CHAPTER 6

A COMPARISON OF CULTIVATION AND WILD COLLECTION OF MEDICINAL AND AROMATIC PLANTS UNDER SUSTAINABILITY ASPECTS

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Abstract. With the increased realization that many wild medicinal and aromatic plant (MAP) species are being over-exploited, a number of agencies are recommending that wild species be brought into cultivation systems. Others argue sustainable harvest to be the most important conservation strategy for most wild-harvested species, given their contributions to local economies and their greater value to harvesters over the long term.

Besides poverty and the breakdown of traditional controls, the major challenges for sustainable wild-collection include: lack of knowledge about sustainable harvest rates and practices, undefined land use rights and lack of legislative and policy guidance.

Identifying the conservation benefits and costs of the different production systems for MAP should help guide policies as to whether species conservation should take place in nature or the nursery, or both.
Keywords: domestication; plant breeding; livelihoods; health care; plant trade; poverty alleviation; income generation

INTRODUCTION

Since time immemorial, people have gathered plant and animal resources for their needs. Examples include edible nuts, mushrooms, fruits, herbs, spices, gums, game, fodder, fibres used for construction of shelter and housing, clothing or utensils, and plant or animal products for medicinal, cosmetic or cultural uses. Even today, hundreds of millions of people, mostly in developing countries, derive a significant part of their subsistence needs and income from gathered plant and animal products (Iqbal 1993; Walter 2001). Gathering of high-value products such as mushrooms (morels, matsutake, truffles), medicinal plants (ginseng, black cohosh, goldenseal)

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also continues in developed countries for cultural and economic reasons (Jones et al. 2002).

Among these uses, medicinal plants play a central role, not only as traditional medicines used in many cultures but also as trade commodities that meet the demand of often distant markets. For the purpose of this paper the term 'medicinal and aromatic plants' (MAP) is defined to cover the whole range of plants used not only medicinally *sensu stricto* but also in the neighbouring and often overlapping fields of condiments, food and cosmetics.

Demand for a wide variety of wild species is increasing with growth in human needs, numbers and commercial trade. With the increased realization that some wild species are being over-exploited, a number of agencies are recommending that wild species be brought into cultivation systems (BAH 2004; Lambert et al. 1997; WHO 1993). Cultivation can also have conservation impacts, however, and these need to be better understood. Medicinal plant production through cultivation, for example, can reduce the extent to which wild populations are harvested, but it also may lead to environmental degradation and loss of genetic diversity as well as loss of incentives to conserve wild populations (*Assessing the impacts of commercial captive breeding and artificial propagation on wild species conservation, IUCN/SSC Workshop, 7-9.12.2001, Jacksonville. Draft workshop report* 2002).

The relationship between *in situ* and *ex situ* conservation of species is an interesting topic with implications for local communities, public and private land owners and managers, entire industries and, of course, wild species. Identifying the conservation benefits and costs of the different production systems for MAP should help guide policies as to whether species conservation should take place in nature or the nursery, or both (Bodeker et al. 1997; Schippmann et al. 2002; Schippmann et al. 2005).

CONCEPT OF SUSTAINABILITY

As a baseline element of the ecosystem approach it has to be recognized that humans, with their cultural diversity, are an integral component of ecosystems. In conceptual terms, the essence of sustainable development is expressed by the long-term relationship between people and the ecosystem around it. This implies that ultimately one is entirely dependent upon the other. Human and ecosystem well-being need to be assessed together. When both the human condition and the condition of the ecosystem are satisfactory or improving, then a society is considered to be sustainable. The system improves only when both the condition of the ecosystem and the human condition improve (Prescott-Allen and Prescott-Allen 1996).

Sustainability is more commonly viewed from an ecological perspective in terms of plant or animal populations. A sustainable system for harvesting MAP is one where fruits, seeds or other plant parts can be harvested indefinitely from a set area without detrimental impact on the structure and dynamics on the harvested plant populations (Peters 1994; Cunningham 2001). What is needed, however, is a sustainable harvest approach which takes four interlinked scales into account at the:

(1) landscape level; (2) community and ecosystem level; (3) plant population level; and (4) genetic level (Noss 1990). Disturbance processes can directly affect sustainable harvesting through their influence on plant populations. Positive links between plant diversity and disturbance factors exist for medicinal plants. One example is *Arnica montana* in traditional meadows in Europe, where annual mowing and seasonal grazing by livestock without artificial fertilizer inputs enable diverse and often rare species populations to thrive (Ellenberger 1999; Myklestad and Saetersdal 2004).

