crabwood Oil International Technical Workshop, Guyana, November 2002. 30 copies.

'Marula - a tree for everyone!'. 2003. CEH Wallingford. Presented at Marula Commercialisation workshop, South Africa, 2003. 30 copies.

'Why are trees important for our lives?'. 2003. CEH Wallingford. Presented at Marula Commercialisation workshop, South Africa, 2003. 30 copies.

TV Programme/interview/report

Guyana Television Broadcasting Co. (GTV). *6 O'Clock News*, 15 August 2002. Broadcast of 2 minutes of interview with Dermot O'Regan (CEH), Sharon Ousman and Sabanto Tokoroho (Iwokrama) at Iwokrama offices in Georgetown, Guyana.

Namibian Broadcasting Corp. (NBC). 08 May 2003 1830, broadcast of project film *'Trees of Life: 10 lessons from the marula and crabwood trees'*. No viewer figures available.

South African Broadcasting Corporation (SABC). 19 February 2003. Short report on Marula Workshop, Nelspruit, February 2003, on evening news programme.

Video

'Trees of Life: 10 lessons from the marula and crabwood trees'. 2002. Duration: 30 mins. Camera, Script & Direction: Tony Cunningham. Version: VHS/PAL/NTSC/Betacam. People and Plants/CEH Wallingford. 50 copies.

'Crabwood, Communities and Markets'. 2002. Duration: 20 mins. Camera, Script & Direction: Tony Cunningham. Version: VHS/PAL/NTSC/Betacam. People and Plants/CEH Wallingford. 10 copies.

'Fruits and Foragers: tree regeneration in Guyana's forests'. 2002. Duration: 12 mins. Camera, Script & Direction: Tony Cunningham. Version: VHS/PAL/NTSC/Betacam. People and Plants/CEH Wallingford. 10 copies.

Website

http://www.ceh-wallingford.ac.uk/research/winners/ 2003. Design and maintenance: Dermot O'Regan. CEH Wallingford.

12. Bibliography

Acocks, J.P.H. 1988. Veld types of South Africa. Third edition. Botanical Research Institute, Pretoria.

Alden Wily, L. 2002. Democratising the commonage. The changing legal framework for natural resource management in eastern and southern Africa with particular reference to forests. http://www.cbnrm.uwc.ac.za.

ANU 1999. Marula fruit. Australian National University's (ANU) forest products website. http://www.anu.edu.au/Forestry/wood/nwfp/toesu/Toesu2.html

Arnold, T.H. & de Wet, B.C. (Eds.). 1993. Plants of Southern Africa: names and distribution. National Botanical Institute. Pretoria, South Africa..

Arnold, J.E.M. & Ruiz Perez, M. 1998. The role of non-timber forest products in conservation and development. In, Wollenberg, E. and Ingles, A. (eds). Incomes from the forest. Methods for the development and conservation of forest products for local communities. CIFOR/IUCN. CIFOR, Bogor, Indonesia.

Arnold, M. & Townson, I. 1998. Assessing the potential of forest product activities to contribute to rural incomes in Africa. ODI Natural Resource Perspectives (NRP) series, no 37.

Arnold, M.J.E. & Perez, R.M. 2001. Can non-timber forest products match tropical forest conservation and development objectives? Ecological Economics 39, pp 437-447

Bandeira, S.O., Albano, G. & Barbosa, F.M. 1999. Diversity and uses of plant species in Goba, Lebombo Mountains, Mozambique, with emphasis on trees and shrubs. In: Timberlake, J. & Kativu, S. (Eds.) African Plants: Biodiversity, taxonomy and uses. Royal Botanic Gardens, Kew. Pp 429-439.

Bank of Guyana. 2002. Half Year Report and Statistical Bulletin 2002. Bank of Guyana. Georgetown, Guyana. South America.

Banks, D.I., Griffin N., Shackleton C.M., Shackleton S.E. & Mavrandonis J. 1996. Wood supply and demand around two rural settlements in a semi-arid savanna, South Africa. Biomass & Bioenergy, 11: 319-331.

Baraloto, C. 2001. Tradeoffs between neotropical tree seedling traits and performance in contrasting environments. University of Michigan, Ann Arbor.

Barham, B.L., Coomes, O.T., & Takasaki, Y. 1999. Rain forest livelihoods: income generation, household wealth and forest use. Unasylva 198. Volume 50. pp 34-41.

Barnard, P. (ed.). 1998. Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force. 322 pp.

Barton, S. 2001. Overview of marula-based small business and industry. In: Anon. Marula workshop: report and abstracts. pp 25-27. University of Pretoria, Pretoria.

Beentje, H.J. 1994. Kenya trees, shrubs and lianas. National Museums of Kenya. Nairobi.

Beglund, A.I. 1976. Zulu thought patterns and symbolism. David Phillip, Cape Town.

Belcher B. M. 1998. A Production-to-Consumption Systems Approach: Lessons from the Bamboo and Rattan Sectors in Asia. In Wollenberg E. and Ingles A. (eds) Incomes from the Forest: methods for the development and conservation of forest products for local communities. CIFOR. Bogor. Indonesia.

Belcher, B.M. and Ruiz-Perez, M. 2001. An International Comparison of Cases of Forest Product Development: Overview, Description and Data Requirements. Working Paper No. 23, Centre for International Forestry Research.

Bell, J. and Hammond, E. 2000. Biodiversity for sale – dismantling the hype about benefit sharing in Global Trade and Biodiversity in Conflict Issue 4, April 2000, published by The Gaia Foundation and GRAIN

Ben Gurion University, 2000. Exotic fruit tree to be raised commercially by Kibbutzim. http://www.bgu.ac.il/html/march2000.htm

Boffa, J.M., Yameogo, G., Nikiema, P. & Knudson, D.M. 1996. Shea nut (Vitellaria paradoxa) production and collection in agroforestry parklands in Burkina Faso. In: Leakey, R.R.B., Temu, A. B., Melnyk M., & Vantomme, P. (Eds.). Domestication and commercialisation of Non-Timber Forest Products in agroforestry systems. FAO, Rome.

Botelle, A. 2001. A History of Marula Use in North-Central Namibia CRIAA SA-DC, Windhoek.

Botelle, A., du Plessis, P., Pate, K. and Laamanen, R. 2002. A Survey of Marula Fruit Yields in North-Central Namibia. CRIAA SA-DC.

Brigham, T., Chihong, A. and Chidumayo, E. 1996. Trade in woodland products from the miombo region. In Campbell, B. (ed). The Miombo in transition: Woodlands and welfare in Africa. CIFOR, Bogor, Indonesia.

Brown, K., Rosendo, S. 2000. Environmentalists, rubber tappers and empowerment: the politics and economics of extractive reserves. Development and Change. Vol. 31, pp 201-227

Brunner, M., Kucera, L.J. and Zurcher, E. 1994. Major timber trees of Guyana: A lens Key. Tropenbos Series 10. Stiching Tropenbos, Swiss Federal Institute of Technology, Wageningen, Netherlands.

Burger, A.E.C., de Villiers, J.B.M., & du Plessis, L.M. 1987. Composition of the kernel oil and protein of the marula seed. South African Journal of Science 83: 733 - 735.

Buwalda, A.O., Otsyina, R. & Souza-Machado, V. 1996. Identification of indigenous fruit trees of the Miombo woodlands in Maswa, Tanzania, Poster paper in Domestication and commercialisation of Non-timber Forest Products in agroforestry. Non-wood Forest Products, No. 9, p 286. FAO, Rome, Italy.

Clarke, J. 1995. Putting users needs and preferences first: PRA methods for eliciting selection criteria for indigenous fruit tree research, In: Maghembe A., Ntupanyama, Y. & Chirwa, P.W. (Eds.). Improvement of indigenous fruit trees of the Miombo woodlands of southern Africa. Pp 78-83. ICRAF, Nairobi, Kenya.

