



Roger D. Smith

Seed Conservation Department, Royal Botanic
Gardens Kew, Wakehurst Place, Ardingly, West
Sussex RH17 6TN, UK

Geoffrey Hawtin

International Plant Genetic Resource Institute, Via
dei Tre Denari 472/a, 00057 Maccarese
(Fiumicino), Rome, Italy

Summary

This chapter looks at the implications of three large international initiatives on the future of seed banks, both collectively and individually.

Introduction

At the time of the 2001 workshop, the future of seed banks was less certain than it is at the time of going to press. In the intervening period, three large international initiatives have taken place, raising the profile of *ex situ* plant conservation. Simultaneously, the profile of seed banks has been raised due to their cost effectiveness in conserving species which produce desiccation tolerant dispersed seeds and fruits.

The three international initiatives are:

- The adoption of the Global Strategy for Plant Conservation, GSPC, at the sixth Conference of the Parties of the Convention on Biological Diversity (Den Haag, Netherlands, 2002);
- The adoption of the International Treaty on Plant Genetic Resources for Food and Agriculture, ITPGRFA (Rome, Italy, 2001); and
- The launch of the Global Conservation Trust (Johannesburg, South Africa, 2002).

The rest of this chapter looks at the implications of these initiatives for seed banks, collectively and individually, over the coming years. The views expressed here are those of the authors, who joyfully took the opportunity to put down their institutional responsibilities and express their own, no doubt prejudiced, views of what the future may hold.

The Global Strategy for Plant Conservation

This strategy contains 16 measurable, but aspirational targets for plant conservationists to achieve, by 2010. Two of these targets specifically relate to *ex situ* conservation. Within the work of the Convention on Biological Diversity (CBD), the GSPC is somewhat controversial. The GSPC is a response to a recommendation of the 19th Botanical Congress (St Louis, USA, 1999). A small inter-continental group of plant scientists developed the GSPC at the request of this larger group. The Conference of the Parties (COPs) to the CBD would normally expect to instruct the Secretariat of the CBD to prepare a paper on an issue for their later consideration and adoption. The initiative of plant scientists in breaking with protocol and still getting the GSPC adopted concerns some diplomats. Plant scientists should be aware that failure to deliver their conservation targets may please some of those who attend the COPs, a body that keeps under review the implementation of the CBD and steers its development. Seed bankers should be aware of their special responsibilities to deliver 12.5% of the targets of this bold initiative. Specifically the two targets are:

- *Target 8: 60 per cent of threatened plant species in accessible ex situ collections, preferably in the country of origin, and 10 per cent of them included in recovery and restoration programmes.*

Currently, over 10,000 threatened species are maintained in living collections (botanic gardens, seed banks, and tissue culture collections), representing some 30% of known threatened species. It is considered that this could be increased to meet the proposed target by 2010, with additional resources, technology development and transfer, especially for species with recalcitrant seeds. Within this target, it is suggested that priority be given to critically endangered species, for which a target of 90% should be attained. It is estimated that currently about 2% of threatened species are included in recovery and restoration programmes. Against this baseline, a target of 10% is recommended.

- *Target 9: 70 per cent of the genetic diversity of crops and other major socio-economically valuable plant species conserved, and associated indigenous and local knowledge maintained.*

Theory and practice demonstrate that, with an appropriate strategy, 70% of the genetic diversity of a crop can be contained in a relatively small sample (generally, less than one thousand accessions). For any one species, therefore, the target is readily attainable. For some 200–300 crops, it is expected that 70% of genetic diversity is already conserved *ex situ* in gene banks. Genetic diversity is also conserved through on-farm

management. By working with local communities, associated indigenous and local knowledge can also be maintained. Combining gene bank, on-farm, and other *in situ* approaches, the target could be reached for all crops in production, as well as major forage and tree species. Other major socio-economically important species, such as medicinal plants, could be selected on a case-by-case basis, according to national priorities. Through the combined actions of countries, some 2,000 or 3,000 species could be covered in all.

1. Target 8 of the GSPC

Simple arithmetic suggests that this target is globally achievable in the eight years that remain until the end of 2010. Already around 10,000 threatened species are conserved to some extent. Another 10,000 remain to be collected by 2010, i.e., 1,250 species per year. Given that there are around 2,200 botanic gardens worldwide, of which at least 150 have seed banks, the task seems feasible. Each of these seed banks taking responsibility for eight species for each of the next eight years should achieve the target. However, different countries have different numbers of threatened flora, different facilities, and different financial and human resources. Neither do all plant conservationists or botanic gardens or seed banks belong to a single collective structure, through which formal partnerships (balancing out these inequalities) can be brokered. Yet partnerships will be necessary if the aspirations for technology development and transfer are to be achieved. Partnerships should also work to maintain and sustain the improvements in performance that should result from attending workshops and training courses.

