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**Item 5 of the Provisional Agenda**

**COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE**

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# REGENERATION OF ACCESSIONS IN SEED COLLECTIONS: A DECISION GUIDE

## EXECUTIVE SUMMARY

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1. This decision guide is intended to facilitate the development of optimum procedures for regeneration of seed germplasm. It deals with the timely identification of accessions with an inadequate quality or quantity of seed. It also considers the regeneration of those accessions to produce new seed of maximum quality and optimum quantity, with minimum loss of genetic integrity and as cost-effectively as possible.

2. The optimal protocol for regeneration depends on the breeding system and seed storage characteristics of the species concerned, the physiological condition and genetic composition of the original sample, its expected usage and perceived value within the collection, and operational constraints on genebank activities, such as funds, human resources and equipment. There is often insufficient knowledge about the species concerned to select the optimal regeneration protocol; and the effects of the various options on genetic population structure are often poorly known. Regeneration procedures must, therefore, be flexible, to enable them to meet the needs of different genebanks and accessions, and to be responsive to research developments. This guide is intended to facilitate the decision-making process involved in developing appropriate protocols.

3. The guide discusses the establishment of achievable targets for quality and quantity of seed produced, the maintenance of genetic integrity, and minimizing the costs of regeneration. Calculations are based on the requirements of different units of usage - the distribution unit, test unit and base unit - together with a safety factor allowing for losses and a factor allowing for uncertainty of usage. A single case study is presented by way of illustration, and discusses the consequences of the various causes of loss of genetic integrity, by drift, selection and contamination.

4. The main body of the guide deals in detail with establishing the regeneration protocol. To maximize the practical value of the guide, sub-sections are presented in the same order as the practical activities involved in regeneration: selection of the site, accessions and seed for regeneration; preparation of the site and seed, crop management before, during and after anthesis; and harvesting and post-harvest management. Flow charts of the decision-making process are provided to assist understanding.

5. Two aspects of the location for regeneration are considered. The choice of the overall site is jointly determined by policy considerations, adaptation of the crop to the regeneration environment, and the need for maintenance of genetic integrity. The types of location at a site include field, glasshouse or other facilities for better control of the environment.

6. Selection of accessions for regeneration requires the definition of threshold levels for seed quality and quantity, below which regeneration is required; a protocol for monitoring seed quality and quantity; and a protocol for prioritizing accessions when the number in need of regeneration exceeds genebank capacity. Highest priority is given to regenerating accessions that have seed of inadequate quality in the base collection. Separate thresholds and protocols are required for newly received seed and accessions already held in storage.

7. Selection of seed to be used to provide parental plants deals with the source of seed, the number of seeds to be used and their identity. Emphasis is placed on using seed held in the base collection to replenish seed stocks in the active collection to prevent cumulative degradation of genetic integrity and the number of seeds to be used is determined jointly by the number required for the satisfactory maintenance of genetic integrity and the number of offspring seeds to be produced. Seed for use as parents is usually selected at random from the available seed; however, in a few cases, consideration should be given to selecting seed that more fully represents the genotypic composition of the original population sample.

8. The remainder of the regeneration protocol is heavily dependent on the agronomy of the species concerned. The guide focuses on issues that are of particular importance to regeneration and that, therefore, will not feature in standard agronomy texts: the importance of these issues and approaches to resolving them is again heavily dependent on the biology of the species concerned.

9. Ensuring accuracy and preventing contamination by alien plants, seed or pollen are key issues throughout, from preparation of regeneration plots to storing the harvested seed. Mechanization should be based on purpose-built machinery, since adequate cleanliness and accuracy is not usually achievable with commercial agricultural implements. Effective use of information technology is encouraged in combination with cross-checking procedures. Where possible, complete isolation from all sources of alien pollen is strongly recommended for all species except obligate inbreeders and obligate apomicts.

10. Maximizing uniformity among plants in their contribution of male and female gametes to the offspring generation is also a key issue throughout, although different measures are required at different stages. Pruning, manual pollination and balanced bulks are amongst the more labour intensive measures that should be considered to increase uniformity where variation between plants is high.

11. Ensuring the highest possible health and viability of offspring seed is another key issue that becomes important from anthesis onwards. It depends on good disease control, appropriate harvesting, and appropriate rapid post-harvest processing, particularly for seed drying and threshing.

12. The decision guide also touches on broader issues of genebank management policy that have implications for regeneration strategy. However, whilst consideration of these broader issues is important for the development of an efficient regeneration programme, their interactions with other aspects of genebank management place them beyond the scope of this guide. Therefore, it is planned that they are dealt with more fully in future work.

13. In conclusion, the guide aims to provide general considerations how to improve the effectiveness of germplasm regeneration programmes. In addition, there will be a need to develop more detailed guidelines for individual crops or groups of crops, which could in many instances be done through the activities of international crop genetic resources networks. There is also an urgent need for research to gain the crop-specific knowledge necessary to optimize regeneration protocols and to quantify the consequences of the various options presented, in particular from a population genetic and economic point of view.