Chapter 7

The Dilemma of Balancing Horticultural Development with Conservation of the Diversity of Genetic Resources in the HKH Region

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Introduction

Diversifying agriculture in mountain areas has become a priority target, with the aim of economic security rather than food self-sufficiency. Governments and mountain farmers in the Hindu Kush-Himalayan (HKH) region have been making a concerted effort towards diversification of agriculture into cash crop farming. As a result there is a growing trend towards commercialisation of agriculture in the region (Partap 1995). This trend represents the efforts of mountain farmers to use their land resources for cash crop farming. This emphasis on high-value cash crop farming is succeeding in bringing people out of the poverty trap in some areas. The overall economy of these areas shows signs of food security and some measure of economic well-being (Partap 1995). Governments of the region have been encouraged by these successful examples and are emphasising the development of horticulture[1] wherever possible. Agricultural development planning at national, provincial, and local levels has been tuned to meet the new objectives. This paper analyses horticultural development strategies and experiences in many areas of the HKH from the viewpoint of their impact on the diversity of indigenous genetic resources. The paper highlights the fact that native agrobiodiversity has not been harnessed for horticultural development, although it is a potentially valuable source, and this indicates potential problems of lack of sustainability which may emerge if current approaches continue.

1 In this paper, horticulture is broadly defined to include cash crop farming, such as fruit farming, vegetable farming, floriculture, and mushroom cultivation, etc.

The Value of Horticultural Genetic Resources

A look at past efforts shows that genetic resources have been successfully used to our advantage in many ways — including the domestication of new crops and the development of plant strains with disease resistance, pest resistance, high yield, vigour, environmental adaptation, high food value (vitamins, proteins), cytoplasmic male sterility, petaloid male sterility, and adaptations for harvesting, transport, and post-harvest handling and quality.

The use of these resources can be expected to continue and will probably increase. This will be made necessary by the need to cope with new ecological conditions, more virulent diseases, more difficult pests, fluctuations in climate, and changing economic demands. Changes in technology and social expectations also encourage greater use of genetic resources.

Broadly, there is a great potential for using genetic resources in horticulture for the development of new domesticates and the improvement of existing domesticates. Hundreds of species could be used to improve existing horticultural domesticates alone. However, the main factor that determines the degree of their use is the availability of suitable germplasm. Breeders and genetic engineers can devise more and more ingenious ways of using available genes, but they cannot create new ones. The reasons for conserving variations within species are firstly that genetic variation is essential for species to adapt and survive and secondly that genetic variation is the new material for domestication and for the continued survival and improvement of the domesticate. Both reasons are equally valid and each requires different approaches to conservation. But so far conservationists have usually only considered the first reason, whereas the second has been mostly ignored.

The following pages explain how loss of habitat, overexploitation, and competition and predation by introduced species are threatening the horticultural genetic resources of the HKH region. The possibilities of finding new species of potential genetic value are diminishing, as the areas of greatest ecological diversity within the region are subjected to more and more deforestation, shrinking of habitats, and agricultural expansion. The wild gene pools of many fruit crops have been drastically reduced by habitat destruction already (Partap 1993).

Horticultural Development Strategies of the HKH Countries

Horticulture is being advocated as an important activity for mountain areas as part of the agricultural diversification process. The basic intention is to take advantage of different climatic conditions to provide better sources of income for mountain people, improve their living standards, and stabilise fragile mountain land.

Horticultural development strategies in the HKH Region have a three-fold approach: emphasis on self-sufficiency in horticultural items that are currently imported; promotion of those crops which could be exported to gain foreign exchange (especially crops with a proven market value that are well developed and cultivated in large amounts elsewhere); and a low priority effort to improve the nutritional status of undernourished mountain communities by encouraging the cultivation of fruits and vegetables for family use. Horticultural policy planning and research institutions are making earnest efforts to bring a range of activities, such as vegetable farming, floriculture, mushroom cultivation, and farming of medicinal plants, within the scope of horticulture.

Following the introduction of this approach, there have been impressive financial gains from horticulture in some areas of the HKH region. However, the objectives of rational use and conservation of available genetic resources and their biological diversity are still missing. The results of this neglect become clear when the strategies and impact of various programmes are analysed.

