Chapter 22

Crop Gene Pools in the Mountain Areas of Pakistan and Threats

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Diverse crops are cultivated in the mountain areas of Pakistan. Wheat accounts for 66 per cent of the total crop area. Wheat and barley are grown to elevations above 3,000m, whereas rice and maize crops are mostly grown below 2,500m. Pearl millet and sorghum are mainly grown on the plains and in the low hills (Table 22.1).These crops account for 97 per cent of the total area used for agricultural crops. Various types of fruits, mainly citrus, guava, banana, and mango, are grown on over 0.43 million hectares. The remaining three per cent of the area is occupied by other food legumes such as faba beans, pigeon peas, cowpeas, and moth beans. Peas, mung beans, urd beans, lentils, and faba beans occupy about 29,000 hectares in the mountain regions of Pakistan. Farmers mostly grow land races of lentils, faba beans, and peas.

Some minor cereal crops are also grown in the mountains in addition to the major food crops(Table 22.1). Foxtail millet (Setaria italica), common millet (*Panicum miliaceum*), barnyard millet (*Echinochloa frumentacea*), oats (*Avena* spp), amaranthus (*Amaranthus* spp), and buckwheat (*Fagopyrum* spp) are common as food crops in the high mountain areas (Anwar et al. 1987). Varieties of these crops have been grown in the mountains for centuries. Substantial quantities of medicinal plants also grow in the mountains.

Temperate fruit such as apples, pears, apricots, walnuts, peaches, plums, grapes, and almonds are grown mainly in the middle to high mountains of Pakistan. Citrus and guava are found in the low to middle mountains.

Table 22.1: **Crops Grown in Pakistan's Mountains, Their Importance and Uses**

Common Name		Botanical Name	Importance	Use
A.	**Cereals**			
	Wheat	*T. aestivum*	xxx	Bread, many other uses
	Rice	*Oryza sativa*	xxx	Boiled and other uses
	Maize	*Zea mays*	xxx	Bread, roasted and others
	Sorghum	*S. bicolor*	xx	Flour, boiled, fodder
	Millet	*P. americanum*	xx	Flour, boiled, fodder
	Barley	*H. vulgare*	xx	Fodder, local food
	Oats	*Avena sativa*	xx	Fodder
	Buckwheat	*Fagopyrum* spp	xx	Bread and other uses
	Foxtail millet	*Setaria italica*	xx	Boiled, bread, fodder
	Millet, common	*P. miliaceum*	xx	Bread, boiled, fodder
	Millet, amaranthus	*Amaranthus* spp	xx	Sweets
B.	**Food Legumes**			
	Mung beans	*Vigna radiata*	xxx	Pulse curry
	Black gram	*Vigna mungo*	xxx	Pulse curry
	Lentils	*Lens culinaris*	xxx	Pulse curry
	Faba beans	*Vicia faba*	xx	Curry and boiled
	Dry beans	*P. vulgaris*	xxx	Curry, boiled, roasted
	Chickpeas	*C. arietinum*	xxx	Many uses
	Peas	*Pisum sativum*	xx	Vegetable, curry
	Pigeon peas	*Cajanus canjan*	xx	Curry
	Cowpeas	*V. unguiculata*	xx	Curry, boiled
	Moth beans	*Vigna acontifolia*	xx	Curry, boiled
	Dry peas	*Lathyrus sativus*	xx	Curry, fodder
	Soybeans	*Glycine max*	xx	Oil, fodder
C.	**Fruit**			
	Tangerines	*Citrus reticulata*	xxx	Fresh and many other uses
	Oranges	*Citrus sinensis*	xxx	Fresh and many other uses
	Guavas	*Psidium guava*	x	Fresh and many other uses
	Apples	*Malus pumila*	xxx	Fresh and many other uses
	Apricots	*Prunus armeniaca*	xxx	Fresh and many other uses
	Peaches	*Prunus persica*	xxx	Fresh and many other uses
	Plums	*Prunus domestica*	xxx	Fresh and many other uses
	Almonds	*Prunus amygdalus*	xxx	Dried fruits
	Cherries	*Prunus avium*	xx	Fresh & other preparation
		Prunus cerasus	xx	Fresh & other preparation
	Pears	*Pyrus communis*	xxx	Fresh and dried
		Pyrus pyrifolia	xxx	Fresh and dried
	Mulberries	*Morus alba/nigera*	xxx	Fresh and dried
	Grapes	*Vitis vinifera*	xxx	Fresh and other preparations
		Vitis jacquemontii	xxx	Fresh and other preparations
	Walnuts	*Juglans regia*	xxx	Dried
	Pomegranates	*Punica granatum*	xx	Dried and used as spice
	Persimmons	*Diospyrous* spp	xxx	Fresh
		Diospyrous lotus	xxx	Fresh and dried
	Hazelnuts	*Coryllus* spp (wild)	xx	Dried

