Assessing the contribution of genebanks: the case of the UPM seed bank in Madrid

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Summary

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Through a combination of methods, the contribution of seed material distributed from the UPM (Madrid, Spain) seed bank for basic or applied research on a worldwide basis over 40 years is estimated.

Key words: [AUTHOR TO PROVIDE KEYWORDS]

Résumé

Resumen

Introduction

Genebanks are usually established to fulfil two major objectives. Firstly, to avoid—or at least minimize—genetic erosion, i.e. the loss of valuable plant material at any level: genotypes, varieties, species, etc. Secondly, they are expected to make their material available to others for scientific or applied research or for other purposes. How these objectives are accomplished with the passing of time is usually very difficult to assess because feedback is either lacking, incomplete or dispersed. An accurate record of the destinations where seed accessions were sent is important, but not enough, because it is the use of these accessions afterwards that really matters. Though inquiries or questionnaires to the users might appear to be the correct follow-up method, many difficulties may arise because of the time elapsed between the reception, the use of the material and the publication of the results. Also, there may be changes in the staff to whom the material was originally sent, or in the lines of research, all resulting in imperfect or fragmentary information.

Activities of the UPM Genebank

Some essential characteristics of the UPM (Universidad Politécnica de Madrid) Genebank make this assessment possible. It is a small bank (4000 accessions preserved), with two well defined objectives: (1) wild crucifers, including relatives of crops belonging to the genera *Brassica, Sinapis, Raphanus, Eruca,* etc.; and (2) rare, threatened or endemic species of any family from the west Mediterranean area. It was started in 1966 to keep a small collection of Cruciferae seeds that had been left over from a previous experiment [72] and has steadily grown as the result of a large number of collecting missions. Seeds are kept in flame-sealed glass vials, with silica gel to ensure low moisture content. More recently, other possibilities to adapt this method to crop species have been explored (see www.seedcontainers.net). From 1969, several editions of a catalogue, both specialist Cruciferae and a general catalogue, have been distributed (see www.etsia.upm.es/DEPARTAMENTOS/biologia/index.asp) to interested specialists. In 1973, the bank extended its scope to include rare or endemic species. In 1983, it was designated as the Global Base Collection for Wild Crucifers by IBPGR (later IPGRI, and now Bioversity International). In 1994, it was honoured with the National Award for the Environment by the Government of Spain, and other important awards have followed.

Highly encouraging germination results have been obtained in several intermediate assessments [60; 186; 245], and recent evaluations after removing dormancy indicate average viability rates very close to 100% after four decades [219]. The level of duplication in other banks is high: 90% for the Crucifer collection and 50% for the collection of rare plants.

Since 1966, the combination of the double specialization of the bank (Cruciferae + rare species) and the scientific staff closely associated with it, working very persistently in related lines, have made it easy to follow the relevant bibliography and to relate it with previously recorded data on seed distribution. The receipt of reprints, the acknowledgement of the origin of the seeds that most papers include and, in some cases, direct testimony by the users, have helped this follow-up. In particular the cruciferous material has been extensively used, and therefore considerable information could be obtained. In contrast, the use of the collection of endemic species has been more limited since its main orientation is towards conservation itself, and has therefore been managed as a kind of 'black-box' collection.

In relation to the first objective, that of avoiding losses of plant material in the field (genetic erosion), the UPM genebank collected and multiplied seeds of *Diplotaxis siettiana* in 1974. This was a few years before this limited endemic endangered species completely disappeared from its natural habitat on the Island of Alborán (southern Spain), thus saving this plant

Table 1. Intended use of samples supplied from the UPM Genebank. Numbers refer to the relevant information sources in the bibliography.

