PAKISTAN:

COUNTRY REPORT TO THE FAO INTERNATIONAL TECHNICAL CONFERENCE ON PLANT GENETIC RESOURCES

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Note by FAO

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CHAPTER 1
Introduction

Pakistan is an ancient civilization, although its political boundaries were drawn only 48 years ago when it acquired independence in August 1947. Initially comprising east and west Pakistan separated by 1,760 kilometer of India. Its present territory since December 1971 has confined to the former west wing which has a total area of 79.61 million hectares.

This territory is a region of diversified relief with mountain to the north and east and arid and semi arid expanses to the south and east. Down in the centre is a flat fertile plain fed by the Indus river and its tributaries. Beneath the northern part of this plan, hydrologist found a huge fresh water lake equal in volume to ten time the annual discharge of the river flowing above. The indus plain has the largest canal irrigation system in the world, making cultivation possible despite of scanty and erratic rainfall and ranges of extreme temperature.

The Northern mountains are bestowed with beautiful valleys, eternal glaciers and snow covered peaks, including the second highest mountain of world K2. Pakistan is situated between Latitudes 24°-37°N and Longitude 61°-78°E. The climate is characterized by extreme variation of temperature and rainfall. The average rainfall varies from about nil to over 1,000 mm. Most of central and southern areas have less than 500 mm annual rainfall.

The distribution of cropped area is further influenced by the agro-ecological condition prevailing in the Pakistan. The country has bean categorized in to the following ten distinct agro-ecological zones.

Zone I: Comprises the indus delta with an arid tropical marine climate and clay and silty soil. The mean maximum temperature in summer ranges from 34-40°C and in the winter 19-20°C. The mean monthly rainfall during summer (July to September) is about 75 mm, while in winter (December to February) is less than 5 mm.

Zone II: Includes the lower Indus Basin with sub-tropical climate and silty and sandy loam soils. The mean monthly temperature in summer rises up to 50°C in the shade. The summer rainfall is about 16 mm.

Zone III: This region comprises Thal and Cholistan deserts and is characterized by a summer maximum temperature rising to 41°C. The monthly rainfall during the summer season varies from 32 to 71 mm.

Zone IV: The region covers the area between Satluj and Jhelum river. The soil is sandy loam and clayey loam. The mean monthly rainfall in summer ranges from 75 to 108 mm.

Zone V: The salt range of the Pothwar Plateau and the Himalayan Piedmont plains form this region. Climate in nearly humid to semiarid and hot.

Zone VI: This includes mountains ranges with tops covered by snow during the winter and spring seasons. The mean monthly rainfall in summer is 236 mm and in winter 116 mm.

Zone VII: Comprises of high mountain areas with undifferentiated climate and clayey soils. The top of the mountains are generally covered with snow for the greater part of the year.

Zone VIII: This lies to the south of koh sufaid and west of the Indus with an undifferentiated climate and loamy strongly calcareous soils.

Zone IX: This zone covers mountainous area with intermountain basins, plateaus and the costal belt. It has desert type tropical climate and strongly calcarious silty loam soils.

Zone X: This covers the Piedmont plains of the Sulaiman Ranges, sloping toward the Indus river.

Pakistan today is the world's 10th most populous nation. The count at present estimate is over 115 million people. The population is estimated to be about 145 million by the tune of the century. The annual growth rate is about 3.2%. The population is predominantly rural. About three quarters of the population lives in 49,000 farm villages ranging in size from small clusters of homes to a large villages and market towns. Karachi is the biggest city and its population is about one tenth of the whole country. The following are the latest statistics on land use in Pakistan:

Table 1: Land use in Pakistan

Land use	Million hectares
Geographical area	79.61
Cultivated area	21.25
Culturable waste	8.85
Forest	3.48
Not available for cultivation	24.53
Other (Road, Town, River, etc.)	21.50

Sources: Agricultural Statistics of Pakistan,1992-93.

The number and area of private farm classified by farm size is as follows:

Table 2: Farm classification

Farm size	Number		Area (million ha.)
	(Million)	(%)	
Small farms (up to 5 ha.)	4.11	81	7.44
Medium farms (6 - 10 ha)	0.62	12	4.12
Large farming (11 ha. and above)	0.34	7	7.64

Sources: Agricultural Statistics of Pakistan, 1992-93.

There are two main crop season in Pakistan i.e. Kharif (summer) and Rabi (winter). About 55% of the area is covered by food grains cereal crops, including wheat, barley, rice, maize, sorghum and millets. 10% by Cotton, Sugar-cane, Tobacco and Sugar beat. About 7% covered by pulses, 2% by oilseed, 2% by fruits, 1% by vegetables and 15% by other miscellaneous crops.

Agricultural production is dominated by crop production, which account for almost 69% of the agriculture Gross Domestic Product (GDP). The rest is accounted for by livestock, which is almost 30% forestry and fisheries currently make up just over 1% of the total. There are five major crops namely, wheat, rice, sugar-cane, maize and cotton. Among minor crops the most important are fruits and vegetables followed by pulses and oilseeds. These crops are important because they are high value crops and have a great potential for export earning (fruit and vegetables) and import substitution (oilseed and pulses).

As little as 5.2% of the total Pakistan area (including Azad Kashmir) is under forest. However, only about 30% of this total is economically utilized, while the balance is basically under protective cover. Both environmental and economic consideration suggest that desirable range of 20-25% of the country

land area has to be forested. The bulk of Pakistan's land lies in arid zone, vast area of the country notably in Punjab and parts of Sindh forested in the last century and were the habitat for a considerable range wild-life, are now devoid of forest cover. The fauna has shrunk dramatically both in number and species.

Pakistan has widely varied topography and a considerable range of soils. Both the climate and the levels of precipitation vary in different zones of the country. Predictably this has lead to a variety of forest types. Some of which are entirely or partially man made.

The extent of forest are as under:

Table 3: Forest types

Forest type	Productive forest (000 ha.)	Protective forest (000 ha.)	Total	(%)
Coniferous Forests	867	1,092	1,959	42.75
Scrub Forests	158	1,568	1,726	37.65
Riverain Forests	158	138	296	6.50
Mangrove Forests	-	347	347	7.60
Irrigation Plantations	83	151	234	5.10
Linear Plantations	-	17		17.00
0.40				
Total area	**1,266**	**3,313**	**4,579**	**100.00**
Area (%)	**27.6**	**72.4**		

Source: Pakistan Forest Institute, Peshawar.

