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STATUS OF GENETIC RESOURCE POTENTIAL OF THE MOUNTAINS OF PAKISTAN

Rashid Anwar and M. Sadiq Bhatti

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International Centre for Integrated Mountain Development

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PREFACE

ICIMOD's approach to problem oriented research involves both knowledge reviews and field studies. The focused reviews and field studies conducted by the Mountain Farming Systems Division cover various aspects of agricultural development. Since early 1988, a series of 'state of the art' reviews of agricultural policies and programmes were sponsored by ICIMOD in different countries of the HKH Region. The purpose of these studies and the subsequent National Workshops in different countries was to understand some of the constraints and prospects of Mountain area development. These exercises were also aimed at acquiring comparative perspectives of development approaches and strategies in different countries.

This paper was also a part of this series of studies commissioned by ICIMOD, and was also presented at the Workshop on "Mountain Agriculture in Pakistan", held by ICIMOD in February, 1989, in Swat, Pakistan. This specific issues that are discussed in this study concerns the status of genetic resource potential of the mountains of Pakistan. The responsibility of the content rests with the authors.

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Introduction

It is now universally agreed that a catastrophic loss of diversity in our crop plants has been taking place during the last few decades, and this process of genetic erosion is likely to continue at an even greater speed in future, due to the introduction of improved varieties; changes in agricultural land use; clearing of forests; construction of dams, canals, and roads; and expansion of cities and industrial areas. Plant breeders need this genetic diversity as a basis for the creation of high yielding, better adapted, and disease resistant varieties to help solve the problems of hunger and malnutrition.

Innovative crop varieties and the introduction of high yielding varieties are rapidly transforming traditional and peasant farm lands into fields with uniform crops. These new varieties provide a significantly higher yield or quality and have other beneficial characteristics bred into them. Unfortunately, they replace traditional cultivars and may be responsible for the elimination of around 10,000 years of evolution. Once a local traditional cultivar is totally displaced, its unique characteristics are gone forever. Future generations are, thus, deprived of genetic variation which is the basic material for any breeding programme, and, in particular, they are deprived of genetic combinations to combat the potential ravages of pests and diseases.

From more than 10,000 years ago, when primitive hunters and gatherers first developed agriculture by cultivating wild plants for food, human society and the earth's abundant plant resources have experienced a joint evolution, producing innumerable patterns of variation, especially in locally adapted plant populations used for food, textile, and fuel. Cultivated plants have the capacity to evolve rapidly. Rapid evolutionary bursts are possible only through some variation on the theme of differentiation - hybridization cycles, in which the variability already accumulated can be exploited (Harlan 1966 and 1970). Such cycles are, more or less, automatically built into the traditional agricultural system. Farmers are basically sedentary. They settle down in an area and occupy it for a long period of time. This results in an array of varieties adapted to that particular area. But, occasionally, farmers move, taking their seed stock and plant materials with them. In the new location there is an opportunity for the transported varieties to cross with the local ones. Populations separated geographically and differentiated ecologically are thus brought together where they cross and the germplasm is exchanged and the potential variability released. Seed agriculture originated in the mountainous regions of warm temperate to tropical zones with areas having very well-marked wet and dry seasons.

Physiography of Pakistan's Mountain Areas

Pakistan is situated in the north-western part of the South Asian sub-continent. It can be subdivided into six natural regions : the Northern Mountains, the Submontane plateau, the Indus Plains, the Baluchistan Plateau, the western bordering mountains, and the desert areas. The mountains and the Submontane regions are briefly described below.

The Northern Mountains

The Himalayan and the Trans-Himalayan mountains occupy the entire northern end of Pakistan. The mountains rise to an average height of more than 6,100 meters and include such towering

peaks as Nanga Parbat (8,126 m) and K-2, also called Godwin Austen (8,611 m). According to rough estimates, about 82,000 km^2 of the Himalayan Range is situated in Pakistan. Beyond the Karakoram Range, in the extreme north, lies the Chinese Province of Sinkiang, to the north-west is the Hindu Kush Range beyond which are the Pamirs - the "Roof of the World" - where only a narrow strip of Afghanistan separates Pakistan from the Soviet Union.

The Submontane Plateau

Lying below the Himalayas, the Submontane plateau has four distinct divisions - the Trans-Indus Plains, the Potwar Plateau, the Salt Range, and the Sialkot District.