Area of interest	Reference
Anatomy	27, 30, 53, 70, 71, 75, 149, 166, 214.
Breeding	42, 43, 177, 190.
Cancer research	62, 66, 192.
Chemosystematics	1–5, 90, 251–260, 282, 283, 300.
Chloroplast DNA	113, 141, 142, 147, 153, 200, 203, 206, 208, 209, 216, 235, 296, 301, 302, 304, 307, 309, 311, 312.
Chorology	73, 77, 78, 142.
Conservation	31, 35, 98, 127, 261.
Cotyledons	76, 182.
Cryopreservation	92–95, 97, 98, 175, 220.
Cultivation	31.
Cytogenetics	7, 15, 34, 40, 42, 79, 80, 102, 103, 104, 109, 232, 265, 277. 280.
Fertility	18, 19, 22, 32, 54, 130, 134, 237, 238, 274.
Fertility restoration	22, 54, 130, 237, 238.
Flavonoids	1–5, 256–260.
Flowering	267.
Genetics	39, 51, 63, 81, 133, 134, 161, 216, 249.
Germplasm	35, 60, 86, 92, 93, 101, 121, 162, 186, 187, 219, 278.
Germination	8, 12, 55, 56, 91, 92, 175, 218–223, 226, 227, 229, 230, 245.
Glucosinolates	38, 62, 63, 66–69, 100, 107, 137, 150, 163–165, 194, 196, 199, 217.
Hybridization (sexual)	7, 14, 16–20, 24, 25, 102, 111–120, 131, 178, 190, 212, 243, 244, 247, 266, 268, 269, 270, 274, 284, 285, 287.
Intergeneric hybrids	7, 13, 14, 16–20, 24, 25, 28, 41, 102, 111–120, 129, 131, 135, 153, 202, 213, 244, 247, 269, 284, 285, 287, 291–294, 296, 297.
Interspecific hybrids	102, 115, 136, 178, 212, 243, 266, 268–270, 274.
In vitro culture	94–97, 119, 122–128, 168–172, 191, 285, 287, 290.
Isozymes	143, 154, 157, 245, 282, 283.
Male sterility	21, 22, 32, 33, 54, 130, 189, 236, 237, 238, 239.
Micropropagation	44, 96, 122, 125, 169, 171, 172.
Mitochondrial DNA	200, 235.
Morphology	6, 36, 45–49, 53, 75, 89, 99, 105, 121, 149, 167, 182.
Morphogenesis	26, 71, 263.
Molecular taxonomy and/or phylogeny	26, 29, 50, 64, 108, 110, 138, 140, 141, 144–148, 151–159, 173, 185, 202–211, 216, 233–235, 261, 275, 276, 301–309.
Pests and diseases	23, 37, 38, 52, 58, 59, 68, 193–195, 194–199, 215, 248, 262, 264, 289.
Photosynthesis	11, 247, 286, 298, 299.
Plant geography	139, 142, 143, 204
Plant physiology	11, 20, 72, 87, 247, 286, 288, 296– 299.
Polyploids	142, 143, 161.
Proteins, peptides	1, 3, 202, 204, 207, 212, 252–255. 282, 283.
Seed morphology	5, 30.
Seed preservation	60, 91, 93, 101, 167, 175, 186, 219, 220, 245.
Seed physiology	8, 12, 55–57, 60, 65, 91–93, 98, 175, 186, 218–223, 228, 245.
Somatic hybridization	13, 28, 41, 129, 135, 136, 200, 213, 291–294, 296.
Taxonomy (classical)	9, 10, 61, 73, 74, 76, 82–85, 88, 106, 132, 160, 174, 176, 177, 179–181, 183, 211, 224, 225, 231, 232, 240–242, 250, 267, 271, 273, 279, 281.
Transgenesis	246, 288, 295, 310.
Variability	58, 77, 98, 126, 170, 174, 183, 279, 299, 306.
Wax	75.
Weed research	51, 55–57, 221, 272.
Wide hybridization	212, 284.
Wild relatives	1, 75, 155, 157, 158, 244.

from extinction. This episode and the re-introductions that followed are well known to conservationists, and provide a good example of the important role a genebank can play [86; 184; 188; 202]. The number of other endemic species with limited distribution preserved in the bank is considerable, and similar situations might occur in the future.

The second objective, that of ensuring the availability of the material, has also been fulfilled. Hundreds of packages with samples of viable Cruciferae seeds have been despatched in the past forty years, mostly to specialists. Around 35% of the references derive from the UPM team and can be identified by the names of Aguinagalde, Clemente, Durán, Gómez-Campo, González-Benito, Hernández-Bermejo, Iriondo, Lázaro, Martín, Martínez-Laborde, Pérez-García, Sánchez-Yélamo and Sobrino-Vesperinas. Other recipients of our seed material (65%) are distributed over at least another 16 countries. Endemic species have also been distributed, although to a much lesser extent. The references listed below belong strictly to activities and investigations where material from our seed bank has played a role, whether major or minor. No indirectly related subjects—such as reports of collecting missions, data bases, sending of duplicates or investigations based on directly collected material—are considered, unless collected material entered the seed bank. Other uses, such as exhibits of rare or common species in botanical gardens have probably been very extensive, but are practically impossible to reflect. According to the information we managed to obtain, the seeds have been used for many different purposes, summarized in Table 1.

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A seed bank (also seedbank or seeds bank) stores seeds to preserve genetic diversity; hence it is a type of gene bank. There are many reasons to store seeds. One is to preserve the genes that plant breeders need to increase yield, disease resistance, drought tolerance, nutritional quality, taste, etc. of crops. Another is to forestall loss of genetic diversity in rare or imperiled plant species in an effort to conserve biodiversity ex situ. Many plants that were used centuries ago by humans are used CGIAR genebanks safeguard some of the largest and most widely used collections of crop diversity in the world, critical to attaining global development goals to end hunger and improve food and nutrition security, which arguably gives their stewardship an imperative and prominence unsurpassed by any other single undertaking in CGIAR.Â The 11 CGIAR genebanks manage 730,000 accessions in 35 collections, as seed, as plants in the field or screenhouse, in tissue culture, in cryopreservation and as DNA samples. These collections include tree species, forages, crop wild relatives, root and tuber crops, and bananas, as well as a wide range of cereals and grain legumes. The seed bank standards (Chapter 4) deals with the conservation of the desiccation-tolerant orthodox seeds, i.e. can be dehydrated to low water content and are responsive to low temperatures. Lowering moisture and temperature decreases the rate of metabolic processes, thus. 3.Â The following standards are provided for the respective type of genebank: n Genebank Standards for Orthodox Seeds: acquisition of germplasm, seed drying.