

## Genetic Resource Issues in Horticultural Developmental Approaches of the Hindu Kush-Himalayan Countries

*Tej Partap*

### Introduction

The contribution of genetic resources to horticulture has been the most important application of the new science. Taking famous examples from history (Lamb and Aldwinckle, 1981), French grapes relied heavily on rootstock developed from wild American vines. Strawberries and several minor fruits have drawn extensively on wild germplasm and banana breeders have turned to wild stock for disease resistance. Apple breeders have used several *Malus* species for disease resistance and to widen the adaptations of the cultivated apple. New scab-resistant cultivars of apple have been developed using genes from the Japanese crab-apple *M. floribunda*, which is otherwise domesticated as a flowering plant (Lamb and Aldwinckle, 1981).

In the USSR and China, breeders have used the cold tolerance of *M. baccata* to extend the northward range of apple growing (Cummins and Aldwinckle, 1979). A review of other fruit reveals that wild genetic resources have had a major impact on strawberry, raspberry, and currants, while others that have benefited to a lesser degree include peach, plum, apricot, almond, walnut, chestnut, and pistachio (Robert and Prescott-Allen, 1988).

What can be expected from genetic resources in the future is also largely based on past trends. A look at past achievements shows that

genetic resources have been successfully used to our advantage in the following ways:

- Domestication of new crops
- Disease resistance
- Pest resistance
- High yield
- Vigour
- Environmental adaptations
- High food value (vitamins, proteins)
- Cytoplasmic male sterility
- Petaloid male sterility
- Harvest and transport adaptations (such as post-harvest adaptations and quality).

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

More genetic resources may be screened for potential biochemical crops and those yielding latex (e.g., *Euphorbia* sp.), waxes (e.g., *Calthea* sp.) and oils (e.g., *Prinsepia* sp., and *Bassia butyraceae*) may be in great demand.

Broadly, the potential of genetic resources is seen to be in the culture of biochemicals, the development of new domesticates, and the improvement of existing domesticates. Thousands of species could be used in improvement of existing domesticates alone (Robert and Prescott-Allen, 1988). However, the factor that will determine the degree of their use in the future largely depends on 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. Although genetic resources are a relatively brand new resource and their utility is growing dramatically, the lack of progress in conserving them is casting a shadow over their future.

Loss of habitat, overexploitation, and competition and predation by introduced species are the main threats to genetic resources today. The possibilities of finding new species of potential genetic value diminishes as the areas of greatest ecological diversity, such as the mountains, face deforestation, habitat shrinking, encroachment, and agricultural expansion. The wild gene pools of many fruit and nut crops are being reduced throughout the world by habitat destruction, cutting for fuel, and overgrazing and overbrowsing by animals (Robert and Prescott-Allen, 1988).

A standing example is that of the wild pear in Japan. The wild Japanese forms of *Pyrus usuriensis* and *P. pyrifolia* and the species *P. dimorphophylla* are of great importance as genetic resources for the improvement of pears of China, Japan, and other countries. However, Iizuka (1975) reported that these species were already near extinction and could be classified as rare species.

The reasons for conserving variations within species are: first, genetic variation is essential for species to adapt and survive, and second, genetic variation is the new material of domestication and of 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 thought only of the first while the second has been largely ignored. New ways of maintaining and using these newest resources are high on the international agenda today (Jacobs and Munro, 1987). It has been realized that development that is inflexible and too little influenced by ecological considerations is unlikely to make the best use of the available genetic resources. When ecological damage occurs, economic and social damage are also likely. The most effective way society can avoid such problems is to integrate every stage of conservation and development processes, from the initial setting of policies to their eventual implementation and operation (IUCN, 1980; Swaminathan, 1986).

In the farming sector, after decades of considerable debate on sustainability and the wisdom of expanding industrialized agriculture to marginal lands, it is now realized that the time has come for an assessment of agricultural development vis-a-vis sustainability (Dover and Talbot, 1987). A region-by-region agro-ecological audit covering the use pattern of energy, physical, and biological resources and preservation of biological diversity along with environment is suggested to identify principal problem areas in terms of sustainability. It is intended to provide a basis for developing coordinated comprehensive research and development programmes and policy changes.

### **Selected Genetic Resources Issues in Mountain Horticultural Development**

#### *Objectives and Strategies of Horticulture Development in the Hindu Kush-Himalayan Region*

Horticulture advocated as a dominant activity for mountain areas has the basic intention of taking advantage of varied climatic conditions to provide better sources of income to mountain people, improve their lifestyle, and stabilize fragile mountain land.

However, the objective of rational use and conservation of available



genetic resources and their biological diversity are peculiarly missing from the basic approach so far. The results of this neglect become clear when analysing various programme strategies and their impact.

The horticulture development strategies of the Region are intended to be a three-way effort—special emphasis on self-sufficiency in horticulture items currently imported; promotion of those crops which could be exported to gain foreign exchange (especially crops which are highly developed and largely cultivated elsewhere, with proven market value); and a low priority effort to improve the nutritional status of undernourished mountain communities through encouraging cultivation of fruits and vegetables for family use. Horticulture policy planning and research institutions are making earnest efforts to bring several other activities, also called ancillary activities, under the scope of horticulture.

In following this approach the financial gains from horticulture have been impressive in selected areas of the Hindu Kush-Himalayan region.

### *Genetic Resources and Biological Diversity*

Several factors have dictated the choice of horticultural species in this region. Some are stated in objectives and programmes, others are not. Biological diversity was never the main focus of this activity whether for use or for conservation. The chief objective of programmes in the Hindu Kush-Himalayan Region is the introduction of well-developed crops with high marketing potential. Table 11.1 illustrates how little use of the genetic resources of the region has been made to develop new domesticates to diversify horticulture in the ecological context.

An example of the valuable gene pools that exist in these mountain areas is the vast gene pools of several horticultural plant species in the northeastern Indian Himalaya. Rich diversity in this region has been reported for citrus, mango, and banana (Arora and Nayar, 1984; Kaul, 1981). A citrus sanctuary is being established in this region for the preservation of wild forms (Singh, 1977). These indigenous species 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, Garo hills of Meghalaya, and Kaziranga forest of Assam. In mango, the wild forms of *Mangifera indica* and its allied species *M. sylvestris* occur in the forests of this region. Rich diversity occurs for *Musa*, *Pyrus*, *Rubus*, *Ribes*, and *Prunus* as well. The Shillong plateau of Khasi hills in Meghalaya accounts for many *Prunus* species such as *P. nepalensis*, *P. undulata*, and *P. cerasoides* (Kaul, 1988). In vegetables and tuber crops good variability occurs in *Alocasia*, *Abelmoschus*, *Amorphophyllus*, *Colocasia*, *Dioscorea*, *Luffa*, *Cucumis*, and *Trichosanthes* in different parts of this region. In spices and condiments,

TABLE 11.1  
An overview of diversity of horticultural resources within the  
Hindu Kush-Himalayan Region and their utilization

Crop type	Number of species promoted for cultivation		Approximate number of species locally used
	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

*Alpinia speciosa*, *A. galanga*, *Amomum aromaticum*, *Curcuma zeodooria*, *C. amada*, *Piper longum*, and *P. peepuloides* are the major species. The region is considered a home of several species of medicinal plants such as *Berberis*, *Cassia*, *Coptis*, *Gynocardia*, *Litsea*, *Paedera*, and *Solenum* (Kaul, 1988).

These examples are given to show that if only we explore it, there is no dearth of valuable indigenous plant material in the Hindu-Kush Himalayan Region. In other parts of the Himalaya there is vast genetic diversity within various fruit plants which remains underexploited or threatened by extinction, by habitat destruction, and by displacement by new exotic crops.

Tables 11.4, 11.5, 11.6, and 11.7 further prove that everywhere the focus has been on a limited number of similar crops leading to problems of monoculture. The objectives, programme priorities, and horticulture crops choice pattern in Bhutan (DOA, RGB, 1989) seem more judicious (Table 11.8).