SOME FIGURES TO START WITH…

How many MAP are used worldwide?

The number of plant species that have been used at one time or another, and even the number in current use in some culture for medicinal purposes, can only be

Table 1. *How many plants are used medicinally worldwide?*

Country	Plant species	Medicinal plant species	%
Bulgaria	3,567	750	21.0
China	32,200	4,941	15.3
France	4,630	900	19.4
Hungary	2,214	270	12.2
India	18,664	3,000	16.1
Jordan	2,100	363	17.3
Korea, Rep. of	2,898	1,000	34.5
Malaysia	15,500	1,200	7.7
Nepal	6,973	900	12.9
Pakistan	4,950	1,500	30.3
Philippines	8,931	850	9.5
Sri Lanka	3,314	550	16.6
Thailand	11,625	1,800	15.5
USA	21,641	2,564	11.8
Vietnam	10,500	1,800	17.1
Average			17.1
World	**422,000**	**72,000**	

Sources: WHO (1998); Duke and Ayensu (1985); Govaerts (2001); Groombridge (1994); Groombridge and Jenkins (2002); Hardalova et al. (1998); Jain and DeFillipps (1991); Lange (1998); Manandhar and Manandhar (2002); Moerman (1996); Oran and Ali-Eisawi (1998); De Padua et al. (1999)**;** Zahoor Ahmad (1997).

estimated. An enumeration of the WHO from the late 1970s listed 21,000 medicinal species (Penso 1980). However, in China alone 4,941 of 32,200 indigenous plant species are used as drugs in Chinese traditional medicine (Groombridge 1994), an astonishing 15.3 percent. If this proportion is calculated for other well-known medicinal floras and then applied to the global total of 422,000 flowering plant species (Bramwell 2002; Govaerts 2001), it can be estimated that the number of plant species used for medicinal purposes is more than 70,000 (Table 1).

How many MAP species are traded?

It is difficult to assess how many MAP are commercially traded, either on a national or even an international level. The bulk of the plant material is exported from developing countries while major markets are in the developed countries. An analysis of UNCTAD trade figures for 1981–1998 reflects this almost universal feature of MAP trade (Table 2). Adding the volumes for the five European countries in this list (94,300 tonnes) marks the dominance of Europe as an import region. Germany ranks fourth and third as importer and exporter, expressing the country's major role as a turntable for medicinal plant raw materials worldwide.

Table 2. *The 12 leading countries of import and export of medicinal and aromatic plant material, 1991–1998 (Lange 2002)*

Country of import	**Volume [tonnes]**	**Value [1000 US$]**	**Country of export**	**Volume [tonnes]**	**Value [1000 US$]**
Hong Kong	73,650	314,000	China	139,750	298,650
Japan	56,750	146,650	India	36,750	57,400
USA	56,000	133,350	Germany	15,050	72,400
Germany	45,850	113,900	USA	11,950	114,450
Rep. Korea	31,400	52,550	Chile	11,850	29,100
France	20,800	50,400	Egypt	11,350	13,700
China	12,400	41,750	Singapore	11,250	59,850
Italy	11,450	42,250	Mexico	10,600	10 050
Pakistan	11,350	11,850	Bulgaria	10,150	14,850
Spain	8,600	27,450	Pakistan	8,100	5,300
UK	7,600	25,550	Albania	7,350	14,050
Singapore	6,550	55,500	Morocco	7,250	13,200
Total	**342,550**	**1,015,200**	**Total**	**281,550**	**643,200**

Figures based on commodity group *pharmaceutical plants* (SITC.3: 292.4 = HS 1211). Source: UNCTAD COMTRADE database, United Nations Statistics Division, New York.

Iqbal (1993) estimates that about "4000 to 6000 botanicals are of commercial importance", another source refers to 5,000 to 6,000 "botanicals entering the world market" (SCBD 2001). A thorough investigation of the German medicinal plant trade identified a total of 1,543 MAP being traded or offered on the German market (Lange and Schippmann 1997). An extension of this survey to Europe as a whole arrived at 2,000 species in trade for medicinal purposes (Lange 1998). Recognizing the role of Europe as a sink for MAP traded from all regions of the world, it is a qualified guess that the total number of MAP in international trade will be around 3,000 species worldwide.

