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

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SYNOPSIS

Sclerocarya birrea (marula) forms an integral part of the diet, tradition and culture of rural communities in southern Africa and also is central to various commercial initiatives. This second part of a review on the species provides an overview of current commercial activities, the policy framework within which commercialisation occurs, and future prospects with regard to domestication. Much work has been conducted over the years on the properties of *S. birrea* fruit, juice, nuts and oil. Despite this research there has been little commercialisation. Two main commercial enterprises trade marula products in South Africa: one, a large corporation, and the other, a rural development project. In Namibia, marula commercialisation is undertaken through a collaborative project between primary producers, a cooperative, contract processors and a local NGO. Commercialisation is influenced by a wide set of customary and government laws which regulate marula use in southern Africa, comprising different tenure systems, access rights, and levels of protection. Strong customary rules can be linked to the long history of marula use in the region, with clear evidence of early domestication and the selection of desirable traits by local people. Such knowledge has been applied in the development of marula domestication strategies, both by private plant breeders in Israel and southern Africa, and by the International Centre for Research in Agroforestry (ICRAF), which works with small-scale farmers to develop agroforestry options. A number of issues are raised by the domestication of marula which relate to intellectual property and benefit-sharing. They include the compensation of small-scale farmers and original holders of local knowledge for the commercial use of such knowledge; the impact of Plant Breeder's Rights on communities using marula; and the possibility of domestication shifting benefits from poorer groups of farmers to richer ones. Current and future commercialisation strategies clearly need to take these factors into account, and to balance associated costs and benefits.

Keywords: *Sclerocarya birrea,* marula, non-timber forest products, commercialisation, domestication, intellectual property, benefit-sharing, policy

INTRODUCTION

Marula *(Sclerocarya birrea* subsp. *caffra)* forms an integral part of the diet, tradition and culture of rural communities in southern Africa. It also comprises the basis of various commercial enterprises. Part 1 of this review (Shackleton *et al.*, 2002) described the taxonomy, ecology, and traditional use of marula, and highlighted its essential role in the livelihoods of rural communities. A focus was placed in Part 1 on the 'endogenous' commercialisation process in which households, and women in particular, trade marula at a local level to supplement other livelihood activities.

This Part deals with the more formal and 'externally driven' commercialisation process, which has seen the emergence and development of a variety of marula-based commercial enterprises, one of which exports its product to global markets. The potential of *S. birrea* to provide commercially marketable products has long been recognised by both the private sector and development agencies, resulting in a variety of initiatives with varying objectives, commercial products and supply chains. It was these initiatives which spurred the development of a project, funded by the UK Department for International Development, to investigate the extent to which communities derive benefit from such commercialisation, and the different sets of benefits obtained from diverse approaches to commercialisation.

This review provides an overview of existing literature on the topic, and forms the basis for the research described above. Information has been derived from review of published and unpublished literature, from an initial scoping exercise in which commercial producers were contacted and interviewed by phone (Cribbins and Mander, 2001), and from interviews with a wide range of government officials, researchers, and non-governmental organisations.

The paper provides an overview of current knowledge about the commercial properties of marula fruits, kernels, oil and other plant parts; existing commercial enterprises and formal markets; the different systems of tenure and access rights concerning marula in the region; and the formal policies governing marula use in South Africa. A description is given of the history of marula domestication and current domestication efforts, and an analysis is provided of associated issues with regard to intellectual property rights and benefit-sharing.