Table 22.1: **Crops Grown in Pakistan's Mountains, Their Importance and Uses (cont'd)**

Common Name	Botanical Name	Importance	Use
d. **Medicinal Plants**			
Kanis	*Dioscorea deltoidea*	xxx	Medicinal use
Bankakri	*Podophyllum emodi*	xxx	Medicinal use
Ban javain	*Thymus serphyllum*	xx	Medicinal use
Revand chini	*Rheum emodi*	xx	Medicinal use
Mamekh	*Paeonia emodi*	x	Medicinal use
Afsantine	*Artemisia maritana*	x	Medicinal use
Afune	*Papaver* spp.	x	Medicinal use

Note: xxx Major crop xx Minor crop x Rare crop

Crop Genetic Diversity

Different crops were introduced into the mountainous regions of Pakistan during early migrations. Varied edaphic, topographic and climatic factors, and different selection pressures over centuries of cultivation have resulted in a pool of variation. The indigenous varieties (population of different land races) have evolved over a span of centuries and are adapted to particular areas. The old varieties (usually termed primitive cultivars or land races) have withstood the rigour of time, have escaped attack by insect pests and diseases, and have tolerated harsh climatic conditions. They possess desired agronomic and genetic traits that can be exploited to give high yield and resistance. The Genetic Diversity of some major crops in the mountains of Pakistan is described below.

Wheat

There is a rich Genetic Diversity in wheat in Balochistan and the Northern Areas - Gilgit, Hunza and Skardu, and Azad Kashmir. Balochistan and the Northern Areas are arid and annual rainfall varies from 100 to 250 mm. The indigenous wheat land races are highly variable in traits such as awn, straw thickness, grain size and colour, and spike density. All the local varieties collected from the region belong to the hexaploid and tetraploid wheats. The different species distributed in the region are listed below.

- *Triticum aestivum - hexaploid*
- *Triticum aestivum spp compactum - hexaploid*
- *Triticum spp sphaerococcum - hexaploid*
- *Triticum durum - tetraploid*
- *Triticum polonicum - tetraploid*
- *Triticum turgidum - tetraploid*

The variation in traits may have been largely caused by differences in aspect, altitude, soil moisture regimes, cultural practices, and social isolation from one

valley to the next. Land races such as Shorawaki, Khushkaba, and Dayak in Balochistan, belonging to hexaploid wheat (*Triticum aestivum*), are of great importance because of their salt and drought resistance. Swaminathan (1970) observed that *Triticum sphaerococcum* (*Triticum aestivum* spp, sphaerococcum) from Balochistan and the North West Frontier Province (NWFP) was extremely drought resistant. So far the rate of genetic erosion of these land races is low, largely as a result of the lack of high-yielding varieties (HYVs) that can tolerate drought stress. However, HYVs have replaced the traditional land races in certain locations with supplementary irrigation facilities. In Azad Kashmir, for example, the rate of erosion of land races is enormously high. The area receives heavy rains (over 1000 mm annually), a major factor in the adoption of modern varieties in the area.

