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Back to the Roots:
Wild Genes for Food Security

by **Colin Khoury and Luigi Guarino,** Global Crop Diversity Trust, Rome, Italy

By 2050 there will be over 9 billion people on Earth. The amount of food we produce now will probably not be sufficient to keep them all alive, let alone healthy. We also face a number of challenges for food production. The erosion and degradation of soils, the scarcity of water, arable land and other natural resources, the shortage and unreliability of energy, and the increasing impacts of climate change will all constrain our efforts to achieve real food security. Changing lifestyles and expectations in developing regions of the world, low stockpiles and high food prices, and decades of underinvestment in agricultural research won't make things any easier. The task is enormous. Luckily agriculture has an ace up its sleeve.

As we come closer to the world's limits in arable land and other resources for agriculture, crop improvement is projected to be the source of an ever-greater share of future production gains. The foundation of this improvement, is genetic diversity. Plant breeders scour genetic diversity – from wild plant populations, farmer's fields, gardens, orchards, and gene banks – to improve the yield, pest and disease resistance, tolerance to climatic stresses, energy efficiency, taste and nutritional quality of existing crops. And indeed to find new crops. It's from such efforts that will come the increased amounts of food we shall need.

As breeders have worked to maintain high production levels over recent decades, they have gone further afield to find the genetic diversity they need. Not just to other countries and even continents, but to other species, and in particular the wild plants that share a relatively recent common ancestry with cultivated plants. We call these plants crop wild relatives (CWR). Unlike your ne'er-do-well uncle, or the black sheep of the family, these wild relatives are actually useful to society!The wild portion of a crop's genepool generally contains more variation than is found in the cultivated taxon, as domestication has tended to create a genetic bottleneck: the efforts of farmers and plant breeders involve the selection of certain favoured types from the diversity available. Necessarily, selection leads to diversity being left behind. In the centres of origin of crops, wild relatives occasionally cross naturally with farmer's varieties, infusing the crops with a stream of new genes. Away from the natural distribution of the wild relatives, though, this process needs a helping hand from breeders and, increasingly, molecular geneticists.

The primary benefit derived from wild relatives by breeders has been the introduction into crops of genes to overcome stresses: examples include

***Musa itinerans,* a crop wild relative that could provide traits useful for commercially grown fruit. This was collected by staff of Southwest China Germplasm Bank of Wild Species and is held there, and at the MSB.**

PHOTO: RBG KEW

resistance to pests and pathogens, drought tolerance, and cold tolerance. Counter-intuitively, wild relatives have also contributed to increased yields and to quality traits, despite the wild species themselves not showing those traits. In tomato, deeper red colouration and larger size have come from wild species, despite the fruits of the wild species themselves being neither red, nor large. It was only by dissecting the genetic basis of fruit size at the DNA level, with molecular techniques, that it was found that some wild relatives had a few genes for large fruit size, along with lots of others which masked their effect. Another trait breeders are looking at in wild relatives is perenniality: think of wheat that wouldn't have to be sown every year.

On the frontiers of the use of CWR, the wild progenitors of wheat and groundnut have recently been used to "re-synthesize" the crops with slightly different starting materials than early farmers used. This broadens the diversity of crops by undoing the domestication bottleneck, a sort of evolutionary do-over. Wild relatives may also play a role in the future as new, alternative crops, especially as forages, fibres, and for industrial uses.

Story continues on page 2

MILLENNIUM SEED BANK PARTNERSHIP Kew

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Back to the Roots: Wild Genes for Food Security Continued from page 1

***Digitaria exilis.* A grass and cereal crop grown through-out the savanna as food for humans and fodder for animals. Held in the MSB.**
PHOTO: RBG KEW

Unfortunately, we may be losing the option of using these resources in the future. There are approximately 50-60,000 CWR species, of which 10,000 may be considered of high potential value to food security, with 1,000 of these being very closely related to the most important food crops. Up to 75% of these species may be threatened in the wild, and climate change is projected to impose further pressures Ironically, resources of potential high value for adaptation to climate change are also threatened by it.

The conservation of CWR is increasingly recognized as a high priority and a number of global and regional initiatives which focus on conservation and information sharing have been established (see links below). The conservation of these species in their natural habitats is important for their continued evolution, although climate change may impact the effectiveness of some *in situ* conservation efforts. The conservation of CWR in genebanks is vital, both as insurance against loss in the wild, and in order to facilitate access by plant breeders, researchers and other users.

