

KEW'S MILLENNIUM SEED BANK: A VITAL RESOURCE FOR AN UNCERTAIN WORLD

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A week is a long time in politics. But seeds can span even human generations with ease, a feature that gives us a vital opportunity to prepare now for the 'perfect storm' of environmental problems predicted by the Government Chief Scientist.

For most plants, on which all life depends, seeds provide a means of surviving this storm. By 'banking' them now, future generations will be able to draw on the widest range of plant diversity and fashion plant-based solutions to problems of human well-being thrown up by a dramatically changing world. In this, its 250th anniversary year, the Royal Botanic Gardens, Kew has successfully conserved seed from 10% of the world's flowering plant species. The Millennium Seed Bank Project, which is led by Kew and international in its scope, has achieved this significant milestone on time and within budget. It is a conservation initiative of which the UK should be very proud. While a tremendous start has been made, a great deal more needs to be done if we are to make a real impact on the erosion of plant diversity. A new ten year project that builds on the current

one is planned. It needs modest financial support and, to achieve this, it needs to build on the political support received to date.

Seed banking is a simple and robust technology. For seeds of most species, drying greatly increases longevity. This drying is often carried out in a low humidity room at cool temperatures. Additional cooling of the dried and hermetically-sealed seeds further increases storage life, though there are diminishing returns as the temperature drops. Many banks such as Kew's Millennium Seed Bank have cold storage rooms running at domestic deep freezer temperatures; others use cryo-storage in liquid nitrogen. But just how long can these seeds live under bank conditions? By extrapolating from experiments that speed up seed ageing, there is good evidence that many of the MSB collections will still be germinated two hundred years from now. Added to this, we have even germinated seeds that were collected in the Napoleonic era and stored under much more adverse conditions than those offered in the state-of-the-art MSB, though admittedly, few of them germinated. These 200-year-old seeds found their way to us after a remarkable journey. They were in the possession of a Dutch merchant on passage out from the South African Cape in



Dr Paul Smith, Head of the Millennium Seed Bank, sharing his seed knowledge with the partners

1803 who was 'relieved' of them by British privateers. The seeds passed via the Admiralty to the Tower of London and eventually into the current National Archives where they were recently discovered and sent to us to attempt germination. Their germination is an exceptionally rare event for seeds of such antiquity.

Storing seeds for two centuries will enable us to bridge a phenomenal period of technological, sociological and environmental change, the conclusion of which is difficult to imagine. Over the last two hundred years, there have been huge improvements in human wellbeing as a result of greater access to plant diversity, in which Kew has played its part. An early Nineteenth Century Briton would be staggered at the variety of fruit, vegetables and plant-based drugs available in

Britain today. Furthermore, the fact that we take these benefits so much for granted would perhaps have shocked someone with an existence more obviously bound to plants, much as it is still in large parts of the Developing World. Of course, things may go full circle. With human population racing towards seven billion, finite agricultural land and increasing water shortages, food insecurity is likely to spread. We may quickly retreat two hundred years in this respect. Therefore, we will need to be able to call on every botanical reserve available to create new crops and to put new genes into existing crops. Rightly or wrongly, we are already returning to plants as a renewable source of fuel. Commodity shortages would certainly reawaken latent awareness of the human

survival value of many plants and could drive an unprecedented wave of conservation and innovation. But by that time we may have already depleted the botanical resources that can help us adapt. Plant diversity is being eroded by habitat loss due to urbanisation and agriculture. Climate change may exacerbate this erosion and has led to the prediction that up to two thirds of all plant species may stand on the abyss of extinction by the end of this century. We cannot rely on conserving plants where they grow. Therefore, off site (*ex situ*) conservation is necessary. Of the techniques available, only seed banks allow us to conserve billions of genetically different individuals for hundreds of years and relatively cheaply.

Long-term seed banks were first established for crop diversity in the middle of the last century. Work by Kew and in Spain in the 1960s showed that this technique could be applied to a much wider array of wild species and, in 1974 Kew created a seed bank for wild species at its Wakehurst Place garden in West Sussex. From the early 1980s the bank focused on plants from the world's dry lands which had received little attention from conservationists and yet which supported nearly a fifth of the world's people, providing everything from local foods and medicines to building materials and fencing. In the early 1990s a challenge was made by Kew's Trustees to expand sufficiently the work to make a significant impact on the problem of genetic erosion and species loss. The result was a plan for the seed collection of 24,000 species in ten years. Kew had recently established a strong fund-raising foundation and, fortuitously, the UK was preparing to celebrate the Millennium. In December 1995 the Millennium Seed Bank

Project was launched with a grant of close to £30 million from the Millennium Commission. The matching funding for this landmark project came from the Wellcome Trust, Orange plc, Kew itself, the public and many others. A fine new facility, the Wellcome Trust Millennium Building, was built at Wakehurst Place with a large underground storage vault, processing and research laboratories, public interpretation designed to show the conservation process unfolding, and residential accommodation for visiting scientists. It was opened by HRH The Prince of Wales on 20 November 2000. Simultaneously, Kew worked with the voluntary sector to collect samples of most of the UK's seed-bearing species; a world first for a national flora that encouraged other countries to follow suit.

In addition to the priceless seeds conserved and the thousands of samples distributed for unique research and habitat restoration, perhaps the greatest legacy of this unique project has been the international co-operation engendered. In some countries partnerships have been catalysed between institutes that have never worked together before. The partnership now comprises 128 institutes in 54 countries. Furthermore, there is now collaboration that is independent of Kew – a sure sign that the network is established. In 16 of these countries a major collaboration has been established with botanical, forestry and conservation agencies based on legally-binding agreements that clarify the expectations of both parties and cover collecting, capacity building and research. These agreements helped exemplify the implementation of the 1992 Convention on Biological Diversity (CBD). The

seed collecting work, mainly in dry vegetation, has brought together each nation's conservation priorities in a way that has helped deliver the project's species target. At the heart of targeting have been endangered, endemic (for which countries have a unique responsibility) and locally economic species. The capacity-building activities have centred on training both here and abroad, and assistance with the design and equipping of partner seed banks. The latter encourages *ex situ* conservation in the country where the plants grow; consequently, Kew's storage role is one of safety duplication. Underpinning this project is an unparalleled seed research programme that seeks to improve the effectiveness of storage and our ability to recover the full genetic potential of the collections by breaking seed dormancy. This can be a major problem with seeds of wild species and there is still much to be learnt. Such new data will not only benefit seed banks but horticulture, agriculture and habitat restoration.

The safeguarding of so many plant species by the partnership is both a major achievement and responsibility. But there is so much left to be done. Kew is now galvanising support for a successor project that will start in January. In order to keep the

seed banking operation lean and focused, a challenging target has been set of bringing the species stored up to 25% of the world's flora by 2020. Obviously, difficulty of locating and collecting new species increases with the law of diminishing returns. Additionally, and in line with Kew's Breathing Planet Programme, the new project will focus on using the collections sustainably including on the repair of damaged habitats. Demonstrating new uses of species drives the financial imperative to conserve. We have a unique chance to do something about the gathering storm. There is still significant plant genetic diversity left in the wild but it won't be there for long. We have the drive, expertise (Kew alone has over 500 person years of seed banking experience), the technology and partners to make a huge impact. With a price tag of £77 million, fund-raising is proving difficult in this time of financial stringency. However, it is money that must be found if the world is to have the tools to thrive in an uncertain future. It would be a fitting tribute to this country's foresight if the people of the 23rd century looked back to this moment as the one when their botanical legacy was secured.



A scientist putting the collected seeds into the vault at the Millennium Seed Bank