Campbell, B.M. 1987. The use of wild fruits in Zimbabwe. Economic Botany, 41: 375-385.

Campbell, B.M., Clarke, J.M. & Gumbo, D.J. 1991. Traditional agroforestry practices in Zimbabwe. Agroforestry Systems, 14: 99-111.

Campbell, B., De Jong,W., Luckert, M., Mandondo, A., Matose, F., Nemarundwe, N., and Sithole, B. 2001. Challenges to proponents of CPR systems: Despairing voices from the social forests of Zimbabwe. World Development 29: 589-600.

Carr, W.R. 1957. Notes on some southern Rhodesian indigenous fruits, with particular reference to their ascorbic acid content. Food Research, 22: 590 – 596.

Cavendish, W. 2000. Empirical irregularities in the poverty-environment relationship of rural households: evidence from Zimbabwe. World Development 28: 1979-2003.

Cherfas, J. 1989. Nuts to the desert. New Scientist 19: 44-47.

Chivaura-Mususa, C., Campbell, B. and Kenyon, W. 2000. The value of mature trees in arable fields in the small-holder sector, Zimbabwe. Ecological Economics 33: 395-400.

Chopra, K. 1993. The value of non-timber forest products: An estimation for tropical deciduous forests in India. Economic Botany 47 (3), pp 251-257.

Clay, J. 1996. Generating income and conserving resources: 20 lessons from the field. World Wildlife Fund. USA.

Clay, J. and Clement, C. 1993. Selected species and strategies to enhance income generation from Amazonian Forests. FAO Forestry Paper (Final Draft). United Nations Agricultural Organisation, Rome. Coates Palgrave, O. 1956. Trees of Central Africa. National Publications Trust, Glasgow. 466 pp.

Combrinck, A. and Muller, J. 2002. Modelling Marula Distribution in South Africa: A deterministic approach. Environmentek, CSIR, South Africa. Convention on Biological Diversity Secretariat. 2001. Sustainable management of non-timber forest resources. Montreal, SCBD, 30 p. CBD Technical Series no. 6.

Coupland, K. and Nichols, J.A. (no date) Lipids – Their Use in Personal Care Products.

Cousins, B. 2002. Reforming communal land tenure in South Africa – why land titling is not the answer. Programme for Land and Agrarian Studies, School of Government, University of the Western Cape.

CRIAA SA-DC (in preparation) Trial Marula Oil Production Project - Final Project Report

Crucible II Group 2000. Seeding Solutions. Volume 1. Policy options for genetic resources: people, plants and patents revisited. Copublished by the International Development Research Centre, the International Plant Genetic Resources Institute, and the Dag Hammarskjöld Foundation.

Cullet, P. 2001. Plant variety protection in Africa. Journal of African Law 45:97-122.

Cunningham, A. B. 1985. The resource value of indigenous plants to rural people in a low agricultural potential area. PhD thesis. University of Cape Town.

Cunningham, A.B. 1988. Collection of wild plant foods in Theme Thonga society: a guide to Iron Age gathering activities. Annals of the Natal Museum, 29: 433-446.

Cunningham, A.B. 1989. Indigenous plant use: balancing human needs and resources. In: Huntley, B.J., (Ed.). Biotic diversity in southern Africa: concepts and conservation. Oxford University Press, Cape Town, pp. 93-106

Cunningham, A.B. 1990. The regional distribution, marketing and economic value of the palm wine trade in the Ingwavuma district, Natal, South Africa. South African Journal of Botany 56: 191-198.

Cunningham, A. B. 1997. Review of ethnobotanical literature from eastern and southern Africa. The African Ethnobotany Network, Bulletin No. 1: 23 –88.

Cunningham, A. B. 2002. Personal communication. peopleplants@bigpond.com.

Dalziel, J. M. 1948. The Useful Plants of West Tropical Africa. An appendix to the Flora of West Tropical Africa by J. Hutchinson & J.M. Dalziel. Crown Agents for the Colonies, London.

De Greyt, W. and Kellens, M. 2000. Refining practice in Hamm W. and Hamilton, R.J. (eds) Edible Oil Processing, Sheffield Academic Press / CRC Press, 2000

De Jong W. and Utama R. 1998. Turning Ideas into Action: Planning for Non-timber Forest Product Development and Conservation. In Wollenberg E. and Ingles A. (eds) Incomes from the Forest: methods for the development and conservation of forest products for local communities. CIFOR. Bogor. Indonesia.

De Jong, W. 2001. Tree and forest management in the floodplains of the Peruvian Amazon. Forest Ecology and Management, 150: 125-134.

deGraaf, N. R., R. L. H. Poels, and R. S. A. R. VanRampaey. 1999. Effect of silvicultural treatment on growth and mortality of rainforest in Surinam over long periods. Forest Ecology and Management 124:123-135.

den Adel, S. 2002. Use of marula products for domestic and commercial purposes by households in North-Central Namibia. CRIAA SA-DC, Namibia.

Descheemaeker, A. 1979. Ravi maitso. T.P.F.C.M. Imprimeries Staint-Paul, Fianarantsoa, Madagascar.

Dewees, P.A. and Scherr, S.J. 1996. Policies and markets for non-timber tree products. EPTD discussion paper no.16, Environment and Production Technology Division, International Food Policy Research Institute, Washington.

DiMauro, P. 2001. Facts about the non-patent patent. International Centre for Technology Assessment, PatentWatch Project. Unpublished paper.

Dovie, D. 2001. Woodland resource utilisation, valuation and rural livelihoods. MSc Thesis. University of the Witwatersrand, Johannesburg.

Downes, DR and SA Laird. 1999. Innovative Mechanisms for Sharing Benefits of Biodiversity and Related Knowledge: Case Studies on Geographical Indications and Trademarks, Prepared for UNCTAD Biotrade Initiative, Geneva.

du Plessis, 2002. Marketing of marula oil in Namibia. Unpublished report prepared for FRP Project No. ZF0140/R7795, CRIAA SA-DC, Windhoek.

du Plessis, P., Lombard, C. and den Adel, S. 2002. Marula in Namibia: Commercial Chain Analysis. CRIAA SA-DC, Namibia.

Durbeck, K. 1999. Green Trade Organisations: Striving for Fair Benefits from Trade in Non-wood Forest Products. Unasylva 198, Vol 50, pp 9-12.

Dutfield, G. 2000. Intellectual Property Rights, Trade and Biodiversity: Seeds and Plant Varieties. Earthscan, London.

Dzerefos, C. M. 1996. Distribution, establishment, growth and utilisation of mistletoes (Loranthaceae) in the Mpumalanga lowveld. M.Sc. thesis. University of the Witwatersrand, Johannesburg.

Edje, T. 2000. The status of Sclerocarya birrea in Swaziland. In, Youde, E. (ed). A workshop to plan the production of a definitive species monograph on Sclerocarya birrea and associated extension literature. 13 – 14 March 2000. Monographs and extension materials on Sclerocarya birrea. DFID FRP Project R7227. School of Agricultural and Forest Sciences, University of Wales, Bangor.

Ekpere J., 2001. The OAU's model law – The protection of rights of local communities, farmers and breeders, and for the regulation of access to biological resources. An explanatory booklet. Scientific, Technical and Research Commission of the Organisation for African Unity. http://www.grain.org/publications/oau-en.chm.

Engelter, C. & Wehmeyer, A.S. 1970. Fatty Acid Composition of Oils of Some Seeds of Wild Plants. Journal of Agriculture and Food Chemistry 8 (1).

Erkilla A. 2001. Living On The Land: change in forest cover in North-Central Namibia 1943-1996. University of Joensuu, Faculty of Forestry.

Fanshawe, D.B. 1950. Forest products of British Guiana. Part II. Forestry Bulletin no. 2. Forest Department, British Guiana.

