

Crop Genetic Diversity

The mountainous regions or hilly areas are centres of crop diversity. The mountains have a more heterogeneous environment than the plains. Furthermore, the valleys, plateaux, and mountains are spatially isolated from one another and contacts among agricultural communities are less frequent compared to the plains.

Different crop plants were introduced into the mountainous regions of Pakistan by the early migrants. In the new areas the crops were exposed to evolutionary forces. Varied edaphic, topographic, and climatic factors, as well as different selection pressures over centuries of cultivation, resulted in immense variation. Indigenous varieties (population of different biotypes) evolved over a span of centuries and are adapted to particular areas. The old varieties (usually called primitive cultivars or landraces) withstood the rigors of time, escaped attacks from insect pests and diseases, and tolerated harsh climatic conditions. They possess the desired agronomic and genetic traits from which high yield and resistant sources can be developed. The gene pool diversity of the major crops found in the mountains of Pakistan is described below.

Wheat

Wheat is the most important major food grain crop in Pakistan. The irrigated plains of the Indus basin is where 80 per cent of the total wheat area is centred (Hashmi & Ahmad 1988). The rain-fed areas are found mainly in the high plains, foothills, and mountain valleys of the northern and western regions of the country. The rainfall varies from 100 mm to 2000 mm.

The mountain regions explored for wheat genetic diversity, include Baluchistan, the Northern Areas (Gilgit, Hunza, and Skardu), and Azad Kashmir. Baluchistan and the Northern Areas are arid and dry, and rainfall varies from 100 to 250 mm. The indigenous wheat varieties are highly variable in traits such as the amount of awns, straw thickness, grain size and colour, spike density, etc. Variations in these traits can be attributed to differences in aspect, altitude, soil moisture regimes, cultural practices, and social isolation from one valley to the next. The landraces in Baluchistan, such as *Shorawaki*, *Khushkaba*, and *Dayak*, belonging to the hexaploid

wheat species (*Triticum aestivum*), are of great importance due to their salt and drought resistant qualities. Swaminathan (1970) describes *Triticum sphaerococcum* as extremely drought resistant. He is of the opinion that the drought resistant ability seems to account for the survival of this variety in the dry areas. The rate of genetic erosion in these areas was observed to be very low, most probably due to the non-availability of suitable high yielding varieties (HYVs) which could resist immense drought. However, in certain locations, where supplementary irrigational water facilities were available, the HYVs replaced the traditional cultivars. In Azad Kashmir, the rate of erosion was very high. The area receives heavy rainfall (over 1000 mm), and this seems to be the major factor for the adaptation of improved modern varieties in the area. All the local varieties collected from this region belong to the hexaploid and tetraploid wheat families. The different species distributed throughout the mountain region are listed below

Hexaploid Wheat :	<i>Triticum aestivum</i> <i>Triticum aestivum ssp. compactum</i> <i>T. aestivum spp. sphaerococcum</i>
Tetraploid Wheat :	<i>Triticum durum</i> <i>Triticum polonicum</i> <i>Triticum turgidum</i>

Potential Wild Gene Pool

The hexaploid wheat or bread wheat species (*Triticum aestivum*) consists of three different genomes (genomic constitution AABBDD). *Aegilops speltodes* and *Aegilops squarrosa* are two diploid donors of the B and D genomes respectively. McIntoch (1983) described *Ae. squarrosa* and *Ae. speltodes* as having genes that resist stem rust and leaf rust. Similarly, other related genera such as Rye, *Agropyron*, etc have resistant genes for some wheat diseases. Since disease resistant genes are present in wild species, they must be collected and conserved. Different wild species of the genus *Aegilops*, *Agropyron*, *Secaie*, etc are found in the mountains of Pakistan. The area of Baluchistan has already been explored during 1986, because of the varieties of *Aegilops* found there. The areas explored were Quetta, Kalat, Nushki, Sibi, Ziarat, Chamman, Muslimbagh, and Qila Saifullah as well as several other small towns and villages in Baluchistan. Mainly, two species of *Aegilops* grow in the area. The *Aegilops squarrosa* was widely distributed in the region, while *Aegilops triuncialis* was restricted to a small area - from Pishin to Khanozai-lying north-east of Quetta. A very large number of *Aegilops squarrosa* were observed along the belt from Khanozai to Ziarat. The *Aegilops squarrosa* has penetrated into the warmer areas to the south of Quetta. The species occupy disturbed habitats and spread as weeds in wheat field, the boundaries of fields; and water channels; they also grow under trees and shrubs.

