# Gene Bank Management for *Ex Situ* Conservation of Germplasm

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Plant genetic resources (PGR) for food and agriculture form the centre-stone of all crop improvement programmes. The utilization of the temporally and spatially distributed genetic resources is facilitated through the gene banks, which act as unique archives of this global wealth. It is the safety deposit for the rapidly depleting biodiversity, with more than 75% of the crop genetic diversity already lost. Conscious efforts to collect and conserve these genetic resources have been initiated in the previous century and it is being carried forward by various stakeholders including farmers, breeders and researchers. Out of the various options available for preserving these resources, the *ex-situ* conservation approach has been proven to be the most cost effective and viable technique, for orthodox seeds. The *ex-situ* resources are currently held in about 1750 gene banks, out of which 130 gene banks hold more than 100,000 accessions. According to the international gene bank databases available in public domain, the four largest gene banks at national level are

I. National Centre for Genetic Resources Preservation (NCGRP) in the United States of America
II. National Bureau of Plant Genetic Resources (ICAR-NBPGR) in India.
III. Institute of Crop Germplasm Resources, Chinese Academy of Agricultural Sciences (ICGR-CAAS). in China and
IV. NI Vavilov All Russian Scientific Research Institute of Plant Industry (VIR) at Russian Federation.

The apex organizations for global *ex-situ* conservation are the gene banks of International Agricultural Research Centres (IARCs) of the Consultative Group on International Agricultural Research (CGIAR Centres or CG centres). In 1994, based on the signed agreement with FAO, the CG gene banks started conservation of these genetic resources as 'in trust' material. This arrangement was made to streamline the global flow of genetic resources. The distribution of these genetic resources is bound by the existing legal regime that governs global exchange of plant genetic resources and the CG centres have no intellectual property rights over the germplasm collection. In addition to these international gene banks, the Svalbard Global Seed Vault (SGSV) was established in 2008, by the Government of Norway, Nordic Genetic Resources Centre (NorGen) and Global Crop Diversity Trust (GCDT). The SGSV is a safety vault for the international conservation system of plant genetic resources. Its relevance has been best highlighted when the ICARDA gene bank was totally destroyed during the West Asian political disturbance and had to be reconstructed at an alternate location. The safety duplicates of ICARDA collection conserved at SGSV was utilized for regeneration of the entire ICARDA germplasm accessions.

India is a major contributor to the wealth of plant genetic resources. The Indian Gene centre is one of the 12 mega diversity centers of the world and it has Eastern Himalayas, Western Ghats, Indo- Burma and Sundaland (Nicobar Islands) regions as four 'biodiversity hotspots' out of 34 spread around the world. The PGR activities in India were initially executed by the Division of Plant Introduction at Indian Agricultural Research Institute (IARI), New Delhi, under the aegis of the Indian Council of Agricultural Research. This was later upgraded as the National Bureau of Plant Genetic Resources in 1976. And in 1985-86, the National Gene Bank (NGB) was functionalized in NBPGR, with the major mandate of *ex situ* conservation. Currently the NGB holds 435072 accessions belonging to 1762 species (Table 1). The collection includes genetic stocks, elite lines, wild relatives, breeding lines, varieties, landraces, primitive cultivars etc. The Genebank functions through a comprehensive management system which is complemented by the 10 regional stations of NBPGR and the 59 National Active Germplasm Sites (NAGS). The NAGS are based at the crop based institutes and are

responsible for multiplication, evaluation and conservation of active collections and their distribution to users.