1.1 SEED SUPPLY SYSTEM

Prior to 1961 the Department of Agriculture was responsible for making the arrangement for the production, quality control and distribution of major crop seeds. But the seed situation remained deficient regarding the production and the supply of pure seed of improved varieties. The seed situation demanded major improvement, so the Government of Pakistan invited World Bank to appraise a seed program for the country, and on their

recommendation a Seed Industry Project was launched. To provide a legal regulation and control of the quality of seed, the Act of 1976 was promulgated. The Institutional infrastructure which include National Seed Council (NSC), Provincial Seed Councils (PSCs), The National Seed Registration Department (NSRD) and the Federal Seed Certification Department (FSCD) were established in the country. The establishment of National Seed Council with the Federal Minister for Food, Agriculture and Livestock as its Chairman. This supreme institution represent all disciplines concerned with the development of the seed industry both in the private and public sectors. Both NSRD and FSCD are the executive arms of the NSC. The Provincial Seed Councils are responsible for arranging the production and distribution of certified seed to the farming community in the country. In addition to the public sector, Seed Corporations, the privatization policy of the Government of Pakistan has encouraged the emergence of some multi-national seed companies like, Pioneer Pakistan Seed, Ltd., Cargill Pakistan Seed (Pvt.) Ltd., Sandoz Pakistan (Ltd.), Lever Brother Pakistan Ltd. and ICI Pakistan Ltd. These companies are specifically introducing hybrid varieties of sunflower, maize, millet and sorghum in addition to other major crop seed. Although there is a great production potential for each improved varieties but there is a significant difference between potential and average yield in the country. This gap can be narrowed by educating the farmer about the latest production technologies etc. The area, production and yield of the important crop is as under:

Table 4: Area and production of major crops

Crop	Area (000 ha)	Production (000 t)	Yield (kg/ha)
Wheat	8,299.7	16,156.5	1,946
Rice	1,973.4	3,116.1	1,579
Cotton	2,835.9	9,053.0 (Bales)	543
Sugar cane	884.6	38,058.9	43,782
Maize	867.5	1,177.6	1,357

Source: Agricultural Statistic of Pakistan, 1992-93.

The area and production of rice, cotton and sugar-cane has decreased as compared to last year. Cotton production has also declined drastically due to leaf curl virus attack and non availability of suitable resistant genetic stock.

CHAPTER 2
Indigenous Plant Genetic Resources

2.1 FOREST GENETIC RESOURCES

The forest distribution in Pakistan is largely governed by the climatic and adaphic factors which ultimately reflect the diversity of forest in the country. The large areas are under natural coniferous and broad leaved forest, some of the forest are entirely man made. The most popular forest species which socially and economically important are *Abies pindrow, Pinus wallichiana, Aconitum heterophyllum, A. chasmanthum, A. laeve, Saussurea lappa, Rheun enodi, Podophylum hexandrum, Cedrus deodara, Pinus gerardiana, Juniperus excelsa, Picea smithiana, Quercus ilex, Q. incana, Q. dilatata, Q. semecarpifolia* and *Rhododendron aroboreum*. The temperate deciduous tree genera *Acer, Aesculus, Prunus, Ulmus, Fraxinus, Corylus* and *Alnus* are met fairly associated in Himalayan temperate forest. In addition to these medicinal plants such as *Ephedra nebrodensis, Artemisia maritima, Carum bulbocastanum, Thymus, Ferula, Zizyphus vulgaris, Punica granatum, Berberis lycium, Skimmia laureola, Viola serpens, Dioscorea deltoidea, Valeriana wallichii, Atropa acuminata, Colchicum luteum, Asparagus racemosus, Mentha piperita* are found in these forests and a sizeable quantities are exploited commercially.

The sub-tropical forest i.e. *Pinus roxburghii, Quercus incana, Lyonia ovalifolia, Rhododendron arboreum, Pistacia integerrima, Syzygium cumini, Mallotus philippinensis, Xylosma longifolium* and *Ficus spp.* are found in Pakistan between of 925 - 1,675 masl.

Both the high-hill moist and dry temperate forests are located on comparatively steep slopes. As such they cannot be regenerated under the clear felling or uniform system but are worked under selection systems which is nothing more than the harvesting of trees of specific sizes. Exploitable size fixed for all coniferous trees is 50 cm dbh. All the trees over the said size, when occurring above established regeneration, are removed in addition to dead, dying diseased, malformed and broken trees. Thinning are carried out when required. A minimum rotation is specified which correspond to the age at which the trees reach the exploitable size i.e. 120 years.

The main species of scrub forest i.e. *Olea ferruginea, Acacia modesta, Pistacia integerrima, Dodonaea viscosa, Reptonia buxifolia, Capparis aphylla, Tecoma undulata, Gymnosporia royleana* and *Zyzyphus nummularia*. Where as dry tropical thorn forest consist of *Acacia modesta, A. nilotica, Salvadora oleoides, Prosopis cineraria, Tamarix aphylla, Zyzyphus mauritiana, Z. nummularia, Capparis decidua, Tecoma undulata, Calotropis procera, Acacia senegal, Euphorbia nerrifolia* and *Acacia jacquemontii* are the prevalent habitats. These forest trees provide valuable protective cover to the watersheds and are source of firewood and fodder to the local communities. They are growing under adverse conditions and will never produce large volume of wood per unit area.

The man made forests are commonly known as irrigated plantations. The major species grown under these forest include *Delbergia sissco, Moris alba, Salmalia malabarica, Eucalyptus camaldulensis, Acacia nilotica, Melia azedarach, Populus spp.* and *Salix spp.* etc. The plantations are being managed for fire wood, timber, furniture and sport good industry. They serve vast grazing ground for domestic cattles and also provide refuge to some wild life.