How many MAP are threatened worldwide?

To satisfy the regional and international markets, the plant sources for expanding local, regional and international markets are harvested in increasing volumes and largely from wild populations (Kuipers 1997; Lange 1998). Supplies of wild plants in general are increasingly limited by deforestation from logging and conversion to plantations, pasture and agriculture (Ahmad 1998; Cunningham 1993).

In many cases, the impact through direct off-take goes hand-in-hand with decline owing to changes in land use. Species favoured by extensive agricultural management like *Arnica montana* in central Europe go into decline with changes in farming practices towards higher nutrient input on the meadows. This requires habitat management as the key factor in managing species populations (Ellenberger 1999).

One of the goals of the IUCN Medicinal Plant Specialist Group is to identify the species that have become threatened by non-sustainable harvest and other factors. The enormity of this task is illustrated by the following estimate: According to Walter and Gillett (1998), 34,000 species out of 49,000 species assessed were found to be globally threatened with extinction. A more recent assessment by Bramwell (2003) estimates that 21% of the world's flora is threatened. If the latter figure is applied to our earlier extrapolation that 72,000 plant species are used medicinally, it leads us to estimate that about 15,000 MAP species are threatened at least to some degree (Table 3).

Table 3. *How many medicinal plant species are threatened?*

Number of flowering plant species worldwide (Govaerts 2001):	422,000 plant species
17.1% of them are used medicinally (see Table 1):	72,000 plant species
21% are threatened (Bramwell 2003):	15,000 medicinal species

How many MAP are under cultivation?

Many medicinal plants, especially the aromatic herbs, are grown in home gardens, some are cultivated as field crops, either in sole cropping or in intercropping systems and rarely as plantation crops (De Padua et al. 1999).

In a survey carried out for the Rainforest Alliance, companies involved in trade and production of herbal remedies and other botanical products were asked what percentage of their material is from cultivated sources and what percentage from the wild. On average, companies reported that 60–90% of material was cultivated, with the remaining wild-harvested. However, when asked about species numbers rather than volume of material, the figures are generally inverted (Laird and Pierce 2002). Lange and Schippmann (1997) state that of the 1,543 species traded in Germany, only 50–100 species (3–6%) are exclusively sourced from cultivation.

Of more than 400 plants species used for production of medicine by the Indian herbal industry, fewer than 20 species are currently under cultivation in different parts of the country (Uniyal et al. 2000). In China, about 5,000 medicinal plants have been identified and about 1,000 are more commonly used, but only 100–250 species are cultivated (Xiao 1991; He and Ning 1997). In Hungary, a country with a long tradition of MAP cultivation, only 40 species are cultivated for commercial production (Bernáth 1999; Palevitch 1991). In Europe as a whole, only 130–140 MAP species are cultivated (Pank 1998; Verlet and Leclercq 1999).

Based on these figures, we assume that the number of MAP species currently in formal cultivation for commercial production does not exceed a few hundred worldwide – less than 1% of the total number of medicinal plants used. On the other hand, however, we recognize that many more MAP species are cultivated on a small scale in home gardens, either as home remedies or by herbalists. Cultivation by local people can take also place as enrichment planting. A global survey on the extent of MAP commercial cultivation in terms of species, volumes and values is currently being carried out by TRAFFIC International.

WILD OR CULTIVATED: WHAT DOES THE MARKET WANT?

Given the demand for a continuous and uniform supply of medicinal plants and the accelerating depletion of forest resources, increasing the number of medicinal plant species in cultivation would appear to be an important strategy for meeting a growing demand (Uniyal et al. 2000).

But why are so few species cultivated? Why are some species cultivated and so many others not?

One explanation may be found in the observation that cultivated plants are sometimes considered qualitatively inferior when compared with wild-gathered specimens. For instance, wild ginseng roots are 5–10 times more valuable than roots produced by artificial propagation (Robbins 1998). The reason is primarily cultural, as the Chinese community, which is the largest consumer group of wild ginseng, believes that the similarity in appearance of gnarled wild roots to the human body symbolizes the vitality and potency of the root. Cultivated roots lack the characteristic shape of wild roots and are therefore not as highly coveted by

consumers (Robbins 1998). In Botswana, traditional medicinal practitioners said that cultivated material was unacceptable, as cultivated plants did not have the power of material collected from the wild (Cunningham 1994).

