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Impact of Cultivation and Gathering of Medicinal Plants on Biodiversity: Global Trends and Issues

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1. 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) 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 als trade commodities which meet the demand of often distant markets. For the purpose of this paper the term "medicinal and aromatic plant" (MAP) is defined to cover the whole range of plants used not only medicinally *sensu strictu* 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 2002; Lambert *et al.* 1997; WHO, IUCN and WWF 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 (Anon. 2002b).

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).

In this paper, we review global trends in the close relationship between cultivation and wild harvest of MAP species, then make recommendations on steps that should be taken to achieve a balance between consumption, conservation and cultivation.

CBD and the ecosystem approach

Since its adoption in 1992, the Convention on Biological Diversity (CBD) has strived to implement its three major goals: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources. Although MAP have not been explicitly on the agenda of the various CBD meetings, all three goals of the Convention are fully applicable to MAP resources.

In decision V/6, the Conference of the Parties of the CBD adopted the ecosystem approach as the primary framework for action under the Convention. It is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The ecosystem approach is based on the application

of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. In April 2002, the CBD adopted the Global Strategy for Plant Conservation which provides a policy environment that is particularly well suited to addressing the conservation challenges for MAP in a coherent way (see Appendix 3).

Concept of sustainability

As a base line 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 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. A society is thought to be sustainable when both the human condition and the condition of the ecosystem are satisfactory or improving. The system improves only when both the condition of the ecosystem and the human condition improve (Prescott-Allen and Prescott-Allen 1996).

2. Some figures to start with …

2.1. How many MAP are used world-wide?

The number of plant species which have at one time or another been used in some culture for medicinal purposes can only be estimated. An enumeration of the WHO from the late 1970s listed 21 000 medicinal species (Penso 1980). However, in China alone 4 941 of 26 092 native species are used as drugs in Chinese traditional medicine (Duke and Ayensu 1985), an astonishing 18.9 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; Govaert 2001), it can be estimated that the number of plant species used for medicinal purposes is more than 50 000 (Table 1).

We recognize, however, that certain plant families have higher proportions of medicinal plants than others. Good examples are the Apocynaceae, Araliaceae, Apiaceae, Asclepiadaceae, Canellaceae, Guttiferae and Menispermaceae. In addition, these families are not distributed uniformly across the world. As a consequence, not only do some floras have higher proportions of medicinal plants than others, but also have certain plant families a higher proportion of threatened species than others (Table 9 in Appendix 1).

Table 1: How many plants are used medicinally world-wide?

Country	Plant species	Medicinal plant species	%
China	26 092	4 941	18.9
India	15 000	3 000	20.0
Indonesia	22 500	1 000	4.4
Malaysia	15 500	1 200	7.7
Nepal	6 973	700	10.0
Pakistan	4 950	300	6.1
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
Viet Nam	10 500	1 800	17.1
Average	13 366	1 700	12.5
World	**422 000**	**52 885**	

Sources: Duke and Ayensu (1985); Govaerts (2001); Groombridge and Jenkins (1994, 2002); Jain and DeFillipps (1991); Moerman (1996); Padua *et al.* (1999**)**

2.2. 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 world-wide.

Table 2. The 12 leading countries of import and export of medicinal and aromatic plant material from 1991-1998

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 (Lange 2002).

Iqbal (1993) estimates that about "4 000 to 6 000 botanicals are of commercial importance", another source refers to 5–6 000 "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 2 500 species world-wide.

2.3. How many MAP are threatened world-wide?

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 (see Appendix 4). The enormity of this task is illustrated by the following estimate: According to Walter and Gillett (1998), 34 000 species or 8 percent of the world's flora are threatened with

extinction. If this is applied to our earlier estimate that 52 000 plant species are used medicinally, it leads us to estimate that 4 160 MAP species are threatened (Table 3).