Table 5: The utilization of main forest timber species

Botanical name	Local name	Uses
Abies pindrow	Partal	Packing cases, railway sleepers, cheap doors and windows, plywood.
Picea smithiana	Partal	-do-
Cedrus deodara	Deoda	Railway sleeper, cross arms, house building beams, door and windows, light furniture
Pinus roxburghii	Chir	Roofing, flooring, railway sleepers, transmission poles
Juglans regia	Akhrot	Carving and furniture making, rifle stock, cabinet making and veneer.
Dalbergia sissoo	Shisham	Furniture, cabinet making, house building, carts and carriage, agricultural implements, and ordinances articles.
Moris alba	Mulberry	Hockey sticks, tennis, badminton and squash racquets, camp furniture, cooperage and bobbins
Eucalyptus	Sufaida	Pulp and paper, fence posts, camaldulensis furniture, charcoal and rural house construction.

Populus americana	Hybrid poplar	Packing cases and crates, match splints and boxes, veneer and plywood, rural house construction, pulp and paper.

2.2 WILD RELATIVES OF CROP PLANTS

The main cultivated crops of Pakistan are wheat, barley, rice, maize, sorghum, millet, cotton, Brassica, sunhemp, jute, tobacco, sugarcane, sugarbeat, mung & mash, lentil, chickpea, groundnut, sessamum, lin seed, chilies, onion, garlic, corriander, turmeric, tomato, potato and fruit & vegetables. Whereas the main popular fruits in the country are citrus, mango, banana, apple, guava, apricot, peach, pears, plums, grapes, pomegranate, dates and almonds.

The wild relatives of cultivated crops which occur in Pakistan are *Aegilops squarrosa, A. triunciallis, Agropyron borianum, A. caespitosum, A. canaliculatum, A. desertorum, A. repens, A. semicostatum, A. trichophorum, Elymus spp., Hordeum aegiceras, H. bogdnnii, H. distichon, H. glaucum, H. murinum, H. spontaneum, Oryza coarctata, Sorghum halepense, S. nilidum, Pennisetum flaccidum, P. hohenackeri, P. lanatum, P. oriental, Gossypium arboreum, G. stocksii, Brassica deflaxa, B. nigra* and *B. tournefortii, Hisbiscus caesius, H. hirtus, H. lobatus, H. micranthus, Nicotiana tobacum, N. rustica, Sacchrum bengalensia, S. spontaneum, Cicer macracanthum, Vigna trilobata, V. vexillata, Lathyrus spp.*

The wild relatives of fruits prevalent in Pakistan are *Malus bacata, M. chitralensis, Citrus medica, C. reticulata, Mangifera indica, Psidium guyava, Prunus amygdalus, P. armeniaca, P. avium, P. bokhariensis, P. cerasus, P. domestica, P. persica, P. prostrata, Pyrus communis, P. lindleyi, P. pashia, Vitis spp., Punica granatum* etc. All these species are still found in Pakistan and threatened with genetic extinction, due to development work, over grazing and cutting of trees by local people for fuel and wood. The species are not protected under any legislation. There is an urgent need to establish clonal repositories for fruit trees. There are about three hundred medicinal plant species in the country. Some of them are harvested at early vegetative stage and others are uprooted for its medicine use. These plants need to be collected, preserved and multiplied for their commercial exploitation.

2.3 LANDRACES AND OLD CULTIVARS

The farmers having large farm size land are still cultivating small area of local wheat varieties for their own use. Whereas local white wheat landrace is still under cultivation in Baluchistan due to its drought tolerance good quality and regenerating ability. In northern areas of Pakistan the local landraces of different crops are popular due to the non-availability of suitable cold tolerant

improved varieties. Similar is the situation for rice, the local land races are still under cultivation in Sindh due to their local preferences. Although Govt. has banned the cultivation of desi cotton, due to its high susceptibility to insect and pest but farmer still prefer to make quilt from this cotton lint. In case of minor food crop and deciduous fruits local cultivars are still under cultivation due to the lack of breeding programme in the country.

CHAPTER 3
National Conservation Activities

3.1 *IN SITU* CONSERVATION

Pakistan's diversity of climate and topography have endowed it richly with 600 species of flora, 188 mammals, 702 birds, 168 reptile and thousands of species of fresh water and marine fish, amphibian and invertebrates. However, till recently wild life conservation has received little attention and certain species have vanished entirely such as cheetah, and wild dog, while not less than 31 species of mammals, 20 of birds, 5 of reptile and more than hundred species of plants are on the endangered list.

There have been moves by the Government of Pakistan to rectify this situation which have received cooperation from international agencies for the conservation of flora and fauna. To preserve the country's major ecosystem and to preserve the threatened species of wild life and forest trees 7 national parks, 72 sanctuaries, 76 game reserves and one biosphere have been established, but due to lack of technical trained manpower these reserves are not properly managed.

3.2 *EX SITU* COLLECTIONS

The collection and conservation activities started in early seventies with the approval of small project under PL480 "Collection of rice germplasm". Under this project about nine hundred rice samples were collected, evaluated and duplicated at International Rice Research Institute, Philippines. The need for genetic conservation and plant exploration was strongly felt during this period due to the introduction of improved varieties and changes in the agricultural land use etc. To safeguard the valuable crop genetic resources a regional project on Plant Genetic Resources was started under the auspices of FAO and financed by the Swedish International Development Authority (SIDA) including six countries in the region i.e. Afghanistan, Iran, Iraq, Syria and Turkey. To provide counterpart contribution to the regional efforts a national research programme entitled "Exploration, Collection, Conservation and Evaluation of Plant Genetic Resources" was started in 1977 under the Pakistan Agricultural Research council, Islamabad. The relevant research

equipment, cooling units etc. were provided by the International Board for Plant Genetic Resources (IBPGR), Rome, Italy. The Government of Pakistan realize the importance of indigenous germplasm for sustainable agricultural production and to meet the growing demand of food supply. Thus a project "Genetic Resources Preservation and Research Lab." was approved and financed by Government of Japan during 1992-93. Under this project plant exploration, seed preservation, germplasm evaluation, in-vitro preservation, data management, plant introduction & seed health Lab. were established. In addition to these, a modern genebank, six glass houses, 400 KV stand by electric generator and other allied facilities were also built. The Plant Genetic Resources Institute (PGRI) of PARC/NARC has undertaken twenty eight plant collecting expeditions in different agro-ecological region of the country in collaboration with the national coordinated commodity programmes and International Agricultural Research Centre (IARC). As a result of these efforts, we were able to assemble and conserve more than eighteen thousand samples of different crops. The major portion of these collections are primitive land races. The germplasm of rice, wheat and vegetables has been duplicated at IARC. About one thousand accessions of different crops are annually distributed to national breeders, universities and other international agencies for utilization in their breeding programmes. The proportion of germplasm supplied abroad is slightly higher than the local demand. The domestic demand of germplasm will increase as soon as PGRI start publishing crop catalogues with passport and evaluation data.

