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Medicinal plants and conservation: issues and approaches

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ABSTRACT
Many types of action can be taken in favour of the conservation and sustainable use of medicinal plants. Some of these are undertaken directly at the places where the plants are found, while others are less 'direct', such as some of those relating to commercial systems, *ex situ* conservation and bio-prospecting. In the latter cases, actions taken will not lead to *in situ* conservation unless they 'feed back' to improvements in the field. Progress is hampered at present by a shortage of good quality information available in forms that can easily be used by relevant parties.
Probably the single most important 'role' for medicinal plants in biological conservation is their ‘use’ to achieve conservation of natural habitats more generally. This stems from the special meanings that medicinal plants have to people, related to the major contributions that they make to many people’s lives in terms of health support, financial income, cultural identity and livelihood security. Under the right circumstances, these values can be translated into incentives for conservation of the habitats in which the medicinal plants are found. Realisation of this potential will depend greatly on the existence of assured rights of access to, and use of, the plants by those members of communities whose lives are most closely bound to them.
Problems associated with biopiracy or (the other side of the coin) excessive restrictions on research have come to assume 'policy prominence’ in the general thematic area of ‘medicinal plant conservation and use’. The fair and equitable sharing of benefits from bioprospecting is required under the Convention on Biological Diversity, but it is not always easy to achieve these ideals in practice. This is particularly so with regard to benefits for conservation and compatible development at the places where the plants are naturally found. Improvements in the standards of research agreements are likely to be made gradually as experience accumulates. What is important, at the present time, is that controls imposed on scientific research to prevent biopiracy or theft of local and indigenous intellectual property do not unduly restrict research that has little or nothing to do with these matters or that, in some cases, may even have the potential to contribute to improved management and livelihoods. There is already evidence that some countries and territories have created restrictions on research that may cause damage to the causes of conservation and sustainable development.

ROLES FOR MEDICINAL PLANTS IN CONSERVATION

The special significance of medicinal plants in conservation stems from the major cultural, livelihood or economic roles that they play in many people's lives. Several themes consistently arise in the various sets of recommendations that have been compiled relating to the conservation of medicinal plants, such as those associated with international conferences at Chiang Mai, Thailand, in 1988 and Bangalore, India, in 1998 (www. frlht-india.org) (Akerele, Heywood & Synge, 1991; Bodeker, 2002). They include: the need for co-ordinated conservation action, based on both *in situ* and *ex situ* strategies; inclusion of community and gender perspectives in the development of policies and programmes; the need for more information on the medicinal plant trade; the establishment of systems for inventorying and monitoring the status of stocks of medicinal plants; the development of sustainable harvesting practices; encouragement for micro-enterprise development by indigenous and rural communities; and the protection of traditional resource and intellectual property rights.
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Because so many species of plants are medicinal, medicinal plant conservation is, in some ways, a microcosm of plant conservation as a whole. Similar questions arise concerning identification of the most significant issues and most effective approaches. This is especially so given that, just because a species has been used somewhere medicinally, it does not follow that it is so used everywhere and at all times. There may be good reasons, for the purpose of genetic conservation, to conserve particular populations of 'medicinal plants', even though their designation as such carries little or no meaning to people living in the neighbourhood. The challenges facing conservationists are then similar to those encountered with other groups of plants singled out by 'plant conservationists' as special, but which lack any special significance to local people, such as, commonly, many ‘threatened' species and wild crop relatives.

There can be aspects of medicinal plant conservation which 'plant conservationists' can pursue, working largely outside the normal dynamics of people/plant relationships. Work of this type can sometimes be found, for instance, associated with seed-banks, information systems or ‘totally protected’ nature reserves. The fact that efforts are made in favour of medicinal plants, rather than plants of any other type, is incidental, except as regards the criteria used for the initial selection of species for attention.

Most work by conservationists on medicinal plants should be with those people who own, manage or make use of these species, or else own or manage the land on which they grow. It is in working with such stakeholders that the special meanings of medicinal plants to people can best be 'exploited'. Billions of people in the world rely chiefly on herbal medicine, while millions gain income from their wild harvest or cultivation, or are involved in their trading or processing. Medicinal plants are symbolically significant in many cultures, often being seen as sources of power. My experience over the years, working for WWF, is that medicinal plants hold more fascination for the British public than any other facet of the botanical world. Probably, the single most important ‘role’ for medicinal plants in biological and ecological conservation stems from the foundations that they can provide for the involvement of people in conservation of natural habitats (Schopp-Guth & Fremuth, 2001). In other words, the significance of medicinal plants to people can be sufficiently great that arrangements made for the conservation and sustainable use of medicinal plants can lay important foundations for the conservation of natural habitats and ecological services more generally. Therefore the 'biological beneficiaries' of ‘medicinal plant conservation’ are not necessarily only the medicinal plants themselves. This is nowhere more so than in those remoter parts of the world where cultural and biological diversity tend to be most concentrated, and where medicinal plants can assume high importance in cultures and for livelihoods.

Working effectively with communities requires conservationists to have an appreciation of the cultures, economies and social structures and dynamics of local societies, in addition to the knowledge that they need about the biology and ecology of the plants themselves. Similar

'lateral engagement' is also necessary for work with other classes of people involved with medicinal plants. For example, the main concerns of conservationists about manufacturers are likely to revolve around questions of the effects of their patterns of obtaining raw materials on the environment. However, manufacturers will often be more interested in other aspects of product quality than biological and ecological sustainability, especially those relating to quality control that involve species authentication, presence of active constituents, limitations to heavy metal content, and residues of pesticides and fertilisers. Conservationists working

with manufacturers need to understand these facts of the business, just as they need to understand those of village life when working with communities. However, in doing so, they should never lose sight of their own conservation objectives.

There can be debate as to what exactly constitutes a ‘medicinal plant’. In many instances, there is little controversy, but what about ‘magical’ plants, plants taken basically as food but believed to have additional benefits to health, or flavourings (spices or 'herbs') that also have medicinal properties? There are cultural differences in the ways that plants are classified according to their properties, for example, with less of a distinction between food and medicine in Eastern and African traditions than in the West. Medicinal plants are grouped for many commercial purposes in the broader category 'medicinal and aromatic plants' (MAPs), covering not only plants used medicinally (as more strictly understood), but also for neighbouring and overlapping purposes, for instance as foods, condiments and cosmetics (Schippmann, Leaman & Cunningham, 2002). The term ‘botanicals’ is becoming commonly used for a wide range of plant-based products.

THE VALUES OF MEDICINAL PLANTS

Plants in traditional medicine

It is estimated that 70-80% of people worldwide rely chiefly on traditional, largely herbal, medicine to meet their primary healthcare needs (Farnsworth & Soejarto, 1991; Pei Shengji, 2001). The global demand for herbal medicine is not only large, but growing (Srivastava, 2000). The market for Ayurvedic medicines is estimated to be expanding at 20% annually in India (Subrat, 2002), while the quantity of medicinal plants obtained from just one province of China (Yunnan) has grown by 10 times in the last 10 years (Pei Shengji, 2002b). An example of increased pressure on collecting grounds is provided by the Gori valley in the Indian Himalayas, where the annual period of MAP harvesting has increased from 2 to 5 months (Uniyal, Awasthi & Rawat, 2002). Factors contributing to the growth in demand for traditional medicine include the increasing human population and the frequently inadequate provision of Western (allopathic) medicine in developing countries (Table 1).

Country	Doctor : Patient	TMP : Patient
Ethiopia	1 : 33,000	
	1 : 7142 (overall)	Kenya
	1 : 833 (urban – Mathare)	1 : 987 (urban - Mathare)
Malawi	1 : 50,000	1 : 138
Mozambique	1 : 50,000	1 : 200
	1 : 1639 (overall)	South Africa
	1 : 17,400 (homeland areas)	1 : 700-1200 (Venda)
Swaziland	1 : 10,000	1 : 100
Tanzania	1 : 33,000	1 : 350-450 (Dar es Salaam)
Uganda	1 : 25,000	1 : 708

Table 1. Ratios of doctors (practising Western medicine) and traditional medical practitioners (TMPs) (practising largely plant-based medicine) to patients in East and Southern Africa (Marshall, 1998).

There are many traditional systems of medicine. Following the practice in China, they may be classified into 3 broad categories: (1) Traditional Medical Systems, with written traditions of

documentation of knowledge, pharmacopoeias for doctors and institutions for training doctors; (2) Traditional Medical Knowledge (Folk Medicine), which is orally transmitted and associated with households, communities or ethnic groups; and (3) Shamanistic Medicine, with a strong spiritual element and which can only be applied by specialist practitioners (shamans). Traditional Medical Systems are especially concentrated in Asia. Some of the more widely familiar are Chinese Traditional Medicine, Tibetan Medicine, Ayurveda, Siddha, Unani and Western Herbal Medicine, the latter being rather ill-defined.

Plants in herbal medicine and botanicals

Herbal medicine is becoming ever more fashionable in richer countries, a market sector which has grown at 10-20% annually in Europe and North America over recent years (ten Kate & Laird, 1999). In addition, there are many related botanical products sold as health foods, food supplements, herbal teas, and for various other purposes related to health and personal care. The extent to which herbal preparations are prescribed within conventional medicine varies greatly between countries, for instance being much higher in Germany than in the UK or USA.

Pharmaceutical medicine

Plants have contributed hugely to Western medicine, through providing ingredients for drugs or having played central roles in drug discovery. Some drugs, having botanical origins, are still extracted directly from plants, others are made through transformation of chemicals found within them, while yet others are today synthesised from inorganic materials, but have their historical origins in research into the active compounds found in plants. There are undoubtedly many more secrets still hidden in the world of plants (Mendelsohn & Balick, 1995).

GLOBAL USE AND VALUE OF MEDICINAL SPECIES

In terms of the number of species individually targeted, the use of plants as medicines represents by far the biggest human use of the natural world. Plants provide the predominant ingredients of medicines in most medical traditions. There is no reliable figure for the total number of medicinal plants on Earth, and numbers and percentages for countries and regions vary greatly (Table 2; (Schippmann *et al*., 2002). Estimates for the numbers of species used medicinally include: 35,000-70,000 or 53,000 worldwide (Farnsworth & Soejarto, 1991; Schippmann *et al*., 2002); 10,000-11,250 in China (He & Gu, 1997; Pei Shengji, 2002a; Xiao & Yong, 1998); 7500 in India (Shiva, 1996); 2237 in Mexico (Toledo, 1995); and 2572 traditionally by North American Indians (Moerman, 1998). The great majority of species of medicinal plants are used only in Folk Medicine. Traditional Medical Systems employ relatively few: 500-600 commonly in Traditional Chinese Medicine (but 6000 overall) (Pei Shengji, 2001); 1430 in Mongolian Medicine (Pei Shengji, 2002b); 1106-3600 in Tibetan Medicine (Pei Shengji, 2001; Pei Shengji, 2002b); 1250-1400 in Ayurveda (Dev, 1999); 342 in Unani; and 328 in Siddha (Shiva, 1996). The number of plant species that provide ingredients for drugs used in Western Medicine is even fewer. It was calculated for an article published in 1991 that there were 121 drugs in current use in the USA derived from plants, with 95 species acting as sources (more than one drug is obtained from some species)

(Farnsworth & Soejarto, 1991). Despite the small number of source species, drugs derived from plants are of immense importance in terms of numbers of patients treated. It is reported that ca. 25% of all prescriptions dispensed from community pharmacies in the USA between 1959 and 1973 contained one or more ingredients derived from higher plants (Farnsworth & Soejarto, 1991). A more recent study, of the top 150 proprietary drugs used in the USA in 1993, found that 57% of all prescriptions contained at least one major active compound currently or once derived from (or patterned after) compounds derived from biological diversity (Grifo & Rosenthal,).

Country or
region

Number of species of medicinal plants	Total number of native species in flora	% of flora which is medicinal	References to figures in Column 2
China 11,146	27,100	41	(Pei Shengji, 2002a)
India 7500	17,000	44	(Shiva, 1996)
Mexico 2237	30,000	7	(Toledo, 1995)
North America 2572	20,000	13	(Moerman, 1998)
World 52,885	297,000-510,000	10-18	(Schippmann *et al*., 2002)

Table 2. Numbers and percentages of medicinal plant species recorded for different countries and regions. The sizes of the floras (Column 3) are from Centres of Plant Diversity (WWF & IUCN, 1994-1997), except for the world estimate (bottom row) which is based on an estimate that 270,000-425,000 species of vascular plants are already known, with a further 10-20% to be discovered (Govaerts, 2001).

The value of medicinal plants to human livelihoods is essentially infinite. They obviously make fundamental contributions to human health, and: "*Is not health dearer than wealth*?" Financially, the retail sales of pharmaceutical products was estimated at US$ 80-90 billion globally in 1997, with medicinal plants contributing very significantly (Sheldon, Balick & Laird, 1997). A study of the 25 best-selling pharmaceutical drugs in 1997 found that 11 of them (42%) were either biologicals, natural products or entities derived from natural products, with a total value of US$ 17.5 billion (Laird & ten Kate, 2002). The total sales' value of drugs (such as Taxol) derived from just one plant species (*Taxus baccata*) was US$ 2.3 billion in 2000 (Laird & ten Kate, 2002). The world market for herbal remedies in 1999 was calculated to be worth US$ 19.4 billion, with Europe in the lead (US$ 6.7 billion), followed by Asia (US$ 5.1 billion), North America (US$ 4.0 billion), Japan (US$ 2.2 billion), and then the rest of the world (US$ 1.4 billion) (Laird & Pierce, 2002).

