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The role of ethnobotany and indigenous knowledge in conservation of plant genetic resources.

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Abstract

This paper outlines the value of traditional knowledge in directing *ex situ* plant conservation efforts to potentially important Namibian plants. Example are given of species that occur in Namibia that are being developed elsewhere, as well as others that deserve further investigation. The importance of recognising the regional value of both the plant resources and the local indigenous knowledge in the process of identifying species with economic value is stressed, and a means of facilitating an equitable distribution of benefits from these regional resources is outlined.

1.0 Introduction

Although most funding and effort have been directed at *ex situ* conservation of forage and crop plant species or their wild relatives, other indigenous species were included in the framework of the SADCC Regional plant Genetic Resources Centre plan of operation (1989-1992), under the following categories: roots and tubers, fruits and nuts, oil seed crops, medicinal plants, industrial crops or species with potential industrial value and ornamentals (SIDA, 1989). Since then, Namibia has become the tenth member of the SADCC region. This paper outlines the role that ethnobotany and the indigenous knowledge of Namibia's people can play in directing plant genetic resources conservation efforts and attempts to place this in a regional context.

2.0 People and plants: Cultural and biological diversity

The vegetation of Namibia falls within three phytochoria (Figure 1), with species diversity decreasing with rainfall. A total of 3 159 plant species occur in Namibia

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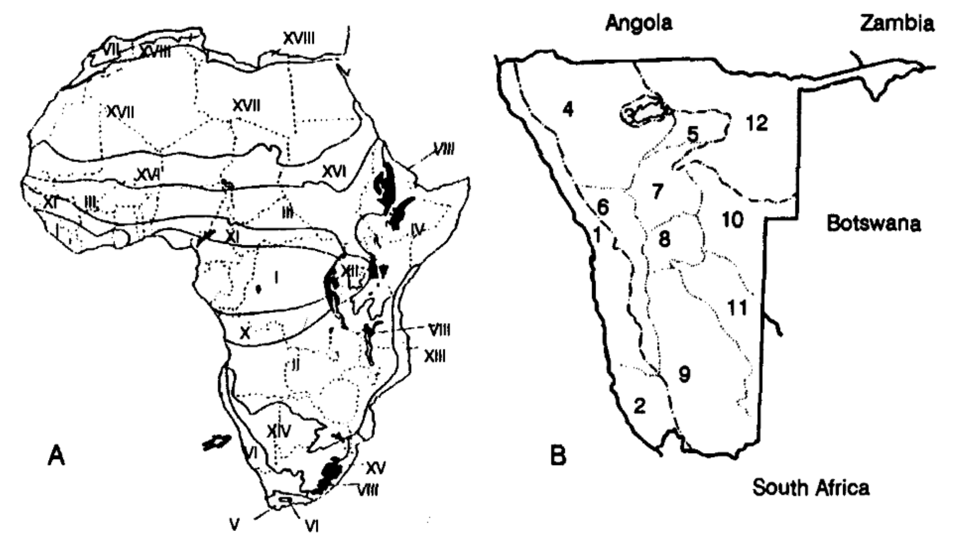

Figure 1: A. The Main Phytochoria of Africa (White, 1983) and **B. Vegetation Zones of Namibia** (*after* Giess, 1971). The phytochria referred to in the text are: II. Zambesian regional centre of endemism. III. Sudanian regional centre of endemism. IV. Somali-Masai regional centre of endemism. VI. Karoo-Namib regional centre of endemism. XIV. Kalahari-Highveld transition zone.
B. Vegetation zones are: **Desert Biome**. 1. *Namib* 2. Desert and succulent steppe. 3. Saline desert with dwarf savanna fringe. **Savanna biome**. 4. Mopane savanna. 5. Mountainous savanna and Karstveld. 6. Escarpment zone. 7. Thornbush savanna (tree *and bush* savanna). 8. Highland savanna. 9. Dwarf shrub savanna. 10. Camelthorn savanna. 11. Mixed tree and shrub savanna. **Woodland Biome**. Northern Kalahari Forest savanna and woodland.

