

## **Vulnerable Medicinal Plants and the Risk Factors for their Sustainable Use in Bhutan**

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### **Abstract**

*Free listing and ranking techniques were used to acquire information on the medicinal plants, which grow exclusively in Bhutan, and to list the 15 most vulnerable species. Furthermore, the possible risk factors that may affect the sustainable use of medicinal plants were also identified.*

*Self-administered, open questionnaires were answered and returned by 10 professionals who possess an extensive knowledge on medicinal plants used in the gso-ba-rig-pa system. A total number of 153 Medicinal and Aromatic Plants (MAPs) were listed. Almost 90% of these species are currently used by the Institute of Traditional Medicine Services (ITMS).*

*All of the 15 most vulnerable species are high altitude medicinal herbs found in fragile ecosystems of the Himalayas between 3,000 to 5,500 meters above sea level. Among them, *Meconopsis simplicifolia* (D.Don), Walpers ranked first in its score and is considered the most threatened species. In the questionnaires, the respondents identified approximately 10 risk factors, which are related to the sustainable use of MAPs.*

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*These risk factors broadly fall into four categories: biological, ecological, social and economical factors. Current policies, frameworks and acts which are put in place to ensure the sustainable use of medicinal plants are described in this paper as well as a discussion on possible future directions.*

## **Introduction**

Human beings, through intuition, have invented the art of healing systems, which are mostly based on medicinal plants. These medicinal plants are accredited with mystical and supernatural powers of healing. They are used widely across the world for primary health care and also in modern drug discoveries. It is estimated that more than 13,000 species of Medicinal and Aromatic Plants (MAPs) are used in traditional medicines and herbal cosmetics throughout the world (Wilkinson et al, 2002). About 8,000 of these MAPs are known in South Asia alone (Karki, 2001).

In Bhutan, medicinal plants have become an indispensable tool for treatment regimens and poverty alleviation. Treatment regimens are available in two systems: *gso-ba-rig-pa* is a codified traditional medical system incorporated and integrated into the mainstream of national health care delivery services, and the *Local Healing System*, which are not documented but practiced countrywide (Wangchuk, 2007). Both these traditional medical systems use medicinal plants as the bulk ingredients.

While the species and the consumption pattern of medicinal plants are not determined for the *Local Healing System*, more than 500 species of medicinal plants are recorded in the pharmacopoeia of *gso-ba-rig-pa* medicines (Chophel 1993). As many as 300 species of medicinal plants, which grow in diverse ecological zones of the country, have been identified so far and more than 200 of them are currently used by the

Institute of Traditional Medicine Services (ITMS) in the formulation of 98 different essential *gso-ba-rig-pa* medicines (Wangchuk, 2004).

In 2007, 16 tons of medicinal plants were procured by ITMS alone (Tenzin, 2008) and 85% of them, almost all wild species, were collected within the country (Wangchuk, 2006). An analysis of the current data shows that around 60% of the plant species collected within the country is harvested from about 3,000 to 5,500 metres above sea level and only 25% are collected from low altitude areas.

The collection, conservation and sustainable utilisation of MAPs in Bhutan are guided by sound legal frameworks and acts: Forest Act 1969, Plant Quarantine Act of Bhutan 1993, Forest and Nature Conservation Act of Bhutan 1995, Environmental Assessment Act 2000 and Biodiversity Act and Framework of Bhutan 2003, 2006 (Yaganagi, 2006; Tshering, 2006). Because of this, the biodiversity scenario in Bhutan is commendable and so flourishes the MAPs.

However, in spite of this, implementation of such legal frameworks is made difficult by lack of basic information on the biology, ecology, synecology, autecology, demecology and sustainability of MAPs in Bhutan. Apart from a few sporadic surveys and consumer chain analysis carried out by the Department of Forest (DoF), Medicinal and Aromatic Plant Section (MAPS) and ITMS, little research has been done on the Non-Wood Forest Products (NWFP) of Bhutan.

Our study on the sustainable use of MAPs in Bhutan is expected to partially bridge the information gap mentioned above. Therefore, this paper identifies the vulnerable medicinal plants, which are believed to be the most threatened species, presents the possible factors affecting the sustainable use of MAPs, and provides some recommendations to enhance sustainability of MAPs in Bhutan.