There is much trade in MAPs, on scales ranging from the local to the international. Much of this is unrecorded in official statistics or poorly documented – reasons why there is typically so little awareness among decision-makers of the significance of the trade to the healthcare and economies of their people, or about problems of unsustainability and the sometimes deleterious impacts of wild collection on natural habitats. Large quantities of MAPs are traded into urban centres from rural areas in developing countries, and also regionally and internationally. China's production of medicinal plants from cultivated and wild-harvested sources, considered together, was calculated at 1.6 million tonnes in 1996, with a total value (excluding exports) in terms of finished products of US$ 3.7 billion (Kuipers, 1997). The

reported annual imports of MAP material into all countries during the 1990s amounted to an average of 400,000 tonnes, valued at US$ 1.2 billion, showing a 100% rise between 1991 and 1997 (Lange, 2000). The three leading exporting countries are China (ca. 140,000 tonnes per

year over 1991-1997), India (about one-third of the Chinese amount) and then Germany (Lange, 2000). Europe is the major trading centre for MAPs globally, with imports into one European country or another amounting to 440,000 tonnes in 1996 [Lange, 1998 #95}. There are at least 2000 species of MAPs marketed in Europe, these originating from over 120 countries. It is guessed that the total number of MAPs in international trade may be about 2500 species (Schippmann *et al*., 2002).

Although virtually everyone on Earth benefits from medicinal plants, it is the financially poorest who are typically most closely dependent on medicinal plants – culturally and for their medicines and income. Only 15% of pharmaceutical drugs is consumed in developing countries (Toledo, 1995), and a large proportion of even this small percentage is taken by relatively more affluent people. The poor have little alternative to using herbal medicine, which, anyway, they may prefer – at least for certain conditions (Marshall, 1998). Both rural and urban dwellers, in developing countries, rely on medicinal plants, many rural people still depending largely on plants collected from close to their homes, while town folk depend, for the most part, on dried plants transported in from rural areas.

Medicinal plants can provide a significant source of income for rural people in developing countries, especially through the sale of wild-harvested material. The collectors are often herders, shepherds or other economically marginalised sections of the population, such as landless people and women. Between 50-100% of households in the northern part of central Nepal and about 25-50% in the middle part of the same region are involved in collecting medicinal plants for sale, the materials being traded on to wholesale markets in Delhi (Olsen, 1997). The money received represents 15-30% of the total income of poorer households.

Medicinal plants can be symbolically very important to people. They can be held in special religious, nationalistic or ideological esteem. This can be advantageous for conservation efforts, given that it is an acknowledgement, well rooted in culture, of the worth of a sizable proportion of the world's flora. But it also carries challenges, in that this can result in dogmatic views about the medicinal properties of plants, resistance to accepting equally effective substitutes, and uncompromising attitudes towards the ownership of the plants and who should benefit from (or pay for) their continuing existence. The subject of 'medicinal plants' can arouse strong feelings, providing opportunities for bringing key conservation debates into the public arena. There is similarity to the emotions surrounding charismatic species, such as elephants and whales, with the difference that medicinal plants carry much more universal appeal.

SOME CONCERNS SURROUNDING MEDICINAL PLANTS

Concerns about loss of biological diversity and the availability of resources

These concerns exist, for a large part, because most species of medicinal plants are collected from the wild. The total number of species of medicinal plants cultivated on any scale is few, although this does include some species of MAPs that are traded internationally in large volumes, as well as the many of the (small) number of species used as starting points for pharmaceutical drugs. As an example, the Rosy Periwinkle (*Catharanthus roseus*), a species

which originated in Madagascar and which is the source of the anti-leukemia drugs vincristine and vinblastine, is widely cultivated in Spain and Texas (Balick & Cox, 1996). China is probably the country with the greatest acreage of medicinal plants under cultivation, with over 300,000 hectares devoted to just one species – Sea Buckthorn (*Hippophae rhamnoides*) – with 10,000 people employed (Lambert, Srivastava & Vietmeyer, 1997). However, even in China, only 100-250 species are cultivated (Schippmann *et al*., 2002) and more than 80% of the 700,000 tonnes of medicinal plants reportedly used annually come from wild sources (Heywood, 2000). Only 130-140 of the 1200-1300 species that are both traded in, and native to, Europe are derived predominantly from cultivation (Lange, 1998). There are many parts of the world in which there is virtually no cultivation on any significant scale, including, by way

of examples, Albania and Turkey in Europe (Lange, 1998), Pakistan and Bangladesh in Asia (Begum, 2002), and all countries in Africa (Dold & Cocks, 2001; Marshall, 1998). An estimated 99% of the 400-550 species currently sold for use in traditional medicine in South Africa originate from wild sources (Williams, 1996).

There is no reliable estimate for the number of medicinal plants that are globally threatened, variously calculated as 4160 or 10,000 (Schippmann *et al*., 2002; Vorhies, 2000). There would seem little doubt from theoretical considerations (Holsinger & Gottlieb, 1991; Menges, 1991) that many medicinal plant species that have been listed as threatened, and indeed others that have not, must be suffering from genetic erosion now, or will do so in the near future. This is because populations of many species are in retreat, with outlying populations being destroyed, as the extent and quality of many natural habitats decline (WWF & IUCN, 1994-1997). However, genetic erosion among wild plants is very poorly documented. The advantage of maintaining a pool of genetic diversity within a medicinal species can be illustrated with reference to Arnica (*Arnica montana*), a popular, but endangered, European medicinal plant, in which genes from wild populations have been used successfully to breed superior cultivated strains (Ellenberger, 1998). Another example is African Cherry or Pygeum (*Prunus africana*), a forest tree yielding a medicinal extract from its bark in high demand in Europe. Varieties of *P. africana* are being tested in a breeding programme to select types that will take less time to reach harvestable age (Ekola, Sutherland & Wilson, 2000).

The number of species of medicinal plants known to have become globally extinct is very few and conservationists are advised to avoid exaggerated claims in this respect. One of the best advertised cases is Silphion, a plant apparently found formerly in the dry hinterlands of the Middle East and much prized by the Ancient Greeks. It is believed to have become extinct in ca. 250 BC, with over-harvesting thought to have been a contributory factor (Lambert *et al*., 1997). It should be noted that many medicinal plants are rather widely distributed (Phillips & Meilleur, 1998). In the USA, only 121 of the 3214 plant species classified as of 'conservation concern' are reported to have been used medicinally or in any other way by native Americans. This low percentage suggests that it may be easier for people to recognise the useful properties of plants that are common than those that are rare (Phillips & Meilleur, 1998).

It has been estimated that over-exploitation threatens 150 species of MAPs in at least one European country (Lange, 1998), but it should not be deduced from this that many, if any, of these species are in danger of complete continental extinction. On the other hand, the seriousness of local, national or regional extinction, or, indeed, of commercial extinction should not be under-estimated. There can be serious consequences for livelihoods and economies, quite apart from issues of genetic conservation.

Many of the threats to medicinal plant species are similar to those causing endangerment to plant diversity generally. The most serious proximate threats generally are habitat loss, habitat degradation and over-harvesting (Hamilton, 1997). Medicinal plants can have other uses than as sources of medicines, and the threats from over-harvesting may be due, or partly due, to collection for purposes other than medicinal. This is so in the case of the African trees *Acacia senegal*, *Boswellia papyrifera* and *Pterocarpus angolensis* (Marshall, 1998). So far as collection for medicines is concerned, there is generally agreement that it is collection for commercial trade rather than home-use that is overwhelmingly the problem.

One reason why medicinal plants have become increasingly threatened has been the weakening of customary laws that traditionally have regulated the use of natural resources. Such laws have proved often to be easily undermined by modern socio-economic forces (Pant, 2002). In at least one case, the collapse of customary institutions seems to have been connected directly to changes in the ways that a medicinal plant was exploited, and this may be a widespread phenomenon. Commercial collection of *Prunus africana* commenced in Cameroon in 1972, being at first a monopoly of Plantecam Medicam, a company which took

steps to promote its sustainable harvesting (Cunningham, Cunningham & Schippmann, 1997; Schippmann, 2001). Bark was removed from opposing quarters of trunks, avoiding girdling, the rotation time for bark recovery being 4-5 years. In 1985, the Government of Cameroon issued 50 additional licenses and the controlled harvesting system broke down. Complete girdling now became the norm, or else trees were simply felled so that all their bark could be easily collected. In the case of one site, Mount Oku, it appears that this sudden injection of capitalist enterprise led to a great weakening in traditional customs that formerly helped to maintain a forest cover. The result was, not only destructive harvesting of *P. africana*, but a sudden massive loss of forest to agriculture, with stabilization only becoming achieved through the intervention of an outside project, able to act as a mediator.

Concerns about loss of medicinal plants, considered as material resources, relate to worries about healthcare, livelihood security and financial income. Among those for whom these problems are most acute are the rural poor, reliant on medicinal plants growing close to their homes for their healthcare and perhaps an income. Manufacturers and consumers, higher up commercial systems, are less influenced by local scarcities of resources, often being insulated by manufacturers switching their sources of supply. Unsustainable harvesting practices result in spreading frontiers of resource-depletion, with the negative impacts of over-exploitation confined to the local level until such time as regional or global resource scarcity becomes critical.

Poorer members of local communities can face additional problems of loss of access to medicinal plants due to the privatisation or nationalisation of land. There is a major trend today in many developing countries towards stricter individual ownership of land and plant resources, replacing older forms of tenure and resource-rights in which poorer people could be less excluded. Loss of access through nationalisation can occur with the creation of more strongly protected types of conservation area.

Concerns about declines in local knowledge and cultural survival

Knowledge of medicinal plants, as once embedded in tens of thousands of indigenous cultures, is rapidly disappearing. Every year, the sum total of human knowledge about the types, distribution, ecology, methods of management and methods of extracting the useful

properties of medicinal plants is declining rapidly – a continuation of a process of loss of local cultural diversity that has been underway for hundreds of years. There has, of course, been a great growth in scientific information about medicinal plants in recent decades, but in many ways this has proved poor compensation, because such information is accessible, in practice, only to a very few people and, anyway, rather little of it is relevant to problems of management and utilisation, as encountered in the field.

Among those liable to suffer most from loss of indigenous knowledge are those who live in harsh places, such as mountain ranges, and who have high degrees of dependency on their local natural environments. The cultures and economies of such people must be closely adapted to the intricacies of their local environments, if they are to prosper.

Knowledge of the natural world is typically a very important part of the knowledge-worlds of rural people following more traditional life-ways (Berlin, 1992). Further, medicinal plants tend to figure prominently in these galaxies. It is therefore not surprising that the revitalisation of traditional systems of medicine can be high on the agendas of those promoting local and indigenous cultures, a political trend in many parts of the world. The Foundation for Revitalisation of Local Health Traditions (FRLHT) is an example of an organisation, in this case working in India, which is engaged in many aspects of medicinal plant conservation and sustainable use, including – prominently – cultural aspects, as is clear from its name.

Concerns relating to the availability and quality of healthcare services

The adequate provision of healthcare is threatened by declines in traditional medical knowledge and related plant resources. There are many people, notably in developing

countries who lack – and will continue to lack for the foreseeable future – effective access to Western medicine, while even those who do enjoy this privilege will be limited in their choices of alternative therapies. Traditional medical practitioners came under attack during the colonial era and the legacy of this widely persists. The spread of Western Medicine was aided in its supremacy by association with the political and economic power of the West. Western Medicine became part of the 'civilising colonial mission'. Ayurvedic medicine was suppressed in state-funded medical colleges in India after 1835 and local medical traditions, with their 'witchdoctors', denounced in Africa. Even in China, never under full colonial rule, Western Medicine came to be seen as progressive. The Kuomintang Government decided that Traditional Chinese Medicine was unscientific and passed a law in 1929 making its practice illegal (Griggs, 1981). The increasing nationalisation of medicine during the 19th and especially the 20th centuries and the rise in the power of pharmaceutical companies have given even further impetus to Western Medicine.

Until recently, and then only in some countries, national healthcare systems have devoted all, or nearly all, their resources to the promotion and delivery of Western Medicine, ignoring other traditions. This is now changing, more so in some countries (such as China and India) than others, but, even so, some medical traditions, such as Tibetan Medicine in India and Nepal, have yet to gain official recognition (unlike Ayurvedic Medicine which is officially recognised in both countries). Lack of official recognition and associated support has implications for conservation, because such recognition can raise the status of practitioners at village level. Since such practitioners are generally the most knowledgeable people about plants in their communities and have an intrinsic interest in their conservation, an increase in their authority has the potential to greatly assist improved management of plant resources.
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From the point of view of efficient and effective provision of national healthcare, a problem facing those countries which acknowledge the value of traditional medicine is how best to utilise the resources available. One approach is to provide official recognition to traditional medicine, which is then permitted to operate as a separate sector parallel to and largely unconnected with the main Western medical services provided by the state. Other countries, such as China, are attempting synthesis through trying to draw on the best of different traditions. Official recognition has several implications, including the desirability of registering authentic practitioners and supporting their training. There is also the question of how best to develop traditional systems to meet modern challenges. The environment in which traditional medical practitioners are operating today is not the same as in the past (Craig, 2002). Payment for treatment is now more frequently being requested, associations of traditional medical practitioners are being formed for networking and political lobbying, and there is a move towards professionalisation, including towards instruction based in schools rather than through lineages. The development of traditional medicine to meet modern challenges can be resisted. For instance some Ayurvedic practitioners in India can be conservative and claim that their treatments have been authenticated through long tradition and should not be subject to research (Subrat, 2002). Authentication of traditional medicine is both a cultural and physiological matter and requires more than just trials similar to those used to test pharmaceutical drugs. Sensitive techniques are needed to avoid unnecessary prohibitions. Due attention needs to be given to traditional standards of quality, which, in Ayurveda, for example, classically refer to cultural and tantric use as well as therapeutic qualities (Misra, 2002).