COMMERCIAL PROPERTIES OF THE FRUITS, KERNELS, OIL AND OTHER PLANT PARTS

Recognition of *S. birrea* as an important food source for rural communities has generated much interest in the nutritional values of the plant and its potential for product development. Considerable research has been conducted over the years on the properties of *S. birrea* fruits, juice, nuts and oil, with some of the earliest references dating as far back as 1906 (e.g. Ingle 1906-07; Krige, 1937; Fox and Stone, 1938; Carr, 1957; Quin, 1959; Wehmeyer, 1966, 1967; Engelter and Wehmeyer, 1970; Burger *et al.,* 1987; Weinert *et al.,* 1990; Leakey, 1999; Zharare and Dhlamini, 2000). During the 1960s, 1970s and 1980s the National Food Research Institute of South Africa's Council for Scientific and Industrial Research (CSIR) carried out extensive analyses on marula fruits and seeds as part of a wider research programme investigating the nutritional content of indigenous food plants. Outputs of this programme included research by Engelter and Wehmeyer (1970) on the fatty acid composition of marula and four other indigenous oil-bearing plants, a comparison of the nutrient composition of various wild fruits (Wehmeyer, 1966, 1967), a paper by Burger *et al.* (1987) which constitutes the seminal work on marula oil, and a review by Weinert *et al.* (1990) of available information on marula lipids. Burger *et al.* (1987), working with samples from sites in South Africa and Namibia, made innovative use of a then novel method to speed up oxidation and so determine the period of resistance to oxidation. The paper also included information on the fatty acid composition of marula kernel oil, the oil and kernel content of marula nuts, a comparison of the average fatty acid content of marula kernel and olive oil, a comparative assessment of the oxidative stability of marula oil, the sterol and tocopherol content of marula oil, the total protein content of marula meal and kernels, and the amino acid content of marula kernel meal.

Marula fruit and juice is extremely high in Vitamin C, and studies have obtained results from as high as 194 mg (National Food Institute of CSIR, cited in Shone, 1979) to 54-67.9 mg of Vitamin C per 100 g of flesh or juice (Quin, 1959; Wehmeyer, 1967). The latter values are comparable to the Vitamin C content of orange juice but are higher than that of other citrus juices (Quin, 1959). This high anti-scorbutic value of the fresh fruit makes it nutritionally important and accounts for early observations of the ability of marula fruit to combat scurvy (Shone, 1979). Potassium content of the fruit is also high, reported by Shone (1979) at 317 mg/100 g of fruit flesh and by Wehmeyer (1967) at 54.8 mg/100 g. Energy value is approximately 130 kJ/100 g of fruit flesh (von Teichman, 1983).

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) which contributes to the importance of these nuts in the diets of some rural communities (Shone, 1979; Arnold *et al.,* 1985). Indeed, analyses indicate that marula kernels have a higher protein and oil content than most other popular nuts, including walnuts, hazelnuts, chestnuts and almonds (Quin, 1959). Other important nutritional components include trace elements and vitamins such as iron, calcium, copper, zinc, thiamine and nicotinic acid (Shone, 1979; Arnold *et al.,* 1985; Peters, 1988). Fatty acids found in the oil include palmetic acid (12 g/100 g fatty acid), stearic acid (9.2 g/100 g fatty acid), oleic acid (69.9 g/100 g fatty acid) and linoleic acid (7.8 g/100 g) (National Food Research Institute of CSIR cited in Shone, 1979). Unlike other nut oils, marula oil is a poor source of Vitamin E due a low level of B-tocopherol (Shone, 1979). The nut comprises an average 90 % shell and only 10 % kernel, making kernel and oil yields relatively low per fruit. However, the oil yield per kernel is high at 56 % (Quin, 1959; Shone, 1979). The energy value of the kernel is approximately 2699 kJ-2 703 kJ/100 g

of kernel (von Teichman, 1983; Arnold *et al.,* 1985), which is generally higher than most other commonly consumed nuts, with the exception of walnut (Quin, 1959).

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). The special properties of marula oil provide it with considerable commercial potential, and ethnobotanical records suggest that such properties have been appreciated and exploited by local populations for possibly thousands of years (Junod, 1927; Krige, 1937; Quin, 1959; Palmer and Pitman, 1972). The oxidative stability of marula oil in particular appears to have been long utilised by certain communities in the region to preserve meat (Palmer and Pitman, 1972; L du Plessis, personal communication, 2001). The basis of such usage is well validated by scientific sources, which point to the oil's exceptional resistance to oxidative rancidity (Burger *et al.,* 1987; Rugheimer, S., unpublished; CRIAA SA-DC 1997-2001 unpublished; CRIAA SA- DC/Leatherhead Food Research Association (LFRA), unpublished). However, marula oil is subject to hydrolytic rancidity, meaning that triglycerides are attacked by moisture and enzymes to create free fatty acids and glycerol (Rugheimer, S., unpublished; CRIAA SA-DC 1997-2001 unpublished). Burger *et al.* (1987) ascribed marula oil's resistance to oxidation to its fatty acid composition. However, recent understanding of the role of fatty acid composition in triglyceride stability (Dijkstra *et al.,* 1998) suggests that this may not be the case (L. du Plessis personal communication, 2001; CRIAA SA-DC/LFRA, unpublished). In all likelihood, some of the minor components may also be contributing significantly to this commercially important anti-oxidant property.