(IUCN, 1990), the highest species diversity occurring *within the* Zambezian regional centre of endemism in the north, followed by the Kalahari-Highveld regional transition zone and the arid Karoo-Namib centre of endemism (White, 1983), with vegetation types ranging from extremely *arid* Namib desert to Zambezian woodland in the north-east (Figure 1). The decline in plant species diversity with decreasing rainfall is exemplified by the reduction in woody edible fruit producing plants from the moist east coast of southern Africa (up to 150 species) to the arid Namibian west coast (10 species) (O'Brien, 1988) (Figure 2). In more densely populated *countries* in the southern Africa region (South Africa, and to a certain extent, Zimbabwe and Swaziland), large urban populations have generated a species-specific trade in favoured plant resources such as bark from *Warburgia salutaris* (Canellaceae) for medicinal purposes (Cunningham, 1990, 1991 a).

In such cases, *ex situ* conservation is necessary as regional over-exploition and possible genetic erosion are taking place. In Namibia, this potential problem has been reduced by a low human population density in much of the country (average 2 persons/km ^{2} (IUCN, 1990)) and a low degree of local or international export trade in indigenous plant products. Exceptions are *the densely* populated Owambo and Ka-

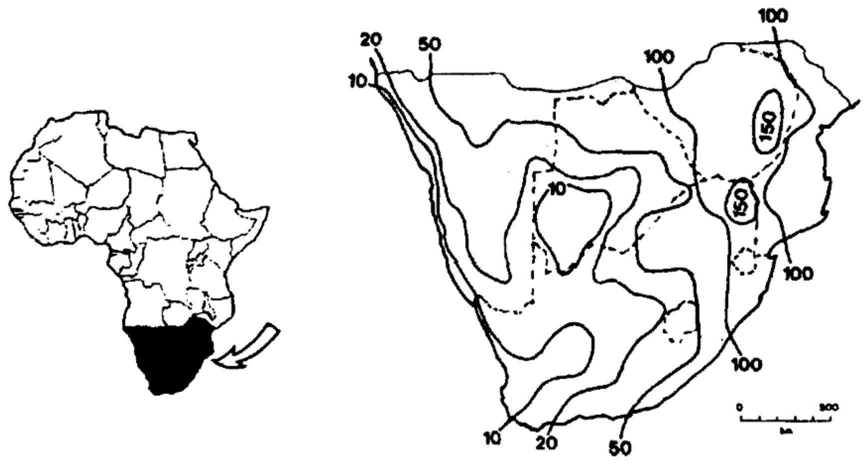

Figure 2. Isometric map of geographic variation in woody edible plant species diversity across southern Africa showing reduction in number of edible species from moist east coast to arid west coast of southern Africa (from O'Brien, 1988).

vango northern communal areas. At a species level, an exception is the local extermination of *Protea gauguedi* (Proteaceae) populations in north-eastern Namibia (with the possible exception of the eastern Caprivi) due to a local trade in the roots for traditional medicinal purposes (as an aphrodisiac) (Hines, C., pers. comm., 1990). Although harvesting of *Harpagophytum procumbens* and *Harpagophytum zeyheri* (Pedaliaceae) is widespread in Namibia (Nott, 1986), with 200 tons of root material exported annually, it was not considerd a threat to *Harpagophytum procumbens* (De Bruine *et al.*, 1977). Far more prevalent in Namibia than direct over-exploitation of a particular species is the change in vegetation structure due to the effects of livestock (low recruitment of palatable species, reduction in perennial grasses) or a high demand for fuelwood or poles leading to altered vegetation structure. This may also apply in *Pterocarpus angolensis* woodlands in north-eastern Namibia due to felling of trees for timber. In most cases, these pose problems for local people, who then spend more time (or money) gaining access to these resources due to local depletion. As a genetic resources conservation issue, however, it is less of a priority, as *Protea gauguedi, Colophospermum mopane, Pterocarpus angolensis* and *Harpagophytum procumbens* are widely distributed in southern Africa. Why, then should Namibia be the focus of effort to collect under-utilized indigenous plants or record indigenous knowledge ?