The data also show that there is an ongoing attempt at identifying distinct climates, comparing them with the agro-ecological requirements of known exotic species, or cultivars, evaluating their suitability, and suggesting their introduction into those specific mountain microclimates. So only the variations in climate have been considered and not the whole agro-ecosystem which develops under the sum total of all the conditions.

To further illustrate the state of genetic resources in horticulture development policies, an examination of the strategies and programmes of Himachal Pradesh, recognized as the fruit or apple state of India, is

TABLE 11.2  
Genetic resource diversity in pear in mountain areas of Pakistan

Vernacular name of variety	Distinguishing features as reasons of folk varietal selection (excluding agroclimatic adaptations)
Parao	Large size, pear shape
Sur Tango	Small, round
Shin Kulay	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 Tango	—
Bap Tango	Early
Khawaga maiwa	Small, round, sweet
Khapa	Sour

These 18 varieties have 13 distinct characters in different combinations. Their agroclimatic specificities are unreported here and will be additional features.

Source: Rashid Anwar and Sadiq Bhatti (unpublished). ICIMOD-commissioned paper on genetic resources of Pakistan.

presented here. Many of the programmes listed below were initiated with financial support from external agencies, both national and international. A brief appraisal of the programmes follows (Azad, 1986):

A programme for *production and supply of fruit plant material* facilitates plantations of hybrid varieties, mostly apple. In the 10 years up to 1985, 24 million plants were distributed.

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

*In programme on top-working wild fruit trees*, wild relatives of fruit crops are being top-worked, *in situ*. The total target for the Sixth and Seventh Plan periods was 11 million plants to be rechristened. The means converting jungles into orchards. Although the intentions behind the programme are good, the implications are dangerous on several counts in general and specifically for maintaining diversity of wild genetic resources.

*Diversification of horticulture*, enlarging its scope to include mush-

TABLE 11.3

## Genetic resource diversity in apricot existing in mountain areas of Pakistan

Vernacular name of variety	Distinguishing features as reasons of folk varietal selection
<i>Skardu area</i>	
Marpho choli	Red apricot
Karfoo choli	White apricot
Warfo choli	Pith used for oil
Bro choli	Late maturing
Khakas choli	Kernel partly split
Cho choli	Juicy
Apo choli	Large size
Beru choli	Small size
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
Halman choli	Best quality
Kazangi choli	Sweet
Khashanda choli	Good taste
Kho choli	Bad taste, sour
Shakanda choli	Sticky
Tacho choli	—
Marghlan choli	Early, good quality
Shanda choli	Small size, early
Stun choli	Late maturing
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	Selections due to specific agro-ecological characters
Yakab yak choli	
Snair choli	
Shikanda joo	—
Brum joo	White
Surasune joo	Good quality

Contd.

Table 11.3 Contd.

Duda-sanag joo	—
Koropiam joo	—
Ali Shan Kakas 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	—
Moen joo	—
Ghaka joo	—
Mamoor joo	—
Brun joo	—
Gario joo	—

Source: Rashid Anwar and Sadiq Bhatti (unpublished). ICIMOD-commissioned paper on genetic resources of Pakistan.

TABLE 11.4  
Fruit crops selected for Nepal Himalaya on the basis of  
agroclimatic suitability

Fruits	Zonation system (districts)
Citrus	Dhankuta, Bhojpur, Terhathem, Sankhuwasabha, Panchthar, Ilam, Sindhuli, Ramechhap, Dhading, Kavrepalanchok, Gorkha, Lamjung, Tanahu, Syangja, Kaski, Palpa, Gulmi, Salyan Dailekh, Dadeldhura
Apple	Solukhumbu, Sindhupalchok, Rasuwa, Mustang, Jumla, Kalikot, Dolpa, Rukum, Doti, Baitadi, Darchula
Banana	Kavre, Dhading, Nuwakot, Sarlahi, Dhanusha, Mahotari, Chitwan
Pineapple	Dhading, Nuwakot, Sarlahi, Chitwan
Mango	Bare, Parsa, Rautahat, Sarlahi, Mahotari, Dhanusha, Sunsari, Sirha, Saptari, Chitwan, Kapilbastu, Nawalparasi, Rupandehi, Surkhet, Dang
Walnut	Jumla, Kalikot, Bajhang, Darchula, Baitadi, Dolpa, Rukum
Pear	Dhankuta, Bhaktapur, Lalitpur, Kavre, Dhading, Makwanpur, Sindhupalchok, Nuwakot, Rasuwa, Palpa
Grape	Banke, Bardiya, Manang, Mustang

Source: Seventh Five-year Plan (1985–1990), National Planning Commission, HMG, Nepal.

room culture, olericulture, cultivation of medicinal plants, and other activities is under way.

*Special crops* such as hops, sarda melon, and pistachio are being introduced in high mountain areas with a temperate climate.



TABLE 11.5  
Fruit crops of various agroclimatic zones of Pakistan mountains

Zonation system by altitude (m)	Fruit crops
1200	Almond, pomegranate, apricot, plum, persimmon, peach, grape, fig, pistachio, mulberry, strawberry
1500	Almond, pomegranate, apricot, plum, persimmon, peach, grape, fig, pistachio, cherry, pear, walnut, mulberry, strawberry
1800	Apple, peach, grape, cherry, pear, walnut, mulberry, strawberry*
2100	Apricot, apple, peach, plum, pear, walnut, strawberry
2400	Apricot, apple, pear, peach, berry fruits*
2700	Apricot, apple, berry fruits* (gooseberry, currants, raspberry)
3000	Apricot (early-maturing cultivars), berry fruits* (gooseberry, currants, raspberry)

\* Prospects for cultivation exist

Source: Alam (1989).

TABLE 11.6  
Fruit crops of various agroclimatic zones of Indian Himalaya  
(Himachal Pradesh)

Agroclimatic zones	Approx. elevation (m above sea level)	Rainfall (cm)	Fruit crops
Low hills' and areas near the plains	365-914	60-100	Mango, litchi, valley loquat, citrus, papaya, ber, fig, low-chilling varieties of pear, early variety of grape
Mid-hills (sub-temperate)	914-1523	90-100	Peach, plum, apricot, almond, persimmon, pear, pomegranate, pecan
High hills into interiors	1523-2742	90-100	Apple, pear (soft and valleys type), cherry, walnut, almond, chestnut
Cold and dry zone	1523-3656	25-40	Grape, prune, drying variety of apricot, almond, chilgoza, sarda melon, pistachio, hops, apple

Source: Azad (1986).

TABLE 11.7  
Fruit crops of various agroclimatic zones of Chinese Himalaya  
(Hengduan mountains)

Agroclimatic zones	Areas of interest	Fruit crops
<b>Hot arid zone:</b> Av. annual temp. > 20°C Winter, 7–12° Summer, 24–28°C	a. Yuanjiang river valley, Shangjiang river valley  b. Jinshanjiang river valley, Ninnan, Qiaojia	a. Coffee, mango, banana, papaya, common  b. Citrus, banana, guava, longan, litchi, > 1900 m apple, pear, peach, grape
Humidity conditions in sub-zones a. 0.67–0.50 b. 0.5–0.29		
<b>Warm arid zone:</b> Av. annual temp. > 14°C Winter, –5–7°C Summer, 22–24°C	a. Dadu river valley, Lhasa river valley, Yalong river, reaches of Lanchangjiang river	a. apple, pear, peach, plum, apricot, cherry, persimmon, grape, walnut, chestnut, loquat, pomegranate, orange, tangerine
Humidity conditions in sub-zones  a. 0.67–0.50 b. 0.50–0.29	b. Jinchuan-Luomo in Dadu river valley  Binchuan Basin in Yunnan	b. Snow pear of Hanyuan Sweet- smelling peach of Luding Nave orange of Shimian and Dechang, Xing peach of Xichang, green skin pomegranate of hills, apple, pear, pomegranate, walnut in Jinchuan Danba, tangerine in Binchuan basin a. Concentrated areas for pear and apple
<b>Temperate arid zone:</b> Av. annual temp. > 710°C Winter, 0°C Summer, 18°C	a. Zagunou river valley, higher reaches of Mingjiang river  b. Songpau in Minjiang valley, higher reaches of Dadu river and its tributaries c. Batau Shangiatou area of Jinshajiang river, higher inaccessible areas or lesser areas of Nujiang river valley	a. Concentrated areas for pear and apple  b. Snow pear Best quality apple  c. Pear, apple
Humidity conditions in sub-zones a. 0.67–0.50 b. 0.5–0.29 c. 0.29–0.2		

Contd.