The Punjab and Sind provinces are the main rice growing areas, while the NWFP and Baluchistan grow rice in small areas (Annex, Table 1). The mountainous regions were explored for rice genetic diversity during 1984 and 1985. In the NWFP a small number of local rice varieties were distributed throughout the rice growing region. In the Swat area a local variety of *Begami* was dominant. In Dir and Chitral, only two local varieties - *Munji* and *Nali* - were grown throughout the area. In Kurram Agency, which has an area of 1970 km², only one local rice variety (*Kolai*) was cultivated. Similarly, a variety called *Booti* was dominant throughout the Kaghan Valley. All these varieties have coarse grains and belong to the Japonica type. Random population samples were collected from the expedition areas, spread over an altitude ranging from 650 to 2570 m.

Rice cultivation up to 2250 m was observed. Among the crop species and number of samples collected from the NWFP during the rice collecting expedition, the local rice varieties were considerably variable in traits such as spike laxness, number of branches per panicle, abundance of awns, kernel colour, etc.

In Baluchistan, rice is grown on a comparatively smaller area. Out of the total cultivated area in the province, 96 per cent is in Nasirabad District, and the remaining four per cent is scattered over several remote pockets. Different areas in Baluchistan were explored, during 1985, for rice germplasm. In the Punjab and Turbat districts, which are very hot and dry, the rice cultivation was confined to oases where water for irrigation was available. Small rice fields surrounded by date palms were the prominent feature of the area. In the remote valleys of Karkh and Mula (Khuzdar District) terrace cultivation was common.

In total, 200 samples of rice and other crops were collected during the expedition. The number of local rice varieties, grown in Turbat, Punjgur, and Khuzdar, was very high. The indigenous rice varieties were highly variable in terms of certain traits such as plant height, panicle length, panicle laxness, abundance of awns, shattering tendency, and kernel size and shape.

The rate of erosion in the indigenous rice varieties was very high in Baluchistan. The indigenous rice varieties occupied 40 per cent of the total rice cultivated in 1972-73, but, during 1983-84, it fell to 2 per cent (Annex, Table 5). A shift from subsistence to commercial farming, due to the Patfeddar Canal, can be considered the major cause of genetic erosion in the region.

Minor Cereals

In the past, the Northern Mountains of Pakistan were mainly explored for major food crops and fruits. 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 for minor cereals and some wild species. The mission explored the area of Chitral, Yasin, Gupis, Gilgit, Hunza, and Skardu and collected foxtail (*Setaria italica*), common millet (*Panicum miliaceum*), and several minor crops and wild species. The samples were collected from 93 sites spread over an altitude ranging from 700 to 3540 m.

The foxtail millet was cultivated over a very vast area from Chitral through Yasin, Gupis, Gilgit, and Hunza to Skardu. But, the common millet was confined only to Chitral and the surrounding valleys. A very interesting pattern of cultivation and distribution of foxtail millet was seen in the Northern Areas. Foxtail millet grown on the western bank of the Indus River belonged to the East Asian type. The Indus River seemed to be the barrier stopping the distribution of the West Asian type to the east and the East Asian type to the west.

Fruit

Geographically, Pakistan lies between the two major centres for 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. The fruit species along the entire route were brought there by traders and have been cultivated for thousands of years. Consequently, in these remote mountain valleys, the fruit species have been subjected to ecological diversity and human and natural selection for hundreds, perhaps thousands, of years. The farmers are traditional fruit growers and these crops form a very important part of their diet. Considerable genetic variability in the number of fruit species exist in these mountains (Bhatti et al. 1984 and Khan et al. 1987).

There are many species of apricot in the Northern Areas (Bhatti et al. 1982). The pattern of variation and adaptation of fruit species varied greatly in different areas. The distribution of major fruit species and the magnitude of diversity in different areas is described below.