There are two main reasons for this. *First*, there are a wide variety of lifestyles and land-use practices in Namibia, ranging from San hunter-gatherers, pastoralists to subsistence and commercial farmers. This diversity of lifestyles has given rise to a rich botanical knowledge, particularly in the communal areas of Namibia. This knowledge is rapidly being lost as these lifestyles change, however. In each case, local knowledge specific to a particular lifestyle can be a key to plant species with value in a wider context. !Kung hunter-gatherers have a particularly rich knowledge of tubers and roots with edible or medicinal potential, pastoralists, a detailed knowledge of salt-resistant grasses growing in southern Owambo that are palatable to livestock, or subsistence agriculturalists a knowledge of edible wild greens that commercial agriculturalists consider as weeds.

Second, although plant species diversity is low and the level of endemism is not known, there are 11 plant species endemic to the Brandberg alone (IUCN, 1990) and the number of endemic species may be highest in the Karoo-Namib centre of endemism. This region could also have the most species exhibiting drought and salinity tolerance. The value of these characteristics is internationally recognised by both agriculturalists and pastoralists. Species with these characteristics have potential value in other arid regions, whether in Africa (eg: the climatically similar Sudanian and Somali-Masai phytochoria) as well as the Middle East and Australia. Even if indigenous species with economic potential are widely distributed, Namibian genotypes may have characteristics which are desirable for development of crops for marginal sites, and should be short-listed for a selection programme for provenance collections.

3.0 The role of indigenous knowledge

Many formally trained professionals in the southern African region would take the view that there the number of botanists in the SADCC region is severely limited. One could also argue that we are also not making sufficient use or recognition of the tens of thousands of rural people, many of them women, who in their local context and despite their lack of formal training, are exceptionally skilled botanists.

3.11 Toxic or edible ?

The use of underground parts (bulbs, corms, tubers) of plants in Namibia is a good example, reflecting a high degree of practical knowledge of plant chemistry, with knowledge of edible or medicinal species and of detoxification procedures. The genera *Boophane* (Amaryllidaceae), *Urginea* and *Ornithogalum* (Liliaceae) and may asclepiadaceae, for example, contain either glycosides or alkaloids, are highly toxic, and are selected for medicinal use. Tubers of *Ceropegia pygmaea, Ceropegia nilotica* (Asclepiadaceae) however, are known to be edible and are collected for food in Namibia (Giess, 1966; Rodin, 1985). Even more detailed knowledge is held by local specialists such as traditional medical practitioners and can be a useful guide not only to medicinal plants (Malan & Owen-Smith, 1974), but also to over-exploited species (Cunningham, 1991 a).

3.12 Intra-specific variation

Indigenous knowledge of variation within a single useful plant species, either in terms of fruit yield, fruiting times or fruit quality can be an important and cost effective guide to collection of plant genetic material and selection for desirable characters in development of cultivars. Israeli horticulturalists collecting *Sclerocarya birrea* fruits in

Botswana, for example, recognised the value of local peoples knowledge of trees with aromatic or sweet-sour tasting fruits, using it as a guide to choose fruits for a "fruit domestication" programme in Israel (Cherfas, 1989). KwaNyama-speaking farmers in Namibia distinguish and can name 6 different varieties of *Citrullus lanatus* (Cucurbitaceae), based on qualities of fruit size, taste, skin colour, seed colour or whether or not the seed margins are ridged (Rodin, 1985). It is highly likely that an equally detailed knowledge would be held by gatherers of *Cucumis* and *Citrullus* species in other parts of Namibia. Both genera have been identified as SADCC priorities for Botswana (SIDA, 1989) and the same should apply to Namibia, with more extensive use and approriate recognition given to traditional knowledge (see Section 5.0) as a guide to collecting a broad range of genotypes of these genera.