Table 3: How many medicinal plant species are threatened?	
Number of flowering plant species worldwide (Govaert 2001)	422 000
12.5% of them are used medicinally	52 000
8% are threatened (Walter and Gillett 1998)	4 160

2.4. 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 (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 percent 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 percent) 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 Pei-Gen 1991, He Shan-An and Ning Sheng 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 world-wide. A global survey on the extent of MAP cultivation in terms of species, volumes and values would be highly desirable. 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 herbalist or cultivation by local people can take place as enrichment planting.

3. 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 plants 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 and 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. 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 practioners 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 mono-culture 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 the 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 are also presently developing wildcrafting standards (Leaman 2002; Palevitch 1991; 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 (slow growth rate, special soil requirements, low germination rates, susceptibility to pests, etc.).

Economical feasibility is the main rationale for a decision to bring a species in cultivation but it also is 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 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).

On a time scale of sometimes many decades, the transition from wild harvesting to possible cultivation goes through various phases (Figure 1):

(i) Discovery Phase: At this point the demand can be met by wild harvest. Extractivism is done for local use or for barter with others.

(ii) Expansion Phase: It is clear that the product is potentially useful and that demand is likely to increase. Harvest is done for local or regional sale and eventually for international markets. In general, species with naturally low densities are unlikely to become important sources of commercially large quantities.

(iii) Stabilization Phase: The species is unlikely to be attractive to growers unless prices are high enough and wild-harvested resources are scarce enough. However, desirable species may be grown on farm land and planted around settlements.

(iv) Decline Phase: Prices increase with scarcity due to transport costs, search time and the long-distance trade. Wild populations will have to decline further before cultivation is a viable option. The trade is characterized by fluctuations in supplies, often to the extent of disrupting the trade balance. For slow growing species, if controls on collection are not strictly enforced, wild populations will be more seriously eroded before cultivated material is available (Cunningham 1994; Iqbal 1993).

(v) Cultivation Phase: Now, formal cultivation systems are developed and instituted. The plants are domesticated and incorporated in agroforestry systems sometimes for the benefit of small-scale farmers. If international market opportunities exist, commercial plantations are created with substantial investment and genetic selection, cloning, breeding and biotechnology may be applied. More resilient species may recover in their wild populations (Figure 1).

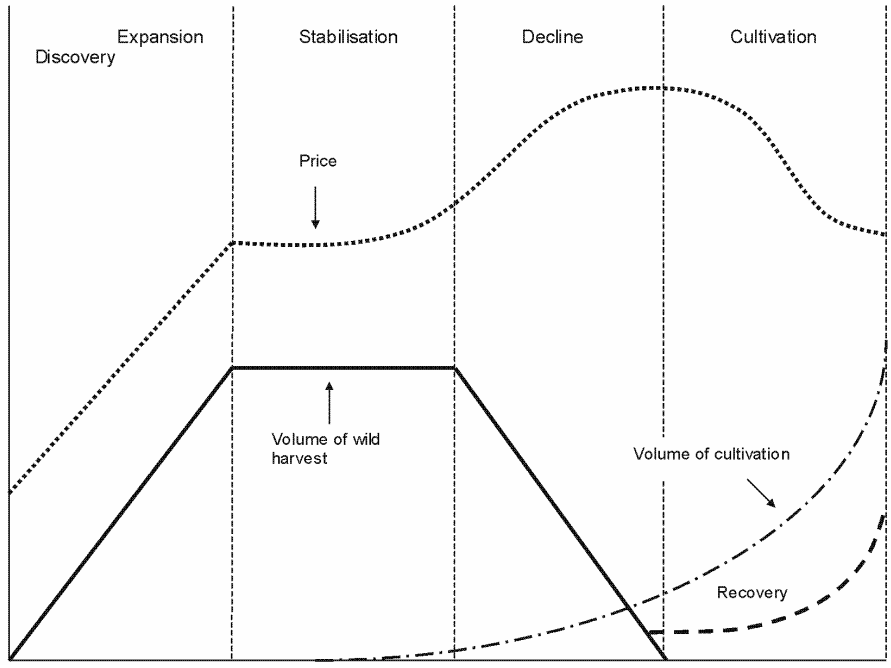

Figure 1: Transition phases from wild harvesting to cultivation: after wild resources decline with over-harvesting, raw material prices increase and cultivation becomes economically feasible; more resilient species can recover (after Homma 1992 and Cunningham 2001).