The Trans-Indus Plains. The Trans-Indus Plains, west of the Indus River, consists of the high - grit plateau of the valley of Peshawar, Kohat, and Bannu which are oases in the arid, scrub-covered landscape of the North West Frontier Province.

The Potwar Plateau. The Potwar Plateau lies at a height of 400 to 600 meters and covers an area of about 12,800 km^2 to the east of the Indus River, in the Province of the Punjab. It is open undulating country, developed from the Siwalik Range which is mainly of sandstone and is covered by varying thicknesses of soil (loam) which erodes easily.

The Salt Range. The Salt Range lies at the southern edge of the Potwar Plateau and has an average height of 670 meters. Its highest peak is Sakesar (1,500 m). It is extremely arid territory that sharply marks the boundary between the Submontane region and the Indus Plains in the south.

The Sialkot District. This district is a narrow submontane region in the north-east. Unlike the Potwar Plateau, it is a rich agricultural region. The soil is heavy and fertile.

The Baluchistan Plateau

The Baluchistan Plateau extends westward with many ridges running across it from the north-west to the south-east. It is separated from the Indus Plains by the Sulaiman and Kirthar Ranges. This plateau can be divided into 5 zones.

The Coastal Zone: stretching over a 50 km wide coastal belt.

The Flat Plain Zone: extending from Sibi and Dhadar to Usta Mohammed.

The Low Upland Zone: consisting of the areas of Loralai and Khuzdar and Chagi and Turbat District at elevations of 700 to 1,300 meters.

Medium Upland Zone: including the areas of Quetta, Kalat, and Zohb at an elevation of from 1300 to 2000 meters.

High Upland Zone: streaching from 2,000 to 2,700 meters, with very cold, long winters and mild, short summers. It includes the Tobina Plateau, Ziarat Areas etc.

Mountains Bordering West of Pakistan

These mountains run south from the Hindu Kush in several parallel ranges, outside the path of the monsoons. Three minor ranges run south from the Hindu Kush to the Kabul River, to the south of which lies the famous Khyber Pass, bordering Afghanistan. Further south the Sulaiman Range runs southwards for about 500 km, after which the lower Kirthar Range runs down to the coast. These hills separate the Indus Plain from Baluchistan.

Crop Genetic Resources of the Mountains of Pakistan

Major Crops

A wide variety of crops are grown in Pakistan, and wheat and rice, among the cereals, and chickpeas, in food legumes, are the principal crops. The areas under cereals and food legumes, in all the four provinces of Pakistan, are given in Tables 1 and 2 (Annex) respectively. It is observed from Table 1 that wheat is the dominant crop, accounting for 66 per cent of the total crop area. Wheat and barley are widespread in the mountain regions and are grown even above 3,000 m. Rice and maize are mostly grown at altitudes under 2,500 m. *Bajra* (millet) and *Jowar* (sorghum) are mainly grown in the plains, but a considerable area of lower hills is also under these crops.

Among the food legumes of Pakistan (Annex, Table 2), the chickpea (*Cicer arietinum*) is grown on 71 per cent of the total area. About 26 per cent of the area is used for lentils, *mung* beans, *urd* beans, peas, and *khesari*. The remaining 31 per cent is used for other legumes such as dry beans, fava beans, pigon peas, cowpeas, and moth beans. The peas, *mung* beans, *urd* beans, lentils and fava beans occupy about 29,000 ha in the mountain regions of Pakistan (Malik 1988). Farmers mainly grow landraces of lentils, fava beans, and peas in the mountain regions.

In Pakistan, different types of fruits are grown over an area of 0.43 million ha (Anonymous 1986). Tropical fruits such as citrus fruits, guavas, bananas, and mangoes etc, are mainly grown in the warm plains. However, citrus and guava are also grown in the low to middle mountains. The temperate fruits, such as apples, pears, apricots, walnuts, peaches, plums, grapes, and almonds, are grown mainly in the middle to high mountains of Pakistan. The areas where different fruits are grown in various provinces of Pakistan are shown in Table 3 (Annex).