Concerns relating to the terms of research on medicinal plants

This has become the most publicised area of 'policy debate' relating to medicinal plants. It is a field in which "*there has been a polarisation and we've ended up arguing over who is in the wrong*" (Sanesh Kishore quoted by (Macilwain, 1998)). In part, the issues can be traced back to the Convention on Biological Diversity (CBD), agreed at the Earth Summit in Rio de

Janeiro in 1992. Parties to the CBD accept that biodiversity is the property and responsibility of states, that the components of this biodiversity should be used sustainably, and that there should be a just sharing of the benefits arising out of the utilisation of genetic resources (Box 1). Some examples of controversies are presented in Annex 1, given here not to be judgmental about any particular case, but rather to give a flavour of the arguments.

Box 1. The Convention on Biological Diversity.

Parties to the Convention (i.e. nearly all countries) acknowledge the sovereignty of states over the biodiversity in their territories and have agreed to: (1) conserve their biodiversity; (2) use the components of biodiversity in ways that can be sustained; and (3) ensure the fair and equitable sharing of benefits arising from the use of genetic resources on mutually agreed terms. With reference particularly to the third of these objectives, the power to exploit biodiversity commercially for new products is seen as concentrated in the 'North', while much biological diversity lies in the 'South'. Mechanisms for the fair and equitable sharing of benefits arising from commercial exploitation are seen as desirable for reasons of social justice, as well as to provide an additional incentive for biological conservation in countries which are financially poor.

Some of the concerns have arisen because of knowledge, or suspicion, that some scientists, research institutes or commercial enterprises have taken samples of plants to test for new

products, such as pharmaceutical drugs, without due permission or on ethically unacceptable terms. The worry is that there will be no, or inadequate, benefits accruing to the countries and communities from where the materials originate. There are also concerns about the theft of local or indigenous intellectual property, given that the traditional uses of plants as medicines can be useful guides for the development of new drugs (Balick & Cox, 1996; Holmstedt & Bruhn, 1995). Proponents of local and indigenous rights argue that traditional knowledge of the uses of plants can be based on years, perhaps millennia, of experimentation, and therefore it is not only scientists or pharmaceutical companies that can claim to be inventors (scientists do so through the filing of patents). There is also an argument that local and indigenous communities have acted historically as the keepers, or even developers, of biological diversity, and thus should be 'compensated' by those who benefit later from their care and labour.

On the other hand, there are accusations that some countries and territories have over-reacted to the scares of biopiracy and theft of intellectual resources through creating such tight restrictions over research as to potentially cause serious setbacks to conservation and sustainable development (Annex 1). It is highly likely that issues surrounding medicinal plants (especially) have been largely responsible for these alleged over-reactions. Probably, there are often misconceptions about the relative prominence that research aimed at bioprospecting should have (compared with research having other objectives), the extent of bioprospecting and the amounts of money to be made (Box 2).

There seems to be an unresolved conflict concerning intellectual property rights (IPRs) between the CBD and the Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement of the World Trade Organisation (WTO) (Masood, 1998). It is not yet clear how a compromise will be reached between the commitments to accessibility and equity enshrined in the CBD and the pressures for private ownership and profit-based systems of reward represented by TRIPS. "*There is no requirement on applicants* (to TRIPS) *to involve or consult with local communities or governments about patenting a compound based on a natural product from that country. Nor is there provision for sharing benefits or including the prior contributions of indigenous peoples to an innovation*" (Masood, 1998).

Box 2. Some contentions and possible misconceptions relating to research on plants for new drugs.

Most research into medicinal plants is aimed at the discovery of new commercial drugs. Actually, it is difficult to know how great is the relative proportion of research undertaken for this purpose, but, in any case, most research into medicinal plants should be aimed more directly at achieving conservation and sustainable use, especially through enhancing the abilities of communities and

management agencies in developing countries to do so. Communities can benefit from scientific research into medicinal plants in various ways, e.g. through acquiring improved methods of managing these resources, helping to bolster self-belief in local culture, improved healthcare and sustainable economic development. Countries can benefit from such research through their strengthened abilities to conserve biodiversity, the development of integrated health-care systems, and reduced dependency on imported pharmaceuticals. There has been too great a fixation on bioprospecting issues in some 'policy quarters', not realising that this is, or should be, only a relatively minor part of the total research picture.

The amount of bioprospecting by researchers or companies is increasing. An accurate picture is difficult to obtain, but, at least in 1998, a consultation of two dozen experts undertaken for an article in the journal *Nature* concluded that there was not much more bioprospecting for new chemical leads going on then than 10 years earlier (Macilwain, 1998). On the other hand, it was thought, by some, that the search for gene-sequence information is likely to increase, not only for drugs but for food supplements and genetic engineering of crops.

The natural world is full of potential new drugs. This perception was developed as an argument by conservation bodies to convince health-conscious Northerners to take an interest in rainforests and other conservation (Laird pers. comm.). It is also said to owe something to the success of the anti-cancer drug Taxol, derived from the Pacific Yew (*Taxus brevifolia*) (Macilwain, 1998). In practice, the rate of discovery of new drugs from plants has been disappointing. Only 1 plant sample out of roughly 10,000 produces promising results in screening, only 1 in 10 of these might pass to clinical screening and only about 1 in 10 of these might pass to the market (Macilwain, 1998). However, many more samples may serve as useful leads for modification through combinatorial chemistry, and some researchers believe that greater chances of success may follow from concentrating on more promising groups of plants, or following leads provided by traditional medical knowledge.

APPROACHES TO MEDICINAL PLANT CONSERVATION

The merits of systems thinking

An ecosystem-based approach is endorsed by the CBD and is appropriate for conservation of medicinal plants. It encourages lateral thinking, inter-disciplinarity and prioritisation. The ecosystem-based approach of the CBD, as encompassed in its 12 principles (Annex 2), recognises that:

• humans, with their cultural diversity, form an integral component of biodiversity;
• the delimitation of ecosystems for conservation action needs to be defined conceptually on scales appropriate to the problems being addressed;
• work can involve all 3 objectives of the Convention (Box 1), requiring the striking of a balance between them;
• there are uncertainties in managing ecosystems and, consequently, a need for conservation measures to contain elements of ‘learning-by-doing’ or feedback from research;

• the approach needs to be used flexibly, so that other approaches to management and conservation can be incorporated, such as protected areas and single-species conservation programmes;
• benefits need to accrue to those responsible for producing and managing the benefits derived from ecosystems, with a special emphasis on local communities; and
• networks are needed for the sharing of experiences and information.

In view of the inherent uncertainties, the CBD recommends an adaptive approach to interventions and management. This requires the establishment of indicators to monitor the effects of new measures, so that the need to make adjustments can be recognised. Conservationists should periodically take time to reflect fundamentally on their work, drawing back from deep immersion in particular matters. The desirability of changes in emphasis or taking on new types of activity may become apparent.

Figure 1. Some sub-systems involved in medicinal plant conservation, showing where feedbacks are needed from commercial systems, ex situ *efforts and new product discovery.*

Activists (conservationists) will be essential to ensure the success of efforts to conserve medicinal plants. Their work (or 'projects') should be designed to influence the ways that

resource managers, traders, manufacturers, consumers or members of other defined social groups go about their normal business. What is required is the institutionalisation of new

Production systems and *in situ* conservation

Commercial systems (traders, manufacturer, consumers)

New product discovery

***Ex situ* conservation, propagation, domestication, crop variety breeding**

Harvest, trade, export, import, manufacture, consumption

Germplasm collection, storage

Materials for *in situ* planting or cultivation, technical assistance, infrastructural development

Information, training and other technical assistance, infrastructural development, financial benefits

Collection of plant samples/local knowledge, research, licensing, manufacture

Assured markets, better prices for quality materials, technical assistance, infrastructural development

activities in favour of conservation. The attainment of institutionalisation requires the taking of responsibility by the various stakeholders involved, and therefore conservationists need to be careful in how much they take a lead themselves, balancing this with encouraging the development of initiatives by those who are more fundamentally parts of the systems. Conservationists can expect progress normally to be slow, though hopefully with occasional

breakthroughs. They need to be persistent and imaginative. Inherent problems in this field of conservation, as in others, stem from the conservatism of human nature and the low priority that people normally give to conservation over more pressing day-to-day affairs. Conservationists must identify priorities if they are to stand much chance of being heard.

The systems involved in medicinal plant conservation tend to be complex, with many variables and many types of actual or potential stakeholders. For the sake of presentation, 4 distinct sub-systems are recognised here, namely (1) production systems and *in situ* conservation, (2) commercial systems, (3) *ex situ* conservation, propagation, domestication and the breeding of crop varieties, and (4) new product discovery (Fig. 1), though actually all can be closely connected.

It is emphasised that the heart of medicinal plant conservation should be aimed at securing robust management systems in favour of conservation or sustainable production (or both) at the sites where the medicinal plants grow. Given the diversity of field contexts, most 'medicinal plant conservation projects' should be field projects rather than projects of any other type. It will be noted from the brief descriptions of approaches that follow that many measures, which can be taken in favour of conservation, are essentially indirect. They include changes in laws and in the purchasing practices of companies and consumers, the compilation of databases, the *ex situ* preservation of germplasm in seed banks, and so on. What should be borne in mind is that all such measures will be essentially useless for supporting *in situ* conservation and sustainable development unless they 'feed back' positively to the field level. Unless due attention is paid, then 'distant' conservation measures, taken with good intent, may be ineffective or even backfire. Take the case of medicinal plants and Bwindi Impenetrable forest in Uganda. The upgrading of Bwindi from being a Forest and Game Reserve to a National Park in 1991 was a reaction to the rampant level of illegal activities, such as timber harvesting, hunting and gold-mining, that previously prevailed (Cunningham, 1996). Following parks policy at the time, this declaration resulted in a total ban on the collection of all forest produce, including medicinal plants. What was not taken adequately into account, however, was the impact of this tough new regime on local livelihoods and attitudes. One of the items no longer legally available was the bark of Nyakibazi (*Rytygynia* spp.), a product so highly valued for medicinal purposes that, without it, declared the people, "*they would die*". Conflict over this and other matters resulted in an increase in cases of deliberate burning of the forest and threats being made against the mountains gorillas, the flagship species of the forest. The conflict was later partially defused through the formulation of agreements on local rights and responsibilities allowing regulated collection of Nyakibazi and other natural products from the park (Hamilton *et al*., 2000; Wild & Mutebi, 1996).

Another example of a good intention back-firing concerns a suggestion emanating from Europe in the late 1990s for the listing of the medicinal plant Devil's Claw (*Harpagophytum procumbens*) on CITES. A proposal to list a species on CITES might be considered to be an entirely positive matter, but in this case this seems not to have been so, related probably to a lack of appreciation of the situation in the field. At the time, the non-governmental

organisation CRIAA (Centre for Research Information for Action in Africa) SA-DC was just beginning to achieve considerable success in assisting rural communities in Namibia to harvest Devil's Claw in sustainable ways, also involving more direct access to markets and greater income for the harvesters (Cole & Lombard, 2000). Even a mention of the idea of including the species on CITES was apparently enough to cause a fall in demand by the trade. This fed back to Namibia, causing a slump in sales and a general feeling of disappointment, threatening to undermine all that had been achieved through hard work on the ground.

Approaches to production systems and in situ conservation

In many ways, the approaches and methodologies used to promote the *in situ* conservation and sustainable production of medicinal plants differ little, in principle, from those used for

conservation and sustainable use of plant diversity generally. In particular, there are many similarities to those used for other categories of wild plants that are harvested as resources, especially those subject to the pressures of commercial trade.

The types and levels of activities that are possible will vary greatly between projects, depending on the resources of time and money available, as well as the particular interests and competencies of those involved. In any event, it is desirable for project teams to be multidisciplinary, preferably with coverage of the biological, ecological, cultural, economic and political dimensions of ecosytems. At least some members of project teams should have an understanding of both the biological and social dimensions of the ecosystems. Interventions will stand less chance of being successful if conservation teams consist solely of different types of specialist, without such linking expertise. This is why a knowledge of applied ethnobotany is so desirable (Cunningham, 2001a; Hamilton *et al*., 2002). (Ethnobotany is the subject that deals with the relationships between people and plants; applied ethnobotany is ethnobotany applied to conservation and sustainable development.)