In Namibia, commercialisation trials by CRIAA SA-DC have led to marula oil being investigated as a potential ingredient in cosmetic formulations (CRIAA SA-DC, 1997-2001, unpublished), and the testing of its cosmetic properties against hemp seed oil, camelina oil, palm olein and, an industry standard, sweet almond oil. Tests included 'skin hydration', 'transepidermal water loss' and 'increase in skin smoothness', with marula oil performing significantly well (Houghton, 1999). Marula oil has also been successfully refined at both bench and commercial scale, with values attained for Iodine of 70-80, Free Fatty Acids <0.15 (% as oleic), Lovibond Colour < 20 Yellow and < 5 Red, Saponification Value 191, and Peroxide Value of 0 (CRIAA SA-DC, 1997-2001, unpublished).

Analysis of the medicinal properties of different parts of *S. birrea* has also received attention (Galvez *et al.,* 1991; Galvez *et al.,* 1992; Galvez *et al.,* 1993; Hutchings *et al.,* 1996; Kubo and Kinst-Hori, 1999), with recent research involving biochemical analyses of the active properties of different marula products and derivatives (e.g. Pretorius *et al.*, 1985; Anderson *et al.,* 1986; Fatope *et al.,* 1993; Trovato *et al.,* 1995; Mhlongo,1997; Mugochi *et al., 1999;*Thiong'o *et al.,* 2000). The bark of marula contains tannins and traces of alkaloids and therefore acts as an astringent and coagulant (Shone, 1979). 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 its use as a medicine. Tannins and flavinoids are present in the leaves, but alkaloids, steroids or triterpenoids have not been detected (Hutchings *et al.,* 1996). Extracts from dry stembark have shown anti-bacterial activity (Hutchings *et al.,* 1996).

COMMERCIAL ENTERPRISES AND FORMAL MARKETS

Given the potential and properties of marula fruits and kernels, it is surprising how little commercialisation there has been within southern Africa. Indeed, other than the marula-based liqueur, know as 'Amarula Cream', which is produced, bottled and marketed all over the world by Cape Distell Pty Ltd. in Stellenbosch, South Africa there has been limited large-scale commercialisation of marula products within the region. In fact, the Israelis appear to be taking greater initiative in this respect (see below). In South Africa, there are two main commercial enterprises dealing with marula products: one being a large corporation and the other a rural development project. There are also several other groups, either experimenting with or producing marula products on a limited scale.

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 800 tons of pulp or 2 000 tons of fruit into Amarula Cream annually. The fruit is collected by rural communities in the vicinity of the town of Phalaborwa in Limpopo Province, and processed at a pulp factory and depot (run by a subsidiary company-Mirma) in the town. Recent surveys suggest that this operation contributes over US$60 000 (ZAR600 000) into the area, including a yearly donation from Distell of some US$10 000 (ZAR100 000). About 60 people are employed directly by the factory, but only four for the full year. Some 420 people are involved in the selling of the fruit on an annual basis. The depot has an arrangement with local chiefs in terms of fruit supply, and collects from identified collection points in surrounding villages as well as purchasing directly from suppliers who come to sell at the depot. The company is conscious of its responsibilities to the primary producers and has registered a Section 21 Company with the objective of reinvesting in the community, particularly in the areas of health and education. The Amarula cream product has been relatively successful and still has an expanding international market.

A recent, but innovative initiative is the Marula Project of the national Mine Workers Development Agency (a Section 21 Company). The primary aim of the DFID-funded project, which was started about three years ago, is "to ensure rural incomes to communities affected by the loss of jobs on the mines" (MDC project outline, undated). Thus, the development project is explicitly focused on poverty alleviation and livelihood enhancement. The project is being piloted at the Mhala Development Centre (MDC) in Bushbuckridge, Limpopo Province, and has been involved in developing three main products: a marula beer, mainly for the local tourism market (subsequently discontinued due to problems with sediment and a lack of technology to 'clear' the beer); a nectar or juice in the form of a pulp; and an oil exported to manufacturers of cosmetics. The potential of other marula-based products such as soap and massage oil is also being investigated.