Scientific studies partly support this. Medicinal properties in plants are mainly due to the presence of secondary metabolites which the plants need in their natural environments under particular conditions of stress and competition and which perhaps would not be expressed under monoculture conditions. Active-ingredient levels can be much lower in fast-growing cultivated stocks, whereas wild populations can be older due to slow growth rates and can have higher levels of active ingredients. While it can be presumed that cultivated plants are likely to be somewhat different in their properties from those gathered from their natural habitats it is also clear that certain values in plants can be deliberately enhanced under controlled conditions of cultivation (Palevitch 1991; Uniyal et al. 2000).

In general, in all countries, the trend is towards a greater proportion of cultivated material. The majority of companies, the mass-market, over-the-counter pharmaceutical companies as well as the larger herb companies, prefer cultivated material, particularly since cultivated material can be certified 'biodynamic' or 'organic' (Laird and Pierce 2002).

From the perspective of the market, domestication and cultivation provide a number of advantages over wild-harvest for production of plant-based medicines: (i) While wild-collection often offers material adulterated with unwanted, sometimes harmful other plant species, cultivation provides reliable botanical identification. (ii) Wild-harvest volumes are dependent on many factors that cannot be controlled, and irregularity of supply is a common feature. Cultivation guarantees a steady source of raw material. (iii) Wholesalers and pharmaceutical companies can agree on volumes and prices over time with the grower. (iv) The selection and development of genotypes with commercially desirable traits from the wild or managed populations may offer opportunities for the economic development of the medicinal plant species as a crop. (v) Cultivation allows controlled post-harvest handling and, therefore, (vi) quality controls can be assured, and (vii) product standards can be adjusted to regulations and consumer preferences. (viii) Cultivated material can be easily certified 'organic' or 'biodynamic' although certifiers and other agencies are also presently developing wildcrafting standards (Honnef et al. 2005; Leaman 2004; Pierce et al. 2002).

However, domestication of the resource through farming is not always technically possible. Many species are difficult to cultivate because of certain biological features or ecological requirements (such as slow growth rate, special soil requirements, interactions with pollinators and other species, low germination rates, susceptibility to pests). Lack of secure, long-term tenure over high-value, long-lived species is also often a concern amongst farmers. These social and biological factors in turn affect the economic viability of medicinal-plant cultivation.

Economical feasibility is the main rationale for a decision to bring a species in cultivation but it is also a substantial limitation as long as sufficient volumes of material can still be obtained at a lower price from wild-harvest. Cultivated material will be competing with material harvested from the wild that is supplied onto the market by commercial gatherers who have incurred no input costs for cultivation.

Low prices, whether for local use or for the international pharmaceutical trade, ensure that few species can be marketed at a high enough price to make cultivation profitable (Cunningham 1994). Domestication of a previously wild-collected species does not only require substantial investment of capital (up to 200,000 US$; Plescher *in litt.*) but also requires several years of investigations (e.g. 12 years for *Alchemilla alpina*; Schneider et al. 1999).

WILD OR CULTIVATED: WHAT DO PEOPLE NEED?

Health-care needs

There is a worldwide trend of increasing demand for many popular, effective species in Europe, North America and Asia, growing between 8 and 15% per year (Grünwald and Büttel 1996). Rapid urbanization and the importance of herbal medicines in African health-care systems stimulated a growing national and regional trade in Africa (Cunningham 1993). A similar situation exists in Latin America, where large volumes of medicinal plants are sold in urban markets (Shanley and Luz 2003). Demand for medicinal plants also reflects distinct cultural preferences. In the USA, for example, only 3% of people surveyed had used herbal medicine in the past year (Eisenberg et al. 1993), whereas in Germany, with a strong tradition of medicinal plant use, 31% of the over-the-counter products in pharmacies in 2001 were phytopharmaceutical preparations (BAH 2004).

The level of herbal medicine use in most developing countries is much higher than this. While most traditional medicinal plants are gathered from the wild, these are not static health-care systems, and introduced species are commonly adopted into the repertoire of plants used by African or South-American herbalists. In many cases, herbal medicines can also be cheaper than western medicines, particularly where access to traditional healers is easier. Demand for traditional medicine continues in the urban environment even if western biomedicine is available (*Assessing the impacts of commercial captive breeding and artificial propagation on wild species conservation, IUCN/SSC Workshop, 7-9.12.2001, Jacksonville. Draft workshop report* 2002; Mander et al. 1996).