Table 11.7: Contd.

<b>Cold arid zone:</b> Av. annual temp. > 74°C a. 0.67–0.50 b. 0.50–0.29	Baiyu-Batan area of Jinshajianj river val- ley, Changdu	Wild domesticates of: Flowering crab-apple ( <i>Malus toringoides</i> ); Chinese crab-apple ( <i>Malus asiatica</i> ); Hawthorn ( <i>Cratae- gus scabrifolia</i> ); and Japanese apricot ( <i>Armeniaca mume</i> ) Many other im- portant wild fruit genetic resources
Winter, -70°C Summer, 12°C Humidity 0.5–0.29	Manhan of Lanchangjiang river valley, Bangda- Zougong of Nujiang river All high altitude areas	

TABLE 11.8

## Horticulture crops of various agro-climatic zones of Bhutan Himalaya

Agroclimatic zones	Important areas	Horticulture crops
<b>Northern</b> 30 km wide. Alt. above 4000 m. Cold climate, perpetual snow, glaciers, barren rocks.	High mountain areas	No farming practices or hor- ticulture activity
<b>Central</b> 70 km wide. Alt. 2000–4000 m. Temper- ate climate, major forest areas, horticulturally suitable.	Thimpu, Paro, Ha, Bhumthang, Wangdipho- drang	Apple, potatoes Scope (trails): Asparagus, apricot, peach, plum, cherry, walnut  Scope (planned): Currants, blackberry, gooseberry, rasp- berry, loganberry
<b>Southern</b> 50 km wide. Alt. foothills to 2000 m. Tropical to sub-tropical warm climate, horticulturally suitable.	Samchi, Gaylephug, Chi- rang, Samdrup	Cardamom (low volume, high value), lemon grass oil (wild resource, low volume, high value), orange, ginger, chill- ies, potato scope (planned): Mango, guava, litchi, banana, kiwi fruit, figs, black pepper

An Indo-Italian project aims to introduce olive cultivation in the state. Other introductions being executed under this project include rootstock for various temperate fruits such as apple, peach, plum, and cherry.

There are quite a few projects assisted by UNDP, FAO, and the Dutch government to promote the cultivation of mushrooms. Under these projects some strains of *Agaricus*, essentially introductions, are being promoted for cultivation.

*Introductions, Monoculture and the Issue of Unsustainability and Environmental Degradation*

Too much dependence on introductions is illustrated here by an example of temperate fruit promotion in the Indian Himalaya and its consequences.

Temperate fruits (apple, pear, peach, apricot, cherry, plum, almond, walnut, pomegranate, and persimmon) have been instrumental in transforming the farming economy of several hilly areas of the Indian Himalaya. But this success is largely based on introductions of varieties and rootstock of several of these crops. The focus of horticultural research in the institutions of the region has been mainly directed to introducing developed genetic material at convenience (Table 11.9) and its evaluation for key features (Chadha, 1986). Higher yields through introductions are to be further pursued. Such large-scale introductions into a region may cause several unforeseen problems. And one of the first to be realized is the introduction of new diseases into a region. These diseases are inadvertently caused by genetic material which might have been infected and have escaped detection. The discovery of this category of diseases in the region shows that they came with crops in which large-scale genetic material introductions were made (Table 11.10).

Though technologies are being perfected to avoid the transfer of such diseases, yet the dangers persist, especially in poor developing countries where the application of these technologies depends on the availability and development of infrastructure facilities.

Apple has emerged as the number one crop of this region in terms of both area and production (Teoatia 1986; Rongsen, 1988; Chaudhry, 1989; Pandey, 1989). Indicators of the unsustainability of apple monoculture are already coming to light. A two-way loss is reported. First, expenditure on plant protection measures is increasing due to large-scale incidence of diseases, upsetting the cost-benefit ratio to a considerable degree. In some areas it has increased to levels where 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, 1988) speak of increasing disease incidence in the apple crop, reducing production by 30–60 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



TABLE 11.9  
Scale of introductions of horticulture genetic resources:  
Temperate fruits of Indian Himalaya

Apple	<ul style="list-style-type: none"> <li>• All commercial cultivars introduced over time.</li> <li>• Latest trend is for introduction of genetic material for dwarfing and disease resistance from Europe.</li> <li>• The cultivars introduced are several spur types.</li> <li>• Present promising rootstock introductions from Malling Merton series, like M 26, M 7, M 25, MM 106.</li> </ul>
Pears	<ul style="list-style-type: none"> <li>• Main introduced commercial cultivar being promoted for cultivation is Bartlett.</li> <li>• Among other recent introductions are Megness, Devoc, Starkrimson.</li> </ul>
Cherry	<ul style="list-style-type: none"> <li>• Many introduced cultivars like Sletta, Merton, Bigarreau, Sunburst, Lapins, Sam, Van.</li> <li>• Some new hybrid selections from Canada under evaluation.</li> <li>• Non-availability of a suitable rootstock and heavy virus infection in existing plant material are major constraints of the crop.</li> </ul>
Peach	<ul style="list-style-type: none"> <li>• Introduced cultivars are Kanto-5, Shimizu from Japan, Red haven, Sun haven, three of the Prairie series and Veteran, all from the United States and under evaluation.</li> <li>• Rootstock Brompton and St. Julian K are under evaluation.</li> </ul>
Plum	<ul style="list-style-type: none"> <li>• Santa Rosa a known cultivar.</li> <li>• Recent introductions in plums are Starking Delicious, Late Santa Rosa, Queen Ann, Nubiana, Burmosa, Laroda, Stanley, Cacenska Rana, Ruth Gersttater, all from the United States.</li> <li>• Introduced Myrobalan has been found to be a promising clonal rootstock.</li> </ul>
Apricot	<ul style="list-style-type: none"> <li>• Newcastle cultivar for mid-hills introduced.</li> <li>• Some native varieties for high hills are known</li> <li>• Recent introductions under evaluation include Hargraud, Reliable, Forming, Dale, Alfred, and many others from Bulgaria.</li> <li>• No clonal rootstock available yet.</li> </ul>
Almond	<ul style="list-style-type: none"> <li>• Introduced cultivars are Non-pareil, Ne Plus Ultra, Drake.</li> <li>• Other introductions under evaluations are Wonder, Bruce, Mercett.</li> </ul>

time more area is being brought under apple crop. A similar situation has developed in the Indian Himalaya also.

The second loss ascribed to apple monoculture is in the degradation of the environment. Huge amounts of poisonous chemicals are being used as pesticides. The Chinese example described above and another example from Himachal Pradesh (India), revealed that 2300 tons of pesticide were sprayed over 425,000 hectares of apple crop up to last year to control diseases. To meet the future needs of the farmers of this state, plans to install plants to formulate several of these pesticides in the state itself are under way (Azad, 1986). By the year 2000, Himachal will have been

TABLE 11.10

**Exotic diseases and pests of horticultural and vegetable crops introduced along with genetic resources into the Himalayan Region of India**

Diseases/pests	Host	Region/country of origin	First recorded
Hairy root	Apple, pear	Sri Lanka	1940
Crown gall	Apple, pear	Sri Lanka	1940
Canker	Apple,	Australia	1953
Woolly aphid	Apple, pear	England	—
Downy mildew	Grape	Europe	1980
Fluted scale	Citrus,	Australia	—
	Guava		
Fluted scale	Mango	Australia	—
Mosaic	Banana	Not known	—
Rust	Chrysanthemum	Europe, Japan	1984
Late blight	Potato,	Europe	1983
	Tomato		
Wart	Potato	Netherlands	1953
Golden nematode	Potato	Europe (UK)	1961
Potato tuber moth	Potato	Italy	—
Downy mildew	Onion	Not known	—
Smut	Onion	Not known	—

Source: Paroda *et al.* (1987).

sprayed with thousands of tons of these non-degradable lethal chemicals. By 2000 these pesticides will have entered most of the food chains of ecosystems to a considerable degree, poisoning most biological organisms, including humans. Similar practices are under way on an even higher scale in olericulture. The issue does not attract much attention because of lack of information and the tendency to ignore it for as long as possible.

