FAO Genebank Standards (draft) : overview, comments and concerns with respect of WG's specific Quality System elements

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I .Introduction

The Commission on GRFA has agreed on the need for revision of the FAO/IPGRI Genebank Standards (GBSt) published in 1994 and requested FAO to undertake the review.

FAO in cooperation with the International Treaty, the CGIAR and other relevant international institutions, within intergovernmental TWG on PGRFA reviewed and finalized both sets of GBSt (GBSt for the Conservation of Orthodox Seeds and germplasm not covered by them) (XIII Regular Session of Commission).

I .Introduction

The revision requested by the CGRFA resulted mainly in policy developments and advances in science and seed storage technology, biotechnology, communication technology.

- **Convention on Biological Diversity (2010 Nagoya Protocol),**
- **InternationalTreaty on Plant Genetic Resources (ITPGRFA),**
- **International Plant Protection Convention (IPPC)**
- **WTO Sanitary and Phytosanitary Agreement (WTO/SPS)**

SCOPE of DRAFT GENEBANK STANDARDS of PGRFA

The Draft GBSt for PGRFA comprise the standards for conservation of

- **orthodox seeds,**
- **non-orthodox seeds and**
- **vegetatively propagated plants**

(GBSt cover field genebanks and in vitro/cryopreservation genebanks, which conserve plants that produce non-orthodox seeds (also known as recalcitrant).

AEGIS Quality Management System (AQUAS)

Set of policies, processes and procedures that are followed by all AEGIS members to assure an appropriate quality of the activities in the virtual European genebank system (AEGIS).

AEGIS Quality Management System = AQUAS

AQUAS elements:

a) operational framework
b) technical elements
c) capacity building
d) oversight mechanism.

AQUAS (AEGIS Quality System) -Technical elements -

(after J. Engels and L.Maggioni, Second Meeting of the Working Group on *Vitis,* 18-20 September 2012, Institut für Rebenzüchtung, Geilweilerhof, Siebeldingen, Germany

1. **Operational** – all AEGIS Associate Members; based on **genebank template** (template finalized – AEGIS Web site; so far three manuals received)

2. **Generic operational standards – Secretariat (cooperation with FAO**; inputs into draft also by ECPGR members; discussed at Commission in July 2011; standards for non-orthodox species on field genebank and *in vitro/cryopreservation drafted* **(more details later)**

3. **Agreed minimum crop-specific technical standards** – all WGs (complementing generic standards, when necessary)
4. **Quality management system procedures** – Secretariat; all WGs; Associate Members **(still to be developed)**:
    a. record keeping
    b. reporting
    c. monitoring (not policing, but guiding and advisory approach)

DRAFT REVISED GBSt's FOR THE CONSERVATION OF ORTHODOX SEEDS
- Generic operational standards (FAO document) -

- The Draft Revised GBSt - **one set of standards16; unlike the two-level** approach of the previous Genebank Standards which contained *„preferred"* and *„acceptable"* standards;

- The standards are **voluntary and nonbinding;**

- The Draft Revised GBSt; **a guideline for genebanks conserving orthodox seed collections; not be used uncritically; continuous technological advances** in conservation methods; much of it species-specific, as well as in the context of the purpose and period of germplasm conservation and use;

- IT takes into account the **changes in ex situ conservation conditions, diversity in storage requirements, purpose and period of germplasm conservation, ranging from** temperate to tropical provenances.

UNDERLYING PRINCIPLES

Underlying principles explain why and for what purpose plant genetic resources are being conserved (major) are described :

Identity of accessions - Proper identification of seed samples conserved in GBs requires careful documentation of data and information about the material (passport data, herbarium voucher specimen/seed reference collection, proper labeling in field GBs, modern techniques)

Maintenance of viability - Maintaining viability, genetic integrity and quality of seed samples in genebanks **need** particular attention to be paid to standards on germplasm acquisition, processing and storage (high viabiliy at storage, check viability at appropriate intervals depending on expected seed longevity)

Maintenance of genetic integrity - All genebank processes, starting from collection and acquisition, through to storage, regeneration and distribution, are important for the maintenance of genetic integrity..

Maintenance of germplasm health - GBs should strive to ensure that the seeds they are conserving and distributing are free from seed-borne diseases and regulated pests; relevant import and PSCs accompany seed material when exchange of germplasm takes place to ensure the health status of samples received.