Another of the problems that will need to be overcome concerns the lack of knowledge about seed behaviour. For most wild species, little if anything is known about seed storage type, seed maturity, seed longevity and seed dormancy/germination. For example, the *Oleaceae* is a tropical and subtropical family with 23% of its species recorded as having some degree of threat. A search on the Web of Science™, a bibliographic database, for any information on the seeds of the five genera which contain 44 of the 59 threatened species, gave only one response. This reference was to the chemical constitution of seed. Where information is available, it is often spread across a very wide range of literature. Therefore, a priority must be to make appropriate and useful information available which helps to conserve seed.

Threatened species are found in all life-forms. Where the species are perennial and take several seasons to reach the flowering and fruiting stage, regeneration of seed crops will be both difficult and expensive. This will be in contrast to the highly understood annual crops, upon which much seed bank practice has been based. Regeneration can often be avoided by making high quality seed collections in the wild in sufficient numbers to meet future needs

but without threatening the continued survival of the parent population. The most challenging part of this approach is to locate and then identify threatened species in the field at a time when they are fruiting.

Within the GSPC, a clear link is established to Target 2 that seeks a preliminary assessment of the conservation status of all known plants at national, regional and international levels. Common sense dictates that in order to prevent duplication of effort, strong links are made between seed conservationists and those scientists that are delivering Target 2. In turn, this will require that sufficient effort be put into managing this relationship to ensure its success. Achieving the target of conserving 90% of critically endangered species will test these partnerships to the full. Analysis of the 1997 IUCN Red List indicates the management skills that will need to be developed. A total of 6,419 seed bearing species are listed as endangered. The number of these species that are already held *ex situ* is not easy to find. Taking the worst case, the target set is 5,777, more than half of the larger target. Some 91% of endangered species are single country endemics. Achieving the target will involve co-ordination of work in more than 30 countries. Clearly, the challenge is as much to do with logistics and management as it is to do with seed biology.

The final element to Target 8 concerns restoration. Seed bank managers are unlikely to wish to stretch beyond their core skills and to develop reintroduction skills. It is more likely that they would prefer to form partnerships with those already possessing such skills. However, there is one further step which seed bank managers may consider appropriate. Currently, seed bank staff conduct germination testing under laboratory conditions. Perhaps they should take this work further and look for ways that ensure such germinants can be established in the soil under nursery conditions.

On reflection, much of what lies within Target 8 of the GSPC is about communication. Perhaps, too often the ‘generals’ rather than the ‘soldiers’ get to talk to one another. There is also some value in becoming clearer about which are the institutional and which the international elements of the work of everyone involved in seed conservation. Successful partnerships and collaborations invest much more resource in managing relationships both within their institutions and internationally than is currently the practice in most botanical institutes.

2. Target 9 of the GSPC

As is the case with Target 8, this target appears achievable. The most challenging scenario of 3,000 species each represented by 1,000 accessions produces a final target of 3 million accessions. The Food and Agriculture Organisation of the United Nations (FAO) World Information and Early Warning System (WIEWS) listed, in 2002, 5,419,003 accessions of 19,437 species held in 1,622 collections. Of these collections, 482 were held in seed

banks operated at medium- or long-term storage conditions. An initial cursory glance at this data might suggest that the task is nearly complete. Simple division shows that each of the species listed could be represented by c. 288 accessions. Sadly, the accessions are not equally distributed across species. Rather, they are heavily biased towards the major cereal crops. Further, the FAO Survey of Genetic Resources Collections in 1996 estimated that only around one third (1,800,000) of the accessions are unique. Thus, at least 1,200,000 unique accessions will need to be collected and conserved if the three million target is to be achieved. Each of the 482 medium- or long-term seed banks will need to collect at least 311 unique accessions each year if they alone are to deliver the target. With so much work already done in Plant Genetic Resources for Food and Agriculture (PGRFA) in the collecting, conservation and databasing, a reconciliation of the current holdings with the target will be necessary to avoid wasted effort. This will necessarily involve some assessment of the seed collections already held, in terms of their identity, viability and supporting data. The outcome should be a baseline measure of the acceptable, high quality accessions already conserved against which gaps and omissions can be identified and future collecting planned. Despite cuts in PGRFA seed bank budgets between 1996 and 2000, additional seed collections have still been made in some 66 countries. Perhaps the target can be more easily achieved than might be supposed initially.