Competition between Old and New Crops

Several factors have dictated the choice of horticultural species in the HKH region. Some are stated in the objectives of programmes, others are not. Biological diversity, whether for use or for conservation has not been given attention so far. The chief objective of programmes in the HKH region is the introduction of well-developed crops with good marketing potential. Table 7.1 illustrates how little use has been made of the genetic resources in the region to develop new domesticates for diversifying horticulture in an ecological context.

An example of the crop gene pools that exist in the HKH mountains is the diversity of land races of pears and apricots maintained by the mountain farmers of northern Pakistan (Tables 7.2 and 7.3). The North East Indian Himalayan region

Table 7.1: **Diversity and Use of Horticultural Resources in the HKH Region**

Crop type	Number of species promoted for cultivation		Approximate number of species used locally
	Major	Minor	
Fruit trees	5	18	150-200
Fruit shrubs	2	5	80-120
Vegetables	8	20	230
Tuber vegetables	1	6	15
Spices	3	8	40
Mushrooms	1	6	280
Medicinal and aromatic plants	10	50	500
Other plant resources, e.g., fibres, insecticides	?	7	50

Source: Partap 1993

Table 7. 2: **Diversity of Local Varieties of Pear Cultivated by Mountain Farmers in Pakistan**	
Vernacular name of variety	Preferred Traits for Selection of Variety
Parao	Large, pear shape
Sur Tango	Small, round
Shin Rulay	Medium, apple shape
Spin Tango	Small, round
Mamusay	Small to medium, round, early
Shakar Tango	Sweet, medium size
Nashpati	Medium to large, sweet
Tang	Large, pear shape
Khan Tango	Small, round
Batang	Large, pear shape, sweet
Nag Tango	Large, apple shape, hard
Nar	Oblong to pear shape
Shal Tango	-
Khar Nak	Large, hard
Gadaray	-
Bap Tango	Early
Khawaga maiwa	Small, round, sweet
Khapa	Sour
Source: Partap 1993	

Table 7.3: **Diversity of Local Varieties of Apricot Cultivated by Mountain Farmers in Pakistan**	
Vernacular name of variety	Preferred Trails for Selection of Variety
Marpho choli	Red apricot
Karfoo choli	White apricot
Warfo choli	*Pit* used for oil
Bro Choli	Late maturing
Khakas choli	Kernel partly split
Cho choli	Juicy
Apo choli	Large
Beru choli	Small
Blafo choli	Small red
Odumar choli	Partially red
Chun choli	Sweet pith
Yakar choli	Reddish
Gurdaalo choli	Like peach
Pharang choli	Dry apricot
Kartaksha	Early, juicy
Sara choli	-
Kacha choli	Hard, good to keep
Halsnan choli	Best quality
Kazangi choli	Sweet
Khashanda choli	Good taste
Kho choli	Bad taste, sour
Shakanda choli	Sticky
Tacho choli	-I
Marghlam choli	Early, good quality
Shanda choli	Small, early

Table 7.3: **Diversity of Local Varieties of Apricot Cultivated by Mountain Farmers in Pakistan (cont'd)**

Vernacular name of variety	Preferred Trails for Selection of Variety
Stun choli	Late
Mamoor choli	-
Ghom choli	-
Sara karfo choli	Early
Stun kuban choli	-
Khustar choli	-
Sapastan choli	Sour, kernel used for oil
Miting choli	Sour, kernel used for oil
Shakar choli	Sweet
Hongool choli	-
Brook choli	-
Halwar choli	-
Duspaong choli	Selected for specific agro-ecological characteristics
Yakab yak choli	-
Snair choli	-
Shikanda joo	-
Brum joo	White
Surasune joo	Good quality
Duda-sanag joo	-
Koropiam joo	-
Al. Shan l;akas joo	Late
Habi joo	Very late
Khanemish joo	-
Kartach joo	Very early, white
Dudar joo	-
Ghulam joo	-
Rashikin joo	Early
Alman joo	Good quality
Koropian joo	Early
Gakateen joo	-
Kaka shikanda joo	-