Wild Gene Pool

Hexaploid wheat or bread wheat (*Triticum aestivum*) combines three different genomes (genomic constitution AABBDD). *Aegilops speltoides* and *A. squarrosa* are two diploid donars of B and D genomes respectively. McIntoch (1983) observed that the wild relatives of wheat, *Ae. squarrosa* and *Ae. speltoides*, have genes resistant to stem rust and leaf rust of wheat. Similarly, other related genera such as Rye and Agropyron have resistant genes for some wheat diseases (Table 22.2). The Pakistani province of Balochistan has many gene pool areas for the two *Aegilops* species, *squarrosa* and *tricuncialis*. Different wild species of *Aegilops*, *Agropyron*, and *Secale* are found here notably in Quetta, Kalat, Nushki, Sibi, Ziarat, Chamman, Muslimbagh, and Qila Saifullah, as well as in several other small towns and villages. *Aegilops squarrosa* is distributed widely throughout these provinces, while *Aegilops triuncialis* is restricted to a small area - from Pishin to Khanozai — in the northeast of Quetta. Very large populations of *Aegilops squarrosa* grow along

Table 22.2: **Disease Resistance Genes in Wild Relatives of Wheat**

Source of Resistance Species	Disease	Resistant Gene	
1. *Aegilops squarrosa*	Stem rust	Sr 33	Aegilops
2. *Aegilops squarrosa*	Leaf rust	Lr 21	Aegilops
3. *Aegilops speltoides*	Leaf rust	Lr 28	Aegilops
4. *Agropyron elongatum*	Stem rust	Sr 24	Agropyron
5. *Agropyron elongatum*	Stem rust	Sr 25	Agropyron
6. *Agropyron* spp.	Leaf rust	Lr 24	Agropyron
7. *Secale* spp.	Poundry mildew	Pm 8	Rye
8. *Secale* spp.	Stem rust	Sr 27	Rye
9. *Secale* spp.	Yellow rust	Yr 9	Rye
10. *Triticum speltoides*	Stem rust	Sr 32	Wheat

(Source: McIntoch 1983)

a belt from Khanozai to Ziarat. *Aegilops squarrosa* has also penetrated to the warmer areas south of Quetta. The species occupies disturbed habitats and spreads as a weed in wheat fields, along the boundaries of fields, along water channels, and under trees and shrubs.

Box 22.1
Wild Gram (Cicer spp) Gene Pool in the Mountains of Pakistan

This box presents the findings of an expedition that showed that the Hindu-Kush Himalayan region (HKH) is a valuable resource centre for wild relatives of chickpea. Two provinces of Pakistan, the Chitral and Swat districts of the North West Frontier Province (NWFP) and the Gilgit, Skardu, and Gangche districts of the Northern Areas (NA), were covered by the expedition.

Scientists have identified a number of wild relatives of chickpea at elevations ranging from 2,450m in Chitral to 3,840m in Gilgit. The number of species collected is summarised as follows.

Cicer *species*	***Districts***				
	Chitral	**Swat**	**Gilgit**	**Skardu**	**Gangche**
Cicer microphyllum	7	0	5	5	13
Cicer nuristanicum	2	0	0	0	0
Cicer macranthum	0	5	0	0	0
Total	9	5	5	5	13

The most valuable gene pool for *Cicer* was found in the vicinity of Barmoghlasht and Warsyuzan in the district of Chitral between 2,630 and 2,930m. *C. microphyllum*, a wild chickpea, was found growing on roadside slopes and pasture land under thorny bushes of *Rosaceae* and together with Juniperus. About 80 per cent of the *Cicer microphyllum* populations had a double pod trait that is seldom found in cultivated chickpea. One plant had three pods on a peduncle. The plants were vigorous, tall, and had long pods of up to 40 mm. Locally wild chickpea is called *zangli nakhoay* (*zangli* = wild and *nakhoay* = channa or chickpea), or *kacha nakhoay* (*kacha* = small and *nakhoay* = chickpea). The yield traits, two to three pods per peduncle, of the populations of chickpea have great potential value for improving the yield of chickpea crops. This is a rare trait in chickpea germplasm (Van der Maesen 1972).

A small population of *Cicer microphyllum* was spotted at an altitude of 3,560m in Sust, 200 km north of Gilgit in Gilgit district. The plants were upright and vigorous. The population was on the verge of extinction due to land levelling and development activities, and this may have happened afterwards.