Although necessary, this major assessment of collection status may be an uncomfortable process for many collection managers. However, future generations will think poorly of us, if our bequest is found dead or disorganised in their hour of need. Good collection managers already recognise that due to the potential longevity of many seeds, success in maximising longevity may not be apparent within their working lives. Sadly, only their failures will become clear in the short-term. We must all learn from these failures if seed banking is to progress. One of the most obvious and growing problems that currently needs to be addressed concerns the regeneration of seed stocks with low viability. Backlogs in regeneration were already large in the FAO report of 1996; they are still accumulating. In their report, 'Global Diversity at Risk: the case for sustaining crop collections', the Department of Agricultural Sciences, Imperial College, Wye, UK rightly recognised that "the regeneration backlog is a strong indication that a gene bank is in trouble". The questions that need to be addressed are straightforward. Given that potential lifespans of many crop seeds are predicted to be decades, if not centuries, it would appear that such banked seed is losing viability much more quickly than expected. If this is so, why is it the case? How much can be attributed to a lack of properly funded and well maintained facilities, operating at inappropriate conditions? How much is due to initial viability problems, mismanagement and human error? Answering these questions successfully should help ensure that regeneration backlogs gradually diminish as the newly-regenerated seeds retain high viability in storage for long periods. Progress could be made by increasing the field

collection of high quality seed in sufficient quantity that they can be directly added to the bank, without regeneration. Obviously, such an approach may have implications to activities that occur concurrently with initial regeneration such as disease evaluation and characterisation. Perhaps when assessing collections for their possible contribution towards the target, a harsher view should be taken of the need to maintain so many costly duplicate collections each carrying the burden of regeneration. Perhaps, sufficient progress has been made under the CBD and the ITPGRFA balancing national sovereignty and the inter-dependency of nations in the conservation of biological diversity, that now is the time to *think* globally, as we *act* locally to achieve the target.

The intention of Target 9 is to conserve between 2,000 and 3,000 crops. The ranges of life-form and phylogeny will be large for the species in this list. At one extreme will be the major cereal crops, highly bred and mostly inbreeding annual species with deeply researched development patterns and agronomy. Such characteristics lead to relatively uniform and simplified seed behaviours. At the other extreme, the species included will have breeding systems, developmental patterns and agronomy, which will result in seed behaviours akin to undomesticated species.

Achieving both of these GSPC *ex situ* targets appears to offer a great many opportunities for seed technology partnerships between seed banks involved in the conservation of endangered and crop species. These partnerships will share twin common goals of (1) achieving improved longevity of banked seeds and (2) removing dormancy more certainly and releasing the fullest genetic potential as all viable seeds germinate.

The International Treaty on PGRFA

The ITPGRFA was adopted in November 2001. It will become international law, 40 days after 40 UN Nations have ratified it. This milestone remains to be passed and 2004 is thought to be a date when it might become international law. When it does so, different obligations will fall on seed banks, when dealing with crops under the multi-lateral system of the ITPGRFA, compared to when dealing with all other species. Successfully discharging these obligations will demand seed bank managers have:

- The clearest understanding of the terms and conditions under which they hold each accession;
- Complete confidence of the specific identity of the material they hold;
- A clear understanding of their clients intentions in the use of the material;

- Easy access to the passport data associated with each accession;
- A customer based, service mentality; and that they use
- Standardised Material Transfer Agreements for the distribution of material within the multi-lateral system.

These are not all new obligations. The successful management of any seed bank requires this kind of understanding. The CBD demanded such an understanding for species collected after the Convention came into force. The difference will be the application of legally-binding obligations to many of the accessions held in crop seed banks. Seed bank managers will not only need to comply, but be able to show that they complied, and possibly in a court of law.

In terms of seed bank traditions, perhaps the biggest change will be the emphasis placed on accurate identification of each accession. This will be necessary to achieve the certainty required to accurately apply the ITPGRFA to those species for which it is intended. For the major crops, accurate identification could be relatively straightforward. For the forage crops, the evidence suggests that this will be more taxing. In the genus *Trifolium* L. (*Fabaceae*), 15 of the 238 species lie within the multi-lateral system. In the genus *Festuca* L. (*Poaceae*), six of the 450 species are within the system. Concern about the accuracy of identification in seed collections, was raised by Taylor *et al.* (1983). Seeds supposedly from 13 species of *Trifolium* section *Chronosemium* Ser. were obtained for cytological studies. Identification of the offspring showed that less than half (six) of the requested species were obtained. Two other unrequired species were also accidentally obtained. Perhaps, this should not be surprising. Many seed collectors are not expert field botanists, with a full knowledge of the flora they are collecting. Perhaps the first step of characterisation should be a positive identification by an acknowledged expert. This could create a substantial workload for managers of the existing forage collections.