Minor Crop Resources (High Mountain Crops)

In addition to the major food crops some minor cereal crops are also grown in the mountains (Annex, Table 4). Foxtail millet (*Setaria italica*), common millet (*Panicum miliaceum*), barnyard millet (*Echinochloa frumentacea*), oats (*Avena spp.*), amaranthus (*Amaranthus spp.*), and buckwheat (*Fagopyrum spp.*) are cultivated as relict crops in the high mountain regions of Pakistan (Anwar et al. 1987). These crops have been grown in the mountains for centuries. Besides these crops, there is a potential for producing medicinal crops in the mountains. Substantial quantities of the following medicinal crops grow in the mountainous regions.

Local Name	Botanical Name
Kanis	*Sioscorea deltoidea*
Bankari	*Podophyllum emodi*
Ban javain	*Thymus serphyllum*
Revand chini	*Rheum emodi*
Mamekh	*Paeonia emodi*
Afsantine	*Artemisia maritana*
Afune	*Papaver spp.*

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 rainfed 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 :	*Triticum aestivum*
	Triticum aestivum ssp. compactum
	T. aestivum spp. sphaerococcum
Tetraploid Wheat :	*Triticum durum*
	Triticum polonicum
	Triticum turgidum

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 km^2, 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, abundancy 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 Patfeedar 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.

Under-exploited Crops

In the mountains, there are several under-exploited crops which are gathered/collected by the farmers for local consumption and marketing. If these crops are developed for commercial cultivation, they will help to improve the economy by improving the farmers' income.

Mushrooms grow in a wild state in the forests of Swat, Dir, and Kohistan (NWFP), and also in Muzafarabad (Azad Kashmir). There are about 10 species distributed throughout these areas. Most of them are edible while a few are poisonous. In the past, the local people used to collect the edible types mainly for local consumption. However, the attractive price offered by the market encouraged people to sell the mushrooms. The local shopkeepers buy the mushrooms and ship them to the cities. In Swat and Azad Kashmir, the rate for dried mushrooms varies from Rs 5,00 to 1,000 per kg.

The hazelnut (*Corylus jacquemontii*) grows in abundance on the high, north facing mountain slopes of Swat. In Kalam it is called *"Mizeer"*. A considerable quantity of nuts are collected by the farmers and sold to the local shopkeepers. According to a local shopkeeper from Mataltan Village in Kalam Valley, he buys 500 to 1000 kgs of the nuts during a season. The intensive cutting of hazelnut trees for fodder purposes is practised in this area. Special measures are recommended to protect the hazelnut species.

The *chilgoza* (*Pinus geradiana*) grows in Baluchistan, the NWFP, and the Northern Areas. The cones are collected by the people and the seeds are extracted and sold. The needed protection and proper management of the *chilgoza* pine forest is neglected.

In addition to the above, the other non-crop resources in the mountains include *Rubus*, *Ribes*, *Indigofera*, and *Ephedra*.

Genetic Resources' Perspective

In view of the catastrophic loss of crop genetic variability in the centres of diversity (particularly developing countries), a regional project, "Exploration, Collection, Conservation, and Evaluation of Plant Genetic Resources," was initiated during 1974 by the Food and Agriculture Organization of the United Nations, in the Near East. Six countries - Afghanistan, Iran, Iraq, Pakistan, Syria, and Turkey - were covered by the Project. To provide a counterpart contribution to the regional effort, a national research programme on "Plant Genetic Resources in Pakistan" was approved by the Government and started in 1977, under the Pakistan Agricultural Research Council (PARC). The exploration and collection of crop genetic resources, conservation of native genetic stock, and preliminary evaluation and distribution of crop germplasm to the user community, within the

country and abroad, were the major objectives of the Plant Genetic Resources' Programme. The Pakistan Agricultural Research Council, Islamabad, extends its full cooperation to the international project for the collection of native crop genetic resources in the country. Foreign nationals who desire to collect these resources should follow certain procedures and these have been outlined below.

- Inform the Plant Genetic Resources' Programme, PARC, at least six months before the exploration trip.

- Send a copy of the biodata of each participant. This is essentially required for clearance from the Government of Pakistan.

- The Pakistani Government's permission for participant(s) to travel to the interior of the country should be obtained by PARC.

- All the material collected during the expedition should be divided into two equal parts and one part handed over to the Plant Genetic Resources' Programme, PARC.