Various mechanisms to enhance returns to the local community, such as local-level value addition, are also being explored (S. Barton, personal communication, 2001). Surveys suggest that over the past two years MDC have contributed about US$36 500 (ZAR365 000) into the local communities. On average MDC employs 34 staff members but due to the seasonality of the marula fruit, only six are employed for the entire year. MDC estimate that over 360 individuals from 27 communities in and around the Thulamahashe area, have benefited financially from the Marula Project (MDC project outline, undated). Each season, 80-100 tonnes of marula fruit is processed, producing 6-10 tonnes of pulp. The nectar and oil developments are still embryonic and no statistics are yet available, but it is anticipated that up to 135 people will earn incomes from supplying kernels. 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 MDC 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.

One of the smaller commercial enterprises is Ina Lessing Jams, which operates from a private farm about 120 km north of Pretoria and produces a wide variety of fruit jams, jellies and chutneys using both commercially grown exotic and indigenous fruits. They have been in operation for seven years. Unlike the larger commercial producers described above, none of their fruit for marula products comes from communal lands. Instead, the fruit is collected from trees on the farm as well as from streets and private gardens in the nearby towns of Nylstroom and Naboomspruit. Products are sold mainly within South Africa.

In Namibia, CRlAA SA-DC has been largely responsible for expanding the market in marula products for rural producers. The marula operation managed by CRlAA SA-DC, is a collaborative effort between primary producers, the Eudafano Women's Cooperative, and contract processors, the Katutura Artisans' Project. The Eudafano Women's cooperative, operating in northern Namibia, consists of nine village-based producer organisations representing some 1500 women. Marula products include kernels, oil and oil-based products (e.g. soap) for local and export markets, and fruit-based products presently for informal markets. Trial production for formal markets began in 1996, with the initiative growing into a US$61 500 (N$500 000) industry by 2000. Kernels are extracted at household level by labour intensive means, whilst the oil is extracted mechanically by the Katutura Artisans' Project near Windhoek. Fruit-juice products are hand and machine processed. The supply logistics and quality control is primarily managed by the cooperative (Lombard *et al.,* 2000).

There have been attempts to commercialise *S. birrea* products in Botswana and an ambitious project was implemented in Gweta, Botswana in the early 1990s, with assistance from the Botswana Natural Resources Management Programme. This resulted in residents from three villages in the Gweta area forming a Trust in 1993. In collaboration with Oasis breweries of South Africa, the Gweta community began marketing marula drinks and puree with a certain amount of success. Acquiring the proper machinery and marketing the product did however prove to be extremely expensive and financing of the project was a continuous problem (Africa Resources Trust, 1998). The project has since been terminated and it would clearly be worthwhile to learn from the experiences here in any future community-based projects to commercialise marula.

Marula commercialisation in Botswana is now negligible although Veld Products Research and Development have initiated some trial marketing of marula 'chunks' and jam. Approximately 10 tons of pulp has been collected, derived from 12-13 tons of fruit (C. de Wolf, personal communication, 2001). The intention is to focus on local supply, but for high- paying markets such as upmarket supermarkets and tourist lodges rather than village residents.

In Zimbabwe, Kadzere (2000) writes, "there is currently no commercial utilisation of the fruit and wood [marula]. Some chiefs will not allow sale of products from indigenous fruit trees and so this will limit potential commercialisation of *S. birrea* products". However, since then, the Zimbabwean NGO SAFIRE (Southern African Alliance for Indigenous Resources) has commenced investigating and piloting business opportunities in marula products for the benefit of local communities (Sola, 2001). One such development, focused on marula oil, is underway in the Chapinduka community. A two-step supply chain is envisaged in which one group collects and extracts the kernels, whilst another takes on the role of "secondary processor" and processes and markets the oil.

TENURE, ACCESS RIGHTS AND POLICY

The equitable and sustainable use of non-timber forest products (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, and 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). These institutions also provide the framework for sustainable use and management. Understanding property rights issues is particularly important when considering commercialisation, and comprises the basis of this section, particularly with regard to communal areas. The policy and legislative framework is described for South Africa only.

Tenure and access rights

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). There are also records of households that have purposely cultivated marulas from seed or truncheons (Erkkila and Siiskonen, 1994; 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). The Pedi and Phalaborwa of Northern Province regarded the trees as sacred, and severe punishment was administered to anyone who did not respect this rule (Krige, 1937). Among the Kwanyama in Namibia, Rodin (1985) noted that the tree was so highly prized for its fruit that it was never cut down. In other cases, marula trees could only be cut with the permission of the chief. Prohibitions on the sale of marula products also served to protect the resource base (Kadzere, 2000). Although these customary regulations still exist, they have lost their power and are seldom strictly enforced. This can partly be attributed to erosion of the authority of traditional leaders as custodians of the resource base, both by colonial regimes and the decentralisation policies of subsequent democratic governments. The latter has resulted in new local governance structures, which are often in strong competition with the traditional structures. Other factors include the common pressures of modern society - population growth, land scarcity, breakdown in social capital, the need for cash income (e.g. by woodcarvers), westernisation and so on.