4. 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 8–15 percent 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). Demand for medicinal plants also reflects distinct cultural preferences. In the USA, for example, only 3 percent 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 percent of the over-the-counter products in pharmacies in 2001 were phytopharmaceutical preparations (BAH 2002).

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 (Anon. 2002b; Mander *et al.* 1997).

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 percent 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 percent 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. 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 (1997), 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 Anon. 2002a). 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).

5. 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, IUCN and WWF 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 Rabinovitz (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 which 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).

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 Himalayas.

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.

Table 5: Susceptibility of species to overcollection as a function of *Life Form* and *Plant Parts Used*						
	Wood	Bark	Root	Leave	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

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 Anon. 2002a).

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 which 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 chapters 3–5, table 7 in Appendix 1 indicates the advantages and disadvantages for the three aspects distinguished: "species/ecosytems", "market" and "people".

6. 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 break-down 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, socio-economic, health and cultural associations that must be understood. Model research approaches are feasible, model solutions are not.

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 population 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 Anon. 2002a). Therefore, national legislation and policies mostly fail to provide frameworks for a rational and sustainable use of wild resource.

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 recent 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 (see Appendix 2).

7. Future trends and solutions

How will the market demand develop in the future? People in developing countries are already and will increasingly depend on medicinal plants as sources for their primary health care. An estimate by the World Health Organization (Bannerman 1982) that more than 80 percent 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, both in 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.

In general, the demand for medicinal plants and herbal remedies and especially its renaissance in the developed countries is driven by the following factors (Iqbal 1993; Leaman 2002):

- increasing costs of institutional, pharmaceutical-based health care;
- interest of individuals, communities and national governments in greater self-reliance in health care;
- interest of communities and national governments in small and large-scale industrial development based on local/national biodiversity resources;
- increasing success in validating the safety and efficacy of herbal remedies;
- legislation improving the status of herbal medicine industry;
- renewed interest of companies in isolating useful compounds from plants;
- search for new drugs and treatments of serious and drug-resistant diseases;
- marketing strategies by the companies dealing in herbal medicine.

Most MAP species will continue to be harvested wild

The limitations of cultivation as an alternative to wild harvest have been examined by Sheldon *et al.* (1997) 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 medicinal and aromatic plant species will continue to be harvested wild 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 (Table 6). 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, IUCN and WWF 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 Anon. 2002a).

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).

Table 6: Steps and standard elements of a management plan for MAP utilization (Schippmann 1997)

- resource inventory of population abundance and distribution
- assessment of regional and global threat based on all available knowledge and expertise
- biological studies (growth and regeneration rates, pollination system, seed dispersal, potential for confusion with similar species, etc.) and assessment of harvest impact on viability of individuals
- assessment of annual sustained yield
- review of local knowledge and harvest practices
- review of harvest and trade levels in the past and evaluation of market trends
- revision of national regulations for the utilization in source country
- assessment of tenure and access
- design and implementation of management scheme: annual harvesting quota, seasonal or regional restriction and on certain plant parts or size classes, domestication programme
- installation of continuing monitoring and re-evalutaion (adaptive management)

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, 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. The Good Harvesting Practices (GHP) developed for medicinal plants cover to some degree ecological aspects (Harnischfeger 2000) but need to be more clearly focussed on this aspect before they can make a meaningful contribution to ensuring sustainability. Dürbeck (1999), Walter (2002) and most comprehensively Pierce *et al.* (2002) present overviews of certification programmes and their activities.

8. Recommendations

(1) To overcome significant knowledge deficits, a global MAP **cultivation survey** should be commissioned by an international organization. Aims are to identify species cultivated, in which countries they are grown, volumes produced and their market values. This survey should also assess public domestication programmes, as well as *in-situ* and *ex-situ* conservation efforts for wild populations of species in cultivation (e.g., in protected areas, in genebanks and botanic gardens).

