

Pakistan's National Germplasm System with Emphasis on Acquisition, Evaluation, Access and Exchange

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1.0 Overview

Pakistan is situated in proximity to major centres of plant species diversity. The ancient trade route from China to Western Asia passed through this region and many crop and fruit species were introduced and cultivated for thousands of years. Many diverse crop and fruit cultivars evolved from both human and natural selection in Pakistan's many remote northern valleys. Excavating the ancient civilisations of Mohanjo Daro and Harappa has revealed that many crops like wheat, barley, rice, cotton and sesame have been cultivated in this region.

Pakistan's rich floristic composition and crop biodiversity led to systematic efforts to collect crop germplasm. This started in the early 1970s when rice germplasm was collected under a project funded by the United States of America. In 1977, after this project ended, the Pakistan Agricultural Research Council (PARC) initiated a national programme to collect, conserve and evaluate plant genetic resources. A small gene bank for short-term storage and a laboratory were established under this programme at the National Agricultural Research Centre (NARC), Islamabad.

In 1993, NARC established a very new facility for germplasm storage and associated research with the financial support from the Japan International Co-operation Agency (JICA). Upon the facility's completion, the former Genetic Resources Programme belonging to the Crop Sciences Institute was re-organised into the Plant Genetic Resources Institute (PGRI) directly affiliated to NARC.

The Institute has five major objectives premised on (1) acquisition, (2) preservation, (3) preliminary evaluation and documentation, (4) plant germplasm distribution and (5) studies on origin and centres of diversity. These are:

1. Expand germplasm collections of seed and clonally propagated crops or new crops via domestic exploration and collection and through foreign exchange.
2. Improve the national plant germplasm maintenance system for seed and clonally propagated crops and potential new crops to preserve genetic diversity.

3. Establish and put into effect a national plant germplasm system useful to breeders and others in the user community.
4. Distribute plant germplasm to scientists in the user community and collect data on its performance.
5. Increase understanding of the taxonomic relationships, geographical and ecological distribution and centres of diversity of crop plants and their wild relatives and help promote their systematic assembly for crop improvement.

Now the Institute has a five-year technical co-operation project with JICA to further strengthen the activities.

2.0 PGRI Laboratory Work Areas

The six laboratories of the Plant Genetic Resources Institute work in six areas: (1) germplasm exploration and collection; (2) seed preservation; (3) evaluation and multiplication; (4) in vitro preservation; (5) introduction and seed health; and (6) information management.

2.1 Germplasm exploration and collection

Indigenous germplasm of crop plants and their relatives is explored and collected. The majority is preserved in a gene bank for breeders to use. In some instances, where the natural habitat is important to their conservation, in situ preservation will also be attempted.

2.2 Seed preservation

Seeds are preserved in two systems. The active collection is for short-term storage and exchange on request. Seeds are dried, packed in transparent bottles and kept at 5°C. Mid-term storage seeds, used to back-up the active collection, are kept at 0°C. Currently 16,000 accessions are preserved in the facilities. They have a total capacity of 50,000 accessions.

Storage seeds are periodically subjected to germinability tests to monitor their vigour. For some crop plants, tests are conducted to find the most appropriate storage conditions. The present germplasm status in PGRI is presented in Table 3

Table 3: PGRI Germplasm Status		
No.	Crop	Number of Accessions
1	Wheat	2650
2	Rice	1985
3	Barley	1170
4	Oat	381
5	Millet	932
6	Sorghum	710
7	Maize	451
8	Chickpea	1400
9	Lentil	768
10	Mungbean	625
11	Mashbean	545
12	Misc. Legumes (pea, Vicia, Moth, Phaseolus, Lathyrus)	632
13	Fruits	886
14	Vegetables	525
15	Brassica spp.	900
16	Misc. Oilseeds (Ground Nut, Sunflower, Sfflower)	167
17	Fibre crops	362
18	Forages	331
19	Misc. crops	75
Total		15495

2.3 Evaluation and multiplication

Germplasm is evaluated and the data preserved for user reference. Evaluation has four steps. “Preliminary evaluation” is based on a record of characters visible in the field such as morphological traits and maturing dates. “Detailed evaluation” is based on agronomic characters such disease and pest resistance. Finally, the

specific characters required for breeding are examined in “biochemical evaluation”. This involves techniques such as electrophoretic protein analysis, DNA analysis with the polymerase chain reaction (PCR) and other tests. “Field evaluation” is often performed at the time of seed multiplication.