## **Materials and Methods**

The study focused on the MAPs used by ITMS and did not include those medicinal plants used by local healers and other traditional practitioners in Bhutan. Free listing and ranking techniques (Martin, 1995) were used to get information on medicinal plant species and to identify and select the highest priority species within the frame-work of sustainability. In this technique, each ranked item is assigned an integer (1, 2, 3 and so on) with the most important or preferred species being assigned the highest number. For example, in a list of 20 species, the most threatened species is rated '20' while the least threatened species is rated '1'.

To obtain a representative selection of species, the professionals who possess an extensive knowledge of the occurrence, distribution, growing conditions, methods of collection, use, cross-boarder trade, risk factors and quantity of medicinal plants used in the *gso-ba-rig-pa* system were asked to participate.

Self-administered, open questionnaire forms were distributed to a total of 16 participants comprising of Drungtshos (Traditional Physician), procurement staffs and researchers, all of whom have been working with the ITMS for several years. They have made numerous field trips in the last 20 to 25 years to identify, collect and explore the availability of medicinal plants within the country.

These participants were asked to: first list the medicinal plants that grow exclusively in Bhutan; secondly to rank 20 medicinal species in terms of vulnerability (sustainability) basing their judgement on personal perception and field experiences, and thirdly to identify the possible risk factors that may affect the sustainable use of medicinal plants and

the reasons why. Of the original 16 potential participants, 10 people answered and returned the completed questionnaire forms.

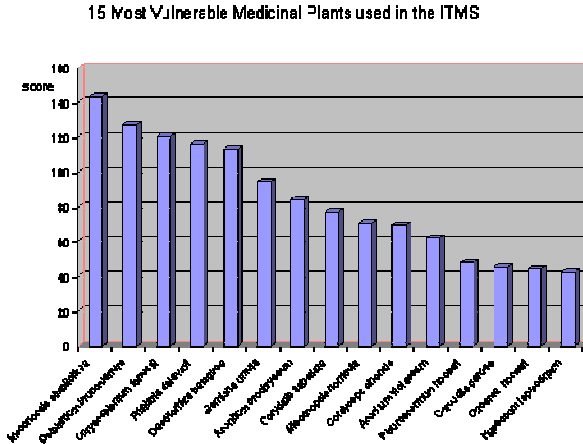
## **Result and Discussion**

### ***Fifteen most vulnerable species of medicinal plants***

A total number of 153 MAPs were identified during the free listing by the 10 professionals involved in the survey. Almost 90% of these species are currently used in the ITMS. As to the ranking of vulnerable species, most of the participants ranked 20 species in response to the request; some listed 15 species, while one participant mentioned only 10 species. For this reason, the first 15 species with the highest scores were identified as the most vulnerable species of medicinal plants. Among them, *Meconopsis simplicifolia* (D. Don) Walpers ranked first in its score and is considered the most threatened species. Ironically, this species consumption by ITMS is comparatively low. The scoring result of the first 15 species is shown in Figure 1.

All 15 vulnerable species are high altitude medicinal herbs found in fragile ecosystems of the Himalayas between 3,000 to 5,500 meters above sea level. Interestingly, the annual consumption of these plants in the ITMS is relatively low. After analysing the ITMS raw material input data for the last nine years (1999-2007), the results showed that the yearly mean consumptions of each of these species varies between 0.5 kg (*Corydalis gerdiae* Fedde) to a maximum of 30 kg (*Aconitum ochrochryseum* Stapf).

**Figure 1. Top 15 most vulnerable species of medicinal plants.**



### **Risk factors for the sustainable use of MAPs**

The sustainability status of the MAPs reflects a broader understanding of how biological, ecological, social and economic factors are intrinsically interconnected to conservation and development. The dynamics of MAPs sustainability and the associated risk factors are discussed in the light of this interconnectedness. In the questionnaires, the respondents identified approximately 10 risk factors, which are related to the sustainable use of MAPs. These risk factors broadly fall into four categories: biological, ecological, social and economic factors.

#### **1. Biological Factors**

**Life Form:** Many NWFPs currently experience significant levels of commercial exploitation. In general, harvesting

interferes with the life cycle of the species. Life cycle characteristics of the species include the phenology of flowering and fruiting, pollination, seed dispersal, species-species and species-environment interaction. However, the life cycle of many MAPs are often poorly known.