The range of possible actions in favour of *in situ* conservation and sustainable use is vast (Aumeeruddy-Thomas *et al*., 1999; Cunningham, 2001a; Hamilton *et al*., 2002; Tuxill & Nabhan, 2001). Some are listed in Annex 3, with a little further information following here on selected items. The broad sequence of activities undertaken at one example of a medicinal plant conservation project, at Dolpa, Nepal, is shown on Figure 2 by way of an example.

The purposes of a project need to be made clear to stakeholders at the outset and revised periodically, as necessary, with local participation as the project proceeds. Because of the interconnections between different components of ecosystems, it will generally be impossible to make progress on matters of prime concern to those instigating a project without some engagement in matters, which, at first sight, might seem peripheral. For example, the objective of a project could be the conservation of local populations of species of MAPs that are globally threatened. However, to achieve this objective might require engagement in a range of 'developmental' activities. Some of these might seem more obviously relevant, such as the strengthening of certain community institutions, but others might seem less so, such as measures to improve livelihood security, healthcare facilities or local income. It is a matter of judgement and experience how far conservation projects should include developmental matters. The experience of FRLHT in southern India is that the involvement of communities in conservation of medicinal plants cannot be achieved without addressing the healthcare concerns of the people. The failure of many integrated conservation and development projects (ICDPs) in the past should not be interpreted as showing that conservation does not need to be integrated with development nor, indeed, that local communities should not be fundamentally involved in conservation projects (Peterson, 2001; Wells *et al*., 1999; Wilshusen *et al*., 2002). Rather, their failure is thought to be due to a delinking of conservation and development ("*we will help you with development, if you don't touch the forest*") and loss of a sense of purpose (and therefore authority) among some conservation agencies, which have increasingly seen their roles as taking responsibility for structural problems, such as poverty, market failures, corruption and the global economic order, rather than getting on with tackling practical problems on the ground (Brandon, Redford & Sanderson, 1998). Current ICDP thinking tends towards an emphasis on building support for conservation based on local cultural and economic concerns, full use of traditional ecological knowledge, and negotiations about the rights and responsibilities of the various stakeholders (Langton, 2000; Naughton-Treves & Weber, 2001).

Figure 2. Example of the sequence of activities in a medicinal plant conservation project (WWF project at Dolpa, Nepal) (Lama et al., 2001).

Initial identification of general problem (over-harvesting of Himalayan medicinal plants for commercial trade, especially for use in India and China).

Selection of site for field work (chosen partly because of presence of an existing

integrated conservation and development project (ICDP) with the potential to support the work on medicinal plants).
Pre-site collection of information relevant to the site/issue (e.g. threat status of commonly traded MAPs; sociology of communities at site).
Formation of multidisciplinary team.
Introduction to community and identification of priority local issues relating to plants (this established that priority local issues included sustainable use of medicinal plants and concerns about the quality of healthcare).
Scoping research to determine broad parameters of the issues.
Return of research results to community: 2 parallel lines of project activities chosen
Development of sustainable harvesting system for MAPs (initially in one trial community/pasture).
Establishment of traditional medical centre (based on Tibetan medicine).
Project continues, with continuing research, feedback to community and other stakeholders, and the use of this local case study to promote national policy debate.

The involvement of local communities will almost invariably be a fundamental ingredient of *in situ* projects aimed at medicinal plant conservation. One reason, crudely stated, is that it is not difficult, in many parts of the world, for collectors of medicinal plants (whether members of local communities or outsiders) to harvest medicinal plants unsustainably or illegally, if the only controls present are those associated with government officials (e.g. (Dold & Cocks, 2001). It is even easier to avoid detection in the case of many medicinals than with timber, which is illegally harvested on massive scales in some countries. Conservation agencies, such as Park and Forest Departments, often suffer from shortages of resources and sometimes also work in conditions of political instability (Hamilton *et al*., 2000). Apart from the problems that they face in regulating medicinal plants, government agencies, acting alone, are liable to have little control over many other activities that can endanger medicinal plants, which may include excessive grazing by livestock, the harvesting of plants for other purposes apart from medicinal (for fuelwood, fodder, etc.) and excessive burning.

The forms of relationships between project teams, local communities and other local stakeholders, established at the onset of work, are critical. These relationships may well be unwritten and relatively informal, but the tone that they set is important if more precise agreements are needed later, including if possibilities of commercial opportunities emerge based on local biodiversity or knowledge (Laird, 2002). Projects are also liable to go through a period of confidence-building as trust is established.

Whatever the initial purposes of a project, it is important that priorities are periodically reevaluated.

As work proceeds, it will often be found that presumptions about priorities at the onset of projects are inaccurate, for instance concerning the abundance and vulnerability of medicinal or other types of plants (Lama, Ghimire & Aumeeruddy-Thomas, 2001; Martin, 1995). It may even be discovered that medicinal plants are of no particular local concern. If this is so, then the project is faced with a challenge similar to that which can occur with other projects started by 'special interest' conservationists. The project team must choose whether to continue narrowly to concentrate on its own special concerns, transform the project into a general habitat conservation project or move to a more promising site.

Successful conservation depends on the existence of rules and regulations, and a reasonable degree of compliance to them. Property rights and terms of access to resources are critical

factors (Subedi, 2002). It is especially important to ensure that the interests of those people in communities whose lives are most dependent on MAPs are properly accommodated. Despite reported successes of joint or participatory forest management in India and Nepal, the MAP sector has often been inadequately covered. For instance, in Nepal there are frequent difficulties relating to a general neglect of NTFPs, excessive restrictions on access, heavy taxes and rent-seeking (Subedi, 2002).

Both customary and statutory laws will often be relevant to medicinal plant conservation. Each type of legal system has its merits and disadvantages, and a critical question facing conservationists will often be how they can best be combined so that their positive elements are strengthened, while avoiding a process of mutual undermining (Pant, 2002). Analysis of the effectiveness of the two types of laws in India and Nepal shows that there can be considerable strength still remaining in customary institutions, but that they often need reinforcement today, as, for example, through their official recognition by government agencies (Pant, 2002; Wade, 1987).

Protected areas, established through statutory law, can be very useful for the conservation of medicinal plants. There are many types (national parks, forest reserves, strict nature reserves, etc.), generally serving various purposes in addition to biodiversity conservation, and with various rules applying to the conservation and collection of medicinal plants. Generally, medicinal plant issues have proved to be low among the priorities of the responsible agencies. In India, for example, the Forest Department is much more interested in timber than nontimber forest products (NTFPs) and, within the broad category of NTFPs, often in other types of products apart from medicinal plants (especially those regarded as being financially more lucrative) (Jain, 2000).

A study of the distribution and exploitation of 14 species of MAPs of high trade and conservation value in a high valley of the Indian Himalayas has started to reveal something of the details which local management plans must incorporate (Table 3) (Uniyal *et al*., 2002). Research resulted in a classification of species according to their distribution (including in relation to altitude and habitat) and pressure (both as regards collection for local use or trade, and pressure from livestock). Recommendations, varying between groups of species, included the protection of particular populations, rotational harvesting, cultivation and development of improved marketing.

The range of measures which can be taken to conserve medicinal plants in protected areas differs little from those that can be applied elsewhere (Annex 3), with the essential difference of an extra layer of legal protection. This means that the rights of communities and other 'outside' parties will be more circumscribed than they are in the general landscape (although, it may be noted, the rights of individual people outside protected areas will depend greatly on systems of land tenure and whether they have private property). Agreements between communities and agencies responsible for protected areas will be necessary if collection of medicinal plants is to be controlled. This legal necessity can create exceptional opportunities to strengthen biodiversity conservation generally – not just in favour of those particular species of medicinal plants which receive specific attention. This is because of the special status that medicinal plants can hold in local societies, related to their symbolic, healing and economic properties. Agreements on medicinal plants can form firm bases for improved management of protected areas generally. If cultivation is introduced in the support zones of protected areas, then the provision of assistance by agencies to encourage this development can usefully be tied to agreements which enhance the participation of communities in conservation of the protected areas.

Various, often isolated, initiatives are being tried to link conservation and livelihoods through a focus on medicinal plants. A project of the WWF-Nepal Programme with the People and Plants Initiative, at Shey Phodsundo National Park, is developing community-based systems

for the sustainable harvesting of medicinal plants, combined with the strengthening of local medical services as provided by amchis (practitioners of Tibetan Medicine) (Lama *et al*., 2001). The amchis are identified as key members of the communities for promotion of conservation, with their allied interests in plant diversity and livelihoods. The Forest Department of the Great Himalayan National Park, India, is promoting cultivation of medicinal plants as an income-generating enterprise linked to conservation (Pandy & Tandon, 2002). The emphasis is on women, in recognition of their economically marginalised status and their special interest in plant resources. By 2002, 92 Women Saving and Credit Groups had been formed involving 930 people.

The Foundation for Revitalisation of Local Health Traditions (FRLHT) is active across the southern cone of India with an integrated programme of conservation, health security and livelihood support, centred around medicinal plants and plant-based medicine (Mrudula, 2002). FRLHT encourages the foundation of micro-credit groups, and seeks to prioritise health problems and related local remedies. Species in demand, and also endemic and threatened species, are grown in nurseries, and planted out in demonstration plots, homegardens, and for enrichment planting in areas of degraded forest (ca. 200-300 ha in size).

Steps are taken to encourage the transmission of medical knowledge between generations. The FRLHT model is proving successful and becoming adopted elsewhere in India.

Three levels of monitoring to guarantee that MAPs are used sustainably have been proposed for Prespa National Park, Albania (Schopp-Guth & Fremuth, 2001). If implemented, they would involve collectors and collectors' organisations, the Forest and National Park Service and scientists, all working co-operatively. They would cover: (1) the recording of the amounts of all MAPs collected, and associated information; (2) detailed population studies of rare species; and (3) monitoring to detect changes in the vegetation, especially on the landscape scale. Actually, in practice, it is necessary to identify indicators in monitoring programmes and the selection of these is important (Cunningham, 2001a; Lama *et al*., 2001). Certain species are of greater cultural or economic significance to communities or agencies, and there is a greater chance that monitoring programmes will give good results if these are included as indicators.

The vulnerability of species to commercial collection depends on the parts of plants used and how they are collected. For example, the collection of underground organs, as is the case with many species in the Himalayas (Aumeeruddy-Thomas, 2002), is liable to be more damaging that if leaves are targeted, as is the case with many species used in tropical forest areas of Africa. Populations of specialist species associated with habitats of restricted occurrence, as *Mecanopsis* spp. in the Himalayas, can easily be decimated (Xie Yongyan, Xu Jianchu & Fang Zhengdong, 2002).

Some countries have laws specifically giving protection to wild plants, some of which may be medicinal. The UK Wildlife and Countryside Act (1981) prohibits the uprooting of any species of wild plant, except by landowners and other authorised people. In several Italian regions, Austrian Länder and Swiss cantons, not only is the uprooting or the collection of subterranean parts of plants prohibited, but there are restrictions on the gathering of aerial parts as well. The number of flowering stems or branches that may be picked varies from 5 to 20, or a handful, according to local regulations. Only a few countries have laws specifically for medicinal plants (Lange, 1998). In Nepal, the collection, sale, transportation and export of *Dactylorhiza hatagirea*, *Juglans regia* and *Picrorhiza scrophulariifolia* are all banned, while other species are specifically banned for export (Aryal, 2002). However, in many parts of the world, for instance Africa and India, laws protecting wild plants are little known by the general public or, indeed, even among those charged with their enforcement (Jain, 2000; Marshall, 1998).

Cultivation is frequently advocated as a measure to take the pressure off wild stocks,

especially for species collected in large quantities for trade (Bodeker, 2002; Lange, 1998). Cultivation can be commercially attractive to companies, because they then have greater control over quality and supply (Harnischfeger, 2000). Various factors influence the feasibility of cultivation, its impact on conservation and by whom it is best undertaken. If

volumes required and market prices are both high, then cultivation is more likely to be economically feasible. The introduction of medicinal plants into home-gardens is seen as a useful means of providing accessible cures for common ailments and supplementary income (Schippmann *et al*., 2002). Medicinal plants have been introduced successfully into traditional farming systems in Guatemala, providing regular incomes to farmers (Eid, 2000).

If cultivation is to be introduced, then there can be many problems inhibiting success – for instance, in India, lack of knowledge of cultivation and post-harvest techniques for some species, and lack of availability of planting material of good quality (Uniyal, 2000). If a species has not previously been in cultivation, then domestication may be needed, which can prove a difficult, expensive and lengthy process (Kuipers, 1997). There should be public funding for domestication programmes for those many species of MAPs which are highly endangered but which economically or otherwise are unlikely to become domesticated. It has been proposed for the Eastern Cape Province of South Africa that faster-growing species are most suitable for communities, but that the cultivation of slower-growing types of plants is best undertaken by statutory bodies, such as the Department of Water Affairs and Forestry, or by private companies (Dold & Cocks, 2001).