The question that arises here is whether we can find solutions to these problems by using genetic resources. If yes, what constraints prevent such as exercise?

### *Rootstock—Exploration and Easy Alternatives*

The use of wild genetic resources as rootstock in horticulture crops does more than develop new crops. One of the significant needs of fruit crops is good rootstock to achieve any of the following main objectives:

- Manipulating plant size, such as creating dwarf varieties
- Disease resistance
- Manipulating phenological calendars and fruiting cycles, so important for mountain areas

The problem of rootstock is aptly described to Alam (1989) quoting the example of Pakistan. He has reported poor selection of rootstock as well as insufficient availability of selected rootstock resources as the number one problem of horticulture in the mountain areas of that country. Using poor rootstock means lower yields. In areas where all trees have the same rootstock it is difficult to account for poor yields and disease, discouraging farmers from cultivation of a particular fruit crop because they mistakenly believe environmental unsuitability to be the cause. He has further stated that non-availability of nursery plants raised on healthy rootstock is a major deterrent today in expanding horticulture successfully in these mountain areas. The scenario describes, in fact, the general situation prevailing in almost all the Hindu Kush-Himalayan Region countries today.

At present, the general practice is to depend heavily on introduced rootstock for fruit trees, such as the Malling Merton rootstock series of apple. It has been introduced on a large scale in almost all countries of the Region. The present use of and future plans showing heavy dependence on introduced rootstock resources, with no programme to explore indigenous materials in the case of temperate fruit crops throughout the Indian Himalaya (Chadha, 1986, Table 11.9), is an example of the unwise trend.

The idea here is not to oppose introductions but to discuss its other implications such as the cost of introductions, their consequences, and indigenously available better material.

There are examples to show that promising rootstock genetic material is available within the Hindu Kush-Himalayan Region to improve many of our fruit crops but that there is lack of interest and efforts to explore and use it (Table 11.11). In China, flowering quince is in use as apple rootstock to bring on dwarfing and early fruiting (three to four years). In Swat valley of Pakistan, local people have gained experience in using incompatible species as rootstock to cope with soil-borne diseases of apple. They use *Crataegus* (hawthorn) as rootstock, by first grafting *Sorbus* on it and then later grafting apple on *Sorbus*, which is compatible. These examples are only the tip of the iceberg as far as available indigenous genetic resources and knowledge of their potential uses are concerned. Lack of information and its exchange seems to be another reason for low use of indigenously available genetic resources.

#### *Medicinal Plant Resources: Underutilization and Reckless Exploitation of Resources Coupled with Ill-conceived Strategies*

Available information shows that a vast amount of medicinal plant resources are available within the Hindu Kush-Himalayan Region with high potential to provide economic benefits to mountain people

TABLE 11.11

**Diversity of underexploited rootstock and crop genetic resources of fruits in the Himalayan region (an example)**

Species	Local name	Use
<i>Pyrus pashia</i>	Kainth	Rootstock for pear
<i>Pyrus lanata</i>	Kainthee	Rootstock for pear
<i>Prunus puddum</i>	Wild cherry	Cherry and fruit crop
<i>Prunus padus</i>	Bird cherry	Cherry and fruit crop
<i>Prunus cerasus</i>	Arid cherry	
<i>Fragaria vesca</i> , <i>indica</i>	Strawberry	Fruit and root breeding material
<i>Cydonia vulgaris</i>	Quince	Fruit, rootstock
<i>Pyrus baccata</i>	Siberian crab	Fruit, rootstock
<i>Ribes grossularia</i>	Gooseberry	Presently all imported stock is used for berry cultivation
<i>Ribes glaciale</i>	Red currant	Native genetic material as rootstock, for breeding and development of currants
<i>Ribes nigrum</i>	Black currant	Native genetic material as rootstock, for breeding and development of currants, introduced
<i>Ribes rubrum</i>	Red currant 5000–12,000 ft., new fruit better than <i>R.</i> <i>glaciale</i>	New fruit crop, rootstock, introduced
<i>Corylus colurna</i>	Hazelnut 5000–10,000 ft	Dry fruit

Source: Atkinson (1860, reprint 1980).

(Dhiman, 1976; PFRI 1984; Teoatia, 1986; DMP, HMG, 1982; Ayensu, 1986). Their use in household medicine has only secondary importance. The main focus is on using the medicinal plant resources of mountain areas to enhance that income of the people, be it through collection from natural habitats or by cultivation. As the institutional efforts in horticulture are to encourage farmers, research efforts are directed to identifying promising drug plants and attempting their domestication. Some examples of medicinal plants being farmed on a commercial scale are found in Tibet, the northwest Himalaya in India and medicinal plant farming cooperatives in Nepal. Compared to farming, the collection of medicinal plants from their natural habitat is on a much larger scale. This two-way harnessing of medicinal plants falls under two kinds of farming activity. One is their cultivation and the second the generation of off-farm employment.

Two important issues emerge in the context of medicinal plants.



One concerns those few species known for their high economic potential. Increasing demand for these scarce plant resources by drug and pharmaceutical industries is resulting in their collection beyond their productivity levels. So far, no effective institutional methods have been devised in any of the countries to contain the threat of genetic erosion of these species. This has led to a situation where many of these species are now listed as endangered species in national and international records (Ayensu, 1983; see Table 11.12). The International Union for Conservation of Nature and Natural Resources (IUCN) and UNESCO, through its Man and Biosphere (MAB) programme, have highlighted this impending danger and cautioned governments and other agencies to take effective steps.

TABLE 11.12  
Overexploited medicinal and aromatic plants of Himachal Pradesh,  
Indian Himalaya, listed as threatened plants

Name	Agroclimatic zone of collection
<i>Aconitum</i> spp.	Alpine zone, high mountain areas
<i>Dioscorea</i> spp.	Alpine zone, high mountain areas
<i>Picrorrhiza kurroo</i>	Alpine zone, high mountain areas
<i>Podophyllum</i>	Alpine zone, high mountain areas
<i>Orchis</i> sp.	Alpine zone, high mountain areas
<i>Jurinea</i> sp.	Alpine zone, high mountain areas
<i>Baniam</i> sp.	Trans-Himalayan high mountain areas
<i>Berberis</i> spp.	Foothills to high mountain areas
<i>Artemisia</i> sp.	Trans-Himalayan high mountain areas
<i>Arnebia</i> sp.	Trans-Himalayan high mountain areas
<i>Atropa</i> sp.	Trans-Himalayan high mountain areas
<i>Gentiana</i> spp.	Trans-Himalayan high mountain areas
<i>Nardostachys</i> sp.	Trans-Himalayan high mountain areas
<i>Rheum</i> sp.	Rocky high mountains
<i>Ranolfia serpentina</i>	Foothills sub-tropics

Source: Chauhan (1988); Lakhanpal (unpublished), commissioned paper by ICIMOD

The second issue is the cultivation of medicinal plants. One school of thought takes the view that encouraging the cultivation of these medicinal plant will save them from extinction and also ensure regular income. Such an approach gives rise to new problems. For example, Hindu Kush-Himalayan mountain farmers have, on average, 0.5 hectare land holding and it could be less than this in high mountain areas where these resources occur. Here the emphasis is on growing food crops on all available cultivable land and, even then, production barely meets the farmers' needs. In such a situation it is highly unlikely that the ordinary farmer will accept cultivation of non-food crops. Moreover, land holdings are too small to give the farmer adequate economic benefit from non-food crop cultivation. There is a danger that scientific and institutional support

and efforts may unwittingly help an outside enterprising wealthier class to initiate large-scale medicinal farming, reaping the benefits at the expense of the native cultivator. It will also destroy the off-farm income opportunities generated by these medicinal plants so far.