2.4 *In-vitro* preservation

Plantlets grown from meristem cultures or regenerated from cultured tissues can be maintained on artificial media in test tubes by sub-culturing them at defined intervals. Some of the important germplasm of vegetatively propagated plants is therefore preserved in vitro as a backup for field preservation.

2.5 *Introduction and seed health*

Avoiding contamination by pathogens and pests is essential to plant germplasm management. It is not only important to quarantine, but also important to secure the vigour and longevity of stored seeds and to avoid cross infection during multiplication. Introduced germplasm materials, and the preserved seed stocks, is examined for pathogen and pest contamination. An internationally co-ordinated research programme is examining the effects of pathogen contamination on seed longevity. Exotic germplasm enters PGRI through the Seed Health Laboratory.

2.6 *Information management*

Information about genetic resources is compiled in a database system. Three types of data are compiled. Passport data is the record of an accession’s entry into the gene bank. It includes information such as species, name, collecting time and location and the name of the collector or sender. Stock data is the record showing the stock situation, acceptance, distribution and multiplication as well as the stock’s storage address. Evaluation data records the accession’s characteristics. It is compiled using descriptor codes.

3.0 *Crop Advisory Committees*

The Pakistan National Germplasm System was set-up to establish a network on plant genetic resources at national and international levels. A National Management Committee and six Crop Advisory Committees make up the system. The Crop Advisory Committees deal with (1) cereals, (2) pulses and oilseed, (3) sugar and fibre crops, (4) fodder, forage, forest and medicinal plants, (5) fruits,

vegetables and ornamentals and (6) special crops. The Advisory Committees provide advice on collecting priorities, multiplication procedures and evaluation, in situ preservation programmes, passport data needs, and the quantity and quality of seeds to be deposited in the gene bank.

4.0 Exchange of Germplasm

The material collected by PGRI is mostly duplicated at International Agricultural Research Centres of the Consultative Group on International Agricultural Research or other relevant institutes in the world. The gene bank material is freely available for research purposes to the scientific community on a mutual exchange basis. Considering that no country is self-sufficient in germplasm, we appreciate mutual exchange especially with countries in the region.

5.0 Plant Breeding in Pakistan

Plant breeding in Pakistan is carried out at three agricultural universities, thirteen multi-disciplinary and thirty-one non-commodity research institutes. The multi-disciplinary research institutes cover almost all economic crops and related disciplines. They have a large number of sections and satellite sub-stations.

Each of the institutes has the mandate to develop better adapted, high-yielding varieties for local agro-ecological conditions. The respective provincial governments sponsor the majority of research institutes. The working programme and some projects are co-ordinated and partly funded by PARC. PARC is responsible for collecting, preserving, evaluating and documenting both indigenous and exotic germplasm. The Pakistan Central Cotton Committee takes responsibility for cotton. To strengthen its national plant-breeding programmes Pakistan also keeps a close liaison with the International Agricultural Research Centres. Germplasm and technology are exchanged.

Conventional and mutation breeding methods are used to develop improved varieties at the aforementioned institutes. Most economic crop varieties were developed by the provincial research institutes, whereas the Agricultural Research Centres of the Pakistan Atomic Energy Commission have developed some promising varieties of grain, legumes, rice, cotton and wheat.

Being the most important staple food, the main research and variety development efforts focus on wheat. Three varieties are released annually. Cotton follows with two varieties released annually. Owing to the increasing gap between the supply

of and the demand for edible oils and food legumes, oilseed and legume crop variety improvement has become important.

As soon as a new high-yielding variety/hybrid is developed, it is important to make its seed widely available for widespread use in the shortest possible time. Before marketing, a new variety is tested for registration protection and release. Both public and private plant breeders want to protect their varieties against piracy. All precautionary measures against pirating and unauthorised distribution are taken prior to proper release. After the promulgation of the Pakistan Seed Act of 1976, the release of new varieties has been systematised on a scientific basis.