The *Cicer* was locally called *Khukhani* by farmers. Farmers reported that the they used to harvest wild *Cicer* during August-September and store it for feeding during the winter. The threat of genetic erosion to the *Cicer* species varied greatly from one area to another. In general, the populations of *C. macranthum* in Swat and of *C. microphyllum* in Gilgit were severely damaged by grazing cattle. These species were also threatened by land-use changes and habitat destruction. None of these factors is under the control of plant genetic resources' institutions, so they cannot control *in situ* conservation. Thus *ex situ* conservation is necessary.

Rice

Rice is grown in a few areas in the NWFP and Balochistan, and there is a small number of local land races grown widely. A local variety, *Begami*, dominates in Swat; two common groups of land races, *Munji* and *Nali*, are found in Dir and Chitral; a single local land race, *Kolai*, is popular in Kurram agency, an area of 1,970 sq. km.; and a native variety, *Booti*, is popular throughout the Kaghan Valley. All the varieties are coarse grain types and belong to the Japonica category. Genetic resource surveys have recorded rice cultivation up to 2,250m. There are about 65 land races of rice in the NWFP, although rice is only grown in a comparatively small area. Several local rice varieties are found in the terraced rice fields of the remote valleys of Karkh and Mula (Khuzdar district). In Balochistan, rice is grown on smaller areas but about 200 samples of rice have been collected. These indigenous rice land races are highly variable for plant height, panicle length, panicle laxness, awnedness, shattering tendency, grain size, and shape.

The rate of erosion of the indigenous rice varieties in Baluchistan is high. In 1972-73 indigenous rice varieties occupied 40 per cent of the area under rice cultivation, by 1983-84 the area under local varieties had been reduced to eight per cent. The principal cause of genetic erosion in the region is thought to be the shift from subsistence to commercial farming which occurred following the construction of the Patfedar canal.

In the past, agricultural explorations in the northern mountains of Pakistan were mainly concerned with major food and fruit crops. During 1987, the Plant Genetic Resources Programme (PGRP) of the Pakistan Agricultural Research Council (PARC), in collaboration with Kyoto University, Japan, explored the region for the first time to collect minor cereals and some wild relatives of crop species. The mission explored the areas of Chitral, Yasin, Gupis, Gilgit, Hunza, and Skardu, to collect foxtail millet (*Setaria italica*), common millet (*Panicum miliaceum*), and several other minor crops and wild species at altitudes ranging from 700 to 3,540m.

Foxtail millet is cultivated over a vast area from Chitral, through Gupis, Gilgit, and Hunza, to Skardu. In contrast, common millet is confined to the area from Chitral to Gupis and the surrounding valleys. A very interesting pattern of distribution of foxtail millet is seen in the northern areas. Foxtail millet growing on the western bank of the River Indus belongs to the West Asian type, whereas that growing on the eastern side of the River belongs to the East Asian type. Thus the River Indus seems to be the barrier for distribution of the West Asian and East Asian types.

Fruit

Geographically, Pakistan lies between two major centres of fruit diversity, the Caucasus Mountains and China. An ancient trade route from China through

Central Asia to Western Asia passes through the Northern Mountains of Pakistan. Fruit species from along the entire route were brought here and have been cultivated for centuries. These fruit species have been diversified through human selection over hundreds of years. Farmers in the mountain areas of Pakistan are traditionally fruit growers, and fruit crops are a very important source of food and livelihoods. Thus there is considerable genetic variability in the fruit species in these mountains (Bhatti et al. 1982). The pattern of variation and adaptation of fruit species varies greatly in different areas.

Various types of apricots are grown in Skardu, Gilgit, and Hunza, the Northern Areas of Pakistan (Table 22.3). All the local varieties belong to only one species (*Prunus armeniaca*). The apricots vary widely in fruit size, shape, colour, taste, and time taken to mature. The varietal variations may result from the nature of seed propagation. Wide variation exists in the seed size and taste of the fruit, which ranges from bitter to sweet. Total Soluble Sugar (TSS) in the local apricot varieties ranges from 22 to 36 per cent. The local varieties, *Halman* and *Marghulam*, have the best quality for taste, and *Kacha Choli* the best keeping quality.