(2) Wild harvesting of MAP will continue to prevail owing to economic reasons outlined above. **Sustainable wild harvest management schemes need to be supported** by governments and authorities. Management plans need to be installed as a standard prerequisite for any such harvesting in the wild. There is a need to monitor and audit the harvesting process to determine whether it is sustainable.

(3) Primary producers need help to improve returns from sustainable harvesting of MAP. Community based **small scale cultivation** enterprises need to be strengthened to enable them to compete with large-scale high-tech cultivation.

(4) Secure *ex-situ* field **gene banks** need to be developed, particularly for habitat specific, slow-growing species with high susceptibility of being over-harvested.

(5) Medicinal plant **domestication programmes** need to be expanded, taking fuller advantage of the genetic and chemical diversity within species over wide geographical areas.

(6) Capacity to assess and monitor the conservation status of MAP and to manage harvest within the limits of sustainability is extremely limited worldwide and needs to be developed through training courses and curriculum development in ethnobotany and applied ecology . **Research** to investigate the sustainability of production systems is lacking and needs to be stimulated for a better understanding of the biological dynamics of the resource in the wild and in domestication.

(7) Management planning has to take the diversity of tenure systems which apply to medicinal plants into account to a far greater degree. Clarification of **user rights** over the resource and access to it, particularly where it is considered common property, needs to be recognized as a crucial factor enabling or preventing a sustainable harvest from wild populations.

(8) Eco-labelling and other social and economic incentives to strengthen market credibility and competitiveness of biodiversity-friendly products need to be promoted. The efforts of certifiers to develop **certification standards** for wild harvested plant material need to be supported as well as the approaches of industry to set up self-binding product quality standards. The private sector should be encouraged to consider local livelihoods and biodiversity when setting up ethical and environmental standards.

(9) Conservation of medicinal plants currently lacks priority in policy and law. There are opportunities to change this within the implementation of legal instruments such as the CBD and CITES. Government **policies and legislation** need to be adapted and implemented to recognize the value of and need for sustainable wild harvesting management regimes, to implement national and/or regional permit systems and make medicinal plant conservation a priority for national health and economic policy.

(10) The **Global Environment Facility** (GEF) needs to consider medicinal plant conservation as a programme priority worthy of funding.

(11) Medicinal plants warrant priority in national efforts to implement the **Global Strategy for Plant Conservation** of the CBD.

(12) Local communities can take more responsibility for sustainable harvest of medicinal plants only if they have the choices afforded by adequate income, control over the resource and the knowledge and skills required. On the issue of **intellectual property rights** it needs to be elaborated how the country, the local user or other entity can be adequately compensated for use of the resource by outsiders.

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Table 7: 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 ...	**cultivate** 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 ecotype 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	👍 it relieves harvesting pressure on very rare and slow-growing species which are most susceptible to threat **but ...** 👎 devaluates wild plant resources and their habitats economically and reduces incentive to conserve ecosystems 👎 narrows genetic diversity of gene pool of the resource because wild relatives of cultivated species become neglected 👎 it may lead to conversion of habitat for cultivation 👎 cultivated species may become invasive and have negative impacts on ecosystem 👎 reintroducing plants can lead to genetic pollution of wild populations

The **market** demands …

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

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 provides herbal medicines for health care needs 👍 it maintains the resources for rural populations on a long-term basis (if done sustainably) **but ...** 👎 unclear land rights create ownership problems 👎 this income and health care resource is becoming scarce through over-harvesting	👍 it secures steady supply of herbal medicines (home gardens) 👍 it provides in-country value-adding **but ...** 👎 capital investment for small farmers is high 👎 competition from large scale production puts pressure on small farmers and on wild harvesters 👎 benefits are made else-where and traditional resource users have no benefit return (IPR)

Table 8: Selected plant families characterized by high numbers of species used for medicinal purposes showing the number and proportion of threatened species. Data on proportion of threatened species per family according to the IUCN criteria from Walter and Gillett (1998)