Fanshawe, D.B. 1961. Principal Timbers: Part 1. Forestry Department. Reprinted by the Guyana Forestry Commission (2002)

Fanshawe, D.B. 1961. Forest Products of British Guiana Part 1 PRINCIPAL TIMBERS. Forestry Bulletin no.1 Third Edition. Department of Forestry, British Guiana.

Fenton L. 2000. Potentials and Challenges of Resin Marketing by Forest User Groups: A Study From the Koshi Hills of Nepal. School of Environment. University of Leeds. Flora Zambesiaca. 1963 - 1966.

Flora Zambesiaca: Mozambique, Malawi, Zambia, Rhodesia Bechuanaland Protectorate. Volume Two. Excell, A. W., Fernandes, A. & Wild, H. (Eds.). Published on behalf of the Governments of Portugal, Malawi, Zambia, Rhodesia and the United Kingdom by the Crown Agents for Overseas Governments and Administrations, London.

Forget, P.-M. 1996. Removal of seeds of Carapa procera (Meliaceae) by rodents and their fate in rainforest in French Guiana. Journal of Tropical Ecology 12:751-761.

Forget, P.-M. 1997. Effect of microhabitat on seed fate and seedling performance in two rodent-dispersed tree species in rain forest in French Guiana. Journal of Ecology 85:693-703.

Forget, P.-M., F. Mercier, and F. Collinet. 1999. Spatial patterns of two rodent-dispersed rainforest trees Carapa procera (Meliaceae) and Vouacapoua americana (Caesalpiniaceae) at Paracou, French Guiana. Journal of Tropical Ecology 15:301-313.

Forget, P-M; Milleron, T. & Feer, F. 1998. Patterns in post dispersal seed removal by neotropical rodents and seed fate in relation to seed size. In Population and Community Dynamics in the Tropics, Ed. D.M. Newberrry; H.H.T. Prins & N.D. Brown). pp 25-49. Blackwell Scientific Publications. Oxford.

Forget, P.-M., J. M. RankinDeMerona, and C. Julliot. 2001. The effects of forest type, harvesting and stand refinement on early seedling recruitment in a tropical rain forest. Journal of Tropical Ecology 17:593-609.

Forte, J., Ousman, S. and Radzik, R. (eds.) Proceedings of the International Technical Workshop on Sustainable and Equitable Marketing of Crabwood Oil in Guyana, November 23-24, 2002, Lake Mainstay Resort, Region 2, Guyana. Iwokrama International Centre, Guyana.

Fox, F. W. & Stone, W. 1938. The anti-scorbutic value of Kaffir beer. South African Journal of Medical Sciences 3: 7 – 14.

Fox, F. W. & Norwood Young, M. E. 1982. Food from the veld. South African Institute for Medical Research, Johannesburg.

Franzel, S., Jaenicke, H. & Janssen, W. 1996. Choosing the right trees: Setting priorities for multipurpose tree improvement. ISNAR Research Report, No 8. 87p.

Galvez, J., Zarzuelo, A., Crespo, M.E., Utrilla, M.P., Jiménez, J., Spiessens, C & de Witte, P. 1991. Antidiarrhoeic activity of Sclerocarya birrea extract and its active tannin constituents in rats. Phytotherapy Research 5: 276 - 278.

Galvez Peralta, J., Zarzuelo, A., Cobbaert, C. & de Witte, P. 1992. (-)-Epicatechin-3-galloyl ester: A secretagogue compound from the bark of Sclerocarya birrea. Planta Medica 58: 174 - 5.

Galvez, J., Crespo, M.E., Zarzuelo, A., de Witte, P. & Spiessens, C. 1993. Pharmacological activity of a procyanidin isolated from Sclerocarya birrea bark: Antidiarrhoeal activity on isolated Guinea-pig ileum. Phytotherapy Research 7: 25 - 28.Gatto, M. 1995. Sustainability: Is it a well-defined concept? Ecological Applications, Vol. 5, Issue 4, pp1181-1183.

Gelfand, M., Mavi, S., Drummond, R.B., & Ndemera, B. 1985. The traditional medical practitioner in Zimbabwe. His principles of practice and pharmacopoeia. Mambo Press, Gweru.

Gerard, J. Miller, R.B. & ter Welle, B.J. H. 1996. Major Timber Trees of Guyana: Timber characteristics and utilisation. Tropenbos Series 15. The Tropenbos Foundation, Wageningen, the Netherlands.

Godoy, R., & Bawa, K.S. 1993. The economic value and the sustainable harvest of plants and animals from the tropical forest: assumptions, hypotheses and methods. Economic Botany. 47 (3), pp215-219.

Godoy, R. Wilkie, D., Overman, H., Cubas, A., Cubas, G., Demmer, J., McSweeney, K., Browak, N. 2000. Valuation of consumption and sale of forest goods from a Central American rain forest. Nature. Vol. 406, pp 62-63.

Godoy, R., Lubowski, R., Markandya, A. 1993. A method for the economic valuation of non-timber tropical forest products. Economic Botany 47 (3), pp 220-233.

GRAIN, 2000. Biodiversity for sale. Dismantling the hype about benefit sharing. Global trade and biodiversity in conflict, Issue no. 4. http://www.grain.org/publications/

Grimes, A., Loomis, S., Jahnige, P., Burnham, M. e. al. 1994. Valuing the rain forest: The economic value of non-timber forest products in Ecuador. Ambio. Vol. 23, No. 7, pp 405-410.

Grimmond, J., Joseph, I. and Datadin, V. 2002. A spatial assessment of Crabwood Oil production in Regions 9 & 10 of Guyana. Iwokrama International Centre, Guyana, Technical Report No. 2002/1.

Gringras, L. 2000 Refining of rice bran oil Inform Vol. 11

Grundy, I.M., Campbell, B.M., Balebereho, S., Cunliffe, R., Tafangenyasha, C., Fergusson, R. & Parry, D. 1993. Availability and use of trees in Mutanda Resettlement area, Zimbabwe. Forest Ecology and Management, 56: 243-266.

Gujarati, D. N. 1995. Basic Econometrics. Third Edition. McGraw-Hill International Editions. McGraw-Hill Inc. Singapore.

Gumbo, D., Mukamuri, B., Muzondo, M. and Scoones, I. 1990. Indigenous and exotic fruit trees: Why do people want to grow them? In: Prinsley, R. Agroforestry for sustainable development: economic implications. Commonwealth Science Council, London. Pp 185 – 214.

Hadassah, 2001. Berries for booze – at Purimtime and year round. Press release. www.hadassah.org/news/releases/03051.htm.

Haden P. 1999. Forestry Issues in the Guiana Shield Region: a perspective on Guyana and Suriname. Overseas Development Institute, London and European Commission, Brussels.

Hall, Pamela, Bawa, K. 1993. Methods to assess the impact of extraction of non-timber tropical forest products on plant populations. Economic Botany. 47 (3), pp 234-247.

Hammond, D. S., A. Schouten, L. van Tienen, M. Weijerman, and V. K. Brown. 1992. The importance of being a forest animal: implications for Guyana's timber trees. Ann. Rev. conf. proc.:144-151.

Hangula-Mungandjela, R. 2000. Estimating the sex ratio of marula (Sclerocarya birrea) in marula stands Unpublished report, Ministry of Environment and Tourism, Directorate of Forestry, Namibia

Henry, O. 1999. Dietary choice of the orange-rumped agouti (Dasyprocta leporina) in French Guiana. Journal of Tropical Ecology 13:291-300.

High, C. and Shackleton, C.M. 2000. The comparative value of wild and domestic plants in home gardens of a South African rural village. Agroforestry Systems 48: 141- 156.

Holtzhausen, L.C. 2001. Enobling the African marula. In: Anon. Marula workshop: report and abstracts. pp 20-22. University of Pretoria, Pretoria.