Apples are an important fruit crop for the mountain farmers of Pakistan. Here, apples are adapted to very diverse climatic conditions. All the cultivated varieties belong to *Malus pumila*. They are grown on the plateau of Balochistan, in the mid to high mountains of the NWFP, and in the high mountains of the Northern Area. Several local varieties are grown in the Skardu area such as *Ambri Kusho, Nas Kusho, Shin Kusho, Skiur Kusho, Mar Kusho*, and *Bong Kusho*. Of these, *Ambri Kusho* is the best apple variety for quality. A large number of local varieties are grown in Gilgit and Hunza. The most common and widespread varieties are *Noor Shah Balt, Mamu Balt, Shakur Balt, Beruit Balt, Alikan Balt, Shikam Balt*, and *Akbaraman Balt*.

To a great extent, the local apple varieties in the NWFP, Azad Kashmir, and Balochistan have now been replaced by a few commercial varieties such as Golden Delicious and Red Delicious. Large scale plantations of improved varieties in Swat and Mansehra (NWFP) and Quetta (Balochistan) during the past few decades have played a vital role in improving the farm economy of these areas but have also led to genetic erosion of native varieties.

The Hunza and Skardu areas have altitudes of 2,450 m and above and a dry and very cold climate. Here local apple varieties have evolved that are winter hardy and adapted to harsh climatic conditions. Farmers in the Swat Valley have developed a double graft technique to cope with some soil-borne diseases of apples. They first graft *Sorbus* on to *Crataegus songarica* (common hawthorn, locally called *chochina*), which is resistant to nematodes and other diseases and

Table 22.3: **Local Apricot Varieties Grown in the Northern Areas of Pakistan**			
Local variety	**Characteristics**	**Local variety**	**Characteristics**
Skardu		**Hunza/Gilgit**	
Marpho choli	Red apricot	*Shikanda joo*	-
Karfoo choli	White apricot	*Brum joo*	White
Warfo choli	Pith used for oil	*Surasune joo*	Good quality
Bro choli	Late maturing	*Duda-sanag joo*	-
Khakas choli	Pith partially split	*Koropiam joo*	-
Cho choli	Juicy	*Ali Shah Kakas joo*	Late
Apo choli	Large	*Habi joo*	Very late
Beru choli	Small	*Khanemish joo*	-
Blafo choli	Small, red	*Kartachi joo*	Very early, white
Odumar choli	Partly red	*Dudur joo*	-
Chun choli	Sweet pith	*Ghulam joo*	-
Yakar choli	Reddish	*Rashikin joo*	Early
Gurdalo choli	Like peach	*Alman joo*	Good quality
Pharang choli	For drying	*Koropian joo*	Early
Kartaksha choli	Early, juicy	*Gakateenan joo*	-
Sara choli	-	*Kaka Shikanda joo*	-
Kacha choli	Hard, good to keep	*Moen joo*	-
Halman choli	Best quality	*Ghaka joo*	-
Kazangi choli	Sweet	*Mamoori joo*	-
Khashanda choli	Good taste	*Brun joo*	
Kho choli	Bad taste, sour	*Gario joo*	
Shakanda choli	Sticky		
Tacho choli	-		
Marghlam choli	Early, good quality		
Shanda choli	Small, early		
Stun choli	Late maturing		
Mamoor choli	-		
Ghom choli	-		
Sara Karfo choli	Early		
Stun kuban choli	-		
Khustar choli	-		
Sapastan choli	Sour, pith used for oil		
Miting choli	Sour, pith used for oil		
Shakar choli	Sweet		
Hongool choli	-		
Brook choli	-		
Halwar choli	-		
Duspaong choli	-		
Yakab yak choli	-		
Snair choli	-		

is compatible with *Sorbus*. When the *Sorbus* has grown an apple variety, such as *Kalam*, the *Utror, Gabral, or Sorbus* (Anj) variety is grafted on to it.

The common pear (*Pyrus communis*) is grown widely in this mountain area. The largest number of local varieties belonging to *P. communis* and *P. pyrifolia* are

found in the Swat Valley. The local pears are very diverse in terms of fruit size, shape, taste, and time of maturity (Table 22.4). *Pyrus pyrifolia (syn. P. Lindleyii)* and P. pashia are mainly adapted to the semi-humid to humid regions of the NWFP and Azad Kashmir.