Family	No. genera	No. species	% of total species threatened	Main uses	Examples of over-harvested species
Stangeriaceae	1	1	**100**	Traditional medicine, symbolic	*Stangeria eriopus*
Zamiaceae	8	144	**90.3**	Horticultural collection & traditional medicine	*Encephalartos* species (56 listed as threatened)
Canellaceae	6	20	**35**	Traditional medicine, Molluscides	*Warburgia elongata. W. salutaris*
Leguminosae	590	12 000–14 200	**18**	Multiple-uses: timber, medicinal, forage & food	*Dalbergia odorifera, D. tonkinensis; Afzelia* species
Araliaceae	47–70	700	**16.3**	Medicinal & carving	*Panax* species
Rosaceae	100	3 000	**14.4**	Stone fruit crops & medicinals	*Prunus africana*
Guttiferae	50	1 200	**13.3**	Dyes, medicines, fruits, chewing sticks	West African *Garcinia* species overexploited for chewing sticks
Lauraceae	35–50	2 000	**13**	Timber, medicines, cinnamon	*Ocotea bullata*
Menispermaceae	70	400	**9.5**	Medicines, dyes	*Stephania (*several species in SE Asia*)*
Apocynaceae	168–200	2 000	**7.5**	Medicines	*Holarrhena floribunda*

The principal tool for monitoring or restricting trade of species threatened by over-exploitation is the **Convention on International Trade of Endangered Species of Wild Fauna and Flora**, or CITES, which entered into force in 1975. The 158 national governments who currently have signed CITES are obliged to monitor and control international trade in the plants and animals listed in its two main Appendices.

Appendix I prohibits trade in wild specimens, except for reasons such as scientific research. Appendix II requires parties to issue export permits that confirm non-detrimental harvest of listed species, and requires importing countries who are Parties to CITES to check and monitor permits on incoming material. It is important to note that for Appendix II species it is solely the country of export that decides whether to issue a permit or not.

Having become parties to CITES, national governments are required to establish or designate scientific authorities to conduct non-detriment studies for listed species, and management authorities to issue permits and certificates.

Table 9. List of plant species which have been included in the CITES Appendices because of trade for medicinal purposes

Species	Family	Date of inclusion in CITES	Appendix
Adonis vernalis	Ranunculaceae	16.8.2000	II
Aquilaria malaccensis	Thymelaeaceae	16.2.1995	II
Cistanche deserticola	Orobanchaceae	16.8.2000	II
Dioscorea deltoidea	Dioscoreaceae	1.7.1975	II
Guaiacum officinale	Zygophyllaceae	11.6.1992	II
Guaiacum sanctum	Zygophyllaceae	1.7.1975	II
Hydrastis canadensis	Ranunculaceae	18.9.1997	II
Nardostachys grandiflora	Valerianaceae	18.9.1997	II
Panax ginseng only populations of the Russian Federation	Araliaceae	16.8.2000	II
Panax quinquefolius	Araliaceae	1.7.1975	II
Picrorhiza kurrooa	Scrophulariaceae	18.9.1997	II
Podophyllum hexandrum	Berberidaceae	18.1.1990	II
Prunus africana	Rosaceae	16.2.1995	II
Pterocarpus santalinus	Leguminosae	16.2.1995	II
Rauvolfia serpentina	Apocynaceae	18.1.1990	II
Saussurea costus	Asteraceae (Compositae)	1.7.1975 App. II 1.8.1985 App. I	I
Taxus wallichiana	Taxaceae	16.2.1995	II

Species can be added, removed, or shifted between Appendices through proposals passed at biennial meetings of the signatories, or Conferences of the Parties. 17 species have been added to CITES Appendices because of their exploitation as medicinal plants, the majority of them in the 1990's (Table 9).

For medicinal plant conservation, CITES accomplishes a number of tasks very well, including: (i) monitoring trade at the species level; (ii) focusing attention on high use, high priority species with global value; and (iii) calling international attention to threatened medicinal plant species.