There is a vast range of genetic diversity in flora of Pakistan. The material collected from the country does not represents the entire genetic variability. To capture maximum crop genetic diversity we have to mount several plant collection expeditions for major and minor crops, and also we have to establish clonal repositories for fruits and forest species.

PGRI has undertaken mission oriented collections but we have also collected the germplasm of other crops of interest during these trips. The random population samples were drawn from the farmer's field and natural habitat of that particular species. For fruit, seed and scion wood were taken as per recommendation of IPGRI. Our collections do contain some of the germplasm which has a medicinal value. These could be exploited for commercial production in near future e.g. *Papaver spp., Plantago spp., Cumin spp.* etc. Therefore, on these ground one could not afford to discard this material from our collections.

3.3 STORAGE FACILITY

Plant Genetic Resources Institute has two types of conservation facilities i.e. short term (working collection) and medium term storage. Genebank has the capacity to accommodate 60,000 seed samples of 500 gm each. The working collections are stored at 10% moisture content at 15°C at 45% RH in a hermetic wide month plastic bottles having silica gel. The bottles are kept in a mobile shelves to utilize maximum space. Whereas under medium term storage the accessions are kept in laminated foiler bags at 6-7% moisture content. The medium term storage has been built on 50 m^2 and partitioned into eight chambers. Each chamber has the capacity to accommodate 8,000 accessions separately. These chambers are being operated at 5°C at 40% RH. Each accession is packed in two laminated aluminum envelops. The envelops are properly sealed and maintained. In addition to these facilities five chest type deep freezers operating at -20°C are being used for long term preservation. About 10 gm seed of 50,000 accessions can easily be stored in these freezers. To ensure the safety and longevity of the precious germplasm, continuous power supply is essential. Therefore, all genebank appliances and other essential equipments are connected with 400 KW automatic power generator. The electric supply (WAPDA/Generator) is routed through automatic voltage regulator to control the power fluctuation and for the safety of Lab. equipments.

The crop germplasm has been assembled either through plant collecting expeditions or obtained from the researcher in the country or introduced from abroad. Once the germplasm arrive at PGRI its health status is monitored and its germination & moisture contents are determined. Seed is then dried, packed and sealed before it goes to the storage room. All these steps are in accordance with international standards. Presently we are dealing with orthodox seed thus there is no worry about the loss of viability during the processing of seed which normally takes 10-15 days. The research work on the conservation of vegetatively propagated crop plants such as potato and sweet potato has recently been initiated on minimal growth media. The research work will be further extended to Cryo-preservation for which the facilities are available. The present facilities have been developed in collaboration with Japan International Cooperation Agency (JICA), keeping in view the international standard for seed preservation. The 100% space in the genebank will be utilized by year 2010. After that there will be need for its further extension of the genebank for which space has already been reserved/earmarked.

The PGRI has already duplicated its material for safety e.g. rice germplasm at International Rice Research Institute (IRRI), Philippine, wheat, barley & chickpea at ICARDA - Aleppo, Syria and vegetable, mung & mash germplasm at AVRDC, Taiwan. At present PGRI do store country's approved varieties seed on behalf of Federal Seed Registration Department. As the storage condition of Pakistan Central Cotton Research Institute, Multan are not according to the recommendation of IPGRI thus we have offered them a one medium term storage room for preservation of their genetic stock till they are able to establish their own facility. The PGRI is also collaborating with West Asia & North Africa (WANA) seed network and has accepted the responsibility of conserving all crop reference seed samples. Sofar Iran and Cyprus has sent some wheat and barley samples for conservation.

At present there are several botanical gardens in colleges and universities, seven national parks, 72 sanctuaries, 79 games reserves and one biosphere, which are serving as field genebanks for different forest species and wild relative of cultivated crop plants. The Government of Pakistan attaches high priority to bio-diversity conservation. In this regard, Government in collaboration with the International Union for Conservation of Nature (IUCN) has jointly developed National Conservation Strategy. According to its recommendation, it has been planned to develop 35 National Park covering all the ecosystem, establishment of water land reserves, proper maintenance of park and wetlands. Now the efforts are underway to preserve all species which are on endangered list, establishment of biodiversity data base, create public awareness and proper maintenance of crop and medicinal plant germplasm.

3.4 DOCUMENTATION

The collections are fully documented manually on format recommended by IBPGR and are kept in the form of data books. There are more than 18,000 samples currently present in the genebank. Out of them about 60% collected though expedition and remaining are donated by other institutes within and outside the country. The passport data of 75% of the collected samples has been entered in the form of dBase files. Most of the donated data is present in electronic form, however, a complete computerized database has not been developed yet but the work is in progress.

Reports have been designed for the users. The process of cataloging the collecting information is in progress. At present only passport data of collections is being catalogued. Reports are generated crop-wise. The

agronomic evaluation information are separately maintained in the form of dBase files and handwritten data registers, but still it is not integrated with the passport data files. Almost 80% of the samples are fully documented. However, correlation between use and quality of documentation has not studied yet.

Informations are made available to users in the form of computer print outs on request. Local scientists can have direct on-line access to the files on a limited scale. Data books maintained can also be consulted at any time by local scientists. A local network is available that links documentation section with all PGRI laboratories, but it is not in working condition yet. However, at present there are no options available for networking with other genebanks to exchange data on regional or crop basis. As stated earlier, the establishment of data base and information system is underway. PGRI has plans to connect itself with other genebanks in future.

