Seed quality of genetic resources at ICRISAT

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Introduction

- Plant Genetic Resources (PGR) are the most important components of biodiversity.
- The Rajendra S Paroda Genebank at ICRISAT conserves over 114,800 accessions of sorghum, pearl millet, chickpea, pigeonpea, groundnut and six small millets (finger millet, foxtail millet, little millet, kodo millet, proso millet, and barnyard millet) from 130 countries.
- Maintaining seed quality of such a large collection requires careful planning and standard protocols for seed production and storage.
- Majority of the accessions are orthodox seed producing lines. Only a few wild species are vegetatively propagated. Seed quality plays a major role in seedling establishment, crop growth and production, and genetic conservation.
- Several pre- and post-harvest factors such as crop management, seed production environment, maturity, harvesting, cleaning and drying practices influence initial seed quality and its subsequent longevity.

Materials and methods

International Genebank Standards (FAO/IPGRI 1994) are followed to maintain seed quality of the conserved germplasm:

Conservation of germplasm

- Active collections are stored in standard aluminum cans (medium-term storage up to 25 years) at 4°C and 30% RH and supplied to scientists for research and training (Figure 1).
- Base collections are stored at –20°C in vacuum packed standard aluminum foil pouches at 3–7% seed moisture (long-term storage up to 70 years) for safety and posterity.

Regeneration of germplasm

- Deterioration of seed in storage necessitates regular regeneration of accessions, which is expensive and involves risk to genetic integrity.
- Germplasm regeneration at ICRISAT is mainly carried out in the postrainy season.
- Genetic integrity in sorghum and in pearl millet accessions is maintained by selfing using paper bags (Figure 2) and in pigeonpea, by growing plants in pollination cages (Figure 3).
- Chickpea fields for regeneration are solarized with polythene sheets during hot summer (6 weeks) to control soil borne diseases, particularly the fusarium wilt.

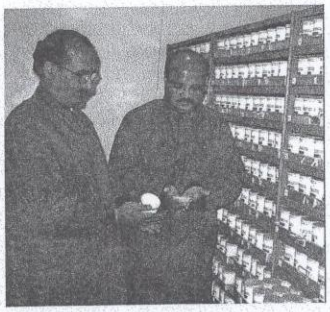


Figure 1. The Rajendra S Paroda Genebank, ICRISAT – a source for unrestricted availability of crop diversity for improvement

Figure 2. Regeneration in cross-pollinated crops-sorghum (left) and pearl millet (right) using bags.

Harvesting and drying

- Harvesting, threshing/shelling are done manually to avoid admixtures and mechanical injuries to seed. Clean seed transferred immediately to cold rooms avoids loss of seed quality.
- Sorghum and millet seeds are cleaned using a blower. Chickpea, pigeonpea, and groundnut seeds are cleaned manually through winnowing.
- Standard sieves are used to obtain seeds of good quality.

Seed moisture testing

- A low-constant temperature oven-drying method (103°C for 16 hours) for groundnut and a high-constant temperature oven-drying method (130°C for 1–2 hours) for sorghum, millets, chickpea and pigeonpea follow the International Seed Testing Association (ISTA) procedures.

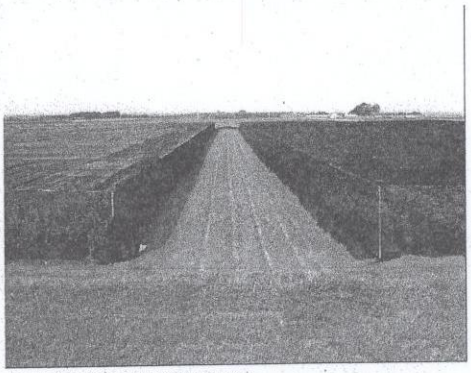


Figure 3. Regeneration in pigeonpea under cages.

Seed drying

Seed longevity depends upon crop species, the initial quality of the seed, the moisture content to which seeds have been dried and the temperature at which they are stored.