There can be advantages to wild collection over cultivation. From the medical viewpoint, there is a widespread belief that wild-harvested material is more efficacious, as is sometimes reflected in higher prices. Asian buyers will pay up to 30 times more for wild-harvested roots of American Ginseng (*Panax quinquefolius*) than for those from cultivated sources. On the other hand, 82% of healers interviewed in the Eastern Cape Province of South Africa stated that they would readily make use of cultivated plants, possibly (according to the researchers) because they recognise that wild supplies are declining (Dold & Cocks, 2001). The social benefits of wild harvest too can be considerable, given that it is generally the most economically and socially marginalised members of communities that are so involved (Lange, 1998). Even if cultivation is introduced, then this may be adopted by relatively well-off people, with better access to land, financial capital or information. The landless and other disadvantaged sectors of society may fail to benefit, but rather continue to collect just as before. Another important factor is that individual land-holdings can be very small and farmers are likely to adopt a high risk strategy in terms of livelihood security if they convet from food crops to MAPs. For example, in the Himalayas topographic and demographic factors limit the size of agricultural land per family often to only 0.4-1 ha (Karki, 2002).

However, from the conservation viewpoint, perhaps the strongest argument for retaining or promoting wild harvesting is that this will then maintain links between people and the intricacies of their local natural worlds (Hamilton, 2001). The successful conservation of biodiversity will always require the existence of people who know about such details and care enough for their existence that they will make efforts to retain them. Without this type of involvement, there is little cultural base at the local level on which to build support for national or global conservation goals.

Approaches to commercial systems

Some conservationists interested in MAPs should become engaged with the commercial sector, both because it is the pressures of trade that are responsible for so much MAP endangerment, and also, more positively, because of the opportunities which engagement with industry and consumers present. Various stakeholders are involved in commercial systems,

including producers (collectors or growers), traders of various types, manufacturers and

consumers (Figure 3). Apart from self-regulation, commercial systems for MAPs are subject to many types of standard, statutory or otherwise. Conservationists can become engaged in various ways, including helping to formulate and promote appropriate standards, supplying relevant information to the parties involved, and also putting parties in touch which each other. Because of the connections between different parts of commercial systems, it will often be productive to work simultaneously with different types of stakeholder. Thus, it can make sense to work simultaneously both with producers (to improve their management systems) and manufacturers (to make their purchasing of raw materials more conservation-friendly). In any event, what is vital is that changes in the behaviour of those at the 'top' of the trade chains (e.g. traders, manufacturers and consumers) feed back to the production level, otherwise efforts will have been in vain.

In many countries, the MAP sector is economically liberalised and in the hands of private enterprise. In such cases, commercial systems tend to be complex, poorly integrated vertically and secretive. There is very little overlap in the UK between the trading systems relating to traditional European herbal medicine, Chinese Traditional Medicine, Ayurveda and Unani (Dennis, 1998). Bhutan has a central system which controls the harvesting of medicinal plants – made into medicines in the capital Thimpu – and then the distribution of the medicines to hospitals throughout the country. In China, there is one major business, the state-owned Company of Chinese Medical Crude Drugs, which is responsible for the bulk of the collection and distribution of raw materials, but there are several major manufacturers of Chinese Traditional Medicine, some under national and others under private ownership. The collapse of Communist regimes in eastern Europe resulted in considerable deregulation of statecontrolled commerce in MAPs and a weakening of pre-existing quota-controlled harvesting structures (Lange, 1998). As a result, the number of traders in MAPs has increased and wild collection has grown in an unregulated fashion, with associated conservation concerns. In Bulgaria, an element of socialist centralisation remains. The main national dealer in MAPs is Bulgarcoop, a co-operative enterprise, but this is joined today by many small, largely familyowned,

businesses. Both Bulgarcoop and 50-60 of the businesses (the latter acting collectively through the 'Private Herb Exchange') provide help to growers with cultivation and guarantees to purchase harvests (Lange, 1998).

Figure 3: Simplified model showing movements of MAP materials or products in a commercial system based on medicinal plants.

Standard-setting with regard to MAPs is a complex business, more so than with timber (which will be a point of comparison for some conservationists) (Pierce & Laird, in press). The complexity is due to the variety of harvesting and socio-economic circumstances, the complexity of the chains of custody through which materials travel, the wide range of markets (local to international) and the numerous types of product. The latter include not only medicines, but also foods, food supplements, fragrances and personal care products. Quite a number of therapeutic products made from MAPs are marketed as food supplements or herbal tonics, rather than medicines, avoiding the stricter regulations that apply to the latter.

The main concerns of the industry (and consumers) as regards standards normally relate to medical efficacy and safety (Pierce & Laird, in press). In terms of botanical ingredients, these

Collectors
or growers
Local
traders
Near-site
processors
Other

traders
Wholesalers
Manufacturers
Retailers Consumers
MORE
THAN ONE
COUNTRY
MAY BE
INVOLVED

concerns translate into specific requirements, most basically that MAP materials or products really are made from the right species, but also concerning the parts of the plants used, the times of harvest, the levels of active principles, and the contents of pollutants. It is not unusual for species to be sold incorrectly labelled (Harnischfeger, 2000). Aside from these medical concerns, some enterprises (and consumers) are also interested in social justice, for instance relating to the distribution of financial benefits received from the trade, and the fair treatment of women and children. There are major questions of social justice in the MAP sector, because of the very low prices generally paid to collectors and, allegedly, the maintenance of artificially high prices by a monopoly of wholesale distributors (Heywood, 2000). Environmental concerns may not be restricted solely to matters strictly related to biological conservation or the sustainability of harvesting. Some environmental standards, such as those relating to organic accreditation, only relate partially to biological conservation. Many manufacturers, at least in some countries, are said to care little about the standards of quality of the material they purchase (Begum, 2002). If manufacturers actually are interested in conservation, then they are faced with the problem of knowing whether the raw materials that they purchase are derived from plants harvested or grown in ways that promote this objective. Manufacturers commonly think about conservation, in this context, in terms of sustainability. In general, even the most environmentally inclined manufacturers will find it impossible to guarantee that all their sources of medicinal plants are sustainable. Many manufacturers buy largely from wholesalers (some of the biggest of which, in Europe, are in Germany). They do so because they then can be more certain that stocks of reliable quality are available, prices are relatively low and purchasing is easy. Therefore, a problem for environmentally inclined manufacturers is how to learn about the origins of MAP materials on sale. Some wholesalers are reluctant to provide information about their sources, fearing that manufacturers might use this information to side-step them in the future. It has been suggested that one way that manufacturers might be able to obtain greater assurance of sustainability is through the incorporation of conservation criteria in the specification sheets which they prepare for the formulation of products (Laird, Pierce & Schmitt, 2003). They can then require wholesalers to confirm that they have met these standards or lose out to other suppliers.

Some manufacturers may be able to encourage higher conservation standards through their more direct sourcing of MAP materials. Likewise, ethical producers may be able to ‘jump up’ market chains, for instance selling MAP materials directly to manufacturers. Collectors and growers often benefit from being organised into associations of co-operatives, including to increase their negotiating power (Pandy & Tandon, 2002; Rastogi, 2002). The US-based Rocky Mountain Herbalist Coalition (www. herbcoalition.wildspecies.com) provides a list of ecologically conscious suppliers of botanicals. Direct sourcing or marketing is not without its drawbacks. Manufacturers may be faced with higher costs and reduced reliability in supplies. For communities, social and economic problems can arise if traditional trading relationships are broken. Probably, direct sourcing is likely to remain a preferred option mainly for manufacturers of 'quality’ products aimed at specialised markets, in which there is an ability

to pay the higher prices required. Nevertheless, there are probably many unrealised opportunities for more direct sourcing awaiting discovery by enterprising communities and manufacturers.

Given the concerns of at least some manufacturers and consumers to produce, or use, medicines of good quality, there would seem to be opportunities for communities, perhaps

motivated by NGOs, to seek market advantage for themselves through adopting higher environmental standards and establishing direct market linkages. An incremental approach is probably often realistic, starting, for instance, from first meeting organic standards, with full certification of sustainability (a complex undertaking) a more distant possibility. If cultivation is attempted, then it is important to select suitable species from the agronomic and economic perspectives, the number of which may be quite limited for any particular site.

An example, which so far is proving successful at promoting a socially and environmentally ethical trade, is the project, mentioned earlier, of the NGO CRIAA SA-DC on Devil's Claw (*Harpagophytum procumbens*). Devil's Claw has become a very popular remedy in Europe, but the plant has been unsustainably harvested in the past and it has even been held that it could be in danger of extinction (Laird, 1999). Between 10,000 and 15,000 harvesters rely on sales from its collection as their only source of cash (Cole & Lombard, 2000). In 1998, a sustainably harvested Devil's Claw project was established at one resettlement farm in Namibia and the scheme rapidly expanded. In 1999, the project covered some 307,415 ha of rangeland and 10,210 kg of Devil's Claw were produced, providing local people with a sustainable product at a guaranteed and fair price. Dave Cole and Cyril Lombard write that (Cole & Lombard, 2000): "*We have been able to demonstrate through this project that by ensuring good prices, by making information available, by creating options, by strengthening their bargaining position and by providing general support, harvesters are taking responsibility for the management of this resource. Compliance with sustainable harvesting techniques, i.e. leaving the tap-root undisturbed and refilling the hole, for example, has increased to between 80 and 85 percent. This is generally not the case in other areas where Devil's Claw is extensively harvested in Namibia.*"

Another example of a project aimed at organising producers for market and conservation advantage is the Medicinal Plants Growers Forum (MPGF) in Uttaranchal, India (Rastogi, 2002). So far, 51 farmers in 4 valleys are members of the Forum, committed to growing medicinal plants to organic standards. One lesson from this and other experiences is the need to involve a wide range of partners from the start, including not only the farmers, but traders, the government, NGOs and scientists, so that the necessary linkages and access to technical expertise are established. The involvement of industry from project inception can help ensure that products will be purchased at agreed prices, taking note of required species and standards of quality. Marketing is a critical issue for the success of organised collectors' or growers' schemes (Begum, 2002). Obstacles to progress with the MPGF have included a cumbersome system of required permits (relating to permission to grow the plants and transport the products), lack of good quality planting material, problems with cultivation practices and access to markets. The Devil's Claw and MPGF projects are trend-setters, but throw up many challenges, requiring dedication and persistence.

There is a wide range of laws, regulations and guidelines (with various degrees of official recognition) relating to MAPs. The major foci of standards along the botanical supply chain are shown in Figure 4 (Pierce & Laird, in press). Actually, biological conservation and sustainability rarely figure prominently in these standards, being, for example, mentioned with very little practical detail in recent proposals for Good Harvesting Practices (GHP) for Collecting Plant Material (Harnischfeger, 2000). Nevertheless, there can be significant opportunities for conservationists in commenting on standards produced by official bodies, recommending improvements in favour of conservation. The World Health Organisation

(WHO) is currently developing Good Sourcing Practice guidelines, which may contain an
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annex on sustainability; if so, they will provide a global point of reference for more local conservation efforts. WHO first published guidelines for Good Manufacturing Practice (GMP) for medicines and herbal products in 1969, recommending these to member states. The aim was to guarantee the consistent quality of medicinal products. The guidelines contained no provision requiring proof of sustainable production, inclusion of which would have stimulated the development of sustainability criteria (Garg, Honnef & Melisch, 2002). In Europe, the European Herb Growers Association (EUROPAM) is currently developing Good Agricultural Practice (GAP) and Good Wild Harvesting Practice (GWHP) guidelines for MAPs (www. europam.net). These might be included in the European Union (EU) Directive on Good Manufacturing Practice for Starting Materials, if and when this directive becomes operational. The GAP guidelines are more or less finalised and have already been endorsed by the European Medicine Evaluation Agency (EMEA). They are weak from the sustainability perspective. There might possibly be a greater chance of incorporating sustainability criteria in the GWHP guidelines, since these are still under active development. There is an EU Directive on Traditional Medicinal Products nearing completion. This deals mainly with issues of efficacy and safety, and apparently will contain nothing on conservation and sustainable production.

Figure 4. The major foci of standards along the botanical supply chain, adapted from (Pierce & Laird, in press)

In the case of China, a new law came into effect in June 2002 relating to the standards of traditional medicines. The main purpose is the regulation of products produced by larger enterprises. The law was introduced because of concerns about inadequate supplies, toxicity (pesticides in the case of cultivated plants; contaminants from plastic wrappings) and lack of standardisation of ingredients (medicines carrying the same name are not always formulated in the same way). The law will require various types of information to be supplied with each batch of MAP material, including the botanical name, the place of origin, the time of harvest and the level of insect contamination. Material of cultivated origin will require information on

PRODUCTION PROCESSING MANUFACTURING
Good Wild Harvesting Practices
(GWHP)
(Wildcrafter standards)
Forest Stewardship Council
Organic Standards
FairTrade Standards
Good Agricultural Practices (GAPs)
Good Manufacturing Practices (GMPs)
Methods Validation Programmes

the fertilisers and pesticides used, and on heavy metal content. Quotas will be set for the quantities of species allowed for wild harvest in particular areas. This is a framework law and regulations for individual species will follow. The current government target in China is to ensure that 50 species of MAPs are cultivated according to GAP by 2010 (Pei Shengji, 2002b). Promotion of GAP is regarded as the most important type of quality standard from the conservation point of view, because it applies directly to the source of the material, but other standards are being pursued in China, including Good Laboratory Practice (GLP), GMP, Good Clinical Practice (GCP) and Good Service Practice (GSP).

Box 3. Potential types of certification for medicinal plants.