Income generation

Wild-harvesting of medicinal plants is a chance for the poorest to make at least some cash income. Especially those people who do not have access to farm land at all depend on gathering MAP to earn at least some money. However, local people generally get a low price for unprocessed plant material. Although income from *Prunus africana* bark sales is an important source of revenue to villagers in Madagascar, in some cases generating >30% of village revenue, the price paid to collectors is negligible compared to Madagascan middlemen (Walter and Rakotonirina 1995). In Mexico, Hersch-Martinez (1995) found that medicinal-plant collectors only received an average 6.17% of the medicinal-plant consumer price.

Whether fruits, roots, bark or whole plants are involved, the potential yield from wild stocks of many species is frequently over-estimated, particularly if the effects of stochastic events is taken into account (Nantel et al. 1996). As a result, commercial harvesting ventures based on wild populations can be characterized by a 'boom and bust' situation where initial harvests are followed by declining resource availability.

Small-scale cultivation and home gardens

Small-scale cultivation, which requires low economic inputs, can be a response to declining local stocks, generating income and supplying regional markets. This can be a more secure income than from wild-harvest, which is notoriously inconsistent. For farmers that integrate MAP into agroforestry or small-scale farming systems, these species can provide a diversified and additional source of income to the family. Home gardens are increasingly a focus of medicinal-plant propagation and introduction programmes intended to encourage the use of traditional remedies for common ailments by making the plant sources more accessible (Agelet et al. 2000).

Large-scale cultivation

As outlined by Leakey and Izac (1996), large-scale cultivation has a number of socio-economic impacts on rural people: "Commercialization is both necessary and potentially harmful to farmers. It is necessary in that without it the market for products is small and the opportunity does not exist for rural people to generate income. A degree of product domestication is therefore desirable. On the other hand, commercialization is potentially harmful to rural people if it expands to the point that outsiders with capital to invest come in and develop large-scale monocultural plantations for export markets. Rural people may benefit from plantations as a result of available employment and hence off-farm income […]. However, plantations may also distort market forces to their advantage, for example, by imposing low wages which will restrict the social and economic development of local people. The major beneficiaries of large-scale exports will probably be the country's elite and, perhaps, the national economy".

Also, those socially disadvantaged groups who actually depend on gathering MAP for their survival and cash income may not have access to farm land at all, and are therefore not able to compete with large-scale production of MAP by well-established farmers ((Vantomme in *Conservation impacts of commercial captive breeding workshop, December 7-9, 2001, White Oak Foundation, Jacksonville, Florida USA. Selected briefing notes* 2002). Other limitations to the domestication approach include boom-bust and fickle markets that let farmers down when consumers turn their attention elsewhere (Laird and Pierce 2002).

WILD OR CULTIVATED: WHAT DO THE SPECIES AND ECOSYSTEMS REQUIRE?

Cultivation of medicinal plants is widely viewed not only as a means for meeting current and future demands for large-volume production of plant-based drugs and herbal remedies, but also as a means for relieving harvest pressure on wild populations (FAO 1995; Lambert et al. 1997; Palevitch 1991; De Silva 1997; WHO 1993). In this chapter we want to assess the benefits and risks associated with such recommendations.

Booming markets with rapidly rising demands often have devastating effects on wild-collected species. A closer look reveals that not all species are affected in the same way by harvesting pressures. The **seven forms of rarity** described by Rabinowitz (1981) make clear that a species which (i) has a narrow geographic distribution, (ii) is habitat-specific, and (iii) has small population sizes everywhere, is more easily over-harvested than species of any other pattern (Table 4).

Table 4. *Seven forms of rarity (after Rabinowitz 1981)*

Geographic distribution	Habitat specificity	Local population size	
wide	broad	somewhere large	least concern
		everywhere small	
	restricted	somewhere large	
		everywhere small	
narrow	broad	somewhere large	
		everywhere small	
	restricted	somewhere large	
		everywhere small	highly susceptible

Secondly, the **susceptibility or resilience** to collection pressure varies among species owing to biological characters such as different growth rates (slow-growing vs. fast-growing), reproductive systems (vegetative or generative propagation; germination rates; dormance; apomixis) and life forms (annual; perennial; tree).