4.0 Species already being investigated

With limited funds and qualified personnel in the region, it is essential that duplication of effort does not take place, and that there is wide recognition that extensive work has been done on some species, whilst further work is required on other edible plants with potential. It is essential that more consideration is given to co-ordination of activities like the development of new drugs from plants or of new crop plants. Extensive medicinal plant data bases such as PHARMEL run by the Agencie de Cooperation Culturelle et Technique (ACCT) in Paris, which has published information from surveys in semi-arid areas comparable to Namibia (Mali, Niger) (Adjanohoun *et al.*, 1980, 1985) and NAPRALERT at the University of Illinois (Chicago) could provide data to researchers in developing countries that facilitates coordination and a knowledge of what species have already been investigated. At a SADCC regional level, the same can apply to development of edible wild fruit species as new crop plants, not only to avoid duplication of effort, but because species such as *Eugenia albanensis* (Myrtaceae) and *Landolphia petersiana* (Apocynaceae) from the Mozambique coastal plain may have potential in the Caprivi region of Namibia or in Zambia, for example. Work is reportedly being done on development of *Parinari curatellifolia* (Chrysobalanaceae) and *Uapaca* (Euphorbiaceae) fruit species in Zamibia (this needs to be confirmed), and on *Strychnos spinosa* (Loganiaceae) in Israel, as well as on the following species from the region:

4.11 Oil-rich Seeds:

Marama bean (*Tylosema esculenta*), which has been internationally recognised as a crop plant with potential due to its protein and oil-rich seeds (NAS, 1979) has been cultivated on an experimental basis in Texas, USA (Bousquet, 1982).

OTHERS : Oil-rich seed sources occurring in Namibia that may be of interest are *Ochna pulchra* (Ochnaceae), *Sclerocarya birrea* (Anacardiaceae) (see below), *Ricinus communis* (Euphorbiaceae) (accessions already in Zambian collection (SIDA, 1989), *Ximenia americana* and *Ximenia caffra* (Olacaceae) for fruits and possibly seed oil.

Seeds of *Acanthosicyos horridus* (Cucurbitaceae) collected from the wild along the Kuiseb River are commercially sold for export (Dentlinger, 1977) and the fruit also deserves consideration for a selection and breeding programme (see Section 4.13).

4.12 Edible bulbs :

Wilde raap, *Cyanella hyacinthoides* (Tecophilaeaceae), a member of a genus restricted to southern Namibia and arid parts of the Cape province, South Africa, produces bulbs that are a favoured food source of Nama speaking people which can be eaten raw or cooked, and is relatively high in vitamin C (11.2mg/100g) (Archer, 1988). Preliminary investigations have shown that seeds remain viable for at least 2 years without specialized storage and that the species is suited to cultivation in high density plots of up to 50 plants/m^2 (Scott, 1989).

OTHERS: Tubers of *Ceropegia pygmaea, Ceropegia nilotica* (Asclepiadaceae) and bulbs of *Walleria nutans* (Tecophilaeaceae) and possibly a range of other species (eg: *Talinum arnottii* (Portulacaceae)) may have potential as new crops for arid or sandy areas with marginal agricultural potential, and need further investigation.

4.13 Edible fruits:

Marula (*Sclerocarya birrea*) (Anacardiaceae) is one of the best known edible fruit-bearing indigenous trees in Central, Eastern and southern Africa. Widespread in frost-free areas, it is the basis for a growing industry involving the selection and propagation of trees for commercial orchards in South Africa and Israel (Goosen, 1985; Cherfas, 1989). Products such as marula jelly, liqueurs and juice from the fruits (Gous *et al.*, 1988) and extraction of the slow-oxidizing oil from the kernels for coating dried fruits (Burger *et al.*, 1987; Du Plessis, 1988) have already been developed from fruits collected from the wild, including a cultivar developed from Namibian stock which has been registered in South Africa. The tree provides a source of nutrients such as protein, vitamin C and riboflavin (from *Gonimbrasia belina* (Saturniidae) larvae that are deficient in the starchy staple diet (Quin, 1959; Cunningham, 1985; 1985). The oil (45.9 %) and protein (27.6%) rich kernels are a particularly important resource to old people unable to cultivate large fields, and although lysine poor, are a useful source of tryptophan (Ferrao, 1960; Burger *et al.*, 1987).