Physical security of collections – Adequate security systems are also required to ensure that genebank cooling equipment as well as backup generators and equipment to control power outage are in good running condition and monitoring.; safely duplicated in other locations

Availability and use of germplasm - the GBs should have a strategy in place to quickly multiply any germplasm for distribution (need to maintain sufficient quantities of seed)

Availability of information - Access, availability and sharing of this information should be treated with high priority, as it leads to better and more rational conservation (EURISCO, SID of MSB of Kew, BRAHMS)

Proactive management of genebanks – at all levels (using SMTA for crops under MS of ITPGRFA)

STANDARDS – Structure and Definitions

The Standards define the level of performance of a GB operation routine where is a high risk of losing genetic integrity (a probability of 5.0% or > of losing an allele in an accession over the storage period).

Each section is divided into:

A. Standards
B. Context
C. Technical aspects
D. Contingencies

The Standards are given in details in 10 sections:

1. Acquisition,
2. Seed drying and storage,
3. Viability monitoring,
4. Regeneration,
5. Characterization,
6. Evaluation,
7. Documentation,
8. Distribution,
9. Safety duplication and
10. Security/personnel.

STANDARDS – Structure and Definitions

Selected sources of information and references are provided in all sections.

The **Context** provides the basic necessary information in which the standards apply as brief description of the routine genebank operation for which the standards are defined and the underlying principles for them.

The **Technical Aspects** explain technical and scientific principles important to understand and underpin the standards.

The **Contingencies** include provisions that cannot be applied in case standards ex.: to a certain species, covering exceptions, alternative routes, and risk management options.

4.1. STANDARDS FOR ACQUISITION OF GERMPLASM

4.1.1. Seeds added to the GB have been acquired legally with relevant technical documentation

- Acquisition is made in accordance with relevant international and national regulations (phytosanitary/quarantine laws, ITPGRFA or CBD access regulations, and national laws for GR access) (ex.: SMTA or MTA) the access should be subject to the prior informed consent of the country.

4.1.2. Seed collecting should be made as close as possible to the time of maturation, avoiding potential genetic contamination and ensure maximum seed quality.

- In case of donation of the seeds the taxonomic classification, donor, ID of the donor, and names in addition to the passport data should be provided;
- Seeds should be assigned a unique identification number
- Whenever possible a herbarium voucher specimen should be taken

4.1.3. To maximize seed quality, seed collecting and transfer to a controlled drying environment should be within 3-5 days or as short as possible; seeds should not be exposed to high T/°C and intense light because seeds may have immature seeds that require time after harvest to achieve embryo maturation.

4.1.4. All seed samples should be accompanied by at least a minimum of associated data as detailed in the FAO/IPGRI multi-crop passport descriptors

- Crucial in identifying and classifying); complete as possible and fully documented during the acquisition.

4.1.5. The minimum number of plants from which seeds should be collected is between 30-60 plants, depending on the breeding system of the target species.

4.2. STANDARDS FOR DRYING AND STORAGE

4.2.1. All seed samples should be dried to equilibrium in a controlled environment of 5-20°C and 10 -25% of relative humidity, depending upon species.

4.2.2. After drying, all seed samples need to be sealed in a suitable air-tight container for long term storage; non airtight for frequent access to seed or likely to be depleted well before the predicted time for loss in viability.

- German genebank uses laminated 11µm aluminium foils; in Svalbard - 20µm laminated aluminium foils; periodic control moisture content required.
- Seeds may need to be re-dried occasionally and containers or gaskets replaced within 20-40 years

4.2.3. Most-original-samples and safety duplicate samples should be stored under long-term conditions (base collections) at a T/°C of -18 ± 3°C and RH of 15% ± 3%.

- Long-term storage conditions provide high seed quality for long periods, but the actual timing is species-specific.

4.2.4. For medium-term conditions (active collection) samples should be stored under refrigeration at 5-10 °C and RH of 15% ± 3%.

- Medium-term storage conditions are adequate for 30 years and will generally require refrigerated storage; Short-term storage is expected to provide high quality seed for at least 8 yrs (at ambient temperatures cool and stable, not >25 °C)

4.3. STANDARDS FOR SEED VIABILITY MONITORING

4.3.1. The initial seed viability test should be conducted after cleaning and drying the accession or at the latest within 12 months after receipt of the sample at the genebank.