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 the Caprivi area in Namibia, the tenure arrangements are somewhat different to most other communal areas in southern Africa, and women have individual tenurial rights over specific trees within the commonage (C. Lombard, personal communication, 2001). More commonly, however, private rights to the tree and its fruits are accorded to households, with access to trees under 'private' tenure provided by owners to others in the community (Shone, 1979; Cunningham, 1997). Similarly, trees in public areas within the village but close to someone's homestead are harvested only after prior consultation with the senior female in the household (Shackleton *et at.,* 1995). In the past, it appears that ownership over trees outside plots and fields was more pronounced than it is now. Shone (1979) quotes the following notes of an early explorer:

" ...each family in the village is allotted one or more marula trees according to the population of the place: they are usually enclosed by a fence placed about three yards from the stem, the object of which is to save the wild fruit from being devoured by animals as it falls".

Quin (1959) observed a similar enclosure of trees with fences. In an explanatory text on customary law and nature conservation in South Africa, Labuschagne and Boonzaaier (1998) also refer to the entitlement of families to plants that grow or appear on their cultivated lands and to the exclusive rights of members of these families to fruit from trees on these lands. Although no specific mention is made of *S. birrea,* the allocation of a residential stand or portion of arable land by a chief, tends to bring with it permission to remove or use the trees growing on it (Vorster, 1989, cited in Labuschagne and Boonzaaier, 1998). However, fruit from trees in the commonage may be gathered and consumed by anybody, including those from outside the village in the case of more distant trees. Indeed, there are often overlapping and shared rights to many resources in the communal lands. The question is whether this has the potential to result in competition and conflict under a commercialisation scenario. Some commentators, for example, have expressed concerns that as the incentive for owners to make use of their own resource increases, commercialisation will result in the increased privatisation of trees and loss of access by current users to trees on neighbours plots (Lombard *et al.,* 2000). These are questions currently under investigation by the authors.

Policy and legislation

Although strong cultural taboos protect marula on communal lands, this is not the case on private lands and the last

century in particular has witnessed a substantial increase in the felling of marula. In South Africa, timber shortages in the Second World War led to increased use of timber resources, among them marula, resulting in the promulgation of the Forest Act 13 of 1941. This Act afforded protection to certain trees found on private land, including *S. birrea.* However, a withdrawal of these emergency regulations in 1945 led to an increase in marula felling, and by 1948 a sawmill existed for the exclusive purpose of sawing marula timber, consuming some 1800 tonnes of timber annually (Shone, 1979). In 1951 it was recognised that the continued existence of marula was threatened and in terms of Proclamation 257 of 1951 *S. caffra* was declared a protected tree in the Transvaal. Appeals against this ruling by sawmillers and farmers selling marula resulted in a relaxation of these regulations, but by 1962 a complete prohibition was imposed, reinforced in 1976 by a further proclamation on protected trees (Shone, 1979). One of the reasons for including marula in the proclamation was its significance as a fodder tree, and the presence of buffalo grass *Panicum maximum* under the tree, also an important fodder species.

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. For example the former Venda Nature Conservation and National Parks Act (20 of 1986) includes *S. birrea* as a protected species; but the Mpumalanga Nature conservation Act (10 of 1998) does not. Through the Forest Act 84 of 1998 it is intended that a more coherent approach to tree protection in South Africa be adopted. 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. An important issue in this regard is the extent to which these restrictions might affect fruit harvesting, and likely impacts on rural livelihoods.