Source: Partap 1993 *Note: See also Table 24.3*

has a similar rich diversity of land races and wild relatives of citrus fruit, mangos, and bananas (Arora and Nayar 1984). The indigenous species of citrus protected in the citrus sanctuary include *Citrus lemon, C. medica, C. jambhiri, C. ichengensis, C. latipes, C. macroptera, C. assamensis, C. indica, C. aurantium, C. lamonica, C. karna,* and *C. aurantifolia*. The Indian wild orange, *C. indica*, is found in the Naga hills near Dimapur, and the Garo hills of Meghalaya contain many *Prunus* species such as *P. nepalensis, P. undulata, and P. cerasoides* (Kaul 1988). There is a good range of vegetable and tuber crops, such as *Alocacia, Abelmoschus, Amorphophyllus, Colocasia, Dioscorea, Luffa, Cucumis* and *Trichosanthes* in different parts of the region. *Alpinia speciosa, A. galanga, Amomum aromaticum, Curcuma zeodooria, C. amada, Piper longum,* and *P. peepuloides* are the main species of spices and condiments. The region is home to several species of

medicinal plants such as *Berberis, Cassia, Coptis, Gynocardia, Litsea, Paedera, and Solenum* (Kaul 1988).

These examples show that there is much valuable indigenous plant material in the HKH region. In some areas of the Himalayas there is a vast genetic diversity within various fruit plants which remains underexploited or threatened by extinction, by habitat destruction, and by displacement with new exotic crops.

Tables 7.4, 7.5, 7.6 and 7.7 show that, by and large throughout the HKH region, the focus has been on a limited number of high-yielding varieties (HYV) of fruit and vegetable crops. This has created agro-ecosystems with monocultures of these crops. However, in some countries, such as Bhutan, the objective has been to develop agro-ecosystems with a limited number of lead crops, and this is justified from the point of view of economic viability (Table 7.8).

Table 7.4: Agroclimatic Niche-based Selection of Fruit Crops in Nepal

Fruit	Zone system (districts)
Citrus fruit	Dhankuta, Bhojpur, Terhathum, Sankhuwasabha, Panchthar, Ilam, Sindhuli, Ramechhap, Dhading, Kabhrepalanchok, Gorkha, Lamjung, Tanahu, Syangja, Kaski, Palpa, Gulmi, Salyan, Dailekh, Dadeldura
Apples	Solukhumbu, Sindhupalchok, Rasuwa, Mustang, Jumla, Kalikot, Dolpa, Rukum, Doti, Baitadi, Darchula
Bananas	Kabhre, Dhading, Nuwakot, Sarlahi, Dhanusha, Mahotari, Chitwan
Pineapples	Dhading, Nuwakot, Sarlahi, Chitwan
Mangos	Bara, Parsa, Rautahat, Sarlahi, Mahotari, Dhanusha, Sunsari, Sirha, Saptari, Chitwan, Kapilbastu, Nawalparasi, Rupandehi, Surket, Dang
Walnuts	Jumla, Kalikot, Bajhang, Darchula, Baitadi, Dolpa, Rukum
Pears	Dhankuta, Bhaktapur, Lalitpur, Kabhre, Dhading, Makwanpur, Sindhu Palanchok, Nuwakot, Rasuwa, Palpa
Grapes	Banke, Bardiya, Manang, Mustang

Source: Partap 1993

Table 7.5: Choice of Fruit Crops in the Mountains of Pakistan According to Altitudinal Zones *(metres above sea level)*

Altitude (m)	Fruit crops
1200	Almonds, pomegranates, apricots; plums, persimmons, peaches, grapes, figs, pistachios, mulberries, strawberries
1500	Almonds, pomegranates, apricots, plums, persimmons, peaches, grapes, figs, pistachios, mulberries, strawberries, cherries, pears, walnuts
1800	Apples, peaches, grapes, cherries, pears, walnuts, mulberries, strawberries
2100	Apricots, apples, peaches, plums, pears, walnuts, strawberries
2400	Apples, apricots, pears, peaches, berry fruits (gooseberries, currants, raspberries)
2700	Apricots, apples, berry fruits (currants, gooseberries, raspberries)
3000	Apricots (early-maturing cultivars), berry fruits (gooseberries, currants, raspberries)