As a conservation tool, CITES also has a number of limitations: (i) Many countries are reluctant to support inclusion of important commercial species on CITES, even when there is justification for restricting or monitoring trade, for fear of losing needed international exchange. (ii) Internal trade is not monitored. (iii) A substantial amount of international trade is not monitored because exported material, such as dried bark and extracts, can be difficult to tie to particular species. (iv) CITES focuses on species that are already threatened, rather than preventing the threat.

Global Plant Conservation Strategy of the CBD Appendix 3

In April 2002, the CBD adopted the Global Strategy for Plant Conservation, including 14 outcome-oriented global targets for 2010. The ultimate and long term objective of the strategy is to halt the current and continuing loss of plant diversity.

Policy relevant to the conservation challenges that arise from the increasing global demand for wild harvest and cultivation of medicinal plants has been scattered among many different areas: forestry, health, agriculture, indigenous knowledge, access and benefit sharing, and sustainable livelihoods. The Global Strategy for Plant Conservation provides a policy environment that is particularly well suited to addressing these challenges in a coherent way for medicinal and aromatic plant species.

Targets for the year 2010

Understanding and Documenting Plant Diversity:

1. A widely accessible working list of known plant species, as a step towards a complete world flora.
2. An assessment of the conservation status of all known plant species.
3. An understanding of basic conservation needs for threatened plant species, with conservation protocols developed for 50% of such species.

Conserving Plant Diversity:

4. 10% of each of the world's ecological regions and 50% of the world's threatened species effectively conserved in situ.
5. 90% of threatened plant species in accessible ex situ collections, and 20% of them included in recovery programmes.
6. 30% of production lands managed consistent with the conservation of plant diversity.
7. 70% of the genetic diversity of crops and other major socio-economically valuable plant species conserved.
8. Threats to plant diversity from invasive alien species tackled.

Using Plant Diversity Sustainably:

9. No species of wild flora subject to unsustainable exploitation because of international trade.
10. 30% of plant based products derived from sources that are sustainably managed.
11. The decline of plant resources that support sustainable livelihoods, local food security and health care, reversed.

Promoting Education and Awareness about Plant Diversity:

12. Every child aware of the importance of plant diversity and the need for its conservation.

Building Capacity for the conservation of Plant Diversity:

13. The number of trained people working with adequate facilities in plant conservation and related activities doubled.
14. Networks for plant conservation activities established or strengthened at international, regional, and national levels.

Source: http://www.biodiv.org/programmes/cross-cutting/plant/targets.asp, viewed 30.9.2002

Role of the IUCN/SSC Medicinal Plant Specialist Group Appendix 4

The **Medicinal Plant Specialist Group** (MPSG) is a global voluntary network of experts contributing within their own institutions and in their own regions to the conservation and sustainable use of medicinal plants. The MPSG was founded in 1994, under the auspices of the Species Survival Commission of the IUCN – the World Conservation Union, to increase global awareness of conservation threats to medicinal plants, and to promote conservation action. The membership is made up of scientists, field researchers, government officials, and conservation leaders.

Goal and objectives

The overall aim is to support and promote efforts leading to medicinal plant conservation and rational, sustainable use. The approach is to provide information, tools, and strategy coordination that builds on the efforts of local, national, regional, and global partners to conserve and use medicinal plants sustainably, focusing particularly on actions that reduce threats to endangered species and habitats.

The programme has, among others, the following objectives:

- To identify priority medicinal plant taxa and habitats threatened by non-sustainable harvest, high levels of trade, environmental degradation, and other factors contributing to loss of species and genetic diversity;
- To work with local, regional, national, and global partners to design and implement conservation action plans for priority medicinal plant taxa and habitats;
- To support and encourage the sharing of information and collaboration among all stakeholders in finding common solutions to the sustainable use and conservation of medicinal plants;
- To provide opportunities for consumers, industry, and other beneficiaries to understand and participate more directly in conservation and sustainable use of medicinal plants and their habitats.