DOMESTICATION, INTELLECTUAL PROPERTY RIGHTS, AND BENEFIT-SHARING

Domestication

The importance of indigenous resources, in particular fruit species, for rural households across the woodlands of southern Africa has been clearly revealed in a number of studies undertaken by the International Centre for Research in Agroforestry (ICRAF) (e.g. Kamau and Odra, 1988; Minae, 1988; Ngugi, 1988; Kamau, 1989; Kwesiga and Kamau, 1989; Ngugi and Saka, 1989). All of these studies showed that farmers and rural households use indigenous fruit trees extensively as a source of food and income. More recently, ethnobotanical surveys (Karachi *et at.,* 1991; Maghembe and Seyani, 1991; Kwesiga and Chisumpa, 1992) found further evidence of the importance of these fruits. Part 1 of this review clearly illustrated the important role that *S. birrea* plays in the livelihoods of the majority of rural dwellers living within its distribution range.

Since the identification of the role of these trees in agroforests, and demonstration of their good performance when cultivated (Kwesiga *et al.,* 1994), farmers surveys have been carried out to determine priority species (Clarke, 1995; Kwesiga and Mwanza, 1995; Minae *et al*., 1995; Buwalda *et al*., 1996), and a conference discussed and identified research priorities (Maghembe *et al.,* 1995, 1998) using participatory priority setting procedures (Jaenicke *et al.,* 1995; Franzel *et al.,* 1996). Subsequently, ICRAF and its partners have made rangewide germplasm collections of *Uapaca kirkiana* and *S. birrea* as the first step in a domestication strategy (Simons, 1996; Leakey and Simons, 1998). These collections provide material for conservation and future utilisation. A prior requirement was to determine the requirements for seed germination (Maghembe and Prins, 1993; Mwabumba and Sitaubi, 1995).

At present marula fruits are collected from tree populations, which are widely considered as 'wild'. However, marula has been a focus of anthropogenic activities for many thousands of years. Archaeological evidence suggests that the fruit of *S. birrea* was known and consumed by humans in southern Africa as far back as 9 000 BC (Walker, 1989). In Zimbabwe, it has been speculated that marula was the key attraction for seasonal foraging in the Matobos, an outcrop of granite hills south of Bulawayo, with shelled marula stones recovered from archaeological deposits dating back 150 000 years (Walker, 1989). About 9 500 years ago foragers began to spend more time in the Matobos, and after a further 400 years or so it is suggested they became permanent residents, relying heavily on wild fruits. Indeed, marula is stated as the *raison d'etre* for settlement of the Nvuyi people in the Matobos (Walker, 1989). In a single cave in the area, it is estimated that over 24 million marula nuts were consumed, considered a mere fraction of the total numbers collected. Similar remains have also been found in several Stone Age sites in the Transvaal (Walker, 1989). Unbroken marula kernels found at Mapungupwe, a hill near the banks of the Limpopo, indicate fruit consumption by a Boskopoid people over 1 000 years ago (Palmer and Pitman, 1972). *S. birrea* is also one of the edible fruit-bearing species recorded from an excavation at Shongweni-South cave, South Africa (Davies, 1975; Cunningham, 1988). It has also been suggested that the specially fashioned pieces of bone, typical of Iron Age sites in the Transvaal, may have been used to extract marula kernels (Palmer and Pitman, 1972).

The early steps towards domestication of marula by local people, and selection of desirable traits, are well documented. For example, the classification by the Pedi of marula trees, according to the palatability of the fruit has already been mentioned (Part 1). Shone (1979) describes the importance of the knowledge of women as to which

trees bear the most and largest fruit, and which trees give the best fruit for beer making. Evidence from other indigenous African fruit trees (Leakey, R.R.B., Tchoundjeu, Z., Smith, R.I., Munro, R.C., Fondoun, J-M., Kengue, J., Anegbeh, P.O., Atangana, A.R., Waruhiu, A.N., Asaah, E., Usoro, C. and Ukafor, V., unpublished) indicates that such influences increase the range of phenotypic variation in fruit traits, offering enhanced opportunities for cultivar development.

Local knowledge has been applied in the development of marula domestication strategies, both at the international and national level. In the 1980s, an investigation of potential new desert crops by Israeli scientists used knowledge of local people in Botswana to glean information about the different qualities, yields and locations of marula trees, notably in the absence of any formal benefit-sharing agreements (Cherfas, 1989). This information was in turn used to choose seeds from fruits having desirable characteristics for potential new crops, forming the basis for a long-term research and development programme on marula in Israel (Mizrahi and Nerd, 1996). Kibbutz Ketura in Israel's Arava region reportedly has up to 25 acres of marula growing[1], 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". Marula has also been identified by the Israelis as one of six species that warrants consideration for further research and development (Mizrahi and Nerd, 1996). It is reported that trees introduced in the Negev Desert produce abundant fruits from early ages, mainly when grown in hot areas with saline water (Nerd and Mizrahi, 1993).