6.0 Development of Plant Variety Protection in Pakistan

Under the Agricultural Programme Loan (APL), the Asian Development Bank imposed a condition requiring Pakistan to enact a plant variety protection law. The National Seed Registration Department was assigned the responsibility to do this. A draft of the Plant Variety Protection Act (PVPA) was prepared and submitted to the National Seed Council (NSC). The NSC wanted to obtain opinions from the provinces and other concerned quarters. Hence the draft was circulated to all the provincial governments, provincial and federal agricultural research institutes, provincial seed corporations, quality control agencies, planning and finance divisions.

The draft PVPA was revised and amended taking into consideration the comments received. It was then submitted to the NSC. On 11 April 1994, NSC further discussed some of the draft clauses with the provincial governments and created a committee comprising the Director General of the Federal Seed Certification Department and the Director of the National Seed Registration Department. The committee had detailed discussions with the provincial authorities and then finalised the draft.

All the agencies have endorsed the views that the PVPA will stimulate investments in the seed industry and that this will help boost quality seed production in the country. The provisions of the PVPA are summarised in Box 9.

BOX 9: Pakistan's Plant Variety Protection Act

The Pakistan Plant Variety Protection Act has a number of features. These are described below.

Conditions

A Certificate of Plant Variety Protection shall be granted to the breeder of any sexually or asexually propagated plant variety which is (1) novel, (2) distinct, (3) uniform, (4) stable and (5) designated by an acceptable denomination.

A variety shall be considered novel unless it has been sold or marketed, with the agreement of the applicant, for more than one year in Pakistan and more than 4 years in origin countries in the case of agricultural crops and more than 6 years in the case of trees or vines before the filing of the application.

An acceptable denomination shall be destined to be the generic designation of the variety and must enable the variety to be identified. It must not be liable to mislead or to cause confusion concerning the characteristics, value or identify of the variety or the identify of its breeder.

Species to which this Act is applicable. This Act shall apply to all sexually and asexually (vegetatively) propagated plant species, except micro-organisms.

Joint breeders

When two or more persons have jointly bred a variety for which protection is sought, they shall be considered joint breeders.

Filing the application

An application for the Certificate of Plant Variety Protection shall be filed by the owner of a variety for which protection is sought or the legal representative of the owner.

Examination of the application

The examination shall be conducted to establish a definitive description of the candidate variety and to determine if all requirements of this Act have been satisfied and, if so, a Certificate shall be issued.

Testing of varieties

The examination shall be conducted, in so far as the characteristics of the variety under examination are concerned, primarily on the basis of scientific information and data supplied by or on behalf of the applicant.

Issuance

A Certificate of Plant Variety Protection shall be issued in the name of the Islamic Republic of Pakistan and shall be signed by the Director of the Director Plant Variety Protection Office.

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BOX 9: Pakistan's Plant Variety Protection Act

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Ownership rights

Each Certificate of Plant Variety Protection shall certify that its owner has the right to exclude others from multiplying or importing and selling the reproductive or vegetative propagating material of the protected variety or offering it for sale.

The terms of the Certificate of Plant Variety Protection

The terms of the Certificate of Plant Variety Protection shall be 18 years in the case of trees and vines and 15 years in the case of all other plants.

Crop exemption

It shall not be an infringement of a person whose primary occupation is farming to save and propagate for his own use seed lawfully obtained from the owner of the variety, provided such propagated seed is not commercially marketed.

Exemption for scientific research

The use of a protected variety for plant breeding or other scientific research shall not constitute an infringement unless it is used for commercial production of F1 hybrids.

Remedy for infringement

The owner of a protected variety shall have a remedy by the way of a civil action in a court for infringement of the Certificate of Plant Protection. The burden of proving infringement shall lie with the owner of the Certificate.

Fees-setting and collection

The Director of the Plant Variety Protection Office shall be authorised to set and collect fees for the implementation of the Act, including services rendered to applicants and the public.

Appeals

Any person affected by a decision of the Director of the Plant Variety Protection Office to decline to issue a Certificate or to cancel a Certificate or to declare it null and void may, within a month after being given notice of that decision by the Director, appeal to the Secretary for Food and Agriculture.

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