### *Mushrooms: A Complex Case of Underutilized Resources*

Like medicinal plants, mushrooms fall both under farming and forestry sectors. Throughout the Himalayan region people have been reported as collecting and eating more than 283 species of mushrooms (Lakhanpal, 1988), a vast edible mushroom bastion by any standard. Mushroom, in fact, is used as a vegetable during distress periods. In March-April when there is only a small stock of pulses left with subsistence mountain farmers and when there are not enough green vegetables, poor farmers depend on local forest supply of mushrooms as a vegetable. Also, they often sell any excess collection in local markets to meet petty cash needs.

On the other hand, the strategy in mushroom cultivation is directed to the cultivation of the world-renowned species *Agaricus* in a major way and other species such as *Pleurotus*, *Volvariella*, and *Lentinus* on a minor regional basis. *Agaricus* is, by all standards, a world mushroom crop (Table 11.13). It has been introduced in a highly developed form and the transfer of technology and technology development in this region is mostly related to composting and spawning (Lakhanpal, 1988). The small concern for the diverse underexplored mushroom genetic resources indigenously available is explicit.

There is yet another significant point worth highlighting which concerns the choice of species for cultivation, e.g., the unique case of morel, *Morchella esculenta*, and other species of the genus. It is a highly valued mushroom (US\$ 80–100 per kg) found in the forests of several areas within the Himalayan region, namely, Nepal, India, Pakistan, and Bhutan. Viewed from the household angle it is an important cash income source for poor mountain folk, vital because its habitat forests are in inaccessible areas. Poor farmers can earn income from morels at a time when there are few other income sources and little work on the farm (March-April). A morel-ethnobotanical study conducted by Lakhanpal and his associates (1988) in Himachal Himalaya lends further support to this statement. Also it is a source of income to all sections of the family, i.e. children, women, shepherds, and cowboys. Official records, however, do not show very impressive production of morels, for example, 25 tons from the northwest Himalaya of India (Lakhanpal, 1988). That may just equal the income from an apple orchard of a few thousand trees. But the fact remains that the money becomes available to the most underprivileged class at a crucial time and from non-agricultural land. It is available without any investment inputs to the section of society which

TABLE 11.13

History of world production of *Agaricus bisporus*, white button mushroom

Country	Production (tons)				
	1939	1960	1970	1980	1983/84
USA	17,000	50,000	88,000	213,000	255,000
UK	6,800	21,000	40,000	61,800	84,000
France	20,000	35,000	68,000	131,700	—
Hungary	800	1,000	2,000	—	—
Denmark	400	2,500	6,500	6,600	—
West Germany	300	3,000	20,000	35,000	34,200
Italy	—	2,000	20,000	44,000	—
The Netherlands	—	3,000	29,500	60,000	80,000
China	—	—	2,000	66,800	—
India	—	—	—	1,500 (est)	2,000 (est)
Japan	—	2,000	4,800	5,500	—
Taiwan	—	700	39,000	64,400	—
South Korea	—	—	6,000	25,600	—
Total world production	46,000	136,000	381,100	812,200	455,200

Note: Compiled figures are from Lakhanpal (unpublished), commissioned paper by ICIMOD.

can least afford to invest. The only effort needed is to devise sound policies to preserve the habitat conditions which, unfortunately, are being degraded, shrinking the gene pool of this valued genetic resource. Dangers in the cultivation of morels lie in snatching a sustenance income source of the poor disadvantaged mountain people which may pass on to a comparatively wealthy farmer enterprising class. Though some may argue that total production of morels will increase through cultivation and that there will be overall state or national income gains, actually the benefits will move from those who had it as a vital resource to those who will have it as a new accessory resource. As the morel is not a medicinal plant but merely a scarce delicacy, the arguments in favour of necessary increases in availability to large sections of society cannot be convincing.

These lengthy explanations have been given to bring home the point that we must understand these linkages and the implications of ignoring them in our development strategies. We should be aware of the implications of already limited options of cash income to remote mountain people. Further depriving them of these options will lead them to desperately find alternative ways, such as increasing cultivation of unwanted crops like hemp (*Cannabis*), which is coming up as one of the new sources of income in several remote mountain areas of the Himalayan region.



*Floriculture: Plant Resources for Comparative Advantage*

Floriculture, a relatively new ancillary activity of horticulture, offers much potential in the mountains. Several hundred species of beautiful mountain flowers are listed in *Flowers of the Himalaya* by Polunin and Stainton (1987). The northeastern Himalaya of India and southeastern provinces of China are centres of diversity and evolution of several ornamental plant species such as *Rhododendron*, *Magnolia*, *Primulas*, *Camelia*, *Iris* and *Jasminum*. It is also home to hundreds of species of orchids (Table 11.14), notably *Dendrobium* spp., *Paphiopedilum* spp., *Cymbipidium* spp., *Phalaenopsis* spp., and *Vanda* spp. Many of these orchids are highly valued for floriculture.

TABLE 11.14  
Orchid diversity in the Indian Himalaya

Important areas of diversity	Approximate no. species found
<i>Northeast Himalaya</i>	
Assam: Rani, Kaki, Garampani, Orang, Digboi	150
Meghalaya: Kawphlong, Jarain, Cherrapunji	300
Arunachal Pradesh: Rupa Valley, Kameng, Subansiri, Siang, Tirap	368
Manipur hills	250
Nagaland hills	150
Tripura hills	100
Sikkim: Rabongola, Margan, Tsunyang, Gangtok	275
<i>Northwest Himalaya</i>	
Himachal Pradesh	
Uttar Pradesh: Garhwal and Kumaon hills	200
Jammu and Kashmir mountain ranges	

Source: Swarup 1989.

Several pockets of the Indian Himalaya are engaged in the flower trade. The practice is based on raising hybrids of known varieties and cut flowers are sent to the cities in the plains during the off-season. The cut flowers of rose, gladiolus, lily, narcissus, daffodil, carnation, chrysanthemum, etc. are supplied from the northwestern Indian Himalaya to Delhi and Bombay; similarly, Kumaon hills of Uttar Pradesh, Kalimpong, and Gangtok in Sikkim supply gladiolus, orchids, gerbera, magnolia, camellia, iris, geranium, and other temperate species to Bombay, Delhi, Calcutta, and other cities of the Indian plains. The economic benefits of flowers with comparative advantage of mountain habitat could be tremendous. The price of a sample spray of orchid, for example, is about US\$ 1–2



in the markets of Delhi and Bombay (Swarup, 1989). Rose (*Rosa* spp.) offers vast scope for farming due to its tremendous genetic diversity in the Himalayan region. Existence of races with high potential for rose oil brighten the chances of increasing yields to economically acceptable levels.

The current emphasis in floriculture is on research and development to evolve improved varieties of mostly exotic species known for their market value and to evaluate their climatic suitability. Except for some attention given to orchids, few attempts have been made to harness mountain floral resources as a cut flower crop and for the production of essential oils of high value, and as garden or potted plants. Instead, the programmes under way are pushing cultivation of hybrid exotic flower varieties, with little effort to harness the floral diversity potential of the mountains.

Further, as with mushrooms and medicinal plants there is always a chance of transferring resource gains, after technology application, from the most needy, the custodians of underutilized genetic material, to an enterprising, resource-exploiting class from outside.

### *Alleviating Malnutrition through Horticulture Crops*

One of the objectives of a horticulture development policy is to improve the nutritional standards of people facing malnutrition. Although malnutrition is recognized, the objective is relegated to a low priority programme.