All the priority species included in our study, except *Cordyceps sinensis* (Berk.) Sacc, are either monocarpic or polycarpic perennial herbs. The habitats of these species remain snow covered from October to February. It appears as if the rough and difficult environment with an extreme short period for plant development are likely to give better chances for survival to perennial herbaceous plants than to annual species.

However, in terms of production, the quantity of dried raw materials produced by these herbs, are far less than that produced by trees. For instance, a “total of 5,731 plants of *Meconopsis horridula* Hook.f. & Thomson is required to get 57.31 kg of dry material,” “15,570 number of *Onosma hookeri* Clarke needs to be uprooted to get 33.32 kg of its root,” and “28,186 *Nardostachys grandiflora* DC is needed to be uprooted in order to collect 39.46 kg of its dried roots” (Shawe 1997).

The extraction of perennial plants before they reach sexual maturity increases the species vulnerability. The monocarpic species such as *Meconopsis horridula* Hook.f. & Thomson need two years to reach the flowering stage and the individuals have to produce more offspring than required to replace them, since not all offspring will reach maturity. The plants die once they have produced flowers and set seeds. When such flowering plants are collected indiscriminately, the natural propagation process is interrupted, thereby inhibiting the individual plants from producing offspring.

The endangered perennial herbs *Meconopsis horridula* Hook.f. & Thomson and *Meconopsis simplicifolia* (D.Don) Walpers

produce seeds in large numbers, but germination and seedling recruitment are low, both in natural habitats and under laboratory conditions (Sulaiman and Babu 1996). Removing a large proportion of such species in one year is likely to have a significant impact on the species resiliency. The low seed germination, high seedling mortality and low productivity (quantity) will render most of the priority species endangered in the event of persistent collection.

**Harvesting Plant Parts:** The extraction of some plant parts has a bigger impact than others, i.e. taking roots are typically more damaging than taking seeds or flowers. It may affect the whole life cycle of the individual plants and produce a number of ecological impacts. For instance, persistent harvesting of the root of a single stemmed, sparsely distributed plant may threaten the survival of the species.

The inappropriate harvesting methods of the tubers and bulbs of *Onosma hookeri* Clarke, *Aconitum violaceum* Jacq, *Fritillaria delavayi* Franchet and *Dactylorhiza hatagirea* D.Don or the uprooting of *Meconopsis simplicifolia* (D.Don) Walpers and *Meconopsis horridula* Hook.f. & Thomson in order to collect the aerial parts, obviously removes the whole individual and has a detrimental effect on sustainability. The uprooting of deep-rooted species in a fragile ecosystem would result in soil impoverishment by erosion and deprive the plants from their required nutrients. As a consequence of high frequency collection, length of roots and volumes of root biomass become smaller and lesser.

Similarly, the uncontrolled harvest of seed leads to decreases in seedling establishment. The over-harvesting of flowers may result in fluctuations of species availability in the following years. The debarking of the plants may result into slow death of the whole plant.

Although the immediate result of indiscriminate harvesting of relatively small number of individuals may not be visible, such practices can have a significant impact on long-term sustainability. On the other hand, for the formulation of traditional medicines; the harvest of roots, seeds and flowers of some species is unavoidable. However, for the last 11 years, the annual harvest of high altitude medicinal plants by ITMS has been optimal and sustainable (Tenzin 2008), and the harvest of high value species like *Nardostachys grandiflora* DC may be lower than what is illegally traded.

## **2. Ecological Factors**

**Habitat and population density of the species:** Studies on distribution patterns of medicinal plants were carried out in the neighbouring countries of India and Nepal but not much investigation has been carried out on distribution and population parameters of MAPs in Bhutan. The first scientific survey for high altitude medicinal plants was conducted in 1997. Only a few important species, based upon their global and perceived local threatened status, were studied at that time.

The plants in high alpine vegetation generally tend to form enormous root systems but hardly grow above the soil. One example of small plants with comparatively big roots is *Gentiana urnula* H.Smith, a species of 7 to 10 cm of height. The important medicinal plants such as *Fritillaria delavayi* Franchet, *Neopicrorhiza scrophulariifolia* (Pennell) Hong, *Onosma hookeri* Clarke and *Nardostachys grandiflora* DC have comparatively large roots. Since the roots of these species are used in the traditional formulations, the whole plants are uprooted. These species are either restricted to alpine scree slopes or inhabit alpine meadows and slopes - all fragile environments. The uprooting damages their habitat and affects the growth of the population.