Source : Partap 1993

Table 7.6: Fruit Farming in Himachal Pradesh According to Agroclimatic Zones

Agrocli. Zone	App. elev. (masl)	Rainfall (cm)	Fruit crops
Low hills (subtropical)	365-914	60-100	Mangos, litchis, *valley,* loquats, citrus fruits, papayas, *ber figs low-chilling,* varieties of pears, early varieties of grapes
Mid-hills (sub-temperate)	914-1523	990-100	Peaches, plums, apricots, almonds, persimmons, pears, pomegranates, pecans
High hills (wet, temperate)	1523-2742	90-100	Apples, pears (soft and valley types), cherries, walnuts, almonds, chestnuts
Cold and dry Trans-Himalayas	1523-3656	25-40	Grapes, prunes, drying varieties of apricots, almonds, chilgozas, sarda melons, pistachios, hops, apples

Source: Partap 1993

Table 7.7: Fruit Farming in the Hengduan Mountains, China, according to Agroclimatic Zones

Agroclimatic Zone	Areas of Interest	Fruit Crops
Hot arid zone Av. annual temp. >20°C Winter, 7-12°C Summer, 24-28°C Humidity in sub-zones 0.67 – 0.50% 0.5-0.29%	• Yuanjiang river valley, Shangjiang River valley • Jinshanjing River valley, Ninnan, Qiaojia	• Coffee, mangos, bananas, papayas, *common* • Citrus fruits, bananas, guavas, longans, litchis *>1900 n* apples, pears, peaches, grapes
Warm arid zone Av. annual temp >14°C Winter, -5 to 7°C Summer, 22-24°C Humidity in sub-zones 0.67-0.50% 0.50-0.29%	• Dadu River valley, Lhasa River valley, Yalong River, reaches of the Lanchangjiang River valley • Jinchuan-Luomo in Dadu River valley, Binchuan Basin in Yunnan	• Apples, pears, peaches, plums, apricots, cherries, persimmons, grapes, walnuts, chestnuts, loquats, pomegranates • Hanyuan snow pears, Luding sweet-smelling peaches, navel oranges from Shimian and Dechang, Xig peaches of Xichang, green skin pomegranates of the hills, apples, pears, pomegranates, walnuts in Jinchuan Danba, tangerines in Binchuan basin
Temperate arid zone Av. Annual temp *>10°C* Winter, 0°C Summer, 18°C Humidity in sub-zones 0.67-0.50% 0.5-0.29% 0.29-0.2%	• Zagunor River valley, higher reaches of the Mingjiang River valley • Songpau in Minjiang valley, higher reaches of Dadu River and its tributaries • Batau Shangiatou area of the Jinshajiang River, higher inaccessible areas or lower reaches of the Nujiang River valley	• Concentrated areas for pears and apples • Snow pears, best quality apples • Pears, apples

Table 7.7: **Fruit Farming in the Hengduan Mountains, China, according to Agroclimatic Zones (Cont'd)**		
Agroclimatic Zone	Areas of Interest	Fruit Crops
Cold arid zone: Av. annual temp. >4°C Winter, -7°C Summer, 12°C Humidity in sub-zones 0.67—0.50% 0.50—0.29%	• Bayu-Batan area of Jinshajian River valley, Changdu • Manhan in Lanchagjiang River valley, Bangda-Zougong in Nujiang River vallley • All high altitude areas	Wild domesticates of: flowering crab apple *(Malus toringoides)*; Chinese crab apple *(Malus asiatica)*; hawthorn *(Crataegus scabrifolia)*; and Japanese apricot *(Armenzaca mume)*.
Source: Partap 1993		

Table 7.8: **Agroclimatic Zones in Bhutan and Horticultural Crops being Promoted**		
Agroclimatic zones	**Important areas**	**Horticultural crops**
Northern 30 km wide. Alt. above 4000m. Cold climate, perpetual snow, glaciers, barren rocks	High mountain areas	• • No farming practices or horticultural activities
Central 70 km wide. Alt. 2000-4000 m. Temperate climate, major forest areas, horticulturally suitable	Thimpu, Paro, Ha, Bhunthang, Wangdiphodrang	• Apples, potatoes • Scope (trials): asparagus, apricots, peaches, plums, cherries, walnuts • Scope (planned): currants, blackberries, gooseberries, raspberries, loganberries
Southern 50 km wide. Foothills, alt. to 2000 m. Tropical to sub-tropical warm climate, horticulturally suitable	Samchi, Gaylephug, Chirang, Samdrup	• Cardamom (low-volume, high-value), lemon grass oil (wild resource, low-volume, high-value), oranges, ginger, chillies, potatoes. • Scope (planned): mangos, guavas, litchis, bananas, kiwi fruit, figs, black pepper
Source: Partap 1993		

The data also show that there is a continual attempt to identify distinct mountain micro-climates, and to look at the agro-ecological requirements of known exotic species or cultivars in order to evaluate their suitability for introduction into these climates. Only the variations in climate are considered, not the whole agro-ecosystem that develops under the sum total of all conditions.