The major components of the National Genebank include the seed genebank, field genebank, cryo-bank and the *in vitro* genebank. The focus of seed genebank of NGB is long term conservation of orthodox seeds. This begins with the receipt of freshly harvested, physically pure seed at the Germplasm Handling Unit (Germplasm Acquisition). The subsequent flow of germplasm is elaborated in Fig 1. On receipt of any sample in NGB, the basic parameters that are assessed for conservation are-

i) Uniqueness of the accession- Redundancy is a major issue in all gene banks and best efforts are made to avoid duplication of accessions.
ii) Seed quality- The global gene bank standards recommends a minimum of 2000 seeds in self pollinated crops and 4000 seeds in cross pollinated crops. In wild germplasm accessions, the minimum number has been relaxed to 500 seeds.
iii) Seed viability - A minimum viability of 85% is essential for seed samples. However in those cases where the Indian Minimum Seed Certification Standards have approved a lower level of standard germination, the viability requirements are accordingly modified in gene bank also.
iv) Seed health- Pest free conservation is a priority at NGB. There is a strong collaboration between the Division of Germplasm Conservation and Division of Plant Quarantine, wherein all accessions are tested for any form of pest infestation prior to their processing.
v) Availability of passport information- The utilization of the conserved accessions can be facilitated only if all relevant passport information is available in the database. Hence, only those accessions having basic information on parameters like biological status, collection details if acquired through exploration, pedigree details if it's a breeding line/genetic stock or cultivar and any other unique trait if applicable, is accepted for long term conservation

The qualified accessions are then subjected to drying, which is the most crucial step in genebank processing. A walk-in-drying chamber functioning at 15% RH and 15$^{o}$C is used for the drying purpose. For species with hard seed coats and which require longer drying duration are shifted to batch dryers, after preliminary drying in chamber. The standard moisture testing method used in gene banks is the hot-air oven method and the procedure recommended for each crop by the International Seed Testing Association is duly followed. Once the desirable moisture is achieved (as mentioned below), the seeds are packed in aluminum foil packets. They have the advantage that they can be resealed and also occupy less space than other containers.

Conservation of genetic resources is carried out through two types of collections:

a. Collection of seed samples for long term conservation, which is known as base collection. Base collections are maintained at $^{-}$18 to - 20$^{0}$C, to ensure seed viability for maximum possible time period. The moisture content of seed to be stored as base collections should be between 3% and 7% depending on the species.
b. Collection of seed samples for immediate use, termed as active collection. Active collection are maintained in conditions that ensure at least 65% viability for 10-20 years. The moisture content of seeds to be stored as active collections should be between 3% and 8% for seeds having poor storability and between 7% and 11% for seeds having good storability, depending on the temperature used for storage.

These collections are conserved in different types of storage facilities. Depending on the duration of storage, three basic types of storages are recognized-

a. Short term storage - The period for short term storage of seeds is from one year upto 18 months. It requires a cool and dry atmosphere (20-220C and 45-50% RH) where the seeds can be conveniently stored for one to two years without much loss in their viability.
b. Medium term storage - The active collection, which are generally larger than those meant for base collection are conserved in the medium term storage. The accessions are for regular distribution and therefore the time period for storage is not more than 5 yrs. The active collections are stored at temperatures ranging from 0-10$^0$C and relative humidity of 20-30%.
c. Long term storage – This is the storage facility for base collection, where the seeds that meet all the above mentioned criteria for NGB conservation are maintained at $^-$18 to - 20$^0$C.

The *ex-situ* gene bank at NBPGR comprises 12 long term modules holding the base collection. The active collections are distributed in 22 medium term modules maintained at 4$^0$C for storing germplasm at active sites. The genebank is going to be upgraded with new infrastructure during the forthcoming years and all efforts are being taken to bring the NGB to global standards.

**Table 1- Status of Base Collections at NGB (as on 31 January, 2018)**

| Crop/Crop Group | Accessions conserved |
|---|---|
| **Cereals** | 161897 |
| **Millets** | 58443 |
| **Forages** | 6930 |
| **Pseudocereals** | 7295 |
| **Legumes** | 65675 |
| **Oilseeds** | 58574 |
| **Fibre** | 15586 |
| **Vegetables** | 26077 |
| **Fruits and Nuts** | 273 |
| **Medicinal and Aromatic plants** | 7947 |
| **Ornamental** | 653 |
| **Spices and Condiments** | 3074 |
| **Agroforestry** | 1642 |
| **Duplicate safety Samples** | 10235 |
| **Trial Material (Wheat, Barley)** | 10771 |
| **Total** | 435072 |