The distribution of seeds from seed banks will need to be checked more in the future than has happened in the past. The CBD first changed the earlier 'laissez-faire' distribution of seeds. The ITPGRFA will change it further. For example, bank managers will need to know:

- Which species are covered by which legal instrument;
- Whether the requester is from a country which is a signatory to either, both or neither of the CBD or ITPGRFA;
- Whether the intended use by the requester is consistent with the terms of ITPGRFA for species belonging to the multi-lateral system;
- Whether there are any legally binding agreements in place, such as intellectual property rights or bilateral Access & Benefit Sharing Agreements (ABSAs), which appear to take precedence over the ITPGRFA.

The Global Conservation Trust

Perhaps the most courageous, exciting and challenging initiative facing seed banks, particularly those involved in PGRFA, is the Global Conservation Trust. The Trust is a foundation for food security, which seeks to raise, through benevolent donation, a large capital sum of money. A sum of about £160 million (US \$260 million) has been suggested. When invested, the interest earned from this sum would be used to both support the maintenance of the world's most critical collections and help build the capacity of under-funded collections. An aim is to secure funding for seed conservation over much the same period that the seeds themselves should live within seed banks. An objective is to free seed bank managers from the burden of securing funds, an increasingly difficult exercise in a world of diminishing public funds and increasing pressures to produce short-term impacts rather than longer-term solutions. Secure and sustainable funding should free the seed bank managers' time so that they can focus on the important technical challenges they face. While these are the very laudable opportunities that the Trust hopes to provide, seed banks, their managers and staff will also face increased pressures to make the very best possible use of the money provided. They will be expected to perform every task at the very highest levels, on time and within tight budgets. If they do not, the Trust will be perceived as wasting money. There are several reasons for, and consequences of this observation:

- No matter how large the capital sum raised, the interest is unlikely to fully finance all the current seed banks for PGRFA. This will inevitably result in competition for funding. To maintain the high esteem of its supporters, the Trust will wish to see the best use made of the money it dispenses. This is likely to lead to some form of linkage between the performance of a seed bank and the funding it receives. Consequently, performance should rise and costs fall. All seed bank managers should support this economic approach because it will result in a greater number of banks being supported.
- If the capital sum suggested is raised, the seed bank community will also be noticed throughout the world. Success, through honest endeavour and raised standards will be the only defence against criticism that might arise from financially starved colleagues in other branches of science.

- People do not give money to Trusts or Projects. People give money to people. The donors give because they believe the recipient has the determination to deliver what is promised. The donors accept they are taking a risk. They judge the recipient will match that risk with their commitment and professionalism. Honest mistakes will be forgiven and unjustified criticism will be ignored. However, failures to manage the resolution of problems (technical, human or political) will raise serious concerns. Budgets spent for little improvement in performance will be recognised as resources wasted. To maintain the support of the investors in the Trust, the seed bank community will need to achieve and continue to work at the highest standards.

A Final Overview

In honesty, the future of seed banks is probably no worse, and arguably perhaps slightly better, than it has ever been. Change is constant. Opportunities arise and they are either grasped or passed. Currently the opportunities appear large and cry out (well at least to the authors) to be grasped. Grasping them will require changes to become commonplace. Managers will need to be proactive and drive quality up and costs down. This will be done most cost-effectively, by forming strategic alliances and partnerships. Formal binding partnerships at an institutional level, rather than casual private relationships between individual scientists, will be required. Better use of business models and less reliance on academic tradition should help objectives to be achieved. Benefactors and customers will need to be cared for. Greater interaction and skill sharing with other botanical disciplines will be necessary, particularly within the GSPC. Interaction with those involved in the development of governmental policy will remain a high priority.

The future will be what the seed conservation community chooses to make it, whether by accident or design. The key is to accept and embrace the necessary change, whilst recognising and discarding the merely modish. For scientists this should be easy: they need change the scientific method little. Observe, analyse, hypothesise and test could be replaced by observe, analyse, decide and act. Numbers rarely deceive. Use them wherever possible.

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INTRODUCTION TO SPECIES INDEX

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