Species can be distinguished quite well in their susceptibility to over-collection if their life form and the plant parts collected are viewed together (Table 5). Harvesting fruits from a long-lived tree presents a far lower threat to the long-term survival of the species than does collecting seeds from an annual plant. In the latter case, if the seed is gone the plant is gone. In some cases the harvest impacts are more complex, e.g., with slow-growing trees that reproduce from seed but only produce few, large fruits (example: *Araucaria araucana*, monkey-puzzle tree). This will increase their susceptibility to over-harvest from low to medium or even high. A

thorough summary of predictors of resilience or vulnerability to harvesting wild populations is presented by Cunningham (2001).

***Table 5**. Susceptibility of species to overcollection as a function of life form and plant parts used*

	Wood	Bark	Root	Leaf	Flower	Fruit / Seed
Annual	---	---	high	medium	medium	high
Biannual	---	---	high	medium	medium	high
Perennial	---	medium	high	low	low	low
Shrub	medium	medium?	medium?	low	low	low
Tree	medium	medium?	medium?	low	low	low

In summary we can state that species most susceptible to over-harvest are habitat-specific, slow-growing and destructively harvested for their bark, roots or the whole plant. These species suffer most from harvesting and many of them have been seriously depleted, for example *Prunus africana* in West Africa, *Warburgia salutaris* in southern Africa and *Saussurea costus* in the Himalaya.

For threatened medicinal plant species **cultivation is a conservation option** because the constant drain of material from their populations is much higher than the annual sustained yield. If the demand for these species can be met from cultivated sources the pressure on the wild populations will be relieved. In these cases, the need for strict conservation of remaining populations, improved security of germplasm *ex situ* and investment in selection and improvement programmes is extremely urgent, as the example of Jaborandi (*Pilocarpus jaborandi*) in Brazil shows (Pinheiro 1997).

However, among the species that can be marketed at a high enough price to make cultivation profitable, only few are in the highest threat categories. Examples for threatened but cultivated species are *Garcinia afzelii, Panax quinquefolius, Saussurea costus* and *Warburgia salutaris* (Cunningham 1994). With respect to economic viability many highly endangered MAP do not qualify for cultivation. This group of plants will enter cultivation only with the help of public domestication programmes.

For all other harvested MAP species the **priority conservation option is sustainable harvest from wild populations**, for a variety of reasons.

Let's imagine that a valuable medicinal plant is exploited by local collectors. A pharmaceutical company has domesticated and begun to cultivate the plant on a commercial scale. When the company no longer needs the wild-harvested material, local harvesters have to abandon the harvest and any **incentive** the local collectors might have had to protect the wild populations is gone. The domestication of MAP species has an environmental implication in the sense that it reduces the economic incentives for forest-dependent people to conserve the ecosystems in which the MAP species occur (Leaman et al. 1997; Vantomme in *Conservation impacts of*

commercial captive breeding workshop, December 7-9, 2001, White Oak Foundation, Jacksonville, Florida USA. Selected briefing notes 2002).

If collectors and collecting communities can be involved in the development of propagation and management methods, the likelihood of their having an interest in protecting the wild populations from over-exploitation, particularly if these are understood to be the genetic resource 'bank' for the domestic enterprises, will be greater.

Another aspect to consider is the **genetic diversity** of the species that is in demand. Long before non-sustainable harvest practices lead to extermination of a whole species, selection of favoured growth forms and concentration on certain harvesting areas which may hold certain ecotypes will lead to a degradation of genetic diversity of the wild populations. The same is true under domestication: industry requirements for standardization encourage a narrow genetic range of material in cultivation. Domestication will not achieve conservation of genetic diversity because a narrow group of high-yielding individuals will be selected for planting.

As a summary of the previous sections, Table 6 in the Appendix indicates the advantages and disadvantages for the three aspects distinguished: 'species/ecosytems', 'market' and 'people'.

CHALLENGES OF HARVESTING SUSTAINABLY FROM THE WILD

Sustainable harvest is increasingly seen to be the most important conservation strategy for most wild-harvested species and their habitats, given their current and potential contributions to local economies and their greater value to harvesters over the long term. The basic idea is that non-destructive harvests and local benefits will maintain population, species and ecosystem diversity.

