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CONSERVATION AND UTILIZATION OF PLANT GENETIC RESOURCES

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Introduction

Success of crop improvement programs depends upon the availability of sufficient genetic variability for the traits of interest of the plant breeders, based on the needs expressed by the farmers and the market and consumer needs. Since the Green Revolution in the 70s and 80s, cultivation of genetically uniform high-yielding crop varieties has replaced the heterogeneous landraces in the farmer fields, and has led to genetic erosion. Further, narrow genetic base of most of the crop cultivars and emergence of new insect-pest and diseases due to the changing climatic conditions poses serious threat to global food security due to genetic vulnerability (Larsson, 2001).

Role of Plant Genetic Resources

Plant genetic resources exhibit significant genetic diversity and provide many useful genes/alleles needed for developing new high-yielding cultivars with a broad genetic base, thus play a crucial role in achieving the global objective of food security, poverty alleviation and sustaining agriculture and environment in the future.

History of Germplasm Collection

Over the years, more than 7.4 million germplasm accessions of different crops have been conserved in over 1750 gene banks worldwide. The RS Paroda gene bank at ICRISAT-Patancheru, India holds over 122,900 germplasm accessions of five mandate crops (chickpea, pigeonpea, groundnut, sorghum and pearl millet) and six small millets (finger millet, foxtail millet, proso millet, little millet, kodo millet and barnyard millet) from 144 countries. The collection offers insurance against genetic erosion and provides new and diverse sources of variation for biotic and abiotic stresses as well as for agronomic and nutrition related traits.

Over 96% accessions have been characterized for morpho-agronomic traits and are being conserved following the international standards under medium- (4°C) and long- (-20°C) term conditions. Besides this, 108,352 germplasm accessions have been safely duplicated at the Svalbard Global Seed Vault, Norway. Since 1975, about 1.41 million seed samples have been distributed to researchers in 147 countries through standard material transfer agreements (SMTA) of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

Conservation of germplasm

Conservation refers to protection of genetic diversity of crop plants from genetic erosion. There are two important methods of germplasm conservation or preservation viz. 1) In situ conservation, and 2) Ex situ conservation. These are described below:

1) In – situ Conservation: Conservation of germplasm under natural habitat is referred to as in situ conservation. It requires establishment of natural or biosphere reserve, national parks for protection of endangered areas or species. In this method of conservation, the wild species and the complete natural or semi natural ecosystem are preserved together. This method of preservation has following main disadvantages.

1. Each protected area will cover only very small portion of total diversity of a crop species, hence several areas will have to be conserved for a single species.
2. The management of such areas also posses several problems.
3. This is a costly method of germplasm conservation.

2) Ex – Situ Conservation:

It refers to preservation of germplasm in gene banks. This is the most practical method of germplasm conservation. This method has following three advantages:

1. It is possible to preserve entire genetic diversity of a crop species at one place.
2. Handling of germplasm is also easy.
3. This is a cheap method of germplasm conservation.

The germplasm is conserved either 1) In the form of seed or 2) In the form of meristem cultures. Preservation in the form of seed is most common and easy method. Seed conservation is relatively safe, requires minimum space (except coconut, etc) and easy to maintain. Glass, tin or plastic containers are used for preservation and storage of seeds. The seeds can be conserved under long term (50 to 100 years), medium term (10-15 years) and short term (3-5 years) storage condition. Roberts (1973) has classified seeds into two groups for storage purpose, viz. 1) orthodox and 2) Recalcitrant.

1. Orthodox seeds:

Seeds which can be dried to low moisture content and stored at low temperature without losing their viability are known as orthodox seeds (Bonner, 1994). This group includes seeds of corn, wheat, rice, carrot, beets, papaya, pepper, chickpea, lentil, soybean, cotton, sunflower, various beans and egg plant. These seeds can be dried and stored at low temperatures for long periods of time.

2. Recalcitrant seeds:

Seeds which show very drastic loss in viability with a degree in moisture content below 12 to 13% are known as recalcitrant seeds. This group includes cocoa, coconut, mango, tea, coffee, rubber, jackfruit and oil palm seeds. Such seeds cannot be conserved in seed banks and therefore, require in situ conservation. Crop species with recalcitrant seeds are conserved in field gene banks which are simply areas of land in which collections of growing plants are assembled.

Utilization of Germplasm

Though a large number of accessions having enormous genetic variability are conserved in the gene banks globally, less than 1% germplasm has been utilized in the crop improvement programs. This is mainly due to the lack of reliable information available for important traits in some of these large sized germplasm collections (collections as large as 1,10,000). At present, in ICRISAT, the major focus is to enhance the utilization of germplasm in crop improvement.

Development of small-sized subsets such as mini core collections (1% of the entire collection) has provided an entry point for crop scientists to utilize these resources in crop improvement. Evaluation of mini core collections across multi-locations have resulted in identification of accessions with desirable traits including tolerance/resistance to abiotic (drought, water-logging, heat, low temperature, and salinity) and biotic stresses (diseases and insect pests) and for nutritional quality traits (oil, protein, Oleic/Linoleic ratio). The mini core collections are also being evaluated across multi-locations in collaboration with NARS partners and in all, 224 mini core sets of mandate crops have been supplied to the researchers in 34 countries. Using mini core collections, scientists at ICRISAT and NARS have identified genetically diverse multiple trait germplasm with desirable agronomic characteristics in chickpea and groundnut meeting the needs of breeders of these crops.

Future Prospects

To enhance the utilization of wild relatives, pre-breeding activities are in progress to develop new gene pools with high frequency of useful genes, wider adaptability, and a broad genetic base. Wild relatives are being utilized to introgress genes/alleles conferring high levels of resistance/tolerance against important biotic/abiotic stresses into cultivated genetic background. These activities will ensure the continuous supply of useful genetic variation in the readily usable form for use by the breeders to develop new cultivars with a broad genetic base. Using TxAG6, an amphiploid (low yielding, 8 g 100 seeds^{-1}) in groundnut, scientists at ICRISAT have developed high-yielding Spanish breeding lines with remarkable large seed size (>130 g 100 seeds^{-1}) compared to 30-35 g 100 seeds^{-1} of cultivated parent, TMV 2. Further, in recent years, vast genomic resources such as *BAC libraries, ESTs, SSRs, DArT clones,* and *SNPs* have been developed which will increase the efficiency and effectiveness of identifying new sources of genetic variations in these vast collections.

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