- A walk-in seed-drying room with 15°C and 15% RH (Figure 4) is used for drying germplasm seed and the seeds of different crops with initial moisture content of 8.6 to 11.9% safely dried to 3.4 to 5.8% within four weeks for long-term conservation (Sastry *et al.* 2003).
- Desiccation injury is rare in orthodox seeds and reducing seed moisture content to lower than 5% has proved to be a promising technique for reducing cost of regeneration.

Figure 4. Inside view of seed-drying room.

Seed health testing

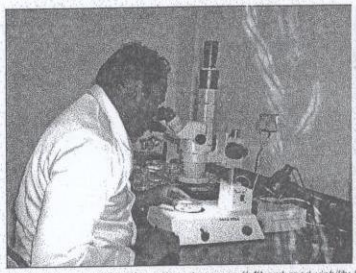
- Germplasm seed health testing is carried out on all accessions meant for storage, and accessions with significant infestation levels are identified for next regeneration.
- A blotter test for all samples and an agar test for a specific pathogen by incubation at 22°C near ultra violet (NUV) light for 7 days, and microscopic examination of individual seed for detecting seed associated microorganisms (Figure 5).

Seed viability testing

- The standard germination test is used to measure the seed quality.
- Seedlings are evaluated and classified as (i) normal, which are capable of developing into plants given favorable conditions, and (ii) abnormal, which are incapable of further development, suffer deficiency, decay or weakness (Figure 5).
- General guidelines and specific advice on the conduct of germination and appropriate dormancy breaking procedures are followed (Ellis *et al.* 1985).
- Mean viability in the baseline viability tests on active collections conserved for 3 to 27 years in the ICRISAT genebank ranged between 87.5% and 97.7% and the mean of all accessions (109,849) is 94.6%, which is well above the minimum standards (85%) for active collections (Table 1).
- The viability of seeds stored in a genebank decreases gradually. Genebank accessions (active and base collections) are monitored regularly. The period varies (3-20 years) depending on storage conditions, the crop and the initial seed quality.

Table 1. Seed viability of active collection conserved at ICRISAT Genebank

Crop	Number of accessions tested	Mean viability (%)
Sorghum	36,591	95.0
Pearl millet	20,770	93.4
Chickpea	16,974	96.1
Pigeonpea	12,786	95.0
Groundnut	13,489	97.7
Finger millet	5,010	96.2
Foxtail millet	1,535	97.5
Proso millet	833	96.2
Little millet	464	95.3
Kodo millet	658	95.1
Barnyard millet	739	93.4
Total	109,849	94.6



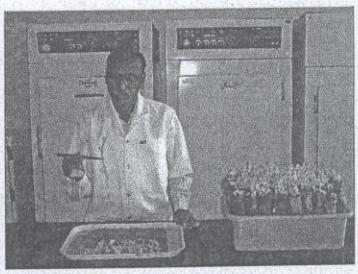


Figure 5. Seed health testing under microscope (left) and seed viability testing – evaluating seedlings (right).

Conclusions

- The *ex situ* collection of ICRISAT has been maintained at preferred genebank standards for present and future use of humankind.
- Core collection (10% of entire collection) and mini core collection (10% of core and 1% of entire collection) are conserved and supplied to researchers.
- Germplasm conserved at ICRISAT genebank has become an important source of diversity available to researchers in both public and private sectors throughout the world.
- Sixty-six germplasm accessions of different crops have been released directly as cultivars in 44 countries contributing to food security. Vast numbers of germplasm accessions have been used as building blocks for numerous varieties and hybrids cultivated in many parts of the world.

References

Ellis RH, Hong TD and **Roberts EH.** 1985. Hand Book of Seed Technology for Genebanks. Volume II. Compendium of Specific Germination and Test Recommendations. Rome, Italy: International Board for Plant Genetic Resources. Pages 211–607.

Food and Agricultural Organization of the United Nations/International Plant Genetic Resources Institute. 1994. Genebank Standards. 13 pp.

Sastry DVSSR, Kameswara Rao N and **Bramel PJ.** 2003. Seed drying under controlled environment for long-term conservation of germplasm. Seed Research 31(2):148–153.

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