## *Vulnerable Medicinal Plants and the Risk Factors*

In general, most of the high altitude medicinal plant species occur in low frequency and density. Species with a higher density are mostly restricted to specific habitats. For example, *Delphinium brunonianum* Royle grows only in Chewla in a small pocket area. Likewise, *Meconopsis horridula* Hook.f. & Thomson inhabits only open alpine slopes.

The sustainable use of any plant species depends upon the renewal capacity of the population. To sustain a consistent population pattern, enough seeds or other reproductive material should be available for future regeneration. Although extraction of entire mature individual does not necessarily reduce population size, *ad hoc* inappropriate collection practices exert a considerable influence upon the ecology and the sustainability of natural resources.

In the same way, harvesting a segment of the population may influence the population pattern. For instance, during a survey in 1997 *Dactylorhiza hatagirea* D.Don was found at 0.086 plants per m<sup>2</sup> in their traditional collection site at Lingshi and the authors argued that harvesting may have contributed to the low density for this species (Shawe, 1997). Currently, ITMS collects *Delphinium brunonianum* Royle from few segments in Lingshi area. As indicated, *D. brunonianum* Royle, grows only in restricted specialized ecological niches. The prolonged harvest of this species from the same locality would endanger the survival of the species in that locality. Species such as *Gentiana urnula* H.Smith, *Corydalis gerdae* Fedde and *Meconopsis horridula* Hook.f. & Thomson have a clumped distribution pattern. If they propagate vegetatively, harvesting part of the clumps may not significantly affect reproduction.

**Natural calamities and outbreak of fire:** Like other Himalayan countries, the environment in Bhutan is highly vulnerable to glacial lake outburst, avalanches, soil erosion

and the decaying of some Himalayan mountains. Bhutan is a volcanic zone and its eruption may be devastating for any life forms especially alpine herbs. Another destructive phenomenon is fire. Acres of forests are destroyed by fire in Bhutan and valuable medicinal plants are lost. Fire management in Bhutan is made difficult by the rugged terrain and impassable ranges.

These entire natural phenomena contribute to the loss of some plant species in Bhutan. While some phenomena are beyond the control of human beings, at least fire can be prevented and controlled with information dissemination and appropriate fire control strategies and equipment engagement.

**Overgrazing:** Cattle, yak and sheep rearing is another significant economic mainstay of Bhutan. Overgrazing of the grasslands/forest by such animals - especially yaks - has a detrimental effect on the survival of the grazed plant species. Yaks consume every type of herbage vegetation apart, from a few toxic species and are able to feed on very short growth (Gyamtsho 1996).

They have an ability to negotiate narrow footpaths on rocky slopes and consume the herbs and grasses from isolated pockets. Unlike other grazing animals, they cover large areas of grazing ground every day. The intensity of yak overgrazing the alpine and temperate rangeland accelerates the rate of ecological destruction. For example, intense browsing by yaks checks the growth of seedlings of the Himalayan yew, *Taxus baccata* Linnaeus (Norbu 1996). The pastures around Laya, Lungo, Jarila and Lingshi are already affected by the grazing activities of large herds of yaks joined by flocks of blue sheep and marmots (Gyamtsho 1996).

Most of the important medicinal plants, e.g. *Meconopsis horridula* Hook.f. & Thomson, *Meconopsis simplicifolia* (D. Don) Walpers, *Fritillaria delavayi* Franchet, *Delphinium*

*brunonianum* Royle and *Corydalis gerdæ* Fedde in the country are restricted to delicate and specialised habitats. The intensive overgrazing, if not monitored, could lead to more habitat destruction and shrinkage of the natural population sizes of the valued medicinal plants.

Besides, some plant species like *Senecio* and the *Ligularia* which contain pyrrolizidine alkaloids that may be of medicinal values, are found to be toxic to yaks and cattle (Winter et al 1994). Such poisonous plants are cleared by cattle herders in order to protect the cattle. This destructive act also significantly contributes to the extinction of many alkaloid-containing MAP species.