- 200 seeds are recommended to be used for initial germination tests (ISTA, 2008) (general guideline);
- 100 or even smaller seed samples , conducted with replications in event there are not sufficient seeds;
- small accession sizes (CWRs): sample sizes of 50 seeds or less could be acceptable.

4.3.2. The initial germination value should exceed 85 percent for most seeds of cultivated crop species (for specific accessions-wild and forest species a lower percentage could be accepted).

- During storage risk of genetic erosion is lower for homogeneous samples than heterogenous;
- Heterogeneous (CWRs and Ls): 85% standard should be adhered;
- Homogeneous: <85% is allowable as long as plant establishment during regeneration remains adequate;
- Some L, specific accession, CWRs, forest sp.: 70% or < if viability in newly replenished seedd is rarely achievable.

4.3.3. Viability test intervals should be set at 1/3rd of the time predicted for viability to fall to 85% or < (no >40 yrs); if this deterioration period cannot be estimated and accessions are long-term stored (-18°C), the interval should be 10 yrs (long lived sp.) and 5 yrs or < (short lived sp.).

- Lower quality accessions: managed carefully, the 1st viability tests should be after 3-5 yrs of storage at first.

4.3.4. The viability threshold for regeneration or other management decision (re-collection) should be 85% or lower depending on the species or specific accessions of initial viability.

4.4. STANDARDS FOR REGENERATION

Regeneration is a key operation and an integral responsibility of any genebank that maintains orthodox seeds.

4.4.1. When? - The viability drops below 85% of the initial viability or when the remaining seed quantity is less than what is required for 3 sowings of a representative population of the accession. THE MOST-ORIGINAL-SAMPLE SHOULD BE USED TO REGENERATE THOSE ACCESSIONS.

- An accession will be regenerated when it does not have sufficient seeds for long-term storage (ex.: 1 500 seeds for a selfpollinating and 3 000 for an out-crossing species; viability < min threshold 85%);
- Rarely requested and seed viability is fine seed numbers can be <1,000 prior to regeneration.

4.4.2. The sample size to-be-regenerated should contain a minimum number of plants which capture at least 95 % of alleles with a minimum frequency of 0.05

- Size of seed sample used in the regeneration has to reflect the accession genetic composition (reproductive biology of the species in question as well as the degree of homogeneity/heterogeneity of the accession)
- To avoid geneflow/contamination it is critically important to use proper isolation between plots of accessions (c applies to ross-pollinated and selfpollinated species);
- To preserve genetic integrity during regeneration sampling of accessions be carried out effectively and seed number used must be sufficient to be representative of genetic diversity and to capture one or more rare alleles with a certain probability.;
- The regeneration methodology is of significant importancae and regeneration event be used also for the characterization; regeneration environment similar to that at the collecting site especially for wild population to minimize genetic drift and shift as well as to produce the best possible quality of seeds

4.4.3. If possible at least 50 seeds of the original and the subsequent most original samples should be archived in long-term storage for reference purposes.

4.5. STANDARDS FOR CHARACTERIZATION

Characterization is the description of plant germplasm. It determines the expression of highly heritable characters ranging from morphological, physiological or agronomical features to seed proteins and oil or molecular markers.

4.5.1. Around 60% of accessions should be characterized within 5 to 7 yrs of acquisition or during the first regeneration cycle.

4.5.2. Characterization should be based on standardized and calibrated measuring formats; characterization data follow internationally agreed descriptor lists and are made publicly available.

- Molecular marker technologies and genomics
- Combine with phenotypic observations

For estimation of uniqueness of a source of variation within / among accessions (detecting intra-accession diversity)

- ✓ **Descriptors published by Bioversity International (helpful for characterisation)**
- ✓ **International Union for the Protection of New Varieties of Plants (UPOV) (Useful descriptors)**
- ✓ **USDA's of the National Plant Germplasm System (NPGS) (Useful descriptors)**

4.6. STANDARDS FOR EVALUATION

4.6.1 Evaluation data on genebank accessions should be obtained for traits that are included in internationally agreed crop descriptor lists. They should conform to standardized and calibrated measuring formats.

- A wide range of developed crop descriptor lists: IBPGRI (now Bioversity International), International Union for the Protection of New Varieties of Plants (UPOV) (further evaluation descriptor lists developed by regional and national organizations- USDA NPGS descriptors);
- Within advanced biotechnology Molecular markers are increasingly used for evaluation as well included the most commonly used (AFLPs, SSRs, SNP that largely replaced the older marker types-RFLP, RAPD).