The Mongongo nut (*Ricinodendron rautanenii* (Euphorbiaceae)) tree is an edible fruit-bearing indigenous tree which is common in north-eastern Namibia, southern Angola and Zambia. Widespread in frost-free areas, it one of the species selected for selection and propagation in Zambia and in arid regions such as Israel (Peters, 1987; Cherfas, 1989). In communal areas, *Ricinodendron rautanenii* is a multi-purpose resource for food, fuel and medicine to hunter-gatherers and smallholder farmers in marginal areas. The kernels provide an important year round source of protein to rural people. Like *Sclerocarya birrea*, the vegetable fat (45-58 %) and high quality protein (26-29 %) rich kernels are a particularly important resource to impoverished rural people (Peters, 1987).

OTHERS: In addition to the species mentioned in Section 4.0 above, *Ximenia caffra* and *Ximenia americana* (Olacaeae), *Strychnos pungens, Strychnos cocculoides* (Loganiaceae) and *Garcinia livingstonei* (Clusiaceae) deserve further investigation. The last mentioned species is being investigated at the University of Natal, South Africa. Attention is already being paid to various Curcurbitaceae in the region, and both *Acanthosicyos horridus* and *Acanthosicyos naudinianus* are of interest. A breeding programme for *Acanthosicyos naudinianus* has been proposed in Zimbabwe, and deserves financial support.

4.15 Multi-purpose agroforestry species.

There is international interest in *Faidherbia albida* (Fabaceae) as a source of fuel and forage (NAS, 1979), with recent work being carried out in Namibia by the Oxford Forestry Research Institute (R. Barnes, pers. comm.). The endemic *Acacia montis-usti* and near endemic *Acacia robynsiana* (Fabaceae) also deserve attention for extremely arid areas, and *Colophospermum mopane* (Fabaceae) and *Terminalia sericea* (Combretaceae) as termite-resistant multi-purpose trees.

4.16 Aromatic plants.

Arid regions such as Namibia are rich in aromatic species, and again this deserves further investigation as potential new crops for extraction of essential oils for the perfume industry. Local indigenous knowledge can again be a guide to these species, as there is an historical trade in aromatic species for perfume in Namibia. Sources include scented gums from *Commiphora virgata* and *Commiphora multijuga* (Burseraceae) (Jacobsen, 1990). Herbaceous species may have potential for cultivation, although most experimental work has been done in the eastern Cape, South Africa with *Artemisia afra* (Piprek *et al.*, 1982).

4.17 Edible wild greens.

A wide range of edible wild greens are eaten in Namibia, often providing a useful source of nicotinic acid, a nutrient deficient in the starchy staple diet in many communal areas. Examples are: *Celosia argenteiformis* (Amaranthaceae), *Cucumis anguria* (Cucurbitaceae) and *Cleome gynandra* (Capparaceae), all of which can be dried into *omavanda* "cakes" and stored for use during the dry season. The SADCC Gene Bank already has accessions of *Amaranthus*, which is used as a pot-herb elsewhere in the region (SIDA, 1979). A suggestion for the future may be to select for nicotinic acid rich cultivars with a low level of oxalic acid (which binds onto calcium, also deficient in the diet of many poor people) for cultivation.

In all cases, before cultivars are to be released for cultivation in areas where wild populations occur, a policy decision must be taken on the effects this will have on wild genotypes through cross-pollination (eg: the cultivation of *Sclerocarya birrea* cultivars).