Local horticulturalists in southern Africa have also over the past 15 years produced 'improved' varieties of marula (in terms of commercial fruit pulp ratio, not kernel mass). The aim of using these varieties has been to improve the quality, size and flavour of the fruits, and to promote their use in agroforestry (Taylor *et al.,* 1995, 1996; Maghembe *et al.* 1995, 1998).

At the international level, ICRAF has conducted a wide range of germplasm collections of *S. birrea* within the SADC region, in collaboration with the SADC Tree Seed Centre Network, SADC Regional Genebank and national partners (Kindt and Were, 2000). Collections have been targeted from 25 farmer-selected trees of 40 provenances from farmers' fields, and germplasm exchange has occurred between countries for the establishment of multi-locational trials (Kindt and Were, 2000). These initiatives comprise a first step in a formal domestication strategy for the species. ICRAF's approaches to the domestication of marula and other southern African fruit trees contrasts with the other domestication efforts described here. ICRAF and its partners specifically work with local small-scale farmers to identify, propagate and test superior phenotypes as potential cultivars (Maghembe *et al.*, 1998).

Genetic variation in fruit characteristics has 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 those found on wild trees. To domesticate marula, ICRAF aims to bring indigenous fruits into cultivation by multiplying the superior trees, which produce large and sweet fruits while still small young trees. In horticulture, this is done by vegetative propagation, using either grafting/budding or rooted cuttings.

Vegetative propagation methods for marula were first developed by Holtzhausen *et al.* (1990). Grafting and budding are generally used because of the difficulty of propagating mature tissues by cuttings. The field performance of grafted marula plants in Botswana indicated that they started to produce fruits after 4-5 years, whereas seedling plants did not fruit for 8 -10 years (Taylor *et al.*, 1996). As identified by Maghembe (1995) in Malawi, cultivated plants also grew more rapidly. In this case, water-harvesting techniques using macro- and micro-catchments improved tree growth by over 50 %. The preference for grafting is, however, offset by graft incompatibilities that can occur years later. Cuttings on the other hand are currently only practical for juvenile tissues, although potentially have the advantage of higher multiplication rates and easier low-technology vegetative propagation methods (Leakey *et al.,* 1990). Recent developments in the physiological understanding of rooting (Leakey *et al.,* 1994) and the differentiation between ontogenetic and physiological ageing (Leakey *et al.,* 1992), suggest, however, that with further research, cuttings may become a relatively easy and cost-effective means of propagating fruit trees. It is these developments together with the possibility of rejuvenating mature trees through *in vitro* culture that provide the incentive for further research. In the longer term, tissue culture techniques provide perhaps the best scenario for mass propagation of selected cultivars, although the low-technology systems currently being used are more appropriate for participatory domestication at the village level.

Intellectual property rights and benefit-sharing

All of these initiatives have relevance in the context of intellectual property rights and benefit sharing. Three issues are pertinent. First, 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. Second, the impact that Plant Breeder's Rights (PBRs) might have on communities that use and depend on marula. A third, but related issue, concerns the extent to which domestication and commercialisation of marula might impact upon

communities currently harvesting or using the resource. There are currently no PBRs for *S. birrea* in any country in the world (E. de Bruyn, personal communication, 2001; R. Vellve, personal communication, 2001). However, there are pending applications in South Africa by a local horticulturalist who, through identifying wild trees with superior production, fruit size, and fruit quality, has named a number of cultivars for possible registration (Holtzhausen et al, 1990). These include: Pharulani, originating from Phalaborwa; Marula, originating from a community close to the Kruger gate of the Kruger National Park; Swarula, found by the then South West African Police near Ondangwa (and initially named 'Koevoet' meaning 'crowbar', after the notorious unit which fought against the South West African People's Organisation -SWAPO); Toularula, originating on the farm Toul near Trichardsdal; Mpandlarula; and Chopperula, found at the gate of the helicopter hangar at Skukuza airport. Interestingly, Holtzhausen (1988) believes that the ultimate marula (100g fruit size; 60% juice; 20% TSS; very high Vitamin C content) is still to be found, possibly within the Kruger National Park, which is thought to contain the largest genepool of wild marula variants.