Holtzhausen L.C., Swart, E. & van Rensburg, R. 1990. Propagation of the marula (Sclerocarya birrea subsp. caffra). Acta Horticulturae, 275: 323-334.

Houghton, C. 1999. New Natural Oils and their Properties Anglia Oils Ltd. Bulk Speciality Division.

Hutchings, A., Haxton Scott, A., Lewis, G. & Cunningham, A. 1996. Zulu Medicinal Plants. An Inventory. University of Natal Press, Pietermaritzburg in association with University of Zululand, Kwblangezwa and National Botanical Institute, Cape Town.

Immelman, W.F.E., Wicht, C.L., Ackerman, P.P. 1973. Our Green Heritage. A book about indigenous and exotic trees in South Africa, about trees and timber in our cultural history and about our extensive silvicultural and timber industries. Tafel, Cape Town.

IIED. 2000. Unlocking the Trade Opportunity. IIED. London.

Institute of Development Studies (IDS). 1993. Poverty in Guyana: Finding Solutions. Special Transition Issues 20-21.IDS, University of Guyana. pp 145-158.

International Union for the Protection of New Varieties of Plants, 2000. Guidelines for the conduct of tests for distinctness, uniformity and stability. Pear (Pyrus communis L.). TG/15/3. Geneva, Switzerland.

Ireland, C. 1999. An economic valuation of crop production in Manganeng and Makua in the Northern Province of South Africa. MSc Thesis, Imperial College of Science, Technology and Medicine. University of London.

Iwokrama, 2001. Feasibility study.

Iwokrama 2002. Crabwood Oil (Karaba Oil): A Non-Timber Forest Product – Sustaining community Crabwood Oil cottage industry. Iwokrama International Centre for Rainforest Conservation and Development. Guyana.

Iwokrama. 2002a. Crabwood Oil Study: Equitable Use of NTFPs in Guyana. Preliminary Report of Community Level Survey. Iwokrama International Centre for Rainforest Conservation and Development.

Jacana. 1997. Sappi Tree Spotting: lowveld: tree identification made easy. Jacana, Johannesburg. 302 pp.

Jacobs, O.S. 2001. An autecological study of the Marula (Sclerocarya birrea) in the Kruger National Park with specific reference to the relative impact from elephants and fire. MSc Thesis, University of Pretoria, Pretoria.

Jaenicke, H., Franzel, S. & Boland, D.J. 1995. Towards a method to set priorities among species for tree improvement research: a case study from West Africa. Journal of Tropical Forest Science 7: 490-506.

Jansen, P. A. 2003. Scatterhoarding and tree regeneration. Ecology of nut dispersal in a neotropical rainforest. Ph. D. Wageningen University, Wageningen.

Jansen, P. A., and P.-M. Forget. 2001. Scatterhoarding by rodents and tree regeneration in French Guiana. Pages 275-288 in F. Bongers, P. Charles-Dominique, P. M. Forget, and M. Théry, editors. Nouragues: dynamics and plant-animal interactions in a neotropical rainforest. Kluwer Academic Publisher, Dordrecht, The Netherlands.

Jansen, P. A., M. Bartholomeus, F. Bongers, J. A. Elzinga, J. Den Ouden, and S. E. Van Wieren. 2001. The role of seed size in dispersal by a scatter-hoarding rodent. Pages 209-225 in D. Levey, W. Silva, and M. Galetti, editors. Seed dispersal and frugivory: ecology, evolution and conservation. CABI, UK.

Janzen, D.H. et al 1983. Costa Rican Natural History. University of Chicago Press, USA.

Jenkins, M.D. 1987. Madagascar. An Environmental Profile. IUCN. Gland, Switzerland and Cambridge, U.K.

Johnson, D. & Johnson, S. 1993. Gardening with indigenous trees and shrubs. Southern Book Publishers. Halfway House. 182 pp.

Joseph, I. 2002. GIS Internship Final Report. Iwokrama International Centre, Guyana.

Junod, H.A. 1927. The life of a South African tribe. 2 Volumes. McMillan & Co., London.

Junod, H.A. 1938. Bantu Heritage. Hortors Ltd., Johannesburg for the Transvaal Chamber of Mines.

Khan, M.R. & Nkanya, M.H.H. 1990. Antimicrobial activity of Tanzanian traditional medicinal plants. In: Ministry of Health. Proceedings of an International Conference on Traditional Medicinal Plants. Arusha, Tanzania, Feb 18 –13. Dar es Salaam University Press, Dar es Salaam.

Kindt, R., and Were, J. 2000. Regional seed collections. In Youde, E., (Ed). A workshop to plan the production of a definitive species monograph on Sclerocarya birrea and associated extension literature. 13- 14 March 2000. Monographs and extension materials on Sclerocarya birrea. DFID FRP Project R7227. School of Agricultural and Forest Sciences, University of Wales, Bangor, pp. 5.

Kokwaro, J.O. 1993. Medicinal plants of E. Africa. Second Ed. Kenya Literature BureauKrige, E. J. 1936. The social system of the Zulu. Shuter and Shooter, Pietermaritzburg.

Krige, E. J. 1937. Notes on the Phalaborwa and their morula complex. Bantu Studies 11: 357-366.

Kubo, I. & Kinst-Hori, I. 1999. 2-Hydroxy-4-methoxybenzaldehyde: A potent tyrosinase inhibitor from African medicinal plants. Planta Medica 65: 19 - 22.

Kwesiga, F. & Mwanza, S. 1995. Under exploited wild genetic resources: the case of indigenous fruit trees in eastern Zambia, In: Maghembe, J.A., Ntupanyama. Y. & Chirwa. P.W. (Eds.). Improvement of Indigenous Fruit Trees of the Miombo Woodlands of Southern Africa. Pp 100-112. ICRAF, Nairobi, Kenya.

Kwesiga, F., Phiri, D., Simwanza, C.P. & Mwanza, S. 1994. Zambia - ICRAF Research Project, No 87. ICRAF, Nairobi, Kenya.

Lachman-White, D.A., Adams, C.D. and Trotz, U.O. 1992. A guide to the medicinal plants of Coastal Guyana. Commonwealth Science Council. Technical Publications. Series 225. London, UK.

Leakey, R.R.B. 1999. Potential for novel food products from agroforestry trees: a review. Food Chemistry, 66: 1-14.

Leakey R.R.B. & Simons, A.J. 1998. The domestication and commercialisation of indigenous trees in agroforestry for the alleviation of poverty. Agroforestry Systems, 38: 165-176.

Leakey, R.R.B. & Tomich, T.P. 1999. Domestication of tropical trees: from biology to economics and policy. In: Buck, L.E., Lassoie, J.P. & Fernandes, E.C.M. (Eds.) Agroforestry in sustainable agricultural systems. pp 319-338. CRC Press/Lewis Publishers, New York.

Leakey R, Shackleton S and du Plessis P (in press) Domestication potential of Marula (Sclerocarya birrea subsp caffra) in South Africa and Namibia: 1. Phenotypic variation in fruit traits.

Leakey, R., Shackleton, S.E., du Plessis, P., Pate, K. & Lombard, C. 2002. Characterization of phenotypic variation in marula (Sclerocarya birrea) fruits, nuts and kernels in South Africa and Namibia. Unpublished report, James Cook University, Cairns.

Lecup I. and Nicholson K. 2000. Community-based tree and forest product enterprises: market analysis and development. FAO. Rome.

Lecup I. Nicholson K. Purwandono H. and Karki S. 1998. Methods for Assessing the Feasibility of Sustainable Non-timber Forest Product-based Enterprises. In Wollenberg E. and Ingles A. (eds) Incomes from the Forest: methods for the development and conservation of forest products for local communities. CIFOR. Bogor. Indonesia.

Lewis, D.M. 1987. Fruiting patterns, seed germination and distribution of Sclerocarya birrea in an elephant-inhabited woodland. Biotropica 19: 50-56.