Exploration Activities

Exploration for crop germplasm commenced during the early 70s in Pakistan. About 900 accessions of rice germplasm were collected by the PARC from the Punjab and Sind provinces, through a research scheme known as "Collection of Rice Germplasm in Pakistan and its Evaluation". The Plant Genetic Resources' Programme (PGRP) started exploration activities in 1981, after the establishment of the PGR Laboratory and the Genebank. Different agro-ecological regions in the country were explored for crop genetic diversity.

The following germplasm collection expeditions were organized and undertaken by the PGRP, PARC :

Name of Expedition	Year	Region Explored	Samples
Cereal Crops' germplasm	1981	Baluchistan	794
Fruit germplasm	1982	Baltistan	96
Chickpea germplasm	1982	Sind & Punjab	660
Cereals' germplasm	1982	Azad Kashmir	136
Vigina germplasm	1982	Punjab	419
Fruit crops	1983	Northern Areas	227
Lentil germplasm	1983	Punjab	212
Vegetables' germplasm	1983	Northern Areas	80

Cereal germplasm	1983	NWFP, Punjab, & A.K.	79
Rice germplasm	1984	NWFP	144
Chickpeas & lentils	1985	Sind & Punjab	356
Rice germplasm	1985	Baluchistan	200
Aegilops & Wheat germplasm	1986	Baluchistan	105
Wheat germplasm	1986	Northern Areas	150
Fruit germplasm	1987	NWFP & Azad Kashmir	205
Rice germplasn	1987	Sind	205
Minor cereal germplasm	1988	Northern Areas	250
Fruit & nut species	1988	NWFP, Northern Areas	300

The germplasms collected during the expedition were preserved in the Genebank at the PARC. In addition to preservation in the country, duplicate samples were supplied to international institutions and genebanks for conservation and utilization.

International Collaborations

The PGRP of the PARC, Islamabad, is the only institution in Pakistan responsible for conservation, exploration, and distribution of crop genetic resources. Due to the limited budget of the programme, most of the germplasm collection expeditions were supported by the IBPGR and other international institutions. The following germplasms were collected in collaboration with different international organizations.

Name of Expedition	Collaborating Agency
Wheat germplasm from Baluchistan.	SVP, Netherlands
Cereal germplasm from the NWFP, Punjab.	Academy of Agri. Science, China
Chickpea germplasm from Sind & Punjab.	ICARDA, Syria
Aegilops & wheat from Baluchistan.	ICARDA, Syria

Wheat germplasm from Northern Areas.	ICARDA, Syria
Minor cereals from the Northern Areas.	Kyoto Univ. Japan.
Fruits from NWFP, A.Kashmir, & N.A.	OSU/USDA, USA.

Conservation

Germplasm collection is of little use unless it is properly documented and preserved for future utilization in crop improvement programmes. Conservation is for the purpose of genetic totality in such a way that loss of certain genotypes is minimized. The storage of germplasm under controlled temperature conditions has been recommended by the IBPGR.

The PGRP of the PARC was introduced in 1977, but the PGR Laboratory, which includes facilities such as seed processing, packing, drying, and storing (Genebank), was established in 1980. Almost all the necessary equipment for the laboratory and the cooling units of the Genebank were provided by the IBPGR. The germplasms of different crops are processed, packed, and preserved in the Genebank which operates at 0°C for medium-term storage. The conserved genetic stock is tested for seed viability after every three years. Sequential germination tests are conducted, using batches of 40 seeds, to monitor the seed viability. Screw cap tins and laminated foliar bags are used to preserve germplasms in the Genebank.

Other Activities

Characterization and Evaluation

Characterization includes the recording of highly inheritable characteristics which are expressed under all environmental conditions. The characterization of crop genetic resources is the responsibility of the PGRP. This is done in accordance with the IBPGR crop descriptions. About 60 per cent of the genetic stock of cereals, food legumes, and oil seed crops have been characterized at the National Agricultural Research Centre, Islamabad.

Detailed evaluations for specific characteristics is usually done by the crop commodity expert. The PGRP collaborates with the Crop Commodity Coordinated Research Programmes of the PARC for detailed evaluation. In collaboration with a Coordinated Research Programme on food legumes and pulses, at NARC, the chickpea and lentil germplasm collection has already been evaluated for screening against the *Aschochyta* blights and for other agronomic characterizations. The barley and oat germplasms are being evaluated for fodder yield potential. The *Aegilops* collection has been supplied to the Cereal Diseases' Research Institute, NARC, to identify the resistant gene sources in the material.