**References**

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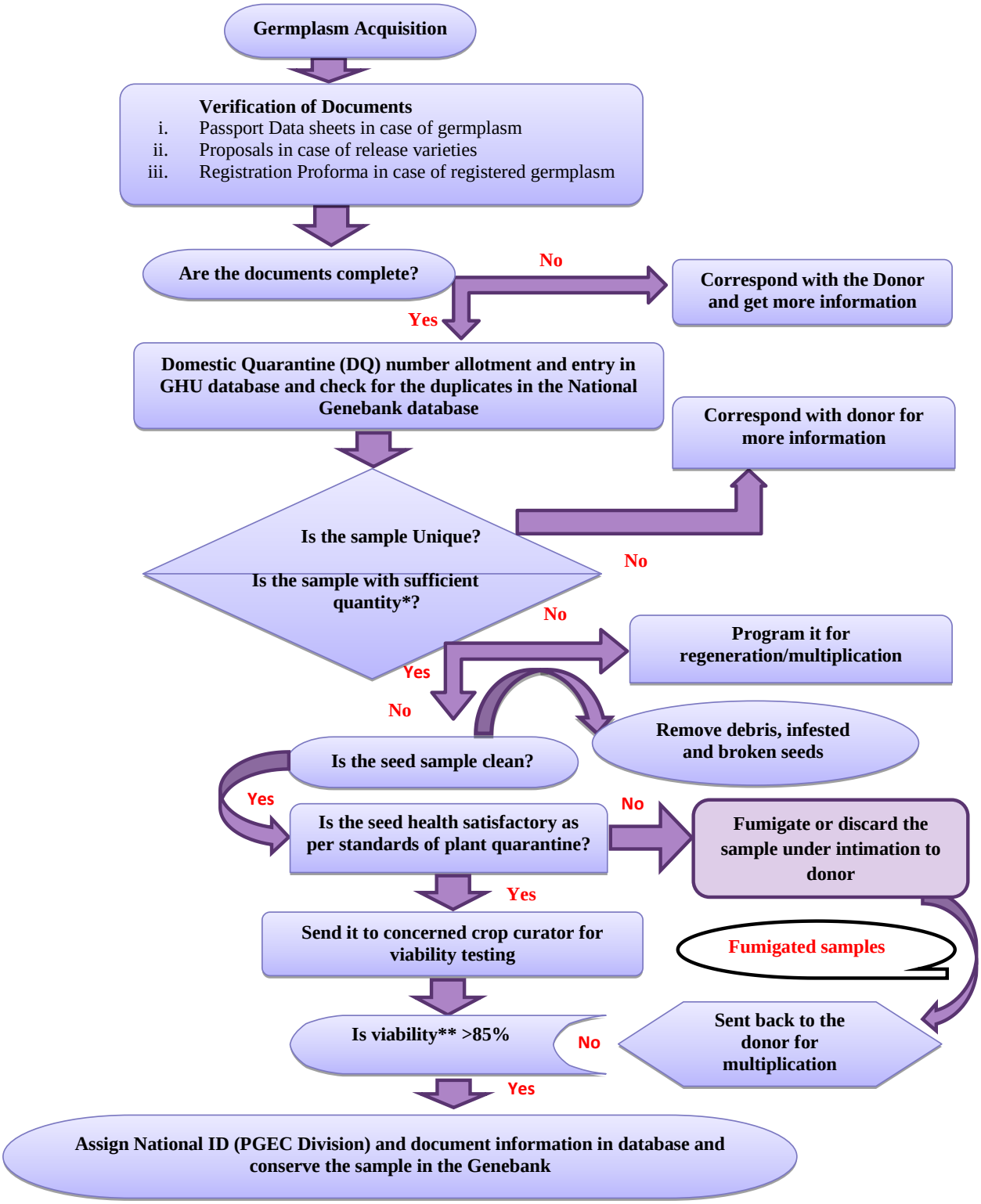
**Fig.1 Flow of germplasm for seed conservation**




* Self-pollinated (>2000), Cross-pollinated (>4000) and wild (>500)

** Viability relaxation for wild species in Vegetable/Medicinal/Rare endangered /forage species (50-70%)