Lombard, C. 1997. Report on the Trial Marula Oil Production (TMOP) Project - 1st Phase Feasibility Study, August 1996 to March 1997 CRIAA SA-DC Windhoek

Lombard, C., Allanic, B. & Shilote, B. 2000. Potential for the development of marula products in the Bushbuckridge area. Unpublished report, DANCED/DWAF, Nelspruit. 67 pp.

Mabogo, D.E.N. 1990. The ethnobotany of the Vhavenda. MSc thesis, University of Pretoria, Pretoria.

Maghembe, J.A. 1995. Achievements in the establishment of indigenous fruit trees of the Miombo woodlands of southern Africa, In: Maghembe, J.A., Ntupanyama, Y. & Chirwa, P.W. (Eds.). Improvement of indigenous fruit trees of the Miombo woodlands of Southern Africa. Pp 39 - 49. ICRAF, Nairobi, Kenya.

Maghembe, J.A., Simons, A.J., Kwesiga, F., and Rarieya, M. 1998. Selecting indigenous trees for domestication in Southern Africa: priority setting with farmers in Malawi, Tanzania, Zambia and Zimbabwe. ICRAF, Nairobi, Kenya, 94 pp.

Makopi, S. 1999. Awards to provide security of tenure and comparable redress, pp. 143-159. In: At the Crossroads. Land and Agrarian Reform in South Africa into the 21st Century. Edited by B. Cousins. Published by PLAAS, University of the Western Cape.

Mander, M. and Cribbins, J. 2002. Marula commercial chains. Unpublished report. Institute of Natural Resources, Pietermaritizburg.

Mander, M., Cribbins, J., and Lewis, F. 2002. The commercial marula industry in South Africa: a sub-sector analysis. Unpublished report, Institute of Natural Resources.

Mander, M., Cribbins, J., Shackleton, S.E. and Lewis, F. 2002. The Commercial Marula Industry in South Africa: A sub-sector analysis. Institute of Natural Resources, South Africa.

Maree, D. & Doyer, T. 2001. The critical aspects of the supply chain for marula yoghurt. In: Anon. Marula workshop: report and abstracts. pp 32-35. University of Pretoria, Pretoria.

Martinborough, T. 2002a. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Family Level Survey. Iwokrama International Centre, Guyana.

Martinborough, T. 2002b. Karaba oil (Crabwood oil): a literature review. Iwokrama International Centre, Guyana.

Martinborough, T. 2002c. The Crabwood Oil Market in Guyana: Increasing Household Income. Dissertation for MSc in Environmental Economics, University of York. U.K.

Martinborough, T., Forte, J. and Hammond, D. 2002. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Chainsaw Operator Survey. Iwokrama International Centre, Guyana.

Mayers J. 2001. Stakeholder Power Analysis in Power Tools, Tools for working on policies and institutions. IIED. London.

Mbuya, L.P., Msanga, H.P., Ruffo, C.K., Birnie, A. & Tengnas, B. 1994. Useful trees and shrubs for Tanzania. Identification, propagation and management for agricultural and pastoral communities. Regional Soil Conservation Unit (RSCU)/Swedish International Development Authority (SIDA). Swedish Embassy, Nairobi.

McGregor, J. 1993. Woodland pattern and structure in a peasant farming area of Zimbabwe: ecological determinants and present land use. Forest Ecology and Management, 63: 97-133.

McHardy, T. 2002. Use of marula products for domestic and commercial purposes by households in Ohande district, Maputaland, South Africa. Unpublished report, Institute of Natural Resource, Pietermaritzburg.

McHardy, T. 2002a. Inventory of available marula resources on the Makhatini Flats, Maputaland, in the fruiting season of 2002. Institute of Natural Resources, South Africa. 15pp.

McHardy, T. 2002b. Use of marula products for domestic and commercial purposes by households in the Ophande district, Maputaland, South Africa. Institute of Natural Resources, South Africa.

Mendelsohn J, O'beid S. and Roberts (2000). A Profile of North-Central Namibia. Environmental Profiles Project, Ministry of Environment and Tourism, Namibia.

Milward, S. 2002. Greasing the Wheels for Conservation and Development: Can Crabwood Oil Enterprises Contribute to Sustainable Development of the Riverine Communities in North Rupununi, Central Guyana? A study of enterprise development. Dissertation for MSc in Biodiversity and Conservation, University of Leeds.

Minae, S., Sambo, E.Y., Munthalo, S.S. & Ng'ongola, D.H. 1995. Selecting priority indigenous fruit-tree species for central Malawi, using farmers' evaluation criteria. In: Maghembe, J.A., Ntupanyama, Y. & Chirwa, P.W. (Eds.). Improvement of indigenous fruit trees of the Miombo woodlands of Southern Africa. Pp 39 - 49. ICRAF, Nairobi, Kenya.

Mizrahi, Y., and Nerd, A. 1996. New crops as a possible solution for the troubled Israeli export market. In: Janick, J., and Simon, J.E., (Eds.). Progress in new crops: Proceedings of the third national new crops symposium. American Society of Horticultural Sciences, pp. 46-64.

Moran, W. 1993. Rural space as intellectual property. Political Geography 12(3): 263-277.

Morris, B. 1996. Chewa medical botany. A study of herbalism in Southern Malawi. International African Institute, London.

Morris, R. 2002. Worldwide success of Amarula Cream has Distell dancing. Business Report 15 October 2002.

Mugochi, T., Parawira,W., Mpofu, A., Simango, C. & Zvauya, R. 1999. Survival of some species of Salmonella and Shigella in mukumbi, a traditional Zimbabwean wine. International Journal of Food Science and Nutrition 50: 451 - 455.

Mwamba, C.K. 1995. Variations in fruit of Uapaca kirkiana and effects of in situ silvicultural treatments on fruit parameters. In: Maghembe, J.A., Ntupanyama, Y. & Chirwa, P.W. (Eds.). Improvement of indigenous fruit trees of the Miombo woodlands of Southern Africa. Pp 39 - 49. ICRAF, Nairobi, Kenya.

National Insurance Scheme. 2002. Tables for 6th Actuarial Review 2002. Research and Planning Department and Actuarial counterparts. Georgetown, Guyana.

Nerd, A. & Mizrahi, Y. 1993. Domestication and introduction of marula (Sclerocarya birrea subsp. caffra) as a new crop for the Negev desert of Israel. In: Janick, J. & Simon, J.E. (Eds.). New crops. pp. 496 - 499. Wiley, New York.

Neumann, R. P & Hirsch, E. 2000. Commercialisation of Non-timber Forest Products: Review and Analysis of Research. CIFOR/FAO. CIFOR, Bogor, Indonesia.

Ntsebeza, L. 1999. Land tenure reform in South Africa: An example from the Eastern Cape Province. Issue paper no. 82, IIED, London.

Obermeyer, N.C. & Pinto, J.K. 1994. Managing geographic information systems. New York: Guilford.

ODI. 2002. Forest Policy and Environment Group. http://www.odifpeg.org.uk

Ousman, S., Martinborough, T., Forte, J. and Hammond, D. 2002. Crabwood Oil Study: Equitable Use of NTFPs in Guyana: Report of the Community Level Survey. Iwokrama International Centre, Guyana.

Palmer, E. & Pitman, N. 1972. Trees of Southern Africa. Volume 2. Struik, Cape Town.

Panayotou, T., Ashton, P.S.1992. Not by timber alone: Economics and ecology of sustaining tropical forests. Island Press.

Parsons, D.A., Shackleton, C.M. & Scholes, R.J. 1997. Changes in herbaceous layer condition under contrasting land use systems in the semi-arid lowveld, South Africa. Journal of Arid Environments, 37: 319-329.

Paton, C. 2002. Ties to the land no longer bind. Sunday Times Monitor. Sunday Times Newspaper, 4 August 2002.