The strategies and programmes of Himachal Pradesh, recognised as the fruit or apple state of India, are presented as a further illustration of the position of

genetic resources in horticultural development policies. These strategies and programmes include the following.

- A programme for production and supply of fruit plants. This material facilitates plantation of hybrid varieties, mostly apple.

- Under an apple cultivation support programme, financial support is given to farmers to purchase plant material, pesticides, and fertilizers. There are also projects supported by international aid agencies on apple crop development and promotion.

- A programme on top-working wild fruit trees was launched and wild relatives of fruit crops were top-worked *in situ*. The total target for the Sixth and Seventh Plan periods was 11 million plants to be detopped. This meant converting jungles into orchards.

- Diversification of horticulture, enlarging its scope to include mushroom culture, vegetable farming, cultivation of medicinal plants, and other activities is underway. Special crops such as hops, sarda melon, and pistachio are being introduced in high mountain areas where the climate is temperate.

One Indo-Italian project introduced olive cultivation in Himachal. Other introductions include rootstocks for various temperate fruits such as apples, peaches, plums, and cherries.

There have been several projects assisted by UNDP, FAO, and the Dutch government to promote the cultivation of mushrooms. Under these projects some strains of *Agaricus*, essentially introductions, were promoted for cultivation.

Introductions and Monoculture

The promotion of the production of temperate fruit crops in the Indian Himalayas has had a number of negative consequences. These are described below as an example of the problems associated with too great a dependence on introductions.

Temperate fruits (apples, pears, peaches, apricots, cherries, plums, almonds, walnuts, pomegranates, and persimmons) have been instrumental in transforming the farming economy of several hilly areas of the Indian Himalayas. But this success has been based largely on introductions of varieties and rootstocks of several of these crops. The focus of horticultural research in institutions in the region has been directed mainly at the introduction of convenient, developed genetic material (Table 7.9) and to the evaluation of the key features of such material (Chadha 1986). Higher yields through introductions are being pursued. Such large-scale

Table 7.9: Dimensions of the Introduction of Temperate Fruit Crops in the Indian Himalayas	
Apples	• All commercial cultivars introduced over time • Latest trend is the introduction of genetic material for dwarfing and disease resistance from Europe • The introduced cultivars are different spur types • At present promising rootstock introductions from the Malling Merton series such as M 26, M 7, M 25, MM 106
Pears	• Bartlett is the main introduced commercial cultivar being promoted for cultivation
Cherries	• Recent introductions include Megness, Devoc, Starkrimson
Peaches	• Many introduced cultivars such as Sletta, Merton, Bigarreau, Sunburst, Lapins, Sarn, Van • Some new hybrid selections from Canada under evaluation • Lack of availability of a suitable rootstock and heavy virus infection in existing plant material are critical constraints to the crop.
Plums	• Introduced cultivars are Kanto-5, Shnnizu from Japan, Red haven, Sun haven, three of the Prairie series and Veteran, all from the United States and under evaluation • Rootstock Brompton and St. Julian K are under evaluation • Recent introductions are Starking Delicious, Late Santa, Queen Ann, Nubiana, Burmosa, Laroda, Stanley, Cacenska Rana, Ruth Gersttater, all from the United States.
Apricots	• Santa Rosa, a known cultivar. • The introduced species Myrobalan is a promising clonal root stock • Newcastle cultivar introduced for the mid-hills • Some native varieties known for the high hills • Recent introductions under evaluation include Hargraud, Reliable, Forming, and many others from Bulgaria • No clonal rootstock available yet
Almonds	• Introduced cultivars are Non-pareil, Ne Plus Ultra, Drake • Other introductions under evaluation are Wonder, Bruce, Mercett.
Source: Partap 1993	

introductions into a region may result in several unforeseen problems. One of the first problems observed has been the introduction of new diseases (Table 7.10). These diseases can be caused inadvertently by using genetic material that is infected but which has escaped detection. Investigation of such diseases in the region shows that they came with crops into which large-scale genetic material introductions were made (Partap 1993). Technologies are being perfected to avoid the transfer of such diseases, yet the dangers persist, especially in poor developing countries in which the application of these technologies depends on the availability and development of infrastructural facilities.