Germplasm Exchange

To fulfill the role of a service facility to breeders, the PGRP has distributed about 8000 accessions of different crop species to the provincial and federal research institutions in the country and international institutions abroad, for experimentation and utilization in crop improvement programmes. Crop germplasms were also obtained in exchange from other genebanks and international research institutions. More than 5000 accessions of chickpeas,

soyabeans, vegetables, wheat, millets were obtained in accordance with the demand of national scientists for utilization in the country.

Crop and Area Priorities

The PGRP, in consultation with the Crop Commodity Coordinated Research Programmes of the PARC, fix priorities regarding crops and areas of exploration. Accordingly, the guidelines provided by the IBPGR for crop priority are strictly followed. Top priority is always given to the endangered crop species - the area where rate of genetic erosion is enormously high.

The indigenous wheat, in Azad Kashmir and NWFP, and the rice in Sind and Baluchistan were being replaced at a very high rate by improved varieties. Similarly, local chickpeas, lentils, and other legumes in the Punjab as well as fruits and other crops in the NWFP, Azad Kashmir, and the Northern Areas were collected on a priority basis and conserved well in time before they disappeared.

Future Plans

Exploration

Although some of the major cereals, food legumes, and fruits have already been collected from different areas, other crops are yet to be collected. Future plans include the collection of valuable genetic resources of different crop species (listed below) to widen the gene pool diversity.

- Barley and oat germplasm from Baluchistan and the Northern mountains.
- Wild species of chickpeas and lentils from the Northern Mountains, in collaboration with ICARDA/IBPGR.
- Pearl millet from the dry regions of the Punjab, the NWFP, and Sind, in collaboration with ICRISAT.
- Sorghum from the Punjab, Sind, and the NWFP.
- Kenaf and other fiber crops from Sind, the Punjab, and the NWFP, in collaboration with the International Jute Organization (IJO).
- Minor cereals from Azad Kashmir, in collaboration with Kyoto University, Japan.
- Fava beans and lentils from Baluchistan, in collaboration with ICARDA.
- Fodder and forage germplasm from the Punjab, Sind, and the Northern Mountains, in collaboration with ICARDA/IBPGR.
- *Lathyrus*, Buckwheat, and other small grain crops from Sind and the Northern Mountains, in collaboration with IDRC.

- Temperate fruits from Baluchistan.

- Maize from the NWFP and the Northern Areas.

Conservation

A new genebank with adequate space is essential, as the existing Genebank is too small and is overloaded with genetic stock. Similarly, the PGR Laboratory has only limited space for working samples. Therefore, a new laboratory and genebank are being planned. New facilities will be established with the financial assistance of the Japanese International Cooperation Agency.

Detailed Evaluation

The germplasm collections from different crops will be further evaluated for stress factors, disease, and pest resistance in collaboration with provincial and federal research institutions as well as with the coordinated research programmes of PARC.

The temperate fruit collection, particularly apples, will be screened for insect pests and diseases to identify the resistant gene sources in the local genetic stock.

Crop Resources and their Role in Mountain Agriculture

Wheat, rice, and maize are the major food crops in the mountains and the yields are generally very low. But, with suitable improved varieties, along with proper management, there is good scope for increasing the crop yields. The PARC has established a few research institutions in the mountain regions. The Arid Zone Research Institute, in Quetta and Baluchistan, and Research Stations at Gilgit and Kaghan are conducting research to improve agriculture in the mountains.

Citrus fruits have the potential to change economic conditions in certain mountain areas. Tangerines and sweet oranges, in the low to middle mountains of Swat, Hazara, and Dir, have augmented the income of the farmers. Citrus cultivation, if expanded further in the mountain regions, will help to improve the economy.

The middle to high mountains of Pakistan have good potential for temperate fruits such as apples, apricots, walnuts, peaches, and plums. The areas of Quetta, Ziarat, and Loralai (Baluchistan), as well as Swat, Dir, and Mansehra (NWFP) have the great potential for apple production. Planned orchards with improved apple varieties, such as Red Delicious and Golden Delicious, have benefitted the farmers a great deal and have played a vital role in improving the economy of the areas.