Pattanayak, S.K., Sils, E.O. 2001. Do tropical forests provide natural insurance? The micro economics of non-timber forest product collection in the Brazilian Amazon. Land Economics. 77(4), pp. 595-612.

Payne, K. 2001. The potential sustainable production of Carapa guianensis (Meliaceae) Abul. Oil in the Iwokrama Rainforest, Guyana. Dissertation for BSc in Environmental Science, University of West of England, UK.

Peters, C.M., Gentry, A.H., Mendelsohn, R.O. 1989. Valuation of an Amazonian Rain Forest. Nature. Vol. 339, pp 655-656.

Peters, C.R. 1988. Notes on the distribution and relative abundance of Sclerocarya birrea (A. Rich.) Hochst. (Anacardiaceae). Monograph in Systematic Botany of the Missouri Botanical Garden 25: 403 – 410.

Pierce, A.R., Laird, S.A. and Malleson, R. 2002. Annotated Collection of Guidelines, Standards, and Regulations for Trade in Non-Timber Forest Products and Botanicals. Rainforest Alliance, New York (www.rainforest-alliance.org/news/archives/news/news44.html).

Plant Diversity in Guyana: with Recommendations for a protected areas strategy in Guyana. Tropenbos Series 18. The Tropenbos Foundation, Wageningen, Netherlands.

Plotkin, M.J., Boom, B.M. and Allison, M. 1991. Monographs in Systemic Botany from the Missouri Botanical Gardens. Volume 35. Missouri Botanical Gardens. USA.

Polak A.M. 1992. Major Timber Trees of Guyana; A field Guide. Tropenbos Series 2. The Tropenbos Foundation, Wageningen, Netherlands.

Pollard, S.R., Perez de Mendiguren, J.C., Joubert, A., Shackleton, C.M., Walker, P., Poulter, T. & White, M. 1998. Save the Sand phase 1 feasibility study: the development of a proposal for a catchment plan for the Sand River catchment. Department of Water Affairs & Forestry, Pretoria.

Pooley, E.S. 1980. Some notes on the utilisation of natural resources by the tribal people of Maputaland. In: Bruton, M.N. & Cooper, K.H. (Eds.). Studies on the Ecology of Maputaland. Rhodes University and the Natal Branch of the Wildlife Society of Southern Africa, Grahamstown and Pietermarizburg.

Pooley, E. S. 1993. The complete guide to trees of Natal, Zululand and Transkei. Natal Flora Publications Trust, Durban. 512 pp.

Poulson, U. 2001. International Market Survey Report for Marula and Crabwood Products. CEH Wallingford, UK.

Quin, P.J. 1959. Food and feeding habits of the Pedi. University of the Witwatersrand Press, Johannesburg.Posey, D.A., and Dutfield, G. 1996. Beyond intellectual property. Towards traditional resource rights for indigenous peoples and local communities. IDRC, Canada.

Rangneker, D. 2002. Geographic Indications: A review of proposals at the TRIPS Council. UNCTAD/ICTSD Capacity building project on intellectual property rights and sustainable development. Geneva.

Reddy, S.R.C. 1998. User group benefit appropriations in the global commons: An economic analysis of tropical forest management under uncertainty with a case study of India. PhD Thesis. School of Agriculture and Forest Sciences, University of Wales, Bangor, UK.

Reinders, M. 1993. Medicinal Plants and their uses and the ideas of illness and healing among the Warao of Guyana. Msc Thesis, Dept. of Cultural Anthropology, Utrecht University, the Netherlands.

Republic of South Africa, Department of Agriculture and Land Affairs, 2002. Communal Land Rights Bill. Government Gazette Vol. 446, No. 23740.

Rodin, R.J., 1985. The Ethnobotany of the KwaNyama Owambos. Monographs in Systematic Botany from the Missouri Botanical Garden 9. Allen Press, Kansas.

Roodt, V. 1988. The Shell field guide to the common trees of the Okavango Delta and Moremi Game Reserve. Shell, Gaborone.

Rouillard et al. 1999. US Patent and Trademark Office-Patent Full text and Image Database. USA

Rouillard F. Crepin J and Saintigny G. 1999. Cosmetic or Pharmaceutical composition containing and andiroba extract. United States Patent 5 958 421. See: http://www.uspto.gov/patft/index.html

Ruiz Perez, .M., Ndoye, O. and Eyebe, A. 1999. Marketing of Non-wood Forest Products in the Humid Forest Zone of Cameroon. Unasylva 198, Vol 50, pp 12-19

Sabatier, D. 1985. Saisonnalité et déterminisme du pic de fructification en forêt guyanaise. Revue d'Ecologie (Terre et Vie) 40:89-320.

Sampaio, Paulo de. 1993. Selected species and strategies to enhance income generation from Amazonian Forests. FAO Forestry Paper (Final Draft). United Nations Agricultural Organisation, Rome.

Schulze, R.E. 1997. South African Atlas of Agrohydrology and -Climatology. Water Research Commission Report TT82/96.

SEPSAL database. 2001. Sclerocarya birrea (A. Rich.) Hochst. Subsp. Caffra (Sond.) Kokwaro. Royal Botanic Gardens, Kew. http://www.rbgkew.org.uk/ceb/sepasal/birrea.htm.

Shackleton, C. M. In press. Use and selection of Sclerocarya birrea (marula) in the Bushbuckridge lowveld, South Africa. In: Kwesiga, F. (ed). Agroforestry impacts on livelihoods in southern Africa, putting research into practice. Proceedings of Regional Agroforestry Conference. ICRAF, Nairobi.

Shackleton, C.M. In press 2002. Growth and fruit production of Sclerocarya birrea in the South African lowveld. Agroforestry Systems.

Shackleton, C.M. & Shackleton, S.E. 1997. Commercialisation potential of veld products in Bushbuckridge. Prepared for the DANCED/DARUDEC Bushbuckridge Community Forestry Project. Nelspruit.

Shackleton, C.M. & Shackleton, S.E. 2000. Direct use values of savanna resources harvested from communal savannas in the Bushbuckridge lowveld, South Africa. Journal of Tropical Forest Products 6: 21-40.

Shackleton, C. M. & Shackleton, S.E. 2002. Use of marula products for domestic and commercial purposes by households in the Bushbuckridge district, Limpopo Province, South Africa. Unpublished report prepared for FRP Project No. ZF0140/R7795, Department of Environmental Science, Rhodes University, Grahamstown.

Shackleton, C.M., Botha, J., Emanuel, P.L. & Ndlovu, S. 2002. Inventory of Marula (Sclerocarya birrea subsp. caffra) Stocks and Fruit Yields in Communal and Protected Areas of the Bushbuckridge Lowveld, Limpopo Province, South Africa. Rhodes University, South Africa.

Shackleton, C.M., Dzerefos, C.M., Shackleton, S.E. & Mathabela, F.R. 2000. The use and trade in indigenous edible fruits in the Bushbuckridge savanna region, South Africa. Ecology of Food and Nutrition, 39: 225-245.

Shackleton, C.M., Griffin, N., Banks, D.I., Mavrandonis, J. & Shackleton, S.E. 1994. Community structure and species composition along a disturbance gradient in a communally managed South African savanna. Vegetation, 115: 157-168.

Shackleton, S.E. 2002. The informal marula beer traders of Bushbuckridge, Limpopo Province, South Africa. Rhodes University, South Africa.

Shackleton, S.E. & Shackleton, C.M. 2002. Use of marula products for domestic and commercial purposes by households in the Bushbuckridge district, Limpopo Province, South Africa. Unpublished report, Rhodes University, Grahamstown.

Shackleton, S.E., Shackleton, C.M. and Cousins B. 2000a. The economic value of land and natural resources to rural livelihoods. Case studies from South Africa. In Cousins (ed). At the crossroads: Land and agrarian reform into the 21st century. Papers from a conference held at the Alpha Training Centre, Broederstroom, Pretoria on 26th - 28th July 1999. PLAAS, University of Western Cape, Cape Town.