Apples have emerged as the number one crop in the HKH region in terms of both areas under cultivation and production (Teaotia 1993). There are already a number of indicators that apple monoculture plantations will not be sustainable

Table 7.10: **Exotic Diseases and Pests of Fruits and Vegetable Crops Which Were Introduced with Genetic Resources into the Himalayan Region of India**

Disease/Pest	Affected Crop	Source of Rootstock	Date of Introduction
Hairy root	Apples, pears	Sri Lanka	1940
Crown gall	Apples, pears	Sri Lanka	1940
Canker	Apples	Australia	1953
Woolly aphid	Apples, pears	England	-
Downy mildew	Grapes	Europe	1980
Fluted scale	Citrus fruit Guavas	Australia	-
Fluted scale	Mangos	Australia	-
Mosaic	Bananas	Not known	-
Rust	Chrysanthemums	Europe, Japan	1984
Late blight	Potatoes Tomatoes	Europe	1983
Wart	Potatoes	Netherlands	1953
Golden nematode	Potatoes	Europe (UK)	1961
Potato tuber moth	Potatoes	Italy	-
Downy mildew	Onions	Not known	-
Smut	Onions	Not known	-

Source: Partap 1993

in the long term. A two-way loss has been reported. *First, the large-scale incidence of disease is resulting in both increasing expenditure on plant protection measures and reduction in production.* This is altering the cost-benefit ratio to a considerable degree. In some areas the costs have increased to levels at which it is no longer economical to grow apples, and a serious search for alternatives has started. For example, reports from the Hengduan mountains of China (Rongsen 1993) speak of an increasing incidence of disease in the apple crop which has reduced production by 30-40 per cent. Pesticides are being used extensively and, with up to eight sprays a season, pests are becoming resistant and chemical control proving ineffective. The natural ecological community of apple orchards has already been damaged and the environment affected. At the same time, more land is being brought under apple crops. A similar situation has developed in the Indian Himalayas.

The second loss ascribed to apple monoculture is the degradation of the environment. Huge amounts of poisonous chemicals are being used as pesticides. In Himachal Pradesh alone, by 1992, more than 2,300 tons of pesticide were being sprayed annually over 425,000 hectares of apple crops. By the year 2000, many more thousands of tons of non-degradable lethal pesticides will have been sprayed over the state and will have entered most food chains to a considerable extent, poisoning animals and humans alike. The issue does not attract much attention at present because of lack of information and the human tendency to ignore problems for as long as possible.

The question that arises is whether we can find solutions to the present problems associated with the culture of temperate fruit crops by using available indigenous genetic resources. If yes, what constraints prevent such an exercise?

Use of Introduced vs. Indigenous Rootstocks

Using rootstocks is not just a way of developing new crops. Appropriate rootstocks can be used to manipulate plant size, for example the creation of dwarf varieties; to increase disease resistance; and to manipulate phenological calendars and fruiting cycles, so important for mountain areas. The selection of good rootstock is a key factor in the success of fruit crops. At present most rootstocks are obtained from introductions, but this can create problems and the possibilities of using wild genetic resources as rootstocks should be investigated more seriously.

The main problem that can be created by the wrong choice of rootstock is the declining productivity of fruit crops. Poor selection of rootstock and insufficient availability of selected rootstock resources are the principal problems for horticulture in the mountain areas of Pakistan (Partap 1993). Using poor rootstock results in lower yields. In areas where all trees have the same (poor) rootstock, farmers become discouraged and stop cultivating a particular fruit crop because they mistakenly believe environmental unsuitability to be the cause. Lack of availability of nursery plants raised on healthy rootstock is also a deterrent today to cultivating fruit crops in mountain areas successfully.

If there is a problem in obtaining sufficient amounts of good, healthy rootstock from introductions what are the alternatives? One possibility is to exploit the local agrobiodiversity and use indigenous alternatives, both as rootstock and to develop certain crops.