### **3. Economic Factors**

**Commercialisation:** The unpolluted environment and environmentally friendly cultivation practices provide Bhutan with a unique advantage for marketing the MAPs and its derivatives. Many medicinal plants such as *Aquilaria agallocha* Roxb., *Ephedra gerardiana* Stapf *Rauwolfia serpentina* (L.) Benth. ex Kurz., *Taxus baccata* Linnaeus, *Rheum nobile* Hook.f. & Thomson, *Rheum acuminatum* Hook.f. & Thomson, *Neopicrorhiza scrophulariifolia* (Pennell) Hong, *Nardostachys grandiflora* DC, *Aconitum spicatum* (Bruehl) Stapf, *Artemisia* species, *Panax pseudo-ginseng* Wall. sub sp. *himalaicus* H.Hara and *Cordyceps sinensis* (Berk.) Sacc are in high demand for pharmaceuticals and have potential international market value (Ngawang, 1996).

Bhutan has already legalised the trading of few species like *Cordyceps sinensis* (Berk.) Sacc, *Swertia chirayita* (Roxb.ex Flem.) Karsten, *Piper mullesua* D.Don and the oil extraction from the lemon grass. It is also rumoured that *Neopicrorhiza scrophulariifolia* (Pennell) Hong and *Nardostachys grandiflora* DC are traded but no data support this.

The legalisation of *Cordyceps sinensis* (Berk.) Sace harvesting has improved the livelihood of highlanders. All the family members, above the age of 18, can collect the *Cordyceps* for a period of one month (May) in a year. In 2008, a kilogram of *Cordyceps sinensis* (Berk.) Sace fetched as high as Nu. 221,000 a kg (approximately US\$5,262) but compared to 2007 (which was Nu. 400,000 a kg), the price had gone down (Gyeltshen 2008). The business of Cordyceps in Bhutan is solely determined by the international market trends and so far it has been lucrative. However, the impact of collection, its biological characteristics and ecological sustainability are yet unknown. But definitely, pressure on the species is increasing. It is reported that the regeneration span of a caterpillar in the same area is at least four years (Dhendup, 2008) and if this is the case, sustainability of Cordyceps remains foggy.

In the temperate and sub-tropical forests of Bhutan, logging activities are common. Although it is said to be managed properly, many valuable medicinal plants are destroyed in the process.

When economic forces become a reality, people's interest in maximising their income could jeopardise their concern for a sustainable harvest of MAPs from the wild. Concomitant with the globalisation of market economics and increase in demand, the rate of demand and utilisation of MAPs will expand and their sustainability, especially the vulnerable species, can be threatened.

**Multiple use and commercial diversification:** The impact of multiple uses exerts intense pressure on some plant resources. The MAPs are extensively used as incense, fruits, dyes, resins, vegetables, spices, oils, fodder, firewood, in rituals and as ornamental plants. Until this date; about 181 fodder plants, 107 ornamental plants, 97 fruit and nut species, 77 forest vegetables, 40 incense aromatic plants, 36 natural dyes, 25 oil/resin species, 20 spice species and 12

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food crops have been identified (Tshering D 2006) and most of them are medicinal plants.

The local markets in Bhutan are flooded with MAPs like the roots of *Nardostachys grandiflora* DC, leaves and stems of *Rhododendron ciliatum* Hook.f, *Rhododendron setosum* D.Don, and aerial parts of *Tanacetum nubigenum* Wall for use as incenses. The *Rhododendron* and *Nardostachys* species are mixed together and widely used in religious rituals. Most of the raw medicinal species sold in the local markets as incense are often collected indiscriminately, with no consideration for future regeneration. This trend would increase as more and more small-scale incense making industries and private sectors which are dependent on NWFP are encouraged by the government. There are already 17 licensed incense entrepreneurs in Bhutan (Tideman, 2006). It is reported that most of the raw materials currently used for incense making in Bhutan are imported from India. But it is more likely that illegal extraction and trade of selected incense plant materials are taking place.

The stem of some medicinal plants like *Juniperus squamata* D.Don and *Juniperus pseudo-sabina* Fisch are commonly used as incense, sacred artefacts for Statues, and as firewood. *Rhododendron anthopogon* D.Don, *Bombax ceiba* L. and *Cinnamomum obtusifolium* Nees are often cut down for use as firewood. The root of *Onosma hookeri* Clarke and *Rubia cordifolia* L, important medicinal plants, are used locally as natural dyes.