Shackleton, S.E., Shackleton, C.M., and Cousins, B 2000b. Re-valuing the communal lands of southern Africa: New understandings of rural livelihoods. ODI Natural Resource Perspectives (NRP) series, No 63.

Shackleton, S.E, Shackleton, C.M., Cunningham, A.B., Lombard, C., Sullivan, C.A. and Netshiluvhi, T.R. 2002. Knowledge on Sclerocarya birrea subsp. caffra with emphasis on its importance as a non-timber forest product in South and southern Africa: A summary. Part 1: Taxonomy, ecology and role in rural livelihoods. Southern African Forestry Journal 194: 27 – 41.

Shackleton, S.E. & Steenkamp, C. In press. The woodcraft industry in the Northern Province-Mpumlanga lowveld. In: Laws, M., Eely, H. & Shackleton, C.M (editors). Use and value of forest and woodland resources in South Africa.

Shackleton, S.E., den Adel, S., McHardy, T. and Shackleton C.M. 2002. Use of marula products for domestic and commercial purposes: Synthesis of key findings from three sites in southern Africa. Rhodes University, South Africa.

Shackleton, S.E., Shackleton, C.M., Cunningham, A.B., Lombard, C., Sullivan, C.A. & Netshiluvhi, T.R. 2002. Knowledge on Sclerocarya birrea subsp. caffra with emphasis on its importance as a non-timber forest product in South and southern Africa: A summary. Part 1: Taxonomy, ecology and role in rural livelihoods. Southern African Forestry Journal, 194: 27-42.

Shackleton, S.E., Stadler J., Jeenes, K., Pollard, S., Gear, J.S.S., Reynolds, J. and Mathebela, F.R. 1995. Adaptive strategies of the poor in arid and semi-arid lands: In search of sustainable livelihoods. A case study of the Bushbuckridge District, Eastern Transvaal, South Africa (170 pp). Prepared for the International Institute of Sustainable Development (IISD), Winnipeg, Canada. Wits Rural Facility, University of the Witwatersrand.

Shackleton, S.E., Sullivan, C.A., Cunningham, A.B., Cribbins, J., Leakey, R., Laird, S., Lombard, C., Mander, M., Netshiluvhi, T.R., Shackleton, C.M., and Wynberg, R. 2001. An overview of current knowledge on Sclerocarya birrea (A. Rich.) Hochst. subsp. caffra (Sond.) Kokwaro with particular reference to its importance as a non-timber forest product (NTFP) in southern Africa. 58pp. Rhodes University/CEH Wallingford

Shackleton, S.E., Wynberg, R.P., Sullivan, C.A., Shackleton, C.M., Leakey, R.R.B., Mander, M., McHardy, T., den Adel, S., Botelle, A., du Plessis, P., Lombard, C., Laird, S.A., Cunningham, A.B., Combrinck, A. and O'Regan, D.P. 2002. Marula commercialisation for sustainable and equitable livelihoods: Synthesis of a southern African case study.

Shanley, P., Pierce, A.R., Laird, S.A. and Guillen, A. 2002. Tapping the Green Market: Certification and Management of Non-Timber Forest Products. Earthscan, London.

Shanley, P; Cymerys, M & Galvão J (1998). Frutiferas da Mata na Vida Amazonica. Brazil.

Shone, A.K. 1979. Notes on the marula. Department of Water Affairs and Forestry Bulletin 58: 1- 89.

Stabroek News. 2002. Public Servants Wage Talks: Government in Dire Financial Straits. October 19th. Volume 16. No. 287.

Steenkamp, C. 1999. Analysis of the woodcarving industry in the Bushbuckridge area. DANCED – Community Forestry Project in the Bushbuckridge area, Department of Water Affairs and Forestry, Nelspruit.

Strong, J. 2002. Methods for the Use of Camera Traps and Thread Trails to Monitor Wildlife Use of Crabwood (Carapa guianensis) Seeds in the Iwokrama Forest. Iwokrama International Centre, Guyana.

Sullivan, C. 1999. Valuation of Non-timber forest products: a case study of three Amerindian villages in Guyana. PhD thesis, Dept. of Economics, Keele University, Staffordshire. UK.

Sunday Times. 2002. Dread diseases hit South Africa's starving kids. Three quarters of all South Africans do not have enough food. Article by Schmidt, M., Jurgens, A. and Jordan, B. Cover Page, Sunday 28 July.

Tapson, D.R. 1996. The technical component of mixed and livestock farming in semi-arid lands. In, Liton, M.E. and Lipton, M. (eds). Land, labour and livelihoods in rural South Africa. Volume Two: KwaZulu-Natal and Northern Province. Indicator Press, Durban.

Taylor, D. A. 1999. Requisites for Thriving Rural Non-wood Forest Products Enterprises. Unasylva 198, Vol 50, pp 3-8.

Taylor, F.W. & Moss, H. 1983. The potential for the commercial utilisation of veld products in Botswana. I. The resource and its commercialisation. Unpublished report, Veld products Research, Gaborone.

Taylor, F.W., Mateke, S.M., & Butterworth, K.J. 1996. A holistic approach to the domestication and commercialization of non-timber forest products. In: Leakey, R.R.B., Temu, A.B., Melnyk, M. & Vantomme, P. (Eds.). Domestication and Commercialisation of Non timber Forest Products in Agroforestry Systems. Non-Wood Forest Products, No 9, 8-22. FAO, Rome, Italy.

ten Kate, K. and Laird, S.A. In press. Bioprospecting agreements and benefit-sharing with local communities. The World Bank, Washington DC.

ter Steege, H & Zondervon, G 2000. A preliminary analysis of large scale forest inventory data of the Guiana Shield in Plant Diversity: with recommendations for a National Protected Area Strategy, Ed. Hans ter Steege. Tropenbos series 18. The Tropenbos Foundation. Wageningen, the Netherlands.

ter Steege, H. 2001. Mapping Forest vegetation in Guyana at Regional and National Level. Consultancy report prepared by the Forestry Commission. Georgetown.

ter Steege, H., Boot, R., Brouwer, L., Hammond, D., van der Hout, P., Jetten, V.G., Khan, Z., Polak, A.M., Raaimakers, D., Zact, R. 1995. Basic and Applied Research for sound rain forest management in Guyana. Ecological Applications, 5(4), 1995, pp. 904-910.

ter Steege, H., Zact, R., Bertilsson, P., Singh, J. 2000. Plant diversity in Guyana: implications for the establishment of a protected areas system.

Thiong'o, M.K. and Edje, O.T. In prep. Chapter 4: Food security and Nutrition. Marula Monograph. University of Bangor, Bangor, Wales.

Thomas, C. 2000. Poverty and the 1999 Guyana Survey of Living Conditions. Institute of Developmental Studies, University of Guyana. Prepared for the UNDP.

Thomas, R.S. 1999. Forest productivity and resource availability in lowland tropical forests of Guyana. PhD thesis, Imperial College, Ascot, University of London. (Also published as Tropenbos-Guyana Series 7, Georgetown Guyana)

Thomas, R. 2001. Forest Productivity and resource availability in lowland tropical forests of Guyana. Tropenbos Series 7. Tropenbos-Guyana Programme, Georgetown, Guyana.

Thomas, R. and Hammond, D. 2000. Strategic Zoning of the Iwokrama Forest-Key Plant Species. Draft. Iwokrama, Guyana.

Thomas, R.S. & Hammond, D. 2001. Key species of the Iwokrama forest: Indicators for Forest Monitoring and Planning. Technical Paper. Iwokrama International Centre for Rainforest Conservation and Development. Georgetown, Guyana.