Besides poverty and the breakdown of traditional controls, the major challenges for sustainable wild-collection include: lack of knowledge about sustainable harvest rates and practices, undefined land use rights and lack of legislative and policy guidance.

Lack of information on the wild resource

"The most important ingredient required to achieve a truly sustainable form of resource use is information" (Peters 1994). In reality, resource managers are always confronted with the lack of adequate information about the plants used, their distribution, the genetic diversity of wild populations and relatives and, above all, the annual sustained yield that can be harvested without damaging the populations (Iqbal 1993). Research on the conservation and sustainable use of medicinal plants and their habitats has fallen far behind the demand for this globally important resource. Each species has unique ecological, socioeconomic, health and cultural associations that must be understood. Model research approaches are feasible, 'one size fits all' solutions are not. Lasting solutions have to be tailored to local circumstances.

Problems of open access

In many cases, access to the resource is open to everybody, rather than a limited access or private ownership. To make a living, commercial medicinal-plant gatherers therefore 'mine' rather than manage these resources (Cunningham 1994). Open-access schemes to harvestable plant populations prevent rational and cautious use and make it difficult to adhere to quotas and closed seasons.

Lack of legislative and policy support for wild-harvesting schemes

Information on trade in MAP is scarce and data are rarely collected or published at a national level. Much production and consumption is at subsistence level and as a consequence the economic importance of these activities is largely under-estimated in government decision making regarding rural development, natural-resource management planning and in government budget allocations (Vantomme in *Conservation impacts of commercial captive breeding workshop, December 7-9, 2001, White Oak Foundation, Jacksonville, Florida USA. Selected briefing notes* 2002). Therefore, national legislation and policies mostly fail to provide frameworks for a rational and sustainable use of wild resources.

Opportunities for governments to develop legislation to control and monitor harvest and trade of medicinal plant species and to consider conservation and sustainable use of medicinal plants as a priority in establishing protected areas have been greatly enhanced by two developments in international legislation: the addition of medicinal plant species to the Convention on International Trade of Endangered Species (CITES) and the entry into force of the CBD.

FUTURE TRENDS AND SOLUTIONS

How will the market demand develop in the future? People in developing countries are already and will increasingly be depending on medicinal plants as sources for their primary health care. An estimate by the World Health Organization (Bannerman 1982) that more than 80% of the world's population relies solely or largely on traditional remedies for health care is frequently cited.

Also in the northern countries, use of medicinal plants is expected to rise globally, in both allopathic and herbal medicine (WHO 2002). This upward trend is predicted not only because of population explosion, but also due to increasing popularity for natural-based, environmentally friendly products.

Most MAP species will continue to be harvested from the wild

The limitations of cultivation as an alternative to wild-harvest have been examined by Sheldon et al. (1996) in several case studies. We share their conclusion that, notwithstanding the level of interest in cultivation as a means for enhanced production and in a few cases as an effort to contribute to conservation of the resource, most MAP species will continue to be wild-harvested to some extent. There is therefore a need to recognize and strengthen the role of local people in

forest inventory, monitoring and impact assessment processes and to integrate non-timber product uses into forest management.

Need for implementation of management plans

Limiting the harvest to a sustainable level requires an effective management system and sound scientific information. The management system must include annual harvest quotas, consider seasonal or geographical restrictions and restriction of harvest to particular plant parts or size classes. In addition, clarification of the access and user rights to the resources providing MAP is part of the essential baseline information. Continuous monitoring and evaluation of the success is necessary to adapt the management strategy (FAO 1995; Leaman et al. 1997; Prescott-Allen and Prescott-Allen 1996; Schippmann 1997; WHO 1993).

In many cases harvesting techniques need to be improved as the extraction of the roots or bark is often negatively affecting the recovery of the species or may even kill it. Collecting methods are often crude and wasteful, resulting in loss of quality and reduction in price (Iqbal 1993; Vantomme in *Conservation impacts of commercial captive breeding workshop, December 7-9, 2001, White Oak Foundation, Jacksonville, Florida USA. Selected briefing notes* 2002).

Field-based methods have already been developed for sustainable harvest assessment and monitoring of non-wood forest products, resulting in the publication of research guidelines and predictive models (Cunningham 2001; FAO 1995; Nantel et al. 1996; Peters 1994).