Apricot (*Prunus armeniaca*). The areas of Skardu, Gilgit, and Hunza (Northern Areas of Pakistan) have a maximum number of local apricot varieties (Annex, Table 6). All the local varieties belong to only one species - *Prunus armeniaca*. The immense varietal variation may be due to the extent to which they are propagated through seeds. The apricots are highly variable in fruit size, shape, colour, taste, and the time they take to mature. Accordingly, the seed kernel varies in size and taste - either bitter or sweet. The different local varieties evaluated for Total Soluble Sugar (TSS) showed that sugar content varied from 22 to 36 per cent. Local varieties such as *Halman* and *Marghulam* were of high quality. Regarding keeping quality, *Kacha Choli* was the best among several varieties.

Apple (*Genus Malus*). Apple is the most important fruit crop in the mountain regions of Pakistan. All the cultivated varieties belong to *Malus pumila*. Apples are adapted to very diverse climatic conditions. They are grown on the plateau of Baluchistan, the middle to high mountains of the NWFP, and the high mountains of the Northern Areas. To a large extent, the local apple varieties have been replaced by a few improved varieties - Golden Delicious and Red Delicious - in the NWFP, Azad Kashmir, and Baluchistan. The plantation of improved varieties in planned orchards, in Swat and Maneshra (NWFP) and Quetta (Baluchistan), has played a vital role in the economy of the areas.

Out of the several local varieties such as *Nas Kusho*, *Shin Kusho*, *Skiur Kusho*, *Mar Kusho*, *Bong Kusho*, etc the *Ambri Kusho* found in the Skardu areas, is the best apple variety in terms of quality as well as perishability. In Gilgit and Hunza a large number of local varieties are grown. However, the most common and widespread varieties include *Noor Shah Balt*, *Mamu Balt*, *Shakur Balt*, *Beruit Balt*, *Alikan Balt*, *Shikam Balt*, and *Akbaraman Balt*.

The Hunza and Skardu areas lie at altitudes of 2450 m and above. The region is arid, dry, and very cold. The minimum temperature during winter ranges from -7 to -20°C. The local apple varieties, evolved under these harsh climatic condition are a good source for winter hardiness. The local genetic stock has not been screened for pest and disease resistant qualities. Apple root-stocks, resistant to diseases and pests, need to be exploited. Other genera, such as *Pyrus* and *Sorbus*, which are compatible with the genus *Malus* can be exploited as root-stock for developing resistance to insect pests and diseases in apples. Only at a few sites, such as Kalam, Utroro, and Gabral in Swat, the *Sorbus* (*Anj*) and *Malus* (apple) were grafted on to *Crataegus sonorica* (common hawthorn locally called *chochina*). *Crataegus* is compatible with *Sorbus*, therefore, *Sorbus* is grafted on to it and when it has grown, the apple is grafted on to it. This is practiced by the local people to cope with some soil born diseases of apples.

Pear (*Genus Pyrus*). The common pear (*Pyrus communis*) is widely distributed throughout the mountain regions. The *Pyrus pyrifolia* (Syn. *P. lindleyii*) and *P. pashia* are mainly adapted to the semi-humid to humid regions of the NWFP and Azad Kashmir. A maximum number of local varieties belonging to *P. communis* and *P. pyrifolia* was recorded in Swat Valley. The local pears are highly diverse in fruit size, shape, taste, and time taken to reach maturation.

Grape (*Genus Vitis*). The grape gene pool is diverse and consists of landraces of *Vitis vinefera* and *V. jacquemontii*, and a wild species; *V. parvifolia*. The adaptation pattern of different species varies from arid dry to humid regions. The *V. vinefera* displays maximum diversity in Skardu,

Hunza, and Gilgit but is poorly represented in Swat and Azad Kashmir. On the other hand, *V. jacquemontii* is well adapted to the high rainfall areas of Swat and Azad Kashmir. The wild species, *V. parvifolia*, is sparsely distributed in Chikar (Azad Kashmir).

Walnut (*Jugians regia*). The walnuts are distributed over wide areas in the mountains. However, Swat, Kaghan, and Gilgit are the major walnut growing areas. Walnuts have a range of variation in size, shape, colour, and shell thickness - varying from very thin to very hard shells.