There are no *in situ* collection in the country, however, PGRI is planning to establish such collections. In such case the data will be documented accordingly.

There is no duplication of data books, however, the record stored in the form of data base files is duplicated and kept on two different disks after every new expedition. Two hard copies of this data are also maintained regularly within the institute. Crop wise report in different format is also maintained.

3.5 EVALUATION AND CHARACTERIZATION

The collection of germplasm is of no use unless and until it is properly characterized and evaluated. The preliminary characterization is undertaken by PGRI scientist during the multiplication of collected crop germplasm according to IPGRI's descriptors. But in case the particular crop descriptor is not available, then respective crop coordinators/breeders are consulted for the characterization of the crop.

Preliminary characterization is being carried out at the National Agricultural Research Centre, Islamabad due to limited staff and financial constraints. The field evaluation of chickpea germplasm was undertaken for chickpea *Ascochyta rabies* blight in collaboration with Coordinator (Pulses). Now with the establishment of Research Laboratories at PGRI and evaluation of wheat, chickpea, maize, sorghum and millet germplasm has been started by the researchers of the institute. The information generated will be computerized

for efficient utilization of crop germplasm. At present about 65% crop germplasm has been characterized at NARC except for Aegilops which was multiplied and characterized at Arid Zone Research Institute, Quetta.

The evaluation of indigenous landraces, primitive cultivars and their wild relative must be carried out for the entire national germplasm. The evaluation will definitely be helpful to incorporate local desirable traits into the modern cultivar for sustainable agricultural production. It is strongly urged that evaluation be carried out at multi location and also be collaborated with IARC or with any other research Institute having international repute. The multi location evaluation of crop germplasm will enhance the validity of data. The collaborative evaluation of crop germplasm be carried out with the International Agricultural Research Centre which will provide an opportunity to the respective country scientist to work with IARC as trainee scientist to evaluate the respective crop germplasm. Any crop which is not dealt by the IARC, then FAO may designate a crop based research institute for germplasm evaluation studies. This will not only promote the germplasm evaluation work but will also improve the technical competence of the developing countries scientists.

Pakistan has not initiated any *in situ* conservation activities except few botanical garden in colleges and universities, which is also on a limited scale. These botanical gardens are being used by the students/teachers for taxonomic identification/classification purposes. No systematic characterization and evaluation work in these botanical gardens is being undertaken so far.

3.6 REGENERATION

The regeneration of crop germplasm is undertaken if the viability has dropped bellow 85% or the conserved material stock is too small to meet the scientist requirement. The PGRI has a field, glass house, growth chambers facilities for regeneration of both self and cross pollinated crop germplasm. The experiments are being carried out to work out most suitable site/place for regeneration of germplasm to minimize/eliminate the incidence of seed born diseases. Efforts are made to regenerate the material under healthy environments. The qualified staff, labour and logistic arrangements are available to maintain the possible genetic identity of the original stock. As the material (bulk population) is being multiplied/regenerated at the centre other than its place of origin. There are chances that some of the recessive allele may disappear during the process of regeneration. The proper regeneration record i.e. date, year and place is being maintained. More than 50% of the seed

stock has been regenerated once, whereas about 15% germplasm has been regenerated more than twice. The original and regenerated seed stock are maintained in the genebank separately.

3.7 FOREST GENETIC RESOURCES

In fact main conservation activities were focused on the major food crops. The exploration and conservation of forest genetic resources remained neglected since the creation of Pakistan. The Pakistan Forest Institute, Peshawar was the only organization in the country, who is responsible to all research activities related to Forest. Recently Government has realized the growing demand of forest and has established two more institute in Punjab and Sindh respectively. These Forest Institutes maintain various forest species at different location as provenance. The documentation and characterization of provenance are being carried out side by side. The Forest Research Institutes in the country has also realized the importance of forest genetic resources and are planning to establish *in situ* conservation at different agro ecological region of the country. Recently Forest Institute, Peshawar has started Pinus hybridization programme in collaboration with United State Forest Department. The genetic variability created will be further characterized and evaluated for future its exploitation.

CHAPTER 4
In-Country Uses of Plant Genetic Resources

Pakistan has a sound breeding programmes on major food crops, therefore, the PGRI receive request from the National and Provincial crop breeders mainly for wheat, rice, barley, *Aegilops spp., Agropyron*, mung, mash, phaseolus, faba bean, vegetable, brassica, sorghum, millet and lathyrus. The following research programmes/organizations in the country are main users of germplasm:

- Coordinator, Wheat & Barley, NARC, Islamabad.
- Coordinator, Pulses, NARC, Islamabad.
- Cereal Disease Research Institute, NARC, Islamabad.
- Coordinator, Rice, NARC, Islamabad.
- Coordinator, Oilseed, NARC, Islamabad.
- Coordinator, Fodder & Forage, NARC, Islamabad.
- Coordinator, Fruit and Vegetable, NARC, Islamabad.
- Nutrition Lab., NARC, Islamabad.
- Wheat Research Institute, AARI, Faisalabad.
- Pulses Research Institute, AARI, Faisalabad.
- Oilseed Research Institute, AARI, Faisalabad.
- Nuclear Institute for Agricultural Biology, Faisalabad.
- Rice Research Institute, Kala Shah Kaku, Lahore, Punjab.
- Bahauddin Zakria University, Multan, Punjab.
- Fodder Research Institute, Sargodha, Punjab.
- Rice Research Institute, Dokri, Sindh.
- Atomic Energy Agri. Research Centre, Tandojam, Sindh
- Department of Botany, Karachi University, Karachi.
- Arid Zone Research Institute, Quetta, Baluchistan.
- Agricultural Research Institute, D.I. Khan, NWFP.
- Cereal Crops Research Institute, Pirsabak, Nowshera.

Out of 18,000 accessions about 1,700 accessions of different crops were requested by the national programmer for its utilization in crop improvement programme during the last three years. This come to about 9.5% germplasm utilization per annum. About a decade ago multinational seed companies such as Cargill, Poineer, ICI, etc. are marketing hybrid/improved crop varieties seed. They are utilization their own genetic stock for varietal development. So for this institute has not received any germplasm request from private sector.