5.0 Ethics and Ethnobotany

The issue of rights to chemical or genetic resources from indigenous plants in developing countries is an emotive and controversial issue, but is one that is unavoidable. I have no doubt that unless this issue is resolved, biodiversity conservation will be the major loser - and resolving the issue as soon as possible is essential due to the conservation and social implications of this dilemma which may not be apparent from a pharmacological viewpoint.

The more complex a vegetation type is in terms of species (or life-form) diversity (and this usually means those with the highest conservation value), the more complex, expensive and labour intensive it becomes to manage sustainable use. The same can apply in slow-growing vegetation such as the Richtersveld. In most cases, conservation bodies in developing countries do not have the financial or human resources to carry this out. Thus in cases where demand is high, "mining" rather than "managing" resources occurs, and the narrow margin between sustainable use and over-exploitation is crossed (eg: the case of *Prunus africana* in Cameroon). This negates the rationale behind "sustainable use" as a means of justifying conservation as a form of land-use, as the primary reason for maintenance of core conservation areas, as you know, is for long term maintenance of habitat and species diversity. The results of this are seen in Africa, Asia and South America, particularly for commercially valuable products (whether timber, rattan, medicinal plants, craftwork resources or whatever). Developing countries are rich in resources that do have a great value globally, and can be harvested with low impact, however: genes, chemical compounds and knowledge. The problem is that these resources are considered a "global commons" at present, rather than a regional resource (Cunningham, 1991 b).

This attitude, often unknowingly fostered by trained people from temperate zone countries, thus "devalues" the resource which best could justify maintenance of species rich vegetation if financial value were placed on those resources. In the past, the sovereignty of renewable (eg: timber, rattan, latex etc.) and non-renewable (eg: bauxite and other minerals) tropical zone resources has been recognised, (although prices paid for renewable resources may have borne no resemblance to replacement costs). The same does not apply at present to genes (with a few exceptions), chemical components of plants and the knowledge that enables them to be collected and identified. With the rapid expansion in biotechnological expertise and genetic engineering, there is now no doubt that these are a resource. The same applies to plants with horticultural potential (eg: the US$ 30 million/yr from the sale of African violets (*Saintpaulia*) which come from Tanzanian forest (Lovett, 1988), with none of this money directed back to conserving the forest itself, however). What is needed is a mechanism to link the recognition of the origin and value of these resources with the financial requirements for *in situ* habitat conservation in developing countries, so that they are seen as a regional resource rather than global common property. A result of the current situation is that:

1. either collecting takes place in an uncontrolled manner, and sample material is taken back to (usually) Europe, Japan or North America for analysis, with patenting and drug development taking place sometimes without even the knowledge of people in the country/region of origin that this has taken place, and with no recompense for use of regional natural resources.

2. or local professionals (eg: botanists, foresters) are paid individually to collect sample material for an industrial company, without full knowledge of the implications that this has and with payment bearing little relation to the potential value of the resource. As many of the developing countries pay these staff relatively low salaries and "hard currency" is hard to get, it is quite understandable that this takes place, but nevertheless has important implications for regional development and conservation.

3. or raw materials (bark, seeds, roots etc) are subsequently (post screening, and prior to clinical trials or during extraction of active ingredients) bought from local rural people who commercially gather the plants from the wild. Gathering is often uncontrolled and destructive harvesting takes place. This raw material is either exported (eg: *Voacanga* seed from Indonesia to Switzerland, *Prunus* bark from Cameroon to France) or initial extraction of active ingredients is done locally, with the concentrate then exported. This generates some local income and employment, but with:

(a) frequently the destructive harvesting of wild populations of the species involved

(b) little or no attempt to develop or cultivate alternative supplies, with the resultant possibility that a regional national resource is depleted and the local source of income (and in some cases traditional medicines) is lost.