Table 22.4: Local Pear Varieties in Swat (NWFP), Pakistan

Variety	Characteristics	Variety	Characteristics
Parao	Large, pear shape	*Batang*	Large, pear shape, sweet
Sur Tango	Small, round	*Nag Tango*	Large, apple shape, hard
Shin Kulay	Medium, apple shape	*Nak*	Oblong to pear shape
Spin Tango	Small, round	*Shal Tango*	-
Mamusay	Small to medium, round, early	*Khar Nak*	Large, hard
Shakar Tango	Sweet, medium size	*Gadaray tango*	-
Nashpati	Medium to large, sweet	*Bap Tango*	Early
Tang	Large, pear shape	*Khawaga maiwa*	Small, round, sweet
Khan Tango	Small, round	*Khapa*	Sour

The diverse grape varieties (*Vitis* spp) found in the northern mountains of Pakistan include land races of *Vitis vinefera* and *V. jacquemontii* and a wild species, *V. parvifolia*. The adaptation patterns of different species vary from the arid dry to the humid regions. *V. vinifera* demonstrates great diversity in Skardu, Hunza, and Gilgit. *V. jacquemontii* is adapted to the high rainfall areas in Swat and Azad Kashmir. The wild species, *V. Parvifolia*, is distributed sparsely in the Chickar area of Azad Kashmir.

The Swat, Khagan, and Gilgit valleys are major growing areas for walnuts (*Juglans regia*). The walnut land races have a range of variation for size, shape, colour, and shell thickness (varying from a very thin to a very hard shell).

The hazelnut (*Coryllus jacquemontii*) grows in abundance on the north-facing mountain slopes in the high mountains of Swat. In Kalam it is called '*Mizzer*'. A considerable quantity of nuts is collected by farmers and sold to local shopkeepers.

Chilgoza (*Pinus geradiana*) trees grow in Balochistan, the NWFP, and the Northern Areas. The cones are collected, and the seeds extracted and sold.

Exploration Activities and *Ex situ* Conservation

The germplasm collected during these expeditions is conserved in the Pakistan Agricultural Research Council (PARC) gene bank. In addition, duplicate samples have been supplied to international institutions and gene banks for long term ex *situ* conservation.

Table 22.5: Germplasm Expeditions Conducted in the Pakistan Mountains

Expedition Focus	Year	Region explored	No of samples collected
Cereal crops	1981	Balochistan	794
Fruit	1982	Baltistan	96
Vigna	1982	Azad Kashmir (AK)	136
Lentils	1983	Northern Areas (NA)	227
Cereals	1983	NWFP, Punjab and AK	80
Rice	1983	NWFP	79
Rice	1985	Balochistan	200
Aegilops and wheat	1986	Balochistan	105
Wheat	1986	Northern Areas (NA)	150
Fruit	1987	NWFP and AK	205
Minor cereals	1987	Northern Areas	250
Fruit and nuts	1988	NWFP and NA	300

Ex Situ Conservation Priorities

Priority is given to endangered crop species in the area in which the rate of genetic erosion is enormously high. The indigenous wheat in Azad Kashmir and the NWFP and rice in Sindh and Balochistan are being replaced at a rapid rate. Similarly, fruit and other crops in the NWFP, Azad Kashmir, and the Northern Areas are being collected as a priority.

Opportunities in Mountain Agriculture

Temperate fruit, such as apples, apricots, walnuts, pears, peaches, and plums, have great potential in the mid to high mountains of Pakistan. The areas of Quetta Ziarat, Loralai (Balochistan), Swat, Dir, and Mansehra (NWFP) have substantial potential for apple production. Orchards with improved apple varieties such as Red Delicious and Golden Delicious have benefitted farmers and played a vital role in improving the economy of the area.

The areas of Gilgit, Hunza, and Skardu, at altitudes above 2,000m, have great potential for the production of apricots, apples, grapes, cherries, and almonds. The commercial cultivation of these fruits is bringing an economic revolution to the area.

Apricots could be a leading crop in the Skardu and Hunza areas, if proper post-harvest processing and marketing facilities were to be made available. In Gilgit and Hunza, sulphur treatment for drying apricots has increased the quality and price of dried apricots enormously. Planned plantation with proper management and establishment of fruit processing units can certainly bring economic stability and prosperity.

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