Most people assume that increasing the cash income of households automatically helps to increase nutrition levels. The point is particularly argued with reference to horticulture development programmes. Although no data are available to substantiate or contradict this assumption for the mountain areas of the Hindu Kush-Himalayan region, several studies on this issue have been made elsewhere to explain this relationship. (Tinker, 1979; Kumar, 1977; Acharya and Bennett, 1983; Tripp, 1982). A review of these studies reveals several facts which question this assumption.

A recurring theme in all cash crop promotion programmes or technologies is that while the cash income of the people increases, its effects on household food consumption and nutrition are mixed, i.e. positive, neutral, or negative. The disturbing fact is that more often they tend to be negative, as pointed out by Braun and Kennedy (1986). These experts further argue that the actual outcome depends on several factors such as the actual increase in real income, income composition, change in who controls income (men or women), effects on the allocation of time of household individuals, especially mothers, nutritional knowledge, and health and sanitary factors.

Cash cropping influences nutrition in two ways. First, land and other resources are shifted from food crops to cash crops. Secondly, the diet transformation may not necessarily be nutritionally better than the past subsistence diets containing indigenous foods.

Promoting cash cropping to the extent of substituting food crops and thus depending on total or some food imports for a region has the danger of food being used as a political tool. Also, in importing food, the main objective shifts to checking hunger or undernutrition while malnutrition is ignored. Situations can be visualized where price levels and availability of food become important factors in maintaining political stability. Under such conditions food distribution may actually be targeted only toward the social groups relevant for political stability.

Understanding the nutritional consequences of cash cropping depends on what kind of indicator is chosen, such as household food expenditure, caloric intake of family, protein intake of family, or growth, mortality, and morbidity.

Income is one of the major determinants of a family's food consumption pattern. The marginal propensity to spend on food may be significant but the propensity to consume calories and proteins out of additional income may actually be low.

The form in which income is received is another factor that can affect consumption and nutritional status. There is evidence from India that income in kind is more likely to be used for family consumption than cash income (Braun and Kennedy, 1986). Studies in India and Nepal suggest that the children of families practising mixed farming of cash and food crops are better nourished than those switching over to total cash crops. Lastly, home or kitchen garden produce is more likely to meet nutrition demands of households in an effective way.

### *Selecting Horticulture Resources for Remote Mountain Areas*

Inaccessibility, harsh climatic conditions, poor socioeconomic environment, and the availability of several kinds of indigenous crop resources in their traditional farming systems, are notable features of remote mountain areas. Inaccessibility is paramount and varies from a day's walk to a journey of several weeks. Some areas in Nepal are outstanding examples.

The imperatives for horticulture development under such conditions are certainly different from those of other mountain areas. Here the priority focus has to be on horticulture crops which help to make these areas self-sufficient in food needs. Under a traditional system, knowledge exists about perennial plants which can help to supplement the diet.

From several local examples, we learn that any food habit, so long as it provides a nutritious diet, is worthy enough to be protected from unnecessary transformation and its primary sources should be given due



care. It also explicitly explains the ways in which horticulture can contribute to supplementing food. Helping reduce dependence on outside food supplies and reduce human drudgery of transporting it over long distances will be significant contributions. Efforts are needed to base the cash income of these remote mountain communities necessarily on non-agricultural land because of scarcity of agricultural land and primary importance of food crops. Moreover, the products need to be of high value and low volume and non-perishable, e.g., medicinal plants.

### *Mountain Perspective in Horticulture Development and Genetic Resources*

The important conditions characterizing mountain areas, which for operational purposes separate mountain habitats from other areas, are termed 'mountain specificities' (Jodha, 1989). The first four specificities, inaccessibility, fragility, marginality, and diversity or heterogeneity, may be called 'first order specificities'. Natural suitability or niche for some activities or products in which mountains have comparative advantage over plains and human adaptation to mountain habitats are the two second order specificities. The latter are responses or adaptations to the first order specificities.

A development initiative designed with full sensitivity to these mountain specificities will reflect the Mountain Perspective. This perspective is a complex of varying degrees of these mountain characteristics, their multiple dimensionality, and their interrelationships, providing a contextual perspective to decisions and actions in mountain areas.

Sensitivity to such a mountain perspective would determine the relevance and effectiveness of any approach to horticulture development in mountain areas (Table 11.16). Biological resources fall under several categories and the possible range of contributions and benefits they offer to the development of horticulture with a mountain perspective are listed in Table 11.17. Efforts to identify and inventory such plant resources are very much needed for these mountain areas, specially because there is a dearth of any up-to-date information. The following two examples of plant resources are being quoted here to emphasize and illustrate the kind of potential contributions these genetic resources can make. In addition, using them in a sustainable way should also help in their conservation in several ways.

### *Seabuckthorn: Promising Horticulture Plant for High Mountain Farming Condition*

The unsuitability of conventional horticulture crops to remote high mountains areas is well known because of several constraints. *Hyppophae*

TABLE 11.15  
 Relationship between prevalence of malnutrition  
 in children and income flow periodicity

Functional group	Percentage of malnourished children
Horticulturists	25.1
Diversified small farmers	29.1
Maize and rice producers	25.1
Agricultural workers	21.4
Salaried urban class	15.5
Self-employed workers	13.4
Government employees	12.8
Professionals	11.2

Source: Braun and Kennedy (1986).

is one of the few species native to such environment. It can offer multiple benefits to the people living in the high mountains and also help to improve the environment. Rongsen (1988) while citing an example of proper harnessing of *Hyppophae* in west Sichuan mountain areas of China, has discussed how promising this plant resource could be to horticulture and agro-forestry practices of mountain areas with harsh climates and marginal lands. Some of the noteworthy points he made follow.

Seabuckthorn (*Hyppophae*) is equipped with several outstanding features. Most important is its ability to fix nitrogen. Nitrogen-fixing bacteria live in symbiotic relationship, in abundance in its root nodules. So great is its capacity to fix nitrogen that a 1 hectare plantation of seabuckthorn would fix more than half a quintal (50 kg) of nitrogen. It is better than the nitrogen-fixing capacity of soybean, the standard example quoted worldwide. More investigations on its genetic races may reveal still higher potential.

It can resist cold temperatures up to minus 60° C and can tolerate hot summer temperatures up to 40° C. The plant also tolerates alkaline soils (pH 9.5) and salts (1.1 per cent). It has an extensive root system which probably also helps in controlling soil erosion. While secreting acids from roots, it in fact helps improve alkaline soils.

Other features of the plant are its excellent fuelwood in areas where fuel is a scarce commodity (caloric value 4000 kcal/kg). It is most adapted to cold, dry conditions and marginal, infertile soils. High mountain farmers do not have to put fertile agricultural land under it. Rather it will grow on barren slopes and flat lands, making them more fertile and suitable for agriculture. Intercropping with seabuckthorn would forgo the need for additional fertilizer supply. It is also traditionally used as a common hedge plant in trans-Himalayan high mountain areas of Nepal and the Indian Himalaya.