Development of pharmaceuticals is a very expensive and time-consuming process, taking anything up to 10 - 15 years, but sales can also be very lucrative. Lack of institutional and professional infrastructure in many developing countries thus places them in a position whereby they supply the raw materials and often the traditional knowledge but are not in a position to develop pharmaceutical and other industrial products for lucrative export markets. Some countries (eg: India, Brazil) have developed some local expertise in this regard. They then face the problem of patents held by multi-national pharmaceutical companies.

4. A consequence of the above is that in cases where legal contracts are entered for new drug development, they are done so from a "top-down" approach.

5.1 Recommendations towards a strategy for equitable partnerships

This issue has important implications not only for national or regional development policies in developing countries, but also for conservation of biological diversity. There is no doubt that "ethical" companies and key professionals (eg: botanists at reputable botanical gardens and herbaria) and at universities (eg: natural products chemists) have a key role to play as "honest brokers". This can be achieved through:

(i) collection and coding (rather than identification of species to the chemists involved) of potentially important material prior to screening. This could be even taken a step further through initial screening by university based chemists, with legal contracts entered into from a position of strength once important products are identified. This also ensures that an unethical company is not going to over-exploit the species concerned to get material for either clinical trials or processing, and facilitates an agreement for cultivation (which ensures a more sustainable source of income and employment, rather than a "boom and bust" approach where wild stocks are over-exploited).

(ii) confidentiality of test results by all parties until a patent application has been filed on any potentially valuable active ingredients.

(iii) as part of the contract, the involvement by the company or universities involved in training local Namibian staff (eg: senior technicians, scientists or post-graduate students) from the country/region of origin of the plant in the development of local expertise for natural product identification and development, reducing dependency on temperate zone/urban- industrial countries.

(iv) if a new product is developed, patent or legal contract rights should ensure adequate and mutually acceptable return of benefits (or access to cultivars, as in the case of *Sclerocarya birrea*) to the region of origin, preferably to institutions (eg: universities, herbaria, botanical gardens, traditional healers associations or funds for conservation projects/education bursaries or legal resources.

(v) the contract should also specify that if enough sustainably harvested material is not available from wild populations (in some cases, such as with "weedy" species it would be), then cultivation and development (eg: selection of high active ingredient yielding, fast growing genotypes) needs to be developed as an alternative to the over exploitation of wild stocks. In most cases, this should take place as a matter of course if endemic or near-endemic species are involved.

Finally, it is very important to ensure that unrealistic expectations do not develop amongst participants in developing countries regarding benefits from potentially important industrial products, as only a small percentage are finally developed and marketed; development costs are high; and patent rights are generally short-lived. The goal is one of equitable partnerships, and it is sincerely hoped that this can be developed.

If nothing is done, then an already politicized conservation issue will get worse and we will all lose out. The case of Ethiopia is a good example. There are severe restrictions on the collection of plant genetic material, yet Ethiopia is a centre of coffee diversity. The rationale is understandable, as this should be recognised as a regional resource of great value to Ethiopia as well as to world agriculture. What also needs to be recognised, however, is that the prolonged war and economic decline mean that forest habitats cannot effectively be conserved. The result is a double tragedy - neither *in situ, nor ex situ* conservation takes place, and in a worst-case scenario (but not an unlikely one ?) a valuable resource is lost. A similar situation applies to recording of traditional knowledge that is often a key to wild plants with potential value in a global sense - particularly in the case of specialist knowledge of traditional healers made public through scientific journals without any benefits going to the people or region from whom the knowledge originated. If ethnobiologists are blocked from gathering this knowledge, this would be tragic, as knowledge is rapidly disappearing with cultural change.

What is essential is that equitable partnership arrangements are widely developed for "capturing" and effectively dispersing benefits from these resources, rather than considering them a global commons. It is complex issue both in terms of capture and distibution of benefits, but I believe that it can be done. A major deficiency is that there has not been sufficient realization amongst ethnobotanists of these issues, and no code of practice to facilitate development of legal contract agreement, but there already are working examples of legal contracts (eg: the American National Cancer Institute contract) that could possibly be modified to suit local circumstances.

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