Adherence to a set of standards is a prerequisite for certification, which, in relation to medicinal plants, could apply variously to production areas or producers, or to the traded plant material traced through the trade-chain to the final products on the shelf. Certification can be first, second

or third party with reference to how the standards are set, viz. whether they are set by:
• individual traders or manufacturers acting alone (first party certification);
• associations of harvesters, traders or manufacturers, agreeing voluntarily to common standards (second party certification);
• independent standards' setting agencies (third party certification). Third party standards may be mandatory or voluntary. Agencies setting standards include governments, NGOs and private certification companies. Standards set in this way generally carry the greatest credibility, because of the independent element and brand recognition (provided that there is not a confusing number of standards setting agencies with a plethora of logos).

Some countries have laws that regulate the commercial collection or trade of MAPs. Poland lists species of MAPs that cannot be collected without permit. An Italian law of 1931 stipulates that permits for the commercial collection of species that are listed will only be issued to people who have degrees in herbalism from schools of pharmacy. Bulgaria has established a quota system for the gathering of certain MAPs that is reviewed annually, according to species and region. Countries may also ban exports, as did the Government of India in 1994 for 50 species believed to be endangered in the wild (this list was later reduced by one-third following representations by the herbal industry) (Bodeker, 2002).

Adonis vernalis Ranunculaceae
Aquilaria malaccensis Thymeliaceae
Cistanche deserticola Orobanchaceae
Dioscorea deltoidea Dioscoreaceae
Guaiacum officinale Zygophyllaceae
Guaiacum sanctum Zygophyllaceae
Hydrastis canadensis Ranunculaceae
Nardostachys grandiflora Valerianaceae
Panax ginseng Araliaceae (only populations of the Russian Federation)
Panax quinquefolius Araliaceae
Picrorhiza kurrooa Scrophulariaceae
Prunus africana Rosaceae
Pterocarpus santalinus Fabaceae
Rauvolfia serpentina Apocynaceae
Saussurea costus Asteraceae
Taxus wallichiana Taxaceae

Table 3. Plant species included in the CITES Appendices I and II because of concerns about trade for medicinal purposes. All are in Appendix II except Saussurea costus *(in Appendix I).*
[28]

The Convention on International Trade in Endangered Species of Flora and Fauna (CITES) is the main global treaty regulating international trade in plants. Adherence to its provisions is mandatory on the part of its 157 signatory countries. CITES has two Appendices. Commercial trade in wild-taken specimens of species listed in Appendix I is totally prohibited, but allowed under permit for species listed in Appendix II. It is estimated that 233 plant species included in CITES are medicinal, almost all in Appendix II (Schippmann, 2001), though only those on Table 3 were listed specifically because of concerns expressed about their trade as medicinals. *Saussurea costus* is the only frequently traded medicinal plant species in Appendix I (Schippmann, 2001). Most of the 47 species of MAPs in trade in Europe that are listed in CITES are orchids (all species of orchids globally are listed either in Appendix I or Appendix II). Many of these are used in Turkey to make salep, an extract obtained from the dried tubers and found in medicines, drinks and ice-cream (Lange, 1998).

Unfortunately, there are major difficulties in enforcing CITES, not only for MAPs, but for plants generally. Standards of monitoring and reporting for plants are generally poor (Schippmann, 2001). Some parties fail to report plant trade at all, others do not report to species level, and there are frequent inaccuracies in distinguishing between wild and artificially propagated plants (Schippmann, 2001). There is certainly major unrecorded,

sometimes illegal, international trade in MAPs (Mulliken, 2000). One of the difficulties in controlling international trade is the inadequate labelling of medicinal plants for customs purposes. For instance, medicinal plants are imported into Bangladesh under the label of ‘spices’ (Begum, 2002).

To return to the matter of standards, it is known that there can be problems in adherence because there are so many types of standards and some of the requirements are cumbersome to meet (Pierce & Laird, in press). Furthermore, the expense involved in meeting some standards means that they can be discriminatory against small producers. Another issue is that conservation organisations have had problems in devising useful messages for consumers, related to the challenge of combining simplicity with accuracy. A general warning that some medicinal plants are threatened (while most are not) is hardly helpful. There is no unified label existing today guaranteeing sustainability. Fortunately, there is a ground-swell in sections of the industry to improve their conservation standards, partly in recognition that, unless they do so voluntarily, they may well be forced to do so by law. There is also a sizeable market, especially in more affluent countries, for environmentally-friendly products. At present, the best that can be expected generally is that some manufacturers will gain just recognition for their environmental efforts and will accordingly be rewarded by concerned consumers. It might also be useful for a few species which should be avoided by consumers to be identified and publicised, but these have yet to be authoritatively listed.

Because presumably mostl consumers have some interest in the standards of efficacy and safety of medicines, and at least some of them are concerned also about social justice and the environment, it would be useful for conservationists to explore the possibility of establishing a unitary concept of 'quality', covering all of these matters (Pierce & Laird, in press). If so, this could be followed by the development of a system of labelling, with a chance of general recognition, guaranteeing the quality of products containing MAPs across the board. This would greatly help the ethical consumer. Such labelled products should be third-party certified (Box 3).

Approaches to ex situ conservation, propagation, domestication and the breeding of crop varieties

Plant species can be found away from the sites where they naturally occur in a range of contexts, including in botanic and other types of gardens, nurseries, seedbanks, tissue culture units, etc. In fact, *ex situ* conservation is not always sharply separated from *in situ* conservation. There are intermediates between the ‘purest’ forms of *in situ* and *ex situ* conservation, as represented possibly, on the one hand, by the total protection of wild populations of species without any other form of management and, on the other hand, by seedbanks with specialist scientists situated at a far distance from the places where the plants naturally grow. The term *circa situ* conservation has been used for a range of practices commonly associated especially with more traditional (and biodiversity-rich) agricultural systems (Hawkes, Maxted & Ford-Lloyd, 2001). They include the deliberate encouragement of certain species of ‘wild’ plants (which could include MAPs) in 'natural' habitats, the retention of valued 'wild' plants when land is cleared for agriculture or crops are weeded, the growing of valued 'wild' plants in home gardens, and the selection and storage of seed at household level for later replanting. *Circa situ* conservation grades into both *in situ* and *ex situ* conservation.

As an example of how *ex situ* collections of MAPs can be connected to conservation and livelihoods through *circa situ* means, consider the case of the Pepper-bark tree (*Warburgia salutaris*), the most highly prized medicinal plant in southern Africa (Cunningham, 2001b). This species has been collected to the point of national extinction in Zimbabwe, causing difficulties in obtaining the medicine, a matter of great concern to traditional medical practitioners and patients alike. Dr Tony Cunningham and the Zimbabwean NGO SAFIRE

(Southern Alliance for Indigenous Resources) have managed to successfully re-introduce this species from nurseries in South Africa into Zimbabwe. However, reintroduction was not back into its natural forest habitat, from which it would probably again soon disappear since the causes of its over-collection in these largely open-access areas remain. Rather, rooted cuttings were distributed for the home-gardens of local farmers, all of whom knew and valued the species. It is believed that many of these farmers will be prepared to guard the plants with the attention that will certainly be required.

Given that such a large proportion of the world's flora is medicinal, it is not surprising that MAPs are well represented in botanical gardens, even though, in most cases, they will not have been selected for growing because of their medicinal properties. This said, there are many botanical gardens with collections of MAPs and, in some parts of the world, such displays are quite commonly also found attached to schools, museums and other institutions. In general, these living collections consist of only one or a few specimens of each species and, while sometimes of value educationally, they are of limited use from the point of view of genetic conservation. Botanic gardens can play further major roles in medicinal plant conservation through developing propagation and cultivation protocols, and undertaking programmes of domestication and variety breeding. Such research can benefit from traditional knowledge. For example, the seeds of *Paris polyphylla*, a medicinal plant in China, have proved difficult to germinate in trials, but much greater success was achieved after following the practice of a farmer in Yunnan who mixed the seeds with those of another species (Pei Shengji, pers. comm.).

Seedbanks offer a more attractive way of storing the genetic diversity of many plants *ex situ* than botanic gardens, at least in terms of cost (except for species with recalcitrant seeds).

However, medicinal plants are poorly represented in seedbanks (Heywood, 2000). Currently, the International Plant Genetic Resources Institute (IPGRI) is supporting an Economic Crop Protection/Genetic Resources (ECP/GR) Group for MAPs. However, only few members of the group, which convened for the first time in Slovenia in September 2002, have shown an interest in the conservation of threatened species. More concern was expressed at the meeting with gene-banking common culinary herbs with complicated taxonomy (e.g. mint, oregano and thyme – *Mentha*, *Origanum*, *Thymus*).

Unless properly organised, the contribution of *ex situ* collections to *in situ* conservation and sustainable development can be limited. In practice, most seedbanks are used mainly as repositories of the genetic diversity of agricultural crops and their main users are agricultural scientists – breeders of ‘improved’ varieties of crops. Seedbanks will remain of limited use for conservation of MAPs until, and unless, their fundamental purposes and modes of operation are rethought (Richards & Ruivenkamp, 1997). It is not just a question of increasing the stocks of MAPs in genebanks. Nor is there much point in reintroducing endangered species from *ex situ* collections back into natural habitats, unless the factors that caused their endangerment in the first place are reduced or eliminated.

What is needed to make *ex situ* collections more useful for conservation is connection with the socio-economic and cultural dimensions of *in situ* ecosystems (Richards & Ruivenkamp, 1997). This means that *ex situ* collections must be designed to serve developmental purposes (as locally defined), as well as for crop-breeding and 'strict' biological conservation. There is progress in this field in India, where 4 genebanks have been established specifically for MAPs, producing considerable quantities of planting materials for conservation and production purposes.

Approaches to new product discovery

This subject is covered authoritatively in some recent publications (Laird, 2002; Laird & ten Kate, 2002; ten Kate & Laird, 1999) and partially elsewhere in this paper (see Section '*Concerns about declines in local knowledge and cultural survival*'; also Box 1 and Annex 1).

Several stages are involved in the process of prospecting the chemical properties of plants to discover drugs or other novel products. First, unless discoveries are fortuitous, decisions are made about which plants to sample and how to sample them. Sampling may be in the field or from *ex situ* collections, the latter perhaps represented by plants growing in botanical gardens or by dried specimens in herbaria. These decisions are based on published and unpublished information, including sometimes knowledge of local medical uses and about the relative difficulty of undertaking research in different contexts. The next step involves isolation of chemical fractions for automated screening, for example the *in vitro* testing of activity against cell lines. Promising results may lead to further tests, including perhaps clinical trials, and these may result in the development, including licensing, of marketable products. As an alternative to chemical screening, there is growing interest today in screening extracts from plants for genetic information, a branch of science set to grow spectacularly.

Although, according to the CBD, benefits for conservation of biodiversity and sustainable development should accrue from this process, there are often difficulties for researchers, national authorities and communities to agree exactly what these should be. The onus is on all parties to be reasonable, which itself requires a good grasp of the complexities involved. Various types and levels of benefits are appropriate at different stages (Laird, 2002).

Agreements with communities are likely to prove null and void unless they can demonstrate that they have been made with 'prior informed consent'.

The experience of the last 10 years is that the most significant benefits to source countries have resulted from the research process (Laird & ten Kate, 2002). The foundation has been partnerships between bioprospecting companies and institutions in source countries, such as research agencies, universities and local businesses. These benefits have so far been (and are likely so to remain) mainly in the form of scientific and technological capacity-building. They have also been channelled chiefly to central government, and to urban-based companies and institutions, often with little (if any) contributions to conservation or sustainable development at the sites at which the plants actually grow. Even when there have been discussions or inclusion of benefits to source areas, much more interest has generally been taken in equity than conservation.

Thus. the challenge remains for those interested in conservation of biological diversity or development compatible with this objective to connect biodiversity prospecting to real benefits at field level. It is extremely useful if developing country institutions, which enter into agreements with companies, develop clear and transparent institutional policies to ensure that some benefits really are extended to the field. Similar types of policies are also needed on the parts of protected areas, local and indigenous communities, and other involved parties.

Parties to the CBD are required to pass the principles of the CBD into national law to make them effective. Several countries, including the Philippines, the 5 countries of the Andean Commission and Costa Rica have already introduced access and benefit sharing laws, and over 40 other countries are now developing legislation (Laird & ten Kate, 2002). The current challenge is to create a permit system for authorising work by researchers, allowing a fair and equitable distribution of benefits from bioprospecting, while, at the same time, not being overrestrictive
and bureaucratic, and thus preventing or delaying useful research (Annex 1).

KNOWLEDGE SYSTEMS, LEARNING AND INFORMATION

Projects concerned with the conservation and sustainable use of MAPs will normally involve interactions between different knowledge-systems, including associated knowledge-holders, practices and institutions. Interactions between knowledge-systems can provide valuable stimuli for learning how to tackle problems better. Thus, the development of improved systems for managing natural habitats, including populations of MAPs, will benefit greatly from collaborative work between scientists and those local people who are expert in

traditional ecological knowledge (ethnoscientists) (Cunningham, 2001a). The adoption of new cultivation practices for medicinal plants can often best be achieved through building on farmers' own experimental efforts (Uniyal, 2000). The development of improved healthcare systems, especially in developing countries (where financial resources are scarce), can usefully draw on both traditional and Western medicine (Berlin & Berlin, 2000).