A number of medicinal plants are eatable and serve as a food resource. This may be more common in rural communities. When rain does not fall, when the water becomes scanty and when the yield from the farmland cannot support the lives of the rural farmers, it is the only choice for them to turn to the forest for food supplies. Fruits and nuts from *Phyllanthus*

*emblica* L., *Terminalia chebula* Retz., *Terminalia bellerica* (Gaertn.) Roxb. and *Butea buteiformis* (Voigt) Grierson & Long etc. are often plucked, eaten and collected by rural people passing through the forests. *Asparagus racemosus* Willd., *Adhatoda vasica* Nees, *Allium macranthum* Baker, *Taraxacum officinalis* Wigg., etc are used as vegetables and spices. Few species of medicinal plants are used as tea leaf. The oil is sometime extracted from the seeds and nuts of some medicinal plants. Some of these edible wild plants are occasionally marketed in the Thimphu vegetable market.

*Nardostachys grandiflora* DC, *Rhododendron ciliatum* Hook.f., *Rhododendron setosum* D.Don, *Hippophae rhamnoides* Linn., *Dactylorhiza hatagirea* D.Don, *Meconopsis horridula* Hook.f. & Thomson, *Corydalis calliantha* Long, *Juniperus* species, etc are considered important ornamental plants in Bhutan (Chhetri, 1996). In fact, the Japan-Himalayan Company, which was established in 1990, is the pioneer of this ornamental plant business in Bhutan and has exported *Cupressus*, *Gaultheria*, *Edgeworthia* species to Japan at 60-100 yen per cutting (Chhetri, 1996). Many medicinal plants used by the ITMS are also part of the pharmacopoeia of traditional medical systems of neighbouring countries and again this means extra value and more demand for these species.

As indicated above, many plants are used for multi-purposes. The intrinsic value of a plant gets multiplied with its many uses, thereby increasing their risk of over-exploitation. The market trends determine the market values of the plants. The intensity and impact of exploitation on those species could subsequently speed up with the rise in market value. Hence the multiple use and commercial diversification of medicinal plants, if extended and intensified, would surely have an impact on the sustainability of MAPs in Bhutan.

#### **4. Social Factors**

**Poaching and Illegitimate Trade:** Illegitimate harvest puts selective pressure on the species collected. These activities seem to have increased in recent years. Although illegitimate harvest and cross-border trade involves only a few species, high proportions are of conservation concern. For instance, two important species, *Cordyceps sinensis* (Berk.) Sacc and *Fritillaria delavayi* Franchet, are the subject of considerable cross-border trade. Because of the high price and increased demand in other traditional medicines, these species are hunted illegally and are traded across the borders. Since these species are uprooted, the plants are highly susceptible to the impact of illegitimate harvest. *Neopicrorhiza scrophulariifolia* (Pennell) Hong is also extensively collected. The rare species *Delphinium glaciale* Hook.f. & Thomson, *Delphinium brunonianum* Royle, *Nardostachys grandiflora* DC and other medicinal plants like *Rhododendron ciliatum* Hook.f., *Rhododendron setosum* D.Don, and *Tanacetum nubigenum* Wall are traded illegally as incense. While only parts are removed from some plants, many species like *Nardostachys grandiflora* DC, *Neopicrorhiza scrophulariifolia* (Pennell) Hong and *Fritillaria delavayi* Franchet are uprooted.

The sparse data available on the amount of illegally harvested medicinal plants indicates that any that for every one species that is harvested officially, ten are harvested unofficially. (Shawe, 1997). If these illegal activities are not controlled, the gradual disappearance of some species is likely.

On the other hand, the level of forest staff in rural districts are insufficient to manage or control the vast forest areas, which is made even more difficult by the rough undulating impassable terrain of the country. In fact, these difficult terrains have served as the nesting place for illegal harvesters in the country.

**Human Population Expansion:** The current population of Bhutan is 646,851 and the fertility rate is 2.6 percent (NSB 2007). This figure looks small compared to the populations of other countries. But given the small size of a country (38,394 square kilometres), most of which are rugged mountains that are often prone to landslides, and also given the high fertility rate, the population is an issue of concern in Bhutan. The National Statistics Bureau of Bhutan projects the population figure to rise to 886,523 by 2030. This increase in the human population will inevitably exert an increased pressure on the country's natural resources including MAPs.

Human population density in Bhutan's high altitude regions, where the share of medicinal plant growth is high, is much lower than in neighbouring Himalayan countries. But this does not mean that the impact is not felt. Even in those high altitude regions, the local population has been rapidly increasing as a result of better child health care, improved nutrition and implementation of development activities. In fact, this segment of the population has an inherent impact on the MAPs of Bhutan exerted either through their settlement and farming practices or through the related economic activities.

