Introduction to genebanks

Aim of the module

At the end of the module, we should be able to:

- Describe the different types of genebanks;
- Explain the role and functions of genebanks in the management of PGRFA;
- Explain what genebanks can offer to breeders;
- Summarize the considerations in planning a collecting mission; and
- Discuss the essentials of genebank management;

What are genebanks?

- Physical facilities for maintaining collections of live plant materials
  - domesticated cultivated plants
  - wild plant species (crop wild relatives and other wild plant species useful for food and agriculture and other end uses)
  - entire plants, seeds, pollen, embryos, meristems, cells, or DNA, depending on the biology of the species
- Store, maintain and reproduce living samples of PGRFA
- Holdings are obtained through
  - collecting from farms and the natural habitats
  - germplasm exchange with other collection holders
- Genebanks thus ensure that PGRFA are both secure in the long term and are made available for use by farmers, plant breeders and researchers
- Globally, about 7.2 millions accessions in over 1700 genebanks

What are genebanks?

- Maintaining PGRFA in genebanks is often termed ‘ex situ conservation’
  - defined as ‘the conservation of components of biodiversity outside their natural habitats’ (CBD, 1992).
- Whereas in situ conservation is maintenance of viable population in their natural surroundings
  - a dynamic system which allows the biological resources to evolve and change over time through natural selection processes
- Both concepts are therefore fundamentally different but are complementary

What are genebanks?

- Genebanks therefore are managed so as to:
- Maintain the genetic integrity of its accessions
- Make the accessions easily available to users of germplasm
- Provide the raw material for plant breeding and basic biological research
  - Accessions of crop wild relatives are particularly valuable as sources of gene providers
- Provide germplasm for restoration of lost crops after natural or man-made catastrophes

Genebanks – in brief

The main activities in the development and management of a genebank include:

- Collecting and Acquisition – assembling the collection
- Processing – assessing the quantity, viability, health of samples and preparation for storage
- Storage – in a cold store, laboratory or in the field
- Regeneration and Multiplication – periodically rejuvenating and increasing the material
- Characterization and Evaluation
- Documentation, Inventory – maintaining and making available detailed records on each sample
- Distribution – of clean, disease-free seeds, or other planting material, to requestors

Genebanks – in brief

Beyond the routine genebank operations:

- Carry out of research activities
- capacity building
- Engage in policy discussions
- Raise awareness among stakeholders including policy makers, breeders, researchers, farmers and public in general

Types of genebanks

- Seed genebanks
- Field genebanks
- Botanic gardens
  - over 2,500, in 148 countries, with about 6.13 million accessions
- In vitro storage
  - slow growth
  - synthetic seed technique, which aims to use somatic embryos as true seeds by encapsulating embryos in alginate gel
- Cryopreservation
  - Storage of living tissues at extremely low temperatures, usually at -196°C in liquid nitrogen
- Pollen storage
  - Limited usage on account of low viability in storage
- DNA bank

Planning & Implementing Collecting Missions

Historical antecedents

- Plant collecting goes back in time for millennia
  - Early civilizations in the Andes, India, Africa, China, and Egypt gathered and exchanged plant germplasm.
  - Pharaohs of ancient Egypt, as early as 2000 BC, brought back exotic trees and plants from their foreign campaigns and illustrated them on their temple walls
  - About 3,500 years ago Queen Hashetput of Egypt dispatched a collecting mission to Punt to collect Frankincense trees.
  - Emperor Chen–Tsung introduced Champa varieties of rice from Vietnam to China a thousand years ago.

Planning & Implementing Collecting Missions

Historical antecedents

- More recently, in the 1920s and 1930s, the worldwide collecting missions of Nikolai I. Vavilov
  - His work motivated an international movement to collect and conserve PGRFA
- In 1967, a Technical Conference on the Exploration, Utilization and Conservation of Plant Genetic Resources
- In 1974, the International Board for Plant Genetic Resources (IBPGR) (now Bioversity International) was established,
- But gaps still exist even for the major crops

Planning of collecting missions

The technical planning of the mission

- **What** should be collected and in what form?
- **Why** should it be collected?
  - Rescue Collecting;
  - Immediate Use;
  - Gap Filling;
  - Research Purposes; and
  - Opportunistic Reasons.
- **Where** should it be collected from?
- **When** should it be collected?