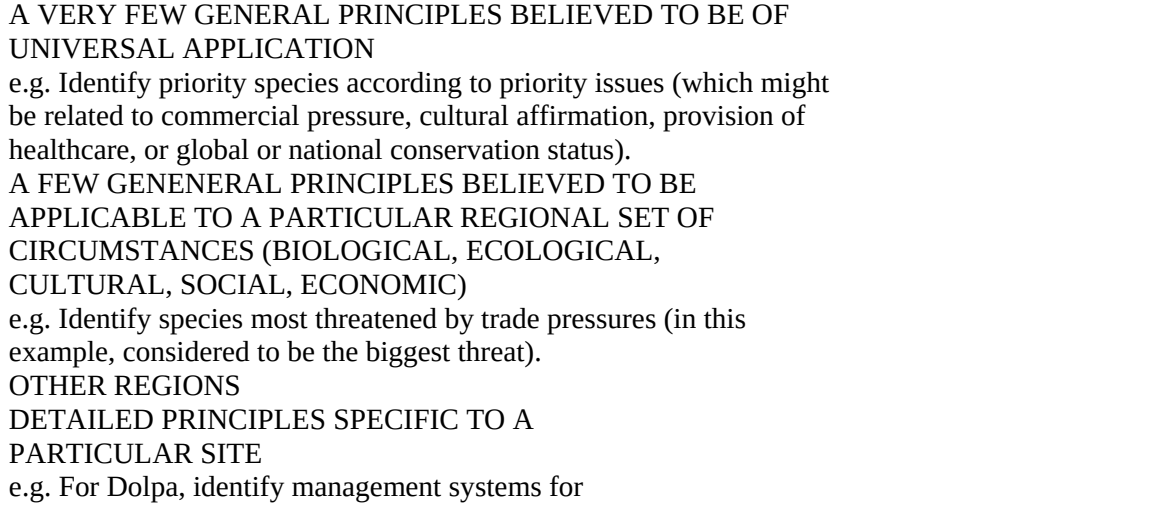
Up to now, most projects aimed at promoting the conservation and sustainable use of MAPs have been local efforts, which, if successful, have led to only local improvements. There is a need to scale-up, to analyse why certain approaches and methodologies have been successful and others not, extract general lessons, and convert examples of good practice into government policies, and the standard practices of scientists, NGOs, traders and manufacturers. The identification of such 'wise practices' is a principal purpose of recent work by the Medicinal and Aromatic Plants Programme in Asia (MAPPA) and by the People and Plants Initiatives in the Himalayas (Aumeeruddy-Thomas, 2002; Karki, 2002). The

development of wise practices is a hierarchical process. Wise practices will be detailed and specific for every particular location, with increasing degrees of generalisation as the scale of application increases (Fig. 5).

The ability to learn will depend on how open people are to new ideas. A sense of history helps in understanding the biases contained in knowledge-systems, allowing clearer views of their strengths as well as limitations. Economics, religion and ideology all influence how cultures develop, including in determining how dogmatic they become and their willingness to change. Conservationists should also have a reasonable grasp of the power and limitations of science, considered as a knowledge-system that has developed according to such influences (Hamilton, 2001).

A major task of conservationists is to create opportunities for the sharing of knowledge to encourage learning. In doing so, they will sometimes find themselves in positions of trust, as confidants of private knowledge. There are strong reasons why some of those involved with medicinal plants try to guard their knowledge. Harvesters of medicinal plants may wish not to reveal the localities of valued plants, fearing that their disclosure will be used by competitors to their disadvantage. An element of mystique increases the power of traditional medical practitioners (as indeed of doctors of all types); the revelation of certain medical formulae or recipes may cause them to lose their potency. The medicinal plant trade is notoriously secretive, fearing competition. Scientists researching on medicinal plants, concerned with plagiarism, may hide their results until they are published.

Figure 5. The hierarchy of wise practices, with the example of prioritising species for research/action at different scales from the global to the local (Dolpa).



conservation and sustainable use of most threatened
species.
OTHER SITES
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There is a traditional distinction between attitudes to knowledge on the parts of academia and industry. Knowledge has typically been considered by educators as a public good, and the acquisition and dissemination of knowledge have therefore been encouraged. The same openminded
approach to knowledge is also a feature of some societies. Referring to the amchis of Dolpo, Nepal, Yeshi Choden Lama and her colleagues have written (Lama *et al*., 2001): "*Transfer of this knowledge* (about the medical uses of plants) *to the global community does not pose any ethical problem to the amchis* (traditional medical practitioners following the Tibetan Medical Tradition)*, except regarding specific compounds that have not been fully tested and therefore cannot be used by non-specialists. It is also to be noted that in the context of Buddhism and Bon, the amchis see this knowledge as an asset to be used for the good of all sentient beings, i.e., human welfare.*" A very different attitude is found among many scientists and commercial companies interested in developing new products. They are likely to resort to the patenting system to register their inventions, receiving, if successful, monopolies over the use of their inventions for a number of years (typically 20 in the case of new drugs). Justifications for this privilege include the claim that inventors need such monopolies to recuperate the expenses incurred in their research and, more generally, that society as a whole will suffer unless there are financial incentives for the development of new technologies.
In actuality, the traditional distinction in attitudes to knowledge between academia and industry is starting to break down. For example, some universities, botanical gardens and research institutions have entered into agreements with private companies, including sometimes for the purpose of new product discovery, and it can no longer be assumed that all such institutions exist, in principle, entirely for the objective pursuit of knowledge and public edification.
A vast quantity of information on medicinal plants is available in publications and on the internet, but, unfortunately, very little of this serves conservation purposes, especially for managers, collectors and growers at field level. Many topics, important for conservation, are little covered, and the information is often unavailable, in practice, to those who might best benefit from it, or comes in unusable forms. There are so many examples that their listing makes depressing reading. Information relevant to the needs of medicinal plant stakeholders in Europe is scattered, difficult to access and not geared towards long term conservation of wild plants (Srivastava, 2000). There are similar problems in Africa (Marshall, 1998) and no doubt other parts of the world. Communities are commonly largely ignorant of market and price information, knowledge of which could sometimes increase their bargaining power. It frequently happens that much material collected by villagers for sale is wasted through lack of knowledge of post-harvest processing, such as techniques of drying and storage. Packages of information developed by research institutes to promote cultivation of MAPs can prove inappropriate under field conditions (Uniyal, 2000). It is reported that most pharmaceutical, perfumery and cosmetic companies have little appreciation of the negative effects that their current methods of obtaining bulk materials can have on the environment (Heywood, 2000). Manufacturers may be ignorant of substitutes for endangered species, such as, it is reported (Behrens, 2001), Marigold (*Calendula officinalis*) or Elder (*Sambucus nigra*) for Goldenseal (*Hydrastis canadensis*).
Those compiling information on medicinal plants need to consider for whom the information is intended, and then the forms in which it should be delivered to be most useful. There is certainly a need to compile general background information relevant to the conservation of MAPs, such as the regional studies undertaken by TRAFFIC (e.g. (Marshall, 1998)), but these

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must be taken a further stage – through selection, refinement and in terms of presentation – if they are to be of much practical use to stakeholders. One practical attempt is that of United Plant Savers in their production of Wildcrafting Guidelines, a 7-point educational guide for harvesters (www. plantsavers.org). On the healthcare side, the organisation Traditional Medicine for the Islands (TRAMIL) has been trying to develop recommendations of simple herbal preparations for home use in the Caribbean and Central America through a programme of validation of traditional remedies.

The analysis of information to select priorities for conservation action can be very helpful. A good example is the identification of *Aquilaria malaccensis* (a tree that produces Agarwood, otherwise known as Gaharu) and *Prunus africana* as the two taxa of highest priority for action under CITES, a selection based on the fact that they are traded in significant quantities, their collection has had detrimental impacts in a number of exporting countries, and they are inadequately reported by Parties under CITES (Schippmann, 2001). Further examples are provided by efforts to identify the most vulnerable species of MAPs (on various geographical scales), based on a range of indicators, e.g. degrees of endemism, habitat specificity, whether destructively harvested, rates of growth, quantities traded, price levels, etc. (Cunningham, 2001a; Lama *et al*., 2001; Marshall, 1998).

As already mentioned, conservationists have found it difficult to provide clear advice to the public relating to their patterns of purchase of botanicals.

CONCLUSION

The special significance of medicinal plants in conservation relates to the values that they hold for people. These values concern the contributions that medicinal plants can make to healthcare, financial income, cultural identity and livelihood security. It is believed that these contributions can sometimes be sufficiently great that a focus on medicinal plants has the potential to achieve much more, in terms of conservation and sustainable development, than just conservation of populations of the medicinal plants themselves, or sustainable production of materials for medicines (though these, in themselves, are admirable objectives).

It would be useful to investigate the geographical relationship between the overall value of medicinal plants to people (if this could be measured) and the distribution of plant diversity. It is suspected that medicinal plants often achieve their highest relative values in societies found in places richest in plant diversity. If this association is found to hold, then projects at many centres of plant diversity aimed at general biological conservation could often usefully have a focus on medicinal plants.

Conservationists need to identify the conditions at field sites that are most favourable for releasing the potential offered by medicinal plants to achieve conservation and sustainable development. It is suggested that the contributions that medicinal plants can make are maximised if local people:

- feel that they receive significant health benefits from locally growing medicinal plants;
- receive an appreciable income from the sale of locally growing medicinal plants;
- ascribe special cultural significance to medicinal plants; and
- believe that there is reasonable chance that these benefits will persist in the future.

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The question of persistence of benefits is crucial. This relates particularly to the relationships of those local people who receive the first three benefits listed above, to systems of land tenure and resource ownership. Different types of tenurial regime will have varying implications:

- Private ownership of land or plant resources may give feelings of security to the owners, who may then possibly conserve or sustainably use medicinal plants (depending on their personal interests), but it may fail to benefit those poorer members of communities whose lives are most closely tied to medicinal plants and is therefore weak in this regard.

• Customary regimes may offer the necessary feeling of security about the future, provided that the customary rules are respected generally in the communities, members of the communities with strong ties to medicinal plants are adequately included, and there is protection (probably by statutory means) from exploitation by outsiders.
• Land which has statutory protection (various types of 'protected area') has the potential to offer security of benefits to local people with strong ties to medicinal plants, provided that this particular group of people is properly included in agreements on rights and responsibilities relating to the protected areas.
• Open access regimes are unlikely to create the necessary feeling that the benefits of natural resources will continue to be available.

There are various ways in which efforts to promote *in situ* conservation or sustainable production can be strengthened through off-site work, including through:

• policy development, in particular to increase the benefits of medicinal plants to local people, including through official recognition of traditional medical systems, measures to increase the proportion of income received from the sales of medicinal plants at the sites of harvesting or growing, official recognition of the rights of local and indigenous peoples, laws that protect customary rights, and laws that designate protected areas with provisions for regulated harvesting of medicinal plants within them, or else promotion of cultivation in their support zones;
• the development of *ex situ* facilities, these having conservation of threatened species and the reinforcement of livelihood security among their objectives, and having good connections to communities;
• stimulating the purchasing decisions of traders, manufacturers and consumers to be in favour of conservation and sustainable use; and
• the compiling of information relevant to the conservation and sustainable use of medicinal plants, and its dissemination in readily comprehensible forms to those people who turn it to practical use.

Finally, there is a need for more work to ensure that benefits from prospecting plants for new drugs or botanicals are fairly and equitable distributed, as required by the Convention on Biological Diversity. In doing so, it is vital that undue restrictions are not imposed on other types of research – as has started to happen in some countries and regions – or else there is a danger that more damage will be done to the causes of conservation and sustainable development than benefits received.

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ANNEX 1. BIOPIRACY VERSUS UNDUE RESTRICTIONS ON RESEARCH: A CONTINUING DEBATE

Some cases of bioprospecting involving medicinal plants that have been seen as unjust.

Quoted in (Commonwealth Secretariat, 2001), originally from: (GRAIN, 2000), The Observer 17/6/01 and the Financial Times 21/6/01: "***South Africa, Kung Bushmen, hoodia cactus:*** *For thousands of years the Kung bushmen who live around the Kalahari Desert in southern Africa used the hoodia cactus to sustain them on long hunting trips. Phytopharm, a small firm in UK, reported the discovery of a potential cure for obesity from the cactus, and patented P57, the appetite-suppressing ingredient in the hoodia. The P57 discovery was hailed by the press as a 'dieter's dream' and Phytopharm's share price rose as City traders expected returns from a drug which would revolutionise the £6bn market in slimming aids. Phytopharm quickly sold the patent rights for $US 35 million to Pfizer, the US pharmaceutical giant which hopes to have the treatment ready in pill form within three years and with estimated annual sales of $300 million. But the P57 patent was made without the prior informed consent of the Kung people, though Phytopharm's excuse was that they were made to believe that the tribes who used the hoodia cactus were extinct, as had been reported to them by the hoodia project officer at the South African Council for Scientific and Industrial Research. Roger Chennels the lawyer acting for the bushmen who number 100,000 across South Africa, Botswana, Namibia and Angola is mounting a legal challenge to what is seen as a major case of theft of the bushmen's traditional knowledge*."