Thus, the overall repercussions of population expansion in relation to medicinal plants in Bhutan are - the increased MAPs trade and demand, over exploitation, habitat loss, and ecological failure undermining the sustainability of the MAPs, especially the rare and high value medicinal plants.

**Access to markets:** The high altitude areas are accessible only by foot and it often take days or even weeks to reach them. Improving the existing mule tract would facilitate the implementation of development and conservation programme. Concurrently, improved roads enable rural people to get to larger customers. In other words, the income of local communities from MAPs could rise with more access to markets. On the other hand, an easy access to valued

medicinal plants could potentially affect their sustainability negatively.

Social issues such as land tenure have a lasting impact on the rangeland. Generally people recognise and safeguard a resource base, which they own. An open access to resources by the outsiders is often detrimental. An unambiguous delineation of land use rights for the local communities would most likely support future sustainability of MAPs in Bhutan.

In the face of income generation, many governmental institutions and non-governmental organisations are encouraging biological, especially MAPs, utilisations in Bhutan. The Marketing Sections at the ITMS and the Ministry of Agriculture are exploring markets for the NWFP and disseminating the market information to the farmers and traders. While the information on market accessibility would give local producers and collectors a stronger bargaining power with the traders, it is more likely that, due to their overpowering greed, this may lead to the indiscriminate and unscientific collection of MAPs.

### **Conclusion and Future Direction**

Our study identified the 15 most vulnerable species of medicinal plants (of those collected by ITMS) and 10 risk factors which are divisible into four major groups for the sustainable use of MAPs in Bhutan. This may not be the true picture since our finding is more or less based on those MAPs in and around Lingzhi and do not reflect the MAP profile of the whole country. Thus, one should be careful to make broad generalisations regarding their sustainability, since it will be necessary to undertake location specific assessments in at least a representative sample of areas to get the overall population picture of these 15 species in the country. Furthermore, some Bhutanese medicinal plants are instead

procured from India, thus minimising the threat against the survival of the plants in Bhutan.

However, it may be safer to assume that there is increasing pressure on the medicinal plants in general and on the 15 identified species in particular.

Among the four major risk factors identified; economical and social factors could be more detrimental to MAPs in Bhutan than the other factors. Nevertheless, they shouldn't be considered in isolation as the factors are interconnected and affect each others. Although risk factors put pressure on the sustainability of MAPs in Bhutan, sound policies on conservation, protection and management in the country are put in place to counterbalance this.

It is an advantage that collection of medicinal plants, including these 15 high priority species, by ITMS are regulated through "Special Permits" issued annually by the Department of Forest under Ministry of Agriculture. Moreover, over the years MAP Section (MAPS) under Ministry of Agriculture and ITMS have jointly initiated the MAPs domestication program and training of farmers on the "Good Collection/Harvesting Practices" and "Post Harvest Care". Recently, based on these cumulative farmer training experiences, MAPS and ITMS jointly developed a "Guidelines for Identification and Collection of 26 Medicinal Plants (Krug and Milliken 2008) and it is expected to help in educating the collectors (farmers) of ITMS.

In fact, farmers are now more aware of MAPs sustainability and they use less destructive harvesting techniques. So, assuming collection is presently within a sustainable range, it can be hypothesised that if current demand and prices offered by ITMS remain at its current level, collectors will protect their source of income against overexploitation.

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The NWFP Task Force, where the first author is also a member, has already endorsed the development of “National Strategy for NWFP Development in Bhutan (2008-2020)”. This body also started developing guidelines for resource assessment and their management of the economically potential species like *Piper mullesua* D.Don and *Swertia chirayita* (Roxb.ex Flem.) Karsten.

While most of the 15 vulnerable species described in this paper are included in the “Guidelines for Identification and Collection of 26 Prioritised Medicinal Plants” (Krug and Milliken 2008), it will be also appropriate to include them in the list of NWFP priority species and accordingly develop guidelines for resource assessment and their management. The identification of risk factors in the present study is expected to help in devising such strategic guidelines and management plans for other MAPs in Bhutan. While it is the responsibility of the DoF to carry out resource assessment, inventories and develop management guidelines for NWFPs in Bhutan; there are lots of challenges for them. They lack expertise on all the NWFPs, especially MAPs, and this is complicated by the fact that there are huge numbers of NWFP species that cannot be handled by the limited staffs they have. Hence, developing such guidelines and data pool for all the 300 MAPs is a Herculean task. Nonetheless, DoF should co-ordinate with different stakeholders and let them initiate the process. In the case of the MAPs, the 15 identified species would be a starting point.