Planning of collecting missions

- 2nd aspect is the **how**:
  - Who are the partners in collecting mission?
  - Who would be part of the collecting team?
  - What is the itinerary to follow?
  - How long will the mission last, i.e its duration?
  - What kind of transport is needed?
  - What equipment will be required?
  - What permits are required and when?
- Additionally, a collecting proposal
  - A collecting mission will require funding from the partners and other donors.

Genebank Management

Day to day management of a genebank is must ensure that:

- the materials are safely maintained at high standards in the most cost effective and efficient manner.
- collections are properly organized and managed in such a way as to facilitate their use by potential users, especially breeders.
- the ultimate objective in managing a germplasm collection is to encourage use of the accessions to promote food security and sustainable production.

Genebank Management

Organized based on the purpose

- **Base collection**
  - Defined as a set of accessions, each of which should be distinct and, in terms of genetic integrity, as close as possible to the sample provided originally, a term often referred to as "Most Original Sample".
  - Preserved for the long-term future (50-100 years) under a storage condition of -18°C or cooler and 3-7% seed moisture content (depending on species)
  - Purely for conservation purposes – so, seeds from the base collection are not distributed directly to users.

Genebank Management

Organized based on the purpose

- **Active collection** – this comprise a collection of accessions maintained at least for medium-term viability (about 30 years),
  - Usually stored at temperatures of 4°C and 3-7% seed moisture content.
  - Immediately available for multiplication and distribution
  - Unlike the base collection, an active collection is more dynamic, i.e. the inventory can fluctuate widely at any given time as the collection is used and regenerated.

Genebank Management

Core collections

- *a subset of a large germplasm collection, containing selected accessions that capture most of the genetic variability in the entire collection*
- Should be no more than 10% of the whole collection, but in practice, usually between 5% and 20%
- Thus, developing a core collection improves the management and utilization of a germplasm collection
- E.g. potato core collection at CIP
- Strategy drastically reduced no. of accessions maintained in field genebank and those safety duplicated *in vitro*

Genebank management objectives

4 main conservation objectives:

- Ensuring security and efficiency
- Maintaining genetic integrity
- Ensuring availability
- Providing information

Genebank management objectives

Ensuring security and efficiency

- Security in terms of the genebank structure and safety of its germplasm
- Safely duplicated in at least one other location,
- Buildings must meet standards
- Emergency electrical generator; back up
- A contingency plan
- Trained genebank staff
- A full risk assessment
- Maintenance of the viability of accessions

Genebank management objectives

Maintaining genetic integrity - Regeneration

- Regeneration is the renewal of germplasm accessions by sowing and harvesting seeds or plant propagules that possess the same characteristics as the original sample
- Considerations
  - Sample size
  - Preparation of planting materials
  - Maintenance of effective population size
  - Choice of environment
  - Isolation
  - Crop management
  - Monitoring accession
  - Harvesting
  - Common pests and diseases

Genebank management objectives

Ensuring availability

- Ability of genebanks to supply and distribute the stored germplasm, together with any associated information, to users.
- Aspects that can affect the availability include:
  - policies,
  - number of seeds,
  - health status of accessions, and
  - distribution quantity.
- Genebanks should keep adequate amounts of seeds of each accession for:
  - supply to requestors,
  - to monitor the viability and
  - For regeneration.

Genebank management objectives

Providing Information

Genebanks must ensure that distributed accessions are accompanied by relevant information e.g.:

- passport data,
- collection data, and
- information about the characterization and evaluation (if any)

Genebanks should therefore have an effective data management system that allows collation, retrieval and dissemination of information

Genebank Learning Resources

Crop Genebank Knowledge Base

http://cropgenebank.sgrp.cgiar.org/