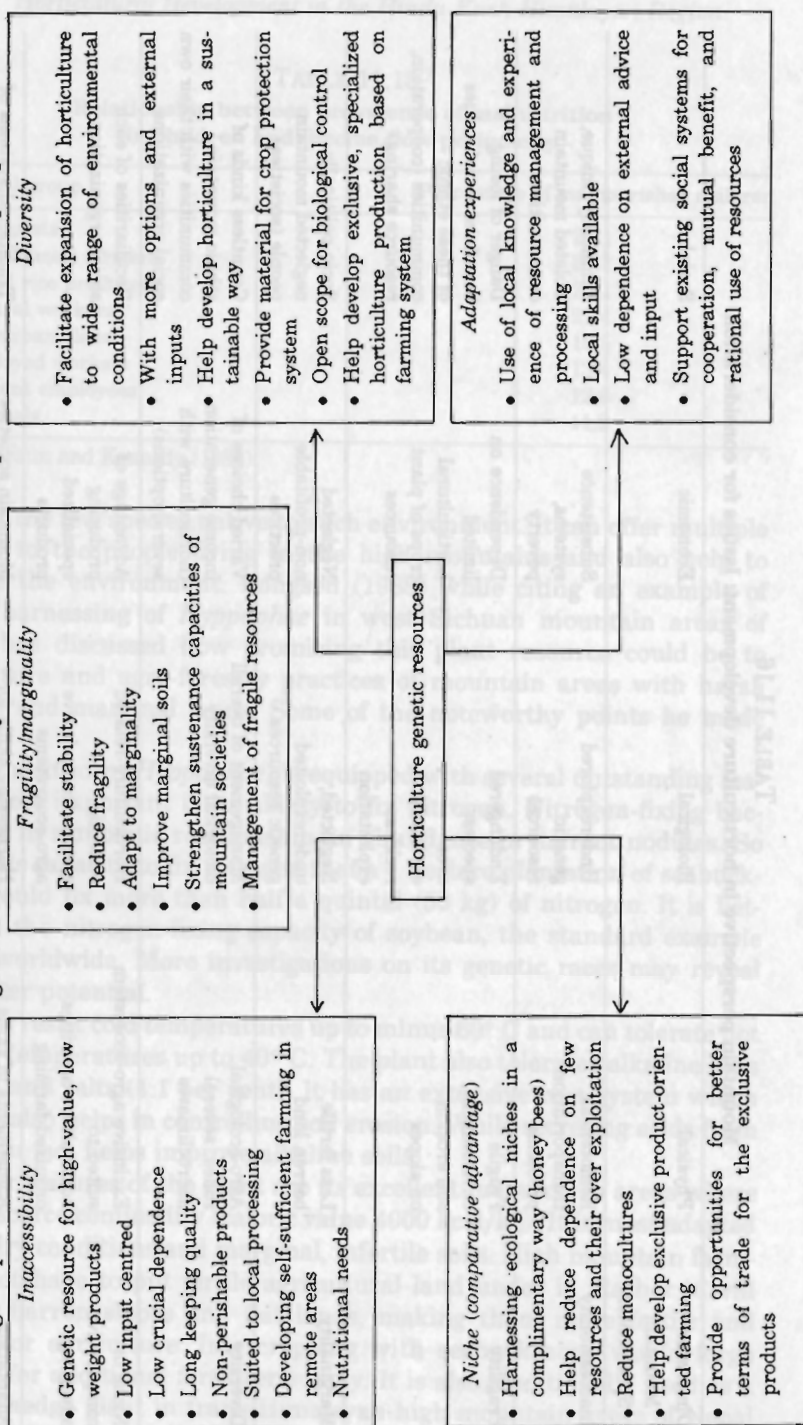


TABLE 11.16  
Mountain perspective in horticulture development: Issues for consideration

Dimension	Physical	Biological	Economic	Social
Mountain Specificities				
Inaccessibility	Remoteness, transportation problems	Underexplored genetic resources	Subsistence systems, poverty	Ethnically unique, isolated mountain communities
Fragility	Fragile environment, soil erosion on slopes	Endangered species, over exploitation, reckless exploitation	Dependence on limited horticultural crops of plant resources	Danger of losing beneficial social values of these ethnic communities (cooperation, resource sharing)
Marginality	Less fertile, barren land	Neglected, underexploited genetic resources	Neglected non-profitable practices	Socio politically neglected mountain people (societies)
Diversity	Agro-ecological zones, several microclimates	Management of overall biological diversity	Varied choices of income generation (horticulture with several options)	Countless kinds of ethnic mountain communities with their own social organizations
Niche or comparative advantage	Exclusive agro-ecosystem suited to horticulture activities or mixed farming	Horticulture-related endemic species for exclusive agro-ecosystems	Advantage of producing specialized products	Peculiarities of each social organization
Adaptation experiences	Adjustments of skills to local environment	Harnessing skills for indigenous plant resources	Mountain societies traditional activities income generation	Traditional systems of cooperation, help, resource sharing

TABLE 11.17

Range of possible contribution of genetic resource diversity to horticulture development with mountain perspective



The plant bears small juicy berries which are rich in nutrients. Of special significance is its vitamin C content of up to 100 times more than any other fruit known so far (Table 11.18). Its significance as a very good source of vitamins further increases when we take into account the fact that in these high mountain areas vitamin sources are always scarce. In addition, fruit pulp and seed contain a high quality oil for use in food and industry.

TABLE 11.18  
Fruit characters and nutritional value of products of seabuckthorn

Parameter	Average (Percentage)	Range (Percentage)	Remarks
Weight of 100 berries	24.9	4.5–405	
Percentage of juice in berries	71.76	33–82.5	
Soluble sugars	6.4	6.1–8.9	
Free amino acids (mg/100 ml)	130	76–264	
Vitamin C (mg/100 ml)	952	471–1709	Vitamin C highest of all plants
Vitamin E	93.2	60–120	Vitamins present in the juice, syrup, and wine of seabuckthorn
Vitamin A (mg/100 g)	11	7.75–14.5	Processed dry powder prepared by Chinese and marketed for preparing drinks
Vitamin B (B <sub>1</sub> , B <sub>2</sub> ) (mg/100 g)	0.6	0.35–0.75	
Vitamin (mg/100 g)	1000	700–1400	

Source: Rongsen (1989), commissioned paper by ICIMOD, unpublished.

The plant has its centre of origin and maximum diversity in the Himalayan region itself. At present, four species and nine sub-species are identified and hopes of more genetic diversity within *Hyppophae* which could be of much ecological and economic significance are not ruled out.

In India, Nepal, and Pakistan, although the plant extensively grows in mountains, it is an unexplored species for horticulture and agro-forestry purposes. It is only in China that there have been major efforts by scientists, planners, and farmers to explore, develop and draw benefits from *Hyppophae* in an effective way. Surveys revealed that around 670,000 hectares are under *Hyppophae* in China. It is capable of producing 22,000 tons of berries. By 1987 three major seabuckthorn berry processing and product making factories were installed and products like

juice, syrup, soft drinks and wine marketed to earn a total profit of 50,000 yuan (US\$ 12,000) per year. Several micro juice-extracting plants have been installed in remote areas at the base of the source and only concentrated juice transported to factory points.

The available information speaks of high economic gains to farmers and vegetation rehabilitation of bare, arid regions. In the mountain area of west Sichuan in China, a large amount of marginal land is available. It is infertile and remains without much vegetation; farmers of this region have small land holdings because of non-availability of fertile land. The Chinese government leased this marginal land to households for putting up *Hyppophae* plantations. The households got the right to pick the fruits and land improved in fertility, giving way to diverse, stable plant cover. In this way, shelterbelt plantations of *Hyppophae* are slowly appearing over large areas.

In October 1989 scientists and other professionals from the USSR, Finland, Norway, Hungary, Czechoslovakia, West Germany, Romania, and Japan gathered in China to exchange information and discuss ways to harness the full potential of *Hyppophae* at an international symposium on seabuckthorn.

The major constraint in other countries of the Hindu Kush-Himalayan Region to using *Hyppophae* is lack of information. An agency like ICIMOD has the mandate and resources to fill in this gap. The plant species is most appropriate even for initiating a limited pilot action programme. There may be several other plants waiting for explorations to make known their promising potential.

#### *Scarcities, New Crops and Unconventional Land Use: The Example of Prinsepia sp.*

Among the plant resources of these mountain areas some have the potential to help solve chronic scarcities. Let us examine the case of edible oils. There is a general scarcity of oilseeds in this region. For example, a technology mission on oilseeds, was set up by the Government of India. The kind of initiative made under the programme, in terms of crop choice, are reflected by the following statement on the oilseed programme of a Himalayan state in India:

'A well-planned programme with the help of national agencies, i.e. a technology mission on oil seeds, has been launched. It emphasizes the increasing production of soybean, toria type of mustard, and flowers. To achieve this, the area under toria mustard would be increased to about 35,000 hectares from that of 5000 hectares at present. At present Himachal grows mustard, sesame, rape, groundnut, linseed, castor, and other minor oilseed crops on 20,000 hectares, and overall production is just over 5000 tons. The total annual production is expected to be



increased from 5000 tons to 16,000 tons by implementing these schemes'.