Eco-labelling and certification

Given that sustainable harvesting from the wild is difficult to achieve, certification standards can play a role to assure that a product meets certain standards of sustainability. Certification programmes related to natural-resource use have mainly been developed for timber and agricultural products, but they are presently being adapted for wild-harvest of non-timber plants. Various schemes focus on different areas along the supply chain: production, processing, trade, manufacturing and marketing. Four categories of certification schemes have been identified to be of relevance for MAP products (Walter 2002): (i) forest management certification (e.g., Forest Stewardship Council FSC); (ii) social certification (e.g., Fair Trade Federation FTF); (iii) organic certification (e.g., International Federation of Organic Agriculture IFOAM); and (iv) product quality certification.

The latter include parameters such as product identity, purity, safety and efficacy. Correct identification of harvested medicinal plants is a basic requirement. Good practices for plant identification have been developed in Canada (Brigham et al. 2004) and for Chinese traditional medicines sold in the UK (Leon et al. 2002). The Good Agricultural and Field Collection Practices (GACP) developed for medicinal plants by WHO cover to some degree ecological aspects (WHO 2003) but need to be more clearly focussed on this aspect before they can make a meaningful contribution to ensuring sustainability. Presently, an International Standard for the

Sustainable Wild Collection of MAP is under development (Honnef et al. 2005). Dürbeck (1999), Walter (2002) and, most comprehensively, Pierce et al. (2002) present overviews of certification programmes and their activities; see also the chapter by Leaman in this book.

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APPENDIX

Table 6. *Wild-harvesting versus cultivation of medicinal and aromatic plants: a summary of advantages and disadvantages*

For **species and ecosystems** it is better to ...	
wild-harvest because ... 👍 it puts wild plant populations in the continuing interest of local people 👍 it provides an incentive to protect and maintain wild populations and their habitats and the genetic diversity of MAP populations **but ...** 👎 uncontrolled harvest may lead to the extinction of ecotypes and even species 👎 common access to the resource makes it difficult to adhere to quotas and the pre-cautionary principle 👎 in most cases knowledge about the biology of the resource is poor and the annual sustained yields are not known 👎 in most cases resource inventories and accompanying management plans do not exist	**cultivate** because ... 👍 it relieves harvesting pressure on very rare and slow-growing species that are most susceptible to threat **but ...** 👎 it devaluates wild plant resources and their habitats economically and reduces incentive to conserve ecosystems 👎 it narrows the genetic diversity of the gene pool of the resource because wild relatives of cultivated species become neglected 👎 it may lead to conversion of habitats for cultivation 👎 cultivated species may become invasive and have negative impacts on ecosystems 👎 reintroducing plants can lead to genetic pollution of wild populations

Table 6 (cont.)

Table 6 (cont.)

The **market** demands …	
wild-harvested plants because ...	**cultivated material** because ...
👍 it is cheaper since it does not require infrastructure and investment	👍 it guarantees continuing supply of raw material
👍 many species are only required in small quantities that do not make cultivation economically viable	👍 it makes reliable botanical identification possible
👍 for some plant parts extra-large cultivation areas are required (e.g., *Arnica* production for flowers)	👍 genotypes can be standardized or improved
👍 successful cultivation techniques do not exist, e.g., for slow-growing, habitat-specific taxa	👍 quality standards are easy to maintain
👍 no pesticides are used	👍 controlled post-harvest handling is possible
👍 it is often believed that wild plants are more powerful	👍 production volume and price can be agreed for longer periods
but …	👍 resource price is relatively stable over time
👎 there is a risk of adulterations	👍 certification as organic production is possible
👎 there is a risk of contaminations through non-hygienic harvest or post-harvest conditions	**but …**
	👎 it is more expensive than wild-harvest
	👎 it needs substantial investment before and during production

Table 6 (cont.)

Table 6 (cont.)

From a perspective of the **people** it is better to …	
wild-harvest because …	**cultivate** because ...
 it provides access to cash income without prior investment	 it secures steady supply of herbal medicines (home gardens)
 it provides herbal medicines for health-care needs	 it provides in-country value-adding
 it maintains the resources for rural populations on a long-term basis (if done sustainably)	**but ...**
but ...	 capital investment for small farmers is high
 unclear land rights create ownership problems	 competition from large-scale production puts pressure on small farmers and on wild harvesters
 this income and health-care resource is becoming scarce through over-harvesting	 benefits are made elsewhere and traditional resource users have no benefit return (IPR)