In response to the pending application for PBRs, the Department of Agriculture has recently placed *S. birrea* on the list of species required by UPOV 1978[2]. The Department is currently developing UPOV Guidelines for marula and will use the existing UPOV Pear Guidelines (International Union for the Protection of New Varieties of Plants, 2000) as its template (E. Buitendag, personal communication, 2001).

In terms of UPOV 1978, the rights obtained will prevent anyone from producing, offering for sale and marketing the reproductive material of the variety. UPOV 1991, which is likely to be ratified by South Africa in the near future, will extend these rights to prevent anyone from producing, conditioning for multiplication, offering for sale, marketing, exporting, importing and stocking for any of those purposes the reproductive material. These rights can extend to the direct product of the harvest if that harvest was produced from material that circumvented any of these rights (R. Vellve, personal communication, 2001). Some exemptions exist for the non-commercial use of protected varieties, and UPOV 1978 obliquely creates a "farmers' privilege", through requiring breeders' authorization only for production of propagating material "for purposes of commercial marketing". Although currently upheld in South Africa's Plant Breeders Rights Act, there are intentions to remove this privilege and to allow farmers to harvest seed only of varieties which are not protected by means of intellectual property rights or compulsory certification schemes (National Department of Agriculture, 2000).

These conditions have important implications for communities. While community use of wild and semi-domesticated relatives will not be affected, the granting of PBRs will prevent communities from exchanging or commercialising reproductive material without a license. As there is generally no fixed license fee, the holder of the PBR will likely charge prices that are out of the range of small-scale farmers. Neither version of UPOV provides a basis for benefit-sharing nor is there legislation in South Africa that requires income to be shared with farmers or communities that have participated in the development of improved varieties. Some developing countries are starting to discuss PBR schemes to impose benefit-sharing, and an African Model Law has been developed by the Organisation for African Unity (Ekpere, 2001) although this discussion is still in its infancy in South Africa. Marula thus provides an important opportunity through which locally developed models could be piloted and working mechanisms for the sharing of benefits elucidated.

Regardless of whether or not PBRs are granted, domestication of marula is likely to have broad impacts on communities that traditionally gather or use the tree. Domestication of commercially important fruit trees could induce shifts in benefits from poorer groups of farmers to richer ones, or to multi-national companies if the benefits to poor farmers are not protected, and if industrial demand becomes considerable. This raises important issues about the direction of publicly funded research to support the provision of public goods - including food security, poverty alleviation and environmental benefits (Leakey and Tomich, 1999). The initiatives of ICRAF and others to develop participatory domestication are focused on maintaining these benefits for poor subsistence farmers. Nevertheless, questions arise as to the ultimate beneficiaries of domestication, and the impacts of such strategies on community-based management and conservation of natural resources, as people gathering the wild product may not be those that are best suited to undertake production of the domesticated version. Harmful outputs from domestication and commercialisation could also potentially arise if interest in growing new tree crops expands to the point where outsiders, with capital to invest, come in and develop large-scale monoculture plantations for export markets. In the case of indigenous fruit trees in general, Leakey and Izac (1996) considered these undesirable outcomes not to be very likely, but if the commercial interest in marula continues to grow, it could be an exception. However, if domestication is linked to small-scale agroforestry, the benefits could greatly outweigh the negative impacts (Leakey, 2001a, b), and be seen as a viable strategy for poverty alleviation (Poulton and Poole, 2001).

CONCLUSIONS

The commercial development of marula brings a suite of opportunities for rural development and social upliftment, but also a growing number of challenges, brought about through insufficient capacity within rural areas, lack of recognition and historical neglect of the value of indigenous products to the rural poor, market distortions which negate against the poor, and poor understanding as to the policy incentives required to accord higher priority to the marketing and processing of NTFPs. Marula commercialisation also brings with it a number of threats - for subsistence users, for the resource base, and for traditional cultures and customs. Finding a balance between the costs and benefits of marula commercialisation, and ensuring the delivery of a sustainable and equitable stream of benefits from marula to rural producers is a difficult, albeit achievable task, but is a question this research team hopes to assist in further unravelling.

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FOOTNOTES

[1] Other estimates suggest that no more than 3 hectares of *S. birrea* are planted in Israel (Y. Mizrahi, personal communication, 2001).
[2] South Africa is a signatory to both the 1978 and 1991 UPOV Agreements, but has not yet ratified UPOV 1991. Thus the 1978 Act applies which requires the listing of species for plant variety protection.

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Editors footnote

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