The perspective for improvement of the sustainable use of MAPs would indeed be determined by the robustness of the implementing body. This robustness can only be achieved if adequate information exists on the MAPs biological and ecological characteristics, the plants vulnerability and on the socio-economic and political dynamics. This is currently lacking in Bhutan. In the absence of this information, the

implementing body is faced with dilemmas over their decisions for utilisations of MAPs. It is therefore important to: conduct MAPs inventories, determine their abundance, gather ethno-medical and ethno-botanical information, assess the impact of current collection practices, enhance research into MAPs and establish databases.

Some legal frameworks need adaptations and revisions to facilitate sustainability and meaningful utilisation. Changes in the resource base combined with changes in operational rules would indicate adaptation and could render sustainable management probable, where as a static rule system could be an indicator that adaptation to an inherently dynamic resource is not taking place; rules and physical attributes could be incongruent, leading to either inefficient use or depletion of the resources (Larsen, 2002).

When the illegitimate cross-border trade and illegal collection of high value MAPs are commonly taking place, it is only appropriate that these illegally traded species are legalised for collection and encouraged for domestication by the Bhutanese people. At least this way, our people can generate income and alleviate their poverty. At the same time, since the exploitation of MAPs by the illegal traders across the borders are of conservation concern, enough forest guards should be stationed there to strictly monitor and guard the resources.

All these gaps and challenges in terms of information pool, research capacity, legal implementation, management and utilisation plans should be addressed as soon as possible. This could be done successfully only if different MAPs stakeholders join forces. Examples of this are seen between ITMS and MAPS, which jointly domesticated and introduced a list of important species in different regions in Bhutan. In collaboration with ITMS, the MAPS at Yusipang in the western region focuses on medicinal plants that grow in mid and high elevation, whilst the MAPS at Mongar in the East

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concentrates on low altitude species. Consequently, the herb gardens were established at Lingshi (4,000 meters above sea level) and at Lingmithang (600 meters above sea level).

A germplasm collection of over 53 species has been established, and a total of 13 species have been successfully propagated and subsequently distributed to farmers or planted out in on-station trials. While the compatibility of community development and the sustainable use of MAPs through such domestication are yet to be seen, it is definitely an optimistic indication that domestication is possible and would reduce pressure on selected wild populations.

Therefore, there is urgent need to strengthen similar collaboration and improve networks among the stakeholders encompassing farmers, government institutions, national and international organisations, NGOs and other agencies and projects involved in conservation and management of MAPs in Bhutan. In spite of all the emerging positive trends occurring inside these different organisations, there are not much cross-disciplinary collaborations and sharing of information.

As a result, there are duplications in the MAPs initiatives thereby leading to wastages of government resources. For the success of any MAPs sustainability schemes and programs, it is also imperative that farmers, local healers, cattle and yak herders and relevant private organisations, who are directly or indirectly involved in MAP activities, are included in the decision making process.

From our experiences and also based on the experiences of Community Forest Management initiated by the Social Forestry Services; sustainability of MAPs would become more robust if government lands, which host MAPs, are leased to those enterprises dealing with MAPs.

These enterprises may include government organisation, private enterprises and the rural communities or farmer associations. Included in the leasing agreements are accessibility rights and the responsibilities for proper management, conservation and utilisation; and these should be vigilantly monitored, evaluated and regulated by the responsible government organisations.

Bhutan is known for her richness in MAPs resources and there are lots of potentials including that of bio-prospecting. However, many Bhutanese and also outsiders feel that not much has been utilised so far. A high proportion of the rural population lives under the poverty line, and engaging them in the MAPs business with strategic management and conservation plans, would be a right approach to eradicate their poverty. It is therefore crucial to speed up research into domestication, cultivation and ecological sustainability of MAPs; reinforce in situ and ex situ conservation; enforce legal frameworks weighing beneficence over risks, and allow sustainable utilisation of MAPs in Bhutan. This requires a huge financing, but perhaps the revenue generated by eco-tourism could be used for rural community development through conservation, protection and enhancing the sustainable use of MAPs in Bhutan.

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