The areas of Gilgit, Hunza, and Skardu, at altitudes above 2000 m, have a lot of potential for the production of apricots, apples, grapes, cherries, and almonds. The commercial cultivation of these fruits, with planned orchards and proper management, will certainly bring about an economic revolution in the area.

Apricots will be the leading resource, in the Skardu and Hunza areas, if proper facilities for drying, manufacturing, and marketing forest products are made available. In Gilgit and Hunza, sulphur treatment for drying apricots has increased the quality and price of dried apricots. Planned plantations with proper management and the establishment of fruit processing units will certainly bring about economic stability and prosperity.

ANNEX

Table 1: Area of Cereals by Province in Pakistan 1985/86. (000 hectares)

Crop	Punjab	Sind	NWFP	Baluchistan	Pakistan
Wheat	5343.0	1030.8	781.9	247.6	7403.3
Rice	113.3	585.7	70.1	94.1	1863.2
Maize	338.6	19.5	440.9	4.9	803.9
Millet	281.7	265.4	13.5	0.2	560.8
Sorghum	210.8	97.0	21.4	43.2	372.4
Barley	70.3	25.4	79.8	13.3	188.8
All Cereals	7357.7	2023.8	1407.6	403.0	11192.4

Source : Agricultural Statistics of Pakistan, 1986

Table 2 : Area of Food Legumes by Province grown in Pakistan, 1985/86. (000 hectares)

Crop	Punjab	Sind	NWFP	Baluchistan	Pakistan
Chickpea	821.1	94.1	79.0	21.0	1033.3
Mung bean	74.4	14.8	10.8	4.2	104.2
Urd bean	79.2	2.4	6.0	1.2	88.8
Lentil	44.7	9.9	2.7	0.1	57.4
Peas	38.6	94.3	1.8	6.2	140.9
Other Kharif	12.2	7.6	4.4	0.5	24.7
Other Rabi	0.6	1.6	-	-	2.2
All legumes	1070.8	224.7	122.7	33.3	1451.5

Source : Agricultural Statistics of Pakistan, 1986.

Table 3 : Area of Fruits by Province in Pakistan (1985/86 '000 ha)

Crop	Punjab	Sind	NWFP	Baluchistan	Pakistan
Citrus	141.9	3.8	3.4	0.6	149.7
Mango	41.0	33.5	0.1	0.7	75.3
Banana	2.2	13.3	0.5	0.1	16.1
Apple	1.1	0.1	6.4	9.7	17.3
Guava	37.1	2.7	2.0	0.3	42.1
Apricot	0.1	-	1.2	3.6	4.9
Peach	0.1	-	0.3	1.1	1.5
Pear	0.3	-	2.5	0.1	2.9
Plum	0.2	-	2.8	1.1	4.1
Grape	-	-	-	2.8	2.8
Pomegranate	1.9	-	0.1	1.4	3.4
Dates	13.0	15.4	1.0	9.3	38.7
Almond	-	-	0.3	6.7	7.0
All Fruits	294.6	72.0	24.6	38.5	430.6

Source : Agricultural Statistics of Pakistan, 1986

Table 4 : Crops Grown in Pakistan's Mountains : their Importance and Uses

Common Name	Botanical Name	Importance	Use/Preparation
A. Cereals			
Wheat	*T.aestivum*	Major food	Bread, many other preparations.
Maize	*Zea mays*	Staple food	Boiled & other uses.
Sorghum	*S.bicolor*	Minor	Flour, boiled, fodder.
Millet	*P.americanum*	Minor	Flour, boiled, fodder.
Barley	*H.vulgare*	Minor	Fodder, local food.
Oat	*Avena sativa*	Minor	Fodder.
Buck Wheat	*Fagopyrum spp.*	Minor	Bread and other uses.
Foxtail-millet	*Setaria italica*	Minor	Boiled, bread, fodder.
Common-millet	*P.miliaceum*	Minor	Bread, boiled, fodder.
Amaranthus	*Amaranthus spp.*	Minor	Sweet preparations.
B. Food Legumes			
Mung bean	*Vigina radiata*	Important	Pulse curry.
Urd bean	*Vigina mungo*	Important	Pulse curry.
Lentil	*Lens culinaris*	Important	Pulse curry.
Fava bean	*Vicia fava*	Minor	Pulse curry.
Dry bean	*P.vulgaris*	Important	Curry and boiled.
Chickpeas	*C.arietinum*	Important	Many uses.
Peas	*Pisum sativum*	Minor	Vegetable, curry.
Pigeon pea	*Cajanus canjan*	Minor	Curry.
Cowpeas	*V.unguiculata*	Minor	Curry, boiled.