Todd, C.B. 2001. A survey of fruit production in Sclerocarya birrea (marula). Unpublished report, Venda University, Thoyhoyandou.

Tollman, S.M., Herbst, K. and Garenne, M. 1995. The Agincourt demographic and health study: field phase 1. Health Systems Development Unit, University of the Witwatersrand, Johannesburg.

Tourism and Hospitality Association of Guyana (THAG). 1999. Explore Guyana: The official guide to Guyana, South America. THAG. Caribbean Papers and Printed Products Limited, Trinidad.

Twine, W. and Siphungu, V. 2002. There is a hole in my bucket: Cause for concern at the increased outflow of woody resource from rural communities in the lowveld savannas of South Africa. Paper presented at the III Natural Forests and Woodlands Symposium, Berg-en-dal, Kruger National Park.

United Nations. 2002. Word Investment Report 2002: Transnational Corporations and Export Competitiveness. Geneva, Switzerland

van Andel, T. 2000. Non-timber Forest products of the North-West District of Guyana Part I. Tropenbos-Guyana series 8A. Tropenbos-Guyana Programme-Georgetown, Guyana.

van Andel, T. 2000. Non-timber Forest products of the North-West District of Guyana Part II. Tropenbos-Guyana series 8B. Tropenbos-Guyana Programme-Georgetown, Guyana.

van Wyk, B. & van Wyk, P. 1997. Field guide to trees of southern Africa. Struik, Cape Town.

Verlinden, A. & Dayot, B. 1999. Indigenous knowledge systems on integrated resource use: local land classification and resource management in North-Central Division. Republic of Namibia, Ministry of Agriculture, Water and Rural Development. Proceedings of the Annual Conference on Agricultural Research, Swakopmund, Namibia 6-10 September 1999.

Verlinden, A. & Dayot, B. 2000. Working with local knowledge systems in a GIS for natural resource assessment, planning and management in North Central Namibia in Caron, P, Swanepoel, F. and Stroebel, A. (eds) Proceedings of the Regional Workshop on Spatial Approaches for Land Use and Local Governance, Pretoria 24-26 November 1999 SACCAR and the University of Pretoria Post-graduate School of Agriculture and Development

Verlinden, A. and Dayot, B. 1999. Indigenous knowledge systems on integrated resource use: local land classification and resource management in North Central Division in Proceedings of the Annual Conference on Agricultural Research, Swakopmund, Namibia 6-10 September 1999 Ministry of Agriculture, Water and Rural Development, Republic of Namibia

Von Breitenbach, F. 1965. The indigenous trees of Southern Africa. Vol. II. Descriptive Text, Part 2. Pp 555. Department of Forestry, Government Printer, Pretoria.

Von Maltitz, G., Brown, P. & Tapson, M.A. 1996. Tree and Shrub Guide Tool. Unpublished report. Pretoria: CSIR.

Von Teichman, I. 1983. Notes on the distribution, morphology, importance and uses of the indigenous Anacardiaceae: 2. The importance and uses of Sclerocarya birrea (the Marula). Trees in South Africa, Apr. – Sept: 2-7.

Walker, N. 1989. “King of foods. Marula economics in the matabos. African Wildlife, 43: 281-285.

Watt, J. M. & Breyer-Brandwijk M.G. 1962. Medicinal and poisonous plants of Southern and Eastern Africa. E & S Livingstone, Ltd. Edinburgh and London.

Wehmeyer, A. S. 1966. The nutrient composition of some edible fruits found in the Transvaal. South African Medical Journal 40: 1102 - 1104.

Wehmeyer, A.S. 1967. Edible wild fruits of the Transvaal. Food Industries S. Africa. 19: 49 -53.

Weinert, I.A.G., van Wyk, P.J., & Holtzhausen, L.C. 1990. Marula. In: Nagy, S., Shaw, P.E. & Wardowski, W.F. (Eds.). Fruits of tropical and subtropical origin. Lake Alfred, Florida Science Source.

Weiss, N. A. 2002. Introductory Statistics. Sixth Edition. Addison-Wesley. U.S.A.

Wignaraja, G. 2000. Reflections on Foreign Investment and Economic Development. Export and Industrial Division. Commonwealth Secretariat.

Wiser, G. 2002. The Ayahuasca Patent Case: Indigenous People's Stand against Misappropriation. In: Laird, S.A. (ed). 2002. Biodiversity and Traditional Knowledge: Equitable Partnerships in Practice. Earthscan, London.

Wollenberg E. 1998. Methods for Assessing the Conservation and Development of Forest Products. In Wollenberg E. and Ingles A. (eds) Incomes from the Forest: methods for the development and conservation of forest products for local communities. CIFOR. Bogor. Indonesia.

Wollenberg, E. and Ingles, A. (eds). 1998. Incomes from the forest. Methods for the development and conservation of forest products for local communities. CIFOR/IUCN. CIFOR, Bogor, Indonesia.

Woods, E.J., Wei, S., Singgih, S. and Adar, D. (2002) Supply Chain Management as Beyond Operational Efficiency Acta Hort. 575

World Trade Organization, Council for Trade-Related Aspects of Intellectual Property Rights. 2001. Review under Article 24.2 of the application of the provisions of the section of the TRIPS Agreement on geographical indications: summary of the responses to the checklist of questions (IP/C/13 and ADD.1). IP/C/W/253, 4 April 2001.

Wunder, S. 2001. Poverty alleviation and tropical forests-What scope for synergies? World Development. Vol. 29, No. 11, pp 1817-1833.

Wynberg, R. 2000. Privatising the means for survival: the commercialisation of Africa's biodiversity. Global Trade and Biodiversity in Conflict Issue No. 5. Gaia/GRAIN International. http://www.grain.org/publications/

Wynberg, R. 2002. A decade of biodiversity conservation and use in South Africa: tracking progress from the Rio Earth Summit to the Johannesburg World Summit on Sustainable Development. South African Journal of Science 98: 233-243.

Wynberg, R.P., Laird, S.A., Botha, J., den Adel, S. and McHardy, T. 2002. The Management, Use and Commercialisation of Marula: Policy Issues.

Wynberg, R., Cribbins, J., Leakey, R., Lombard, C., Mander, M., Shackleton, S., and Sullivan, C. 2002. Knowledge on marula (Sclerocarya birrea subsp. caffra) with emphasis on its importance as a non-timber forest product in South and southern Africa. Part 2: Commercial use, tenure and policy, domestication, intellectual property rights and benefit-sharing. Southern African Forestry Journal 196: 67-77.

Wynberg, R.P., Laird, S.A., Shackleton, S., Mander, M., Shackleton, C., du Plessis, P., den Adel, S., Leakey, R.R.B., Botelle, A., Lombard, C., Sullivan, C., Cunningham T. and O'Regan, D.P. 2002. Marula commercialisation for sustainable and equitable livelihoods: A Policy Brief.

Zharare, P. & Dhlamini, N. 2000. Characterization of marula (Sclerocarya caffra) kernel oil and assessment of its potential use in Zimbabwe. Journal of Food Technology in Africa 5 (4).

Websites

Amazon Co-op Inc.
http://www.amazoncoop.org/

Green Cottage and Electric Soap
http://www.greencottage.com/

IWOKRAMA (2002a)
http://www.iwokrama.org/description.html

IUCN 2000a
http://www.iucn.org/themes/ceesp/Wkg_grp/Theme/theme.htm

Karla Krompegel
http://www.colostate.edu/Depts/Entomology/courses/en570/papers_2000/krompegel.html

L'Ami des ingredients Naturel (l'encyclopedie)
http://www.albanmuller.com/anglais/publications/cd-rom/cd-rom.html

Natu.Science Fitorepelentes
http://www.andiroba.com.br/ingles.html

Rain-tree. 2002. *Andiroba*.
http://www.rain-tree.com/andiroba.htm

Rain tree Nutrition
http://rain-tree.com/

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