There are a number of examples showing that the HKH region contains promising rootstock genetic materials that could be used to improve many crops. Some of these are listed in Table 7.11. In some places, indigenous resources have already been exploited in order to develop needed characteristics or overcome problems. In China, flowering quince is used as a rootstock for apples to obtain dwarfing and early fruiting (in three to four years). In the Swat Valley of Pakistan, local people have gained experience in using incompatible species as rootstocks to cope with soil-borne diseases of apple. They use *Crataegus* (hawthorn) as a rootstock by first grafting *Sorbus* on to it and then grafting apple on to the *Sorbus*, which is compatible. These examples represent only a fraction of the potential of horticultural genetic resources in the HKH region. At present, lack of information and of information exchange seem to be the main reasons for the lack of use of indigenously available genetic resources.

Table 7.11: **Examples Showing the Diversity of Potential Indigenous Genetic Resources for Rootstocks and Fruit Crops in the Himalayan Region**

Species	Local Name	potential use
Pyrus pashia	Kainth	Rootstock for pear
Pyrus lanata	Kainth	Rootstock for pear
Prunus puddum	Wild cherry	Cherry and fruit crops
Prunus padus	Bird cherry	Cherry and fruit crops
Prunus cerasus	Arid cherry	Root stock for cherry
Fragaria vesca, indica	Strawberry	Fruit and root breeding materials
Cydonia vulgaris	Quince	Fruit rootstock
Pyrus baccata	Siberian crab	Fruit rootstock
Ribes grossularia	Gooseberry	Rootstock for gooseberry
Ribes glaciale	Red currant	Breeding of currants
Ribes nigrum	Black currant	Breeding of currants
Ribes rubrum	Red currant 5000-12,000 ft; new fruit better than R. glaciale	New fruit crop
Corylus colurna	Hazelnut 5000-10,000 ft	Dry Fruit

Source: Atkinson 1860, reprint 1980

Mushrooms: A Complex Case of Underutilised Resources

Like medicinal plants, mushrooms fall into both the farming and forestry sectors. Throughout the Himalayan region people collect and eat more than 283 species of mushrooms (Partap 1995), a vast resource of edible mushrooms by any standard. Except in China, however, few countries farm local species. In China, farming of different species of mushrooms is common, but, in other countries in the HKH region, the strategy is to cultivate the world-renowned species *Agaricus* extensively along with other species such as *Pleurotus, Volvariella,* and *Lentinus* on a minor regional basis. There is little concern for the diverse underexplored resources of indigenously available mushrooms.

Floriculture: The Comparative Advantages of Mountain Habitats

Floriculture, a relatively new ancillary activity of horticulture, offers much potential in the mountains. Around 1,700 species of beautiful mountain flowers are available for diversification of farming into floriculture in the HKH region (Partap 1993). The northeastern Himalayas of India and southeastern provinces of China are centres of diversity and of the evolution of several ornamental plant species such as *Rhododendron, Magnolia, Primal, Camellia, Iris, and Jasmine.* It is also home to hundreds of species of orchids — notably *Dendobium* spp, *Paphiopedilum* spp, *Cymbipidium* spp, *Phalenoosus* spp, and *Vanda* spp. Many of these orchids are of high value.

Several pockets of the Indian Himalayas are engaged in the flower trade. The practice is based on raising hybrids of known varieties. Cut flowers are sent to the

cities in the plains during the off-season. The northwest Indian Himalayas supply such flowers as roses, gladioli, lilies, narcissi, daffodils, carnations, and chrysanthemums; and the Kumaon hills of Uttar Pradesh, Kalimpong, and Gangtok in Sikkim supply gladioli, orchids, gerbera, magnolia, camellias, irises, geraniums, and other temperate species. The comparative advantages of mountain habitats result in potentially tremendous economic benefits from cut flowers. The price of a sample spray of orchids, for example, is about US$ 1-2 in the markets. Roses (*Rosa* spp) offer great scope for farming because of their tremendous genetic diversity in the Himalayan region. The existence of races with a good potential for rose oil brightens the chances of increasing yields to economically acceptable levels.

The current emphasis in floriculture is on research and development to evaluate the climatic suitability and evolve improved varieties of the mostly exotic species known for their market value. Except for some attention given to orchids, few attempts have been made to harness mountain floral resources as a cut flower crop, for the production of essential oils of high value, or as garden and potted plants. Instead, most present programmes focus on the cultivation of hybrid, exotic flower varieties and are not concerned with harnessing the floral diversity potential of the mountains.