Common Name	Botanical Name	Importance	Use/Preparation
Moth bean	*Vigina acontifolia*	Minor	Curry, boiled.
Khesari	*Lathryus sativus*	Minor	Curry, fodder.
Soyabean	*Glycine max*	Minor	Oil, fodder.
C. Fruits			
Tangerine	*Citrus reticulata*	Important	Fresh & many other fruit preparation
Orange	*Citrus sinensis*	- do -	- do -
Guava	*Psidium gujava*	Minor	- do -
Apple	*Malus pumila*	Important	- do -
Apricot	*Prunus armeniaca*	- do -	- do -
Peach	*Prunus persica*	- do -	- do -
Plum	*Prunus domestica*	- do -	- do -
Almond	*Prunus amygdalus*	- do -	Dry fruit, etc.
Cherry	*Prunus avium*	Minor	Fresh & other preparation.
	Prunus cerasus	- do -	- do -
Pear	*Pyrus communis*	Important	Fresh & also dried
	Pyrus pyrifolia	- do -	- do -
Mulberry	*Morus alba/nigera*	- do -	- do -
Grape	*Vitis vinifera*	- do -	Fresh & other preparation.
	Vitis jacquemontii	- do -	- do -
Walnut	*Juglan regia*	- do -	Dried fruit.
Pomegranate	*Punica granatum*	Minor	Dried & used as spice
Persimmon	*Diospyrous spp.*	Important	Fresh.
	Diospyrous lotus	- do -	Fresh & dried.
Hazelnut	*Coryllus spp. (wild) Minor*	Minor	Dry fruit.

Table 5: Variety-wise, Rice Cultivation in Baluchistan (000 hectares)

Year	Basmati	% of Total	IRRI	% of Total	Others *	% of Total
1972-73	-	-	23.0	60	15.4	40
1973-74	-	-	21.5	60	14.1	40
1974-75	-	-	31.5	91	3.1	9
1975-76	-	-	15.1	39	23.2	61
1976-77	-	-	13.6	72	5.2	28
1977-78	0.1	-	8.2	22	29.8	78
1978-79	0.1	-	42.2	59	17.1	41
1989-80	0.1	-	25.1	60	16.9	40
1980-81	-	-	30.6	74	10.6	26
1981-82	0.9	1	88.2	97	1.4	2
1982-83	1.7	1	112.6	97	1.8	2
1983-84	8.4	8	97.7	90	1.9	2

Source : Agricultural Statistics of Pakistan, 1985

* Indigenous rice varieties (Landraces/primitive cultivars)

Table 6 : Local Apricot Varieties in the Northern Areas

Skardu

Name of Local Variety	Remarks
Marpho choli	Red apricot
Karfoo choli	White apricot
Warfo choli	Pith used for oil
Bro choli	Late maturing
Khakas choli	Pith split partially
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
Gurdalo 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

Name of Local Variety	Remarks
Shakanda choli	Starchy
Tacho choli	-
Margahlam choli	Early, good quality
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	- do -
Shakar choli	Sweet
Hongool choli	-
Brook choli	-
Halwar choli	-
Duspaong choli	-
Yakab yak choli	-
Snair choli	-
Hunza/Gilgit	
Shikanda joo	-
Brum joo	White
Surasune joo	Good quality
Duda-sanag joo	-
Koropiam joo	-

Name of Local Variety	Remarks
Ali Shah Kakas joo	Late
Habi joo	Very late
Khanemish joo	-
Kartachi joo	Very early, white
Dudar joo	-
Ghulam joo	-
Rashikin joo	Early
Alman joo	Good quality
Koropian joo	Early
Gakateenan joo	-
Kaka Shikanda joo	-
Moen joo	-
Ghaka joo	-
Mamoor joo	-
Brun joo	-
Gario joo	-

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