The buckwheat, minor millet, fibre crops, *Elymus, Solanum spp.* and *Lycopersicum* etc. germplasm has not been requested by any national programme. The main reason for its non utilization is due to lack of national breeding programme on these crops.

4.1 CROP IMPROVEMENT PROGRAMMES AND SEED DISTRIBUTION

There are five major crops in the country, namely wheat, cotton, rice, sugarcane and maize. Their productivity is very low as compared to their potential. The main function of national breeding programme is to evolve, high yielding better adaptive, resistant to pest and diseases with broad genetic base, a crop variety for sustainable crop production. The target is to attain self sufficiency in the food grains. The staple food of Pakistan is wheat and we are little short in our requirement. However, we do export reasonable quantity of cotton, rice and sugar. Therefore, breeding of these crop are export oriented to meet the requirement of importing countries. A brief history regarding the utilization of indigenous landraces/cultivars for evolution of improved varieties follows:

Wheat: the improvement work on this crop in Indo-Pak dates back to the year 1893. Prior to release of improved varieties wheat grown were a mixture of *T. durum, T. sphacroceccum and T. aestivum*. Through selection T-9, T-11, 9-D were released to general cultivation. The hybridization work started in 1926 by exploiting the indigenous germplasm when it was realized that no further improvement is possible through pure line selection. As a result of hybridization work C-265, C-273, C-396, C-516, C-518, C-409, C-505, C-314, C-499 and C-519 were evolved and C-591 and C-518 were officially released during 1933. Which remained under cultivation since late fifties.

Rice: the rice varieties or mixture cultivated in different part of Indo-Pak subcontinent were collected during 1927, isolated and fixed into 503 pure line cultivars which were broadly classified into 16 agricultural cum commercial groups i.e. Basmati, Begami, Mushkan, Hansraj, Jhona, Jhoni,

Jhona Kasarwala, Toga, Dhan, Sathra Ratua, Sone, Palman, Kharsu, Santhi and Red Rice. From these groups different cultivars i.e. 349 Jhona, 346 Mahlar,
246 Palman, 370 Basmati and 278 Sathra were approved for commercial cultivation. 370 Basmati was farther crossed with exotic germplasm the outcome of these efforts resulted in high yield semi drawaf Basmati varieties i.e. 385 Basmati and Super Basmati, which are performing excellent at farmer's field.

Maize: the local cultivars collected from different part of the country. Each line was self pollinated for several generations. These effort resulted in the development of a about a dozen inbred lines which proved excellent both for general and specific combining ability. The most promising inbred lines developed are Pb-7, Pb-70, Pb-96, Pb-127, 83 P1-1, 86 P-3, P-53 and 103 P-1. The single cross 212, 217, 224 out yielded the local varieties over 100% margin. Similarly double cross DC-5, 7, 8, 59 & 100 were also evolved which also significantly out yielded. Later on synthetic varieties Neelam Akbar, Sadaf Agati 72, etc. were also evolved and released for commercial cultivation.

Cotton: during the early stage of variety development the selection of better genotype made possible for the release of AC-134, 289F, LSS, 4F and B-557. the *G. Hersutum* was crossed with exotic lines are we were able to evolve high yielding cotton varieties i.e. MNH 93, NIAB 78 and K 68. Similarly the desi cotton when crossed with *G. Hersutum* this made possible to evolve a new cotton variety i.e. Cyto 10/91 which is not only tolerant for heat and drought, but also a resistance against LCV.

Pulses: the chickpea improvement work was started by selecting suitable line from the local collections. As a process of selection C-44 variety was released which significantly out yielded the local cultivars. Later on a local line of chickpea was radiated which resulted in the evolution of a new variety CM-72. To exploit hybrid vigour C-44 was crossed with some local and exotic germplasm. These crosses proved very successful and gave birth to new varieties i.e. Paidar 91 and Punjab 91 which are high yielding and tolerant to blight. A mung variety 6601 was also developed by selection from the local collections.

Vegetable: Okra T-13, Carrot T-29, Muskmallon T-96, Spinich local, and Kindia ry, Bringa l Sarhen di Tinda local, are also the outcome of selection from the local collections.

The conventional breeding is being undertaken for major food crops and it has almost negligible support from bio-technology. There is no fruit, minor millet and forest tree breeding programmes in the country. The major constraints for crop improvement programme is lack of proper research labs.

and trained manpower. These constraints are directly related with the economic condition of the country. To over come such situation, Government has allowed public sector seed cooperations to evolve high yielding crop varieties. Presently Pioneer, Cargill, Sandoz, Lever Brothers and ICI multinational seed companies are marketing their hybrid varieties of sunflower, maize, millet and sorghum in the country.

The breeders are testing and evaluating large number of strains on a small scale variety trials at research centres. The promising material is further tested in zonal traits out side research centres. These trials are also conducted on the farmers field. When a plant breeder selects promising variety, he sends seed samples to National Seed Registration Department to asses its distinctness and uniformity for registration purpose. The variety is tested in National Uniform Yielding Trials before putting up the case to the variety Evaluation Committee (VEC). Consequent upon the approval of a variety, seed is multiplied at the government farms and registered seed growers under the supervision of Federal Seed Certification Department. The seed of approved variety is marketed through the Provincial Seed Corporations and made available to farmer. At present about 13% wheat, 33% cotton, 5% rice certified seed is made available to farmers for commercial cultivation. This situation is not very satisfactory regarding the provision of quality seed to the farmer. Efforts should be made to multiply approved variety seed at state land and with progressive farmers by offering them premium on quality seed production.

4.2 USE OF FOREST GENETIC RESOURCES

The seed of forest tree is collected annually and nurseries are raised under the supervision of forest officer. One year old sampling are either planted in target areas or distributed to farmer at very nominal price. Several project for nursery development are being implemented with the assistance of UNEP, FAO and World Bank. These plantations are looked after by the forest department. The private land owner has also started cultivation of forest trees due to its high economic return. This utilization of forest tree has been presented in Table 5.