4.6.2 Evaluation data should be obtained for as many accessions as practically possible, through laboratory, greenhouse and/or field analysis as may be applicable.

- The data may be in different formats, thereby to facilitate the use of externally sourced data, it is important to standardize data collection and analysis, and provide uniform reporting formats.

4.6.3 Evaluation trials should be carried out in at least three environmentally diverse locations and data collected over at least three years.

- Accuracy of data should be mitigated through reasonably replicated, multi-locational, multi-season and multi-year evaluations., check varieties.

4.7. STANDARDS FOR DOCUMENTATION

All data and information generated in the genebank relating to all aspects of conservation and use of the material should be recorded in a suitably designed database. Using the internationally agreed standards will very much facilitate data exchange among different genebanks and countries.

All data and information generated throughout the process of acquisition, registration, storage, monitoring, regeneration, characterization, evaluation, and distribution should be recorded in a suitably-designed database and employed to improve conservation and use of the germplasm.

4.7.1. Passport data of 100 percent of the accessions should be documented using FAO/IPGRI multicrop passport descriptors.

- International standards such as the FAO/IPGRI multi-crop passport descriptors (FAO/IPGRI 2001) should be used to record passport data that are minimum data available for each accession to guarantee proper management.

4.8. STANDARDS FOR DISTRIBUTION AND EXCHANGE

4.8.1. Seeds should be distributed in compliance with national laws and relevant international treaties and conventions.

4.8.2 Seed samples should be provided with all relevant documents required by recipient country.

- Germplasm should be distributed in a way that ensures the germplasm reaches its destination in good condition;
- Phytosanitary certificate, additional declarations, certificate of donation, certificate of no commercial value and import permit and others are among the documents required by the recipient country.

4.8.3 The time span between receipt of a request for seeds and the dispatch of the seeds should be kept to a minimum.

4.8.4 For most species a sample of a minimum 30-50 viable seeds should be supplied; accessions with too little seed at the time of request/absence samples should be supplied after regeneration/multiplication, based on a renewed request; For some species and some research uses, smaller numbers of seeds should be an acceptable distribution sample size.

The list of the material and associated information (passport data as a minimum) should be provided to the recipient together with any legal agreement related to access and use of genetic resources provided.

4.9. STANDARDS FOR SAFETY DUPLICATION

4.9.1. A safety duplicate sample for every original accession should be stored in a geographically distant area, under the same or better conditions than those in the original genebank.

- The safety duplicates are genetically identical to the long-term collection and are referred to as the secondary most original sample (Engels and Visser, 2003);
- Safety duplication includes both the duplication of material and its related information, including database back-up. The safety duplication of the materials are deposited in long-term storage at a different location.
- Safety duplication is available at the Svalbard Global Seed Vault (SGSV) on Spitsbergen island, Norway.
- Safety duplicate should contain at least 500 viable seeds for outbreeders and heterogeneous accessions with high diversity and a minimum of 300 seeds for genetically uniform accessions (for accessions with seeds of low viability more seeds are necessary).

4.9.2. Each safety duplicate sample should be accompanied by relevant associated information.

- Safety duplication is generally made under a 'black-box' approach. This means that the repository genebank has no entitlement to the use and distribution of the germplasm;
- Recall of the deposit is also possible when it is replaced with newly regenerated germplasm

4.10. STANDARDS FOR SECURITY AND PERSONNEL

4.10.1. A genebank should have a risk management strategy in place which includes inter alia measures against power cut, fire, flooding and earthquakes.

4.10.2. A genebank should follow the local Occupational Safety and Health (OSH) requirements and protocols where applicable.

4.10.3. A genebank should employ the requisite staff to fulfil all the routine responsibilities to ensure that the genebank can acquire, conserve and distribute germplasm according to the standards.

- Staff should have adequate training acquired through certified training and/or on-the-job training and training needs should be analyzed.
- If suitably trained staff is not available, it might be a solution to outsource some of the genebank work or to approach other genebanks for assistance.
- The international community of genebanks should be informed, if the functions of the genebank are endangered.

Standards to be further elaborated by the WG - wild species - ?

1. Aquisition (size of seed samples)
2. Viability monitoring (difficulties due to nature of seeds)
3. Regeneration/ multiplication (condition, sample size, special handling)
4. Characterization and evaluation (descriptors)
5. Distribution (size of seed samples)









THANK YOU!