Quoted in (Commonwealth Secretariat, 2001), originally from: (Dutfield, 2000; GRAIN, 2000): "***The Tumeric Patent****: In March 1995, the US Patent Office (USPC) granted a turmeric patent to two scientists from University of Mississippi Medical Centre, Jackson, USA. The New Delhi-based Council for Agricultural Research challenged the decision of the USPC on the basis that turmeric* (Curcuma longa) *has been used by Indians for thousands of years for healing woods and rashes, and therefore lacked novelty – a necessary component for granting a patent. The USPC upheld the objection and revoked the patent*."

Some cases of regulations over research which have been perceived as being too restrictive.

From the New York Times (Rohter, 2001): "*Legislation to regulate 'bioprospecting' in Brazil was introduced in 1995. It passed the lower house of Congress in 1998 but has been mired in the Senate ever since, with the opposition accusing the government of being too lenient with pharmaceutical firms and the government arguing that too tough a stance will discourage research that Brazil cannot afford to carry out on its own. In the absence of permanent legislation, the government has issued a series of temporary decrees that are intended to regulate research. But many foreign research institutions have hesitated to sign cooperation*

accords (fearful that the rules will change)."

From The New York Times (Revkin, 2002): "*Existing and proposed restrictions in countries with biological resources are all aimed at controlling research by drug and biotechnology companies. But evidence has grown that they are harming the most basic field work, even observational studies of wildlife in which nothing is taken away. The restrictions not only affect northern scientists' probing southern forests, but also local scientists. … Delays, fees and research restrictions in countries like Brazil and provinces like Sarawak, the Malaysian part of Borneo, have caused many scientists simply to abandon the critical, difficult work of charting the still largely unexplored maze of species.*"

A statement from Brazil (from a personal source): "*The lack of a definitive law in Brazil is not only discouraging pharmaceutical companies, but it has made it nearly impossible for any foreign researchers to get permits for collection of biological samples. … For example, the lion tamarin researchers (Brazilian and foreign) have found it impossible to get permits to take tamarin DNA (derived from hair samples) of tamarins out of the country for sophisticated genetic labs (non-existent in Brazil) to conduct urgently needed (research) for conservation of these critically endangered species.*"

Problems in East Africa (from a personal source): "*At one time recently, suspicions about biopiracy resulted in it becoming almost impossible to exchange herbarium specimens between Kenya and Uganda. These exchanges were wanted for taxonomic research, essentially unrelated to biodiversity prospecting. Such exchanges have, until this restriction, been a normal feature of scientific co-operation between the countries, as they have been elsewhere around the world. It actually became easier for taxonomists in Uganda to exchange specimens with herbaria in the UK than with Kenya.*"

Different sides of the coin!

From The Times (Hawkes, 1998): "*Leading companies in Britain have been accused of 'biopiracy' for patenting plants used for thousands of years in Ayurvedic medicine. Zeneca, Phytopharm and Procter & Gamble have all been attacked by a New Delhi-based pressure group, the Research Foundation for Science, Technology and Ecology, which claims that they are exploiting herbs long known in India to have medicinal uses. … Phytopharm flatly denies the charge of biopiracy. It manufactures Zemaphyte, a treatment for eczema made from* Tribulus terrestris*, a herb that grows widely in Asia. As Chhotagokhru, its Hindi name, the plant is used for treating urinary infections in Ayurvedic medicine. Dr Richard Dixey, chief executive of Phytopharm, said yesterday: "*Tribulus *is widely used, not only in Indian but in Chinese herbal medicine as well. So who owns it? We originally developed Zemaphyte in cooperation*

with the Chinese and get all our supplies from there. … It would be very hard for the Indians to demonstrate they own it, rather than the Chinese." … India has become increasingly reluctant to provide plant material for foreign companies, accusing them of exploitation. But because India has a reputation for producing cheap generic copies of patented Western drugs without payment of royalties, it is hard to tell who is exploiting whom."

ANNEX 2: PRINCIPLES OF THE 'ECOSYSTEM APPROACH' AS ADOPTED BY THE CONVENTION ON BIOLOGICAL DIVERSITY

(Reference: www.biodiv.org/cross-cutting/ecosystem)

PRINCIPLE SUMMARY RATIONALE GIVEN IN THE CONVENTION ON BIOLOGICAL DIVERSITY

SOME PARTICULAR ASPECTS RELEVANT TO CONSERVATION OF MEDICINAL PLANTS

1 The objectives of management of land, water and living resources are a matter of societal choice.

To ensure recognition of the rights and interests of indigenous peoples

and other local communities, and to manage ecosystems for their intrinsic values and for their tangible and intangible benefits to humans.

General encouragement to promote acceptance of the intrinsic value of conserving ecosystems and to take account of the rights and interests of different groups interested in medicinal plant conservation and use, especially indigenous peoples and other local communities.

2 Management should be decentralised to the lowest appropriate level.

To promote greater efficiency, effectiveness and equity, involve all stakeholders, balance local interest with the wider public interest, and increase local responsibility, ownership, accountability, participation and use of local knowledge.

Stresses the need for the involvement of local people in conservation and sustainable use of medicinal plants.

3 Ecosystems managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

To ensure attention is given to actual or potential effects on other ecosystems, including some that may be presently be known or which are unpredictable.

Attention needs to be paid to the impacts of measures for conservation and sustainable use of medicinal plants on other ecosystems, for instance as a result of new regulations controlling levels of harvest or promotion of cultivation.

4 There is usually a need to understand and manage the ecosystem in an economic context. Management should reduce market distortions that adversely effect biological diversity, align incentives to promote biodiversity conservation and sustainable use, and internalise as feasible costs and benefits in the given ecosystem.

To reduce market distortions which, for example, favour land conversion and promote the costs of conservation to be born by those who benefit from it.

Economic benefits for conservation and use of medicinal plants need to flow back to the production areas.

5 Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority

To ensure the longer term maintenance or restoration of ecosystem services, in addition to simple protection of species.

Management systems incorporating the use of medicinal plants should be evaluated according to

target of the ecosystem approach. the capabilities of ecosystems to maintain vital services.

6 Ecosystems must be managed within the limits of their functioning.

To focus attention on factors which limit maintenance of ecosystems, including taking a precautionary approach in the light of uncertainties.

As above, but promoting a precautionary approach at setting levels of offtake of medicinal plants.

7 The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

To ensure that the boundaries for management are set according to appropriate spatial and temporal scales, and highlight connections between components.

Interventions to conserve medicinal plants should

take account of the realities of relevant systems.
8 Objectives for ecosystem management should be set for the longer term.
To compensate for the tendency of humans to seek immediate benefits over future ones.
As 5 and 6, again emphasising the need to be cautious.
9 Management must recognise that change is inevitable. To promote adaptive management to respond to change which is inevitable.
Promotes adaptive management, including with appropriate methods of monitoring and adjusting approaches and activities if desirable.
10 The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
To provide flexibility, seeing conservation and use in context with a range of associated measures from strictly protected areas to humanmade ecosystems
Balances need to be struck between wider consideration interests and use, including through zonation of land for different purposes.
11 The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
To ensure that all available information is shared with all stakeholders and actors, taking into account *inter alia* Article 8(j) of CBD, and the full participation of stakeholders.
Encouragement to promote the sharing of knowledge and information relevant to medicinal plant conservation with certain reservations.
12 The ecosystems approach should involve all relevant sectors of society and scientific disciplines.
To ensure the involvement of necessary expertise and stakeholders at local and international levels, as appropriate.
All parties interests in medicinal plant conservation need to be involved.

ANNEX 3. POSSIBLE PROJECT ACTIVITIES TO PROMOTE THE IN SITU CONSERVATION OF MEDICINAL PLANTS

Activities are listed approximately following a sequential logic, but such a neat order of work will rarely be possible or probably often even desirable. This list has been compiled with particular reference to (Aumeeruddy-Thomas *et al*., 1999; Tuxill & Nabhan, 2001).

1. Selection of site (if an option), based on an awareness of wider priorities in conservation and sustainable development.
2. Prior to work at site, acquisition of existing relevant information, including about the wider context of the local ecosystem (e.g. the wider conservation, developmental and economic policy environments) and also about all aspects of the history of the site.
3. Identification of local stakeholders and proper introductions to them, with an explanation of project purposes.
4. Agreement with stakeholders on whether and how the project should proceed, including in terms of priorities for project focus, those who should be involved in activities, and the use to be made of the information to be obtained by the project. Such agreements can have various degrees of formality, as appropriate to circumstances, and should be revisited at intervals as the project proceeds.
5. Scoping research to ensure that priorities have been well chosen.
6. Participatory research by project staff or associated outside specialists and local

stakeholders, with regular feedback of results to wider audiences (local; occasionally broader, e.g. national) for review, followed by determination of next steps. Research should aim at providing recommendations for practical action as well as base-line data (biological, social and economic indicators) for use in monitoring. Both participatory appraisal and more detailed research are useful, the former being undertaken with groups of stakeholders consulted collectively or in sub-groups (e.g. based on age, gender or household status) and the latter usually in conjunction with local specialist knowledgeholders (e.g. expert herbalists, harvesters or growers). 'Triangulation' (the use of different methods to check on the accuracy of results) is invaluable. According to context, the subjects of resource could include:

6.1. The types, distribution and abundance of species of medicinal plants and of habitats important for them.

6.2. Threats to the survival and sustainable use of medicinal plants, and determination of the most vulnerable species and habitats.

6.3. The biology and ecology of selected species.

6.4. The distribution of knowledge about medicinal plants, within and between different sections of society.

6.5. The social groups and institutions relevant to management of medicinal plants (actually or potentially) and their relative influence and interconnections.

6.6. Existing statutory and customary laws, regulations and customs relating to the conservation and sustainable use of medicinal plants, and how they are applied and interrelate in practice.

6.7. Systems of land tenure and usifruct rights relating to medicinal plants.

6.8. Medical services available locally and their quality (household level, local traditional medical practitioners, Western medical facilities); the degrees to which they interact.

6.9. Local commercial trade in medicinal plants, including the species concerned, the places of collection, the quantities collected and who is involved.

6.10. Financial benefits derived from medicinal plants, and their distribution through society.

7. Practical actions in favour of conservation or related objectives. According to contexts, these might be aimed at:

7.1. Recognition of community and other institutions responsible for natural resource management, and their interrelationships.

7.2. Agreements on rights and responsibilities relating to MAPs associated with different institutions, and methods of enforcement and of resolving conflicts.

7.3. Zonation of land for different purposes, e.g. with designated total protection areas, wild harvesting areas, cultivation areas, etc.

7.4. The setting of quotas for wild harvest (species/areas) and of procedures for their monitoring.

7.5. Measures to promote regeneration or reinforcement of populations of particular species of MAPs, including in relation to pressures imposed by other types of land-use, such as livestock grazing.

7.6. The promotion of cultivation, for example as a means of taking the pressure off wild populations or to provide an alternative income.

7.7. Measures taken to improve the quality of MAP materials, used locally or traded, e.g. related to times of harvesting, avoidance of adulteration and methods of drying.

7.8. Other steps to add value at the local level, e.g. further processing, improved market access.

7.9. Documentation of knowledge of MAPs and its return to communities to promote conservation, livelihood security, healthcare and local culture.
7.10. Introduction of new techniques to improve livelihood security or healthcare, based on the principle of building on local traditions.
8. Recommendations drawn up to influence wider policies (e.g. on conservation, healthcare, community governance, economic incentives, etc.), to be promoted at 'higher' (e.g. national) levels.

Category	**Explanation of category**	**Proposed conservation measures**	**Species, with habitats of greatest abundance**
RDHP (restricted distribution and heavy pressure)	Species of high trade value. Good population only in restricted habitats. Habitats coincide with grazing sites of sheep and goats.	Species-specific conservation plots should be marked and no extraction or exploitation allowed within them.	*Aconitum heterophyllum* - undulating meadows. *Dactylorhiza hatagirea* - marshy meadows. *Jurinea macrocephala* - open slopes. *Picrorhiza kurrooa* - rocky slopes.
RDLP (restricted distribution and low pressure)	Collected (here) for self-consumption only (although these species are in trade elsewhere). Found in restricted habitats (also not easily accessible to people/animals).	Spatial and temporal rotational harvest.	*Arnebia benthamii* - open slopes, shrubberies. *Nardostachys grandiflora* - rocky slopes. *Rheum australe* - rocky slopes. *Rheum moorcroftianum* - open slopes.
LDLP (localised distribution and low pressure)	Very patchy and localised distribution in their habitats. Very limited extraction. Further research needed to assess status and distribution.		*Bergenea stracheyi* - alpine slopes. *Podophyllum hexandrum* - forest,

open slopes.
RDLHP (restricted distribution and locally under high pressure)
Heavily used for self-consumption. Found near grazing sites. Cultivation should be encouraged and markets developed.
Pleurospermum angelicoides - gaps in scrub on alpine slopes.
WDHP (wide distribution and high pressure)
Heavily used, mostly locally as food. Cultivation should be encouraged and markets developed.
Chaerophyllum villosum - shrubberies and forest.
UCLP (under cultivation and low pressure)
Local people have begun their cultivation. Pressure on wild populations low (considered due to the cultivation). Cultivation should be further promoted and markets developed.
Allium stracheyi - naturally found on rocky and open grassy slopes.
Carum carvi - naturally found in marshland.

Table 3. Categories of MAPs according to distribution, conservation status and level of pressure (from collecting or livestock) in the upper Gori valley, Kumaon Himalaya, Uttaranchal, India (Uniyal et al., 2002).