4.3 BENEFIT DERIVED FROM PGR

Plant Genetic Resources programme concentrated their efforts for collection and conservation of crop germplasm because the green revolution in late sixties threatened cereal genetic resources. A little work was carried out for preliminary characterization due to lack of manpower and financial resources. With the establishment of modern facility and technical cooperation with Japan a systematic evaluation research work has been started. The collected crop germplasm is being supplied to Cereal Disease Research Institute for screening against disease, Salinity Lab., University of Agriculture, Faisalabad, Rice Research Institute, Kala Shah Kaku for its evaluation. Thus the information generated by these research institute are exploited by the breeder. As a result of these efforts, the Rice Research Institute able to release a fine rice variety Basmati-385 which is now being cultivated on 95% of the rice growing areas. This rice variety has not only increased yield per unit area but also enhanced the export of rice to middle east countries. Similarly PGR Lab. also introduced one chilli variety from Nepal which has also proved very successful. The rice and wheat germplasm has already been provided to IRRI and ICARDA/CIMMYT. The indigenous germplasm is being used by the crop breeders at these International Agricultural Research Centres. Pakistani breeder's also received enhanced germplasm nurseries, out of these nurseries, breeders were able to select and release rice and wheat varieties. Thus the country is deriving a clear benefit from the use of indigenous and exotic germplasm.

4.4 IMPROVING PGRI UTILIZATION

The main achievement of PGRI during its first phase is to assemble maximum crop genetic resources variability from different agro-ecological region of the country. The collected variability needs special attention for its characterization, evaluation and documentation of genetic resources informations to enhance/promote its utilization. Now the trained scientific staff is giving their maximum time for rejuvenation, characterization and evaluation of this valuable germplasm.

The germplasm characterization and evaluation is being carried out with the collaboration of National Crop Coordinators, thus the respective crop breeder/agronomist etc. are associated during this process. The involvement of breeder, agronomist, entomologist provides an opportunity to screen/evaluate

and identify the suitable accessions for their utilization in crop improvement programme. The Plant Genetic Resources are the national heritage, thus our country attaches great importance as these are more valuable for our future generation. The utilization of crop germplasm could be further enhanced if these are tested at different agro-ecological areas of the country in collaboration with the provincial research scientists. For this activity financial resources, technical, trained manpower is required.

CHAPTER 5
National Goals, Policies, Programme and Legislation

5.1 NATIONAL PROGRAMME

The Plant Genetic Resources Institute of Pakistan Agricultural Research council is a federal institute and has national mandate of collection, conservation, evaluation and documentation of Plant Genetic Resources. This institute coordinate with the provincial research institute and IARC to cater the needs of national scientist. Its activities are being funded by the Government of Pakistan and technical assistance is being provided by the Japan International Cooperation Agency (JICA) in the form of long and short term experts, equipment and chemicals etc. The multi national seed companies operating in Pakistan are maintaining their breeding material out of country, but they are having a small cold room for seed storage. At present neither any NGO's nor farmer's organization is under taking genetic resources conservation activity in the country.

The main objectives and goals of PGRI/Government of Pakistan for maintaining plant genetic resources are:

- Exploration and collection of Plant Genetic Resources from different agro-ecological region of the country.
- *In situ* and *ex situ* conservation of plant biodiversity.
- Characterization and evaluation plant genetic resources and its documentation.
- Documentation and publication of plant genetic resources informations.
- Monitoring health status of indigenous and exotic genetic stock.
- Coordinate with national and international research institutes.

The Plant Genetic Resources Institute is in the process to identify suitable senior scientist in the country having a representation from all the provinces for formulation of National Committee on Plant Genetic Resources. This committee will provide guide line/policies on the subject.

The head of Plant Genetic Resources Institute is accountable to Director General, National Agricultural Research Centre (NARC)/Chairman, Pakistan

Agricultural Research Council (PARC). To make it more clear organizational chart is attached at Appendix I. There are thirteen research institutes at the NARC. The position of the head of PGRI is secure. The Government of Pakistan has the final authority to abolish or to expand the research activities in the council. The annual budget for PGR activities is prepared by the head of Institute, then scrutinised in PARC and submitted to Government of Pakistan. After the approval from Government of Pakistan the budget is released on year to year basis.

The indigenous Plant Genetic Resources are raw material for future candidate crop varieties and Government of Pakistan has high priority to this national heritage. The material is not protected by any legislation anyhow Chairman, PARC is the competent authority to decide its fate. There is a need to protect this valuable germplasm by legislation, to conserve it both *in situ* and *ex situ* before it disappear for ever. If this valuable germplasm not legally protected and conserved this can pose a serious threat to our national food security in near future.

5.2 TRAINING

Keeping in view the number of crops which the PGRI is taking care, the scientific trained manpower is far less to accomplish the national goals and objective. The PGRI has an excellent facility to under take, seed science, agronomic/bio-chemical evaluation, germplasm health, Data management, Plant exploration and cryopreservation research. Whereas, social and anthropological studies and public awareness could be handled by PARC. The PGRI could offer training in the field of exploration & collection, genebank management, seed heath testing. It has been planned to offer short term training course to the national scientist in 1996 with the cooperation of JICA.

At present there are a few short courses on PGR which are being offered by the Department of Botany, University of Agriculture, Faisalabad, but it does not fulfill the national requirement. The International financial/technical support is required for M.Sc. degree and short term training course. Although the concern on global basis has been shown for conserving bio-diversity but there is a need to create an awareness at national level by exploiting different media. This will help policy makers to realize how important Plant Genetic Resources Programme is for the country.

5.3 NATIONAL LEGISLATION

The Department of Plant Protection is working under the Ministry of Food, Agriculture and Livestock. This department has their offices at each port of entry through out Pakistan. They observe international rules and regulations for the safe transfer of animal and plant material. If the consignment is in in-vitro, and plants are visually free from any infection it is released immediately. Whereas in case of seed material, it should be accompanied by phytosanitary certificate and import permit (if required). Pakistan's economy has suffered serious setback from cotton and banana due to its lose/relax quarantine measure. Therefore, it is strongly urged that there should be a well trained staff to examine the material and should have strong coordination with the seed health lab. of PGRI for testing the material. Although some difficulties are experienced during the release of material even though it is proposed to have a strong quarantine control measure to avoid the introduction of new diseases.