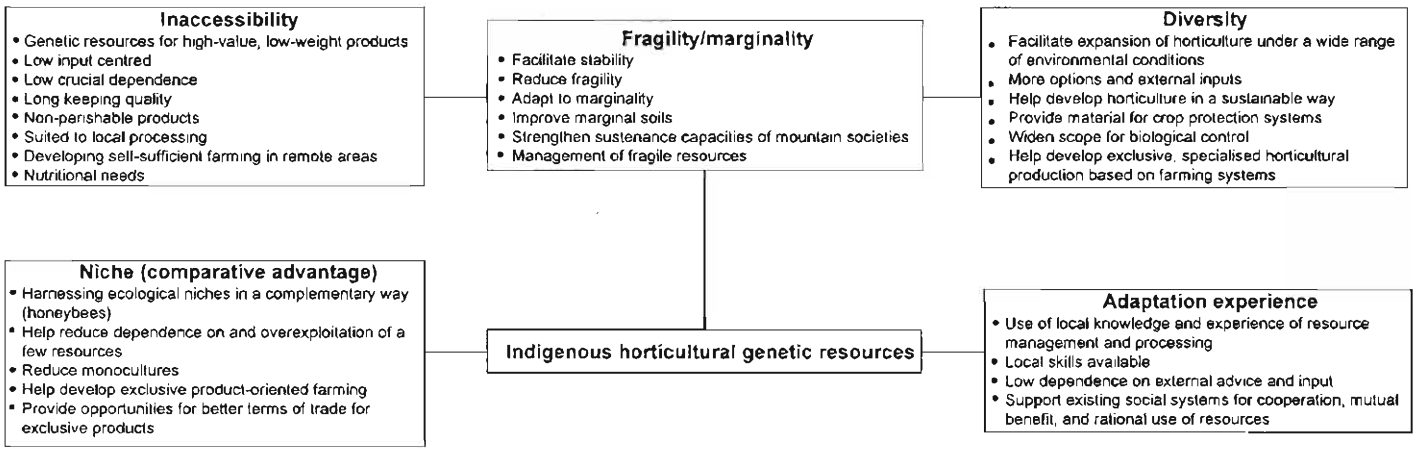
Selecting Horticultural Crops for Mountain Areas

The important factors for horticultural development under mountain conditions are certainly different from those in other areas. The potential contribution of indigenous horticultural genetic resources to mitigating specific problems associated with mountain areas or exploiting specific advantages of these areas are summarised in Chart 1.

Conclusion

There is little doubt that agriculture in the HKH region needs to be diversified in order to improve livelihoods in poor subsistence mountain communities. Promoting horticulture is one promising alternative, and it has proved successful in improving the economic well-being of poor mountain farmers in some pockets of the HKH. The challenge is to make horticultural development sustainable and compatible with the conservation needs of native agrobiodiversity. It is clear from the perspective plans and five-year development plans of the national and provincial governments of the region that these two issues have not yet been integrated into present approaches. For example, the agricultural perspective plan of Nepal emphasises promoting cash crop farming - the approach used in Himachal. The five-year plans of the hill provinces of India and Pakistan, and the development programmes of the mountain counties and provinces of China, also indicate

Chart 1: Range of Potential Contributions of Indigenous Genetic Resource Diversity to the Development of Horticulture in Mountain Areas



clear gaps in integrating conservation of agrobiodiversity with agricultural diversification. The region faces two problems in this regard: poor understanding of the subject itself outside the academic domain and dichotomy in the institutional framework. The institutions responsible for the development of horticulture are not the same as those responsible for the conservation of biodiversity and agrobiodiversity, although the genetic resources of crops are conserved by sections of these institutions.

International development aid has also contributed to the problem. The goal of both technical and financial international development assistance for the horticultural development of agriculture so far has been to help countries to improve their human, social, and economic conditions. Environmental and conservation ethics have not been included in the considerations. Interestingly, at present, such ethics seem to play a prominent role in traditional cultures as well as in highly developed nations. There are also examples of aid that indicate some confusion between development investment and conservation measures. Many programmes supported by international development agencies do not conform to agrobiodiversity conservation principles, wheseas the same agencies are willingly spending on genetic resource conservation elsewhere.

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