Indigenous oilseed plants with no ecological backlash, growing in harmony with nature and acceptable to the agro-ecosystems, already exist and can be perfected for wider use with little scientific effort. One such example is *Prinsepia* spp., a thorny multipurpose bush of this region.

*Prinsepia* is a promising oilseed plant with unconventional land use. It is a multipurpose shrub and makes it possible to plan unconventional land use for boosting oilseed production, without putting pressures on existing agricultural land. The thorny shrub acts as a live fence and gives excellent fuelwood and oilseeds. Its purple fruits are food for birds and other wild animals. As a hedge plant it is an excellent habitat for birds. In winter (November to March), when bee flora is scarce, it provides valuable forage for honey bees, and the honey produced is of excellent quality. The plant commonly grows between the altitudes of 800 and 2500 m on wastelands, road sides, and forest, and around agricultural fields and orchards. The plant is widely distributed throughout the Hindu Kush-Himalayan Region.

*Prinsepia* oil is edible and can be used in medicines, soaps, and varnishes. Its oilseed cake is a good source of animal feed. In the past, oil from its seeds was widely used by several mountain households for cooking purposes but the practice is now vanishing. It still holds value for medicine, massage, and fuel.

The potential benefit of harnessing *Prinsepia* as an oilseed shrub, taking the case of Himachal Pradesh, is illustrated in Table 11.19.

## Conclusions

Today, the foundations of horticulture development in the Hindu Kush-Himalayan Region are largely based on the adoption of uniform cultivars of fewer crops than desirable. Both the technology and crop choice are for high input varieties which are less dependable when grown under traditional horticulture management. Also, the practice of planting vast areas with monocultures of genetically uniform cultivars has made productivity extremely vulnerable to yield-limiting factors. This is illustrated by the apple diseases that occur in the Hengduan mountains and Indian Himalaya. Further, this approach faces several constraints on the large-scale expansion of horticulture to all mountain areas. Moreover, one can discern little concern for conservation in this approach to horticulture and there appears to be little value placed on the diversity of the genetic resources available.

From the technical standpoint, the capability of scientific institutions to work on the new concept requires an interdisciplinary approach and infrastructure facilities. The existing research and development institutions are engaged in working mostly in areas focusing on increasing yield

TABLE 11.19

**Estimation of oilseed potentials of *Prinsepia* under unconventional land use (Himachal Pradesh)**

Average seed production of the plant<sup>1</sup>: 1 kg per year, 0.5–5 kg range. Oil content in seeds: 30–40 per cent.

Assuming no agricultural land is available for *Prinsepia* cultivation in Himachal:

Area under apple orchards in Himachal<sup>2</sup>: 55,000 hectares up to 1988–89, but 75,000 hectares by 2000 (estimated target).

Assuming one hectare as an average size of orchard,<sup>3</sup> fencing area of this size of field: 400 m.

A *Prinsepia* plant, maintained agronomically, would need around 1 m space and if planted closely the fencing area would provide enough space for 400 plants.

Total fencing area available for plantations around apple orchards in Himachal:  $55,000 \times 400 = 22,000,000$  m.

Number of plants supported in the area: 22,000,000.

Estimated oilseed production from *Prinsepia*: 22,000,000 kg

Alternately, it would yield 66,000 tons oil (at 30 per cent), and 15,400 tons oilcake.

Comparison of *Prinsepia* and other oilseeds of Himachal Pradesh.

Total annual oilseed production from 20,000 hectares of oilseed cultivation in Himachal (1980–1985 average): 5000 tons.

Future plans are to increase toria cultivation from 6000 to 35,000 hectares to enhance total oilseed production. It would raise total oilseed area to 50,000 hectares for an estimated production target of 16,000 tons.

In contrast, 2200 km fencing strip 1 m wide is available around apple orchards only and it would produce approximately 22,000 tons of oilseeds, four times the present oilseed production of the state.

Also, there is scope to increase area under *Prinsepia* by 10 times as more fencing area under crops, wastelands, and roadside common property is also available. Production estimates then will increase to 220,000 tons.

<sup>1</sup> Estimates of seed and oil yields are author's own experimental observations.

<sup>2</sup> Keeping in view 1.5 hectares as average size of land holdings and several smaller land parcels of households in Himachal Pradesh.

<sup>3</sup> Keeping in view 1.5 hectares average size of land holdings and several smaller land parcels of households in Himachal Pradesh.

and quick economic gains. They need further reorientation to incorporate the approach based on genetic and biological diversity to horticulture development.

Horticultural development approaches and strategies of the governments of most of the Hindu Kush-Himalayan Region countries seem designed to keep quick economic gains to farmers and the state paramount. Lack of understanding of the mountain environment and its specificities is visible in most cases. International aid has also contributed to this. The goal of international development assistance both technical and fi-

nancial has so far been, in horticultural development of agriculture, to help countries to enhance their human, social, and economic conditions. Environment and conservation ethics did not come into it. Interestingly, at present these ethics seem to prosper in traditional cultures as well as in highly developed nations. The rest of human society is in transition between old cultures and a more economically developed state.

There are also examples which show some kind of confusion between development investment, and conservation measures. Many programmes supported by international development agencies do not conform to conservation principles, while these same agencies are willingly spending on genetic resource conservation elsewhere.

The changing conditions dealt with below are creating a demand for new products from previously underexploited resources and many more will emerge in the future as pressure grows for the increased exploitation of renewable resources:

- Technical innovations and improved scientific knowledge on the use of biological diversity, such as biodegradable from plants.
- New demand for speciality items and the heightened desire for new products, such as rare species, rare fruits and fragrances. A source of comparative advantage to mountain people.
- The pressures of increasing population and poverty call for survival plants which can be grown in unusable marginal lands, e.g., *Hypophae*.

However, faced with an area like the Hindu Kush-Himalayan Region, home to thousands of species of plants, many of which are yet to be discovered by scientists, is it not impractical to screen each species for its potential as a new resource. The concept of using plants which are already known for their ability to aid the local human population should have wider appeal than exploring species totally unknown for their value. The adoption of known plant resources as new crops is also supported by new knowledge on the components of sustainable farming systems. Several workers (Altieri and Merrick, 1987; Harwood, 1979) have reported on the vital role of these underexploited genetic resources in traditional agriculture for its stability and sustainability. These workers strongly argue for incorporating these genetic resources into the design of sustainable farming, stable food production, and the economic well-being of people within the agro-ecosystems.

Plant resources user agencies and genetic resource conservationists often talk about plants, their exploitation patterns, and the risk of extinction. They have seldom recognized the value of folk knowledge about these species, which is disappearing at a much faster rate than the species themselves. The present-day custodians of this knowledge in the mountains are isolated, remote mountain communities and culturally distinct tribes. All the lesser-known species of these underexploited genetic re-



sources are extensively used by them. The need is to document the complete ethnobotanical knowledge of these communities of plant resources of horticultural value. An example of the value of ethnobotanical knowledge is the information on the use of apricot as staple food by Hunza villagers (Jeddy, 1989).

The need for such a study is becoming clearer with each passing year. For as we feel the need for more and more plant species, the folk knowledge, about them is shrinking, partly through extinction of the custodians of this knowledge and partly because of their acculturation. Each time a medicine man dies it is as if a library has burned down (Plotkin, 1988), and we may have been deprived of knowledge about some promising medicinal plants.

Such research, combined with expanded programmes, will help to bring some of the more promising species into cultivation, or may be useful in identifying varieties and wild forms for use in horticulture crop improvements, or reveal ecological information on how best to develop horticultural-dominated mountain farming systems.

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