The national rules and regulation does not restrict the planting of imported genetic resources in the open field. The government does not provide any incentive to the farmers for cultivation/conservation of traditional varieties. The legislation do exist that the farmer should plant certified seed. As the government is unable to meet the farmer's demand for certified seed therefore, it is not practiced. Now the Federal Seed Registration Department, Ministry of Food & Agriculture is preparing a document to become a member of International Union for the protection of new varieties of plant (UPOV) Geneva. Once the government approve this document then Breeder's Rights (BR) and Intellectual Property Rights (IPR) will be enforced in the country.

As far as the exchange of germplasm is concern the government has a very liberal policy. It is believed that Plant Genetic Resources are heritage of mankind it should be available free of charge to researcher within the country and abroad on mutual exchange basis. As number of countries has became a member of UPOV, therefore, it is expected that Breeder's Right, Intellectual Property Rights and Farmer's Right may become a hurdle for exchange of germplasm in future and collection of germplasm from foreign country.

5.4 OTHER POLICIES

The Federal Seed Certification Department supervise the approved variety seed production in the country on Government farms and with the registered seed growers. The certified seed growers get premium price from the seed corporations. The seed is further cleaned, packed, labeled and then sold in the market as certified seed. The farmer has good confidence on the purity of certified seed.

The PGR staff/experts are not involved in planning of major agricultural development projects and at the same time the agricultural development project are also not appraised, monitored and evaluated for their impact on the conservation and utilization of Plant Genetic Resources.

CHAPTER 6
International Collaboration

It is agreed that no country in the world is self sufficient in plant genetic resources. Therefore, all countries are interdependent and Pakistan believe on fair and equitable exchange of PGR. Our country is collaborating with all the International Agricultural Research Centre (IARCs) and International Plant Genetic Resources Institute (IPGRI) for collection, conservation, evaluation of Plant Genetic Resources for the national and global benefit. In addition to this Pakistan is a member to South Asian Association for Regional Cooperation (SAARC) and FAO commission on Plant Genetic Resources thus, collaborate on the all proposed activities of PGR. Pakistan also adopted agenda 21 in 1992. As a result of this we were able to establish Plant Genetic Resources Institute to expedite the plant biodiversity conservation and its utilization for sustainable food production in the country.

Pakistan became member of FAO commission on Plant Genetic Resources to join hand with global efforts to collect and conserve plant bio-diversity before it disappear for ever for the benefit of mankind. The commission supported Pakistan's early efforts for the establishment of genebank, Lab. equipment and training of manpower on different aspect of Plant Genetic Resources. Presently Pakistan has not signed the international undertakings the case is under consideration and hopefully Pakistan will become signatory to undertaking in near future to derive maximum benefit of the Global Plant Genetic Resources We do support the proposal for creation of international funds for Plant Genetic Resources. These funds will expedite the conservation activities in the developing countries.

6.1 INTERNATIONAL AGRICULTURAL RESEARCH CENTRES

The Consultative Group on International Agricultural Research (CGIAR) had made a significant contribution to Pakistan's PGR by providing genetic resources, and enhanced material to our crop breeder for wheat, maize, rice, potato, food legumes, sorghum & millet, groundnut, vegetables etc. The breeder tested the enhanced material under different agro-ecological region of the country and were able to release new crop varieties. The commodity programme also received technical manpower support from CGIAR for Wheat, Rice, Potato, Chickpea, Plant Genetic Resources etc. The national

scientific staff also received training. The CIAT was the only centre who asked the national programme to bear the cost of trainee in the field of cryo-preservation. The CGIAR Centres did not acceded to all national programme request, the reason for are not well understood. The International Plant Resources Institute (IPGRI) played major role for the initial establishment of Plant Genetic Resources Programme in the country by supporting plant collecting expeditions, establishment of genebank, data management and training of PGR staff. It is proposed that CGIAR commodity centres should multiply and characterize and evaluate the genetic resources in collaboration with the National PGR and commodity programmes to enhance its utilization for global sustainable agricultural production. All the genetic resources activities should be address through IPGRI to develop coordination and to achieve the global mandate. The IPGRI during the next decade should pay more emphasis for the evaluation of crop germplasm by developing better understanding/coordination within the regional countries and create public awareness in the developing countries. The IPGRI should also play a vital role in the establishment of genetic resources programme, training of manpower especially in developing countries.

6.2 REGIONAL RESEARCH CENTRE

Pakistan Agricultural Research Council is collaborating with Asian Vegetable Research and Development Centre (AVRDC), Tiwan and International Centre for Integrated Mountain Development (ICIMOD), Nepal in the region. PARC has signed MOU with these regional research centres for exchange of scientific information, germplasm and training of scientist etc. PARC/Government of Pakistan consider CGIAR Centres and Regional Research Centre equally important in their role and function in the development of agriculture sector.

The Islamic Republic of Pakistan is also collaborating in the field of agriculture/PGR with People Republic of China and Government of Japan, in addition to SAARC countries, according to the agreed memorandum of understanding (MOU). Under these MOU the Chinese and Japanese scientist participated in several plant collecting expeditions. Whereas Pakistan has participated in two SAARC meetings to promote Plant Genetic Resources activities in the region.

Bilateral intergovernmental initiatives

Government of Pakistan does not have any bilateral agreement on Plant Genetic Resources with another country.

CHAPTER 7
National Needs and Opportunities

- Collection, conservation and evaluation of cereals, food legumes, oilseed crops, vegetable, fruit, forest, fodder & forage and medicinal plant genetic resources.
- Evaluation of Plant Genetic Resources for biochemical and stress factors.
- Establishment of clonal repositories for fruit and forest genetic resources at different agro-ecological region of country.
- Development of scientific manpower and training on different discipline of Plant Genetic Resources.
- Dissemination of the plant genetic resources information.
- Public awareness.

CHAPTER 8
Proposals for a Global Plan of Action

- Preparation of global plant genetic resources inventory indicating its source of origin.
- IPGRI should establish regional genebank.
- Creation of International funds for conservation of Plant Genetic Resources especially for developing countries.
- Long term training of Plant Genetic Resources Scientists:
- Awards for outstanding scientist for the promotion of Plant Genetic Resources.
- Organise seminars and conferences on regional and global basis.