Major gaps in the genetic diversity of important crop genepools remain to be filled in *ex situ* genebank collections. Estimates of the proportion of *ex situ* crop diversity holdings worldwide range from 2%-18%. Some 94% of European crop wild relative species are entirely missing from *ex situ* collections. Remember that there is more genetic diversity in these species than in the crop to which they are related. They may be more difficult to use than cultivated varieties: the crosses are often difficult to make and the beneficial traits hidden, but the techniques to overcome these difficulties, in particular molecular technologies, are becoming ever cheaper and easier to apply. We run the risk of having at our disposal the methods to cost-effectively exploit the diversity found in crop wild relatives, but having little diversity left.

Unfortunately, the number of new accessions collected yearly has decreased since the mid-1980s. The collection of CWR from important regions of diversity has been constrained by access issues, and limited resources devoted to collecting. Collection of CWR may also have been neglected compared to domesticated crops and to other wild species because their conservation tends to fall between biodiversity conservation and the agricultural development sector. The recent coming into force of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), in alignment with the Convention on Biological Diversity is, however, expected to provide impetus for the development of a collaborative, global approach to conserving plant genetic resources, including facilitating collection and sharing of CWR resources for crop improvement and research.

With the challenges facing agriculture a major new global initiative for the collection, conservation, and use of the wild relatives of crops is called for. The political framework has been facilitated by the ITPGRFA. The need is well understood. It is up to the global community of scientists, researchers, breeders, and conservationists to highlight the importance of this work, in order to provide a diverse foundation for adaptation to climate change, and for our food security.

Links:
1.Gap analysis of crop genepools: http://gisweb.ciat.cgiar.org/GapAnalysis/
2. Bioversity International (2009a) CWR Global Portal: http://www.cropwildrelatives.org
European Crop Wild Relative Diversity Assessment and Conservation Forum (2008): http://www.pgrforum.org/index.htm
3. International Union for Conservation of Nature, Species Survival Commission (IUCN/SSC) (2008) Crop Wild Relative Specialist Group. Internet page hosted by Bioversity International: http://www.cwrsg.org/index.asp

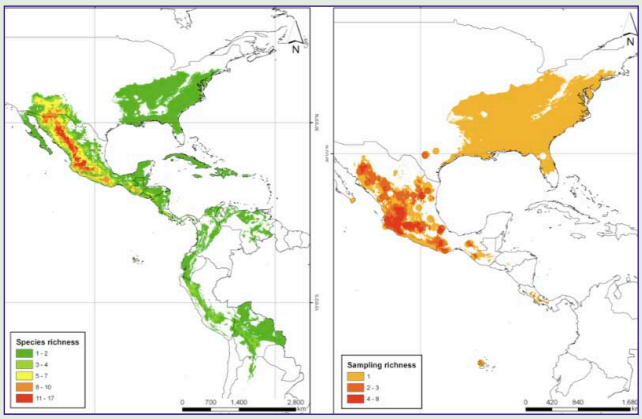


Fig.1A **Fig.1B**

Geographic Information Systems (GIS) are being used to support the research needed for cost-effective collecting efforts for CWR. Figure 1A displays the distribution of the CWR of bean (*Phaseolus*) in terms of richness of species (i.e. the number of species encountered in a given place). Figure 1B displays the priority areas for collecting these species in order to fill gaps in existing *ex situ* collections.

REFERENCE FOR IMAGE: RAMÍREZ-VILLEGAS J, KHOURY C, JARVIS A, DEBOUCK DG, AND GUARINO L (2010). A GAP ANALYSIS METHODOLOGY FOR COLLECTING CROP GENEPOOLS: A CASE STUDY WITH PHASEOLUS BEANS. PLOS1. IN PUBLICATION.

STOP PRESS – Funding for Crop Wild Relatives Project Secured

Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives

The Millennium Seed Bank Partnership has begun a new cooperation with the Global Crop Diversity Trust (GCDT) and the Consultative Group on International Agricultural Research (CGIAR) on a global initiative to systematically find, gather, catalogue, use, and save the wild relatives of wheat, rice, beans, potato, barley, lentils, chickpea, and 16 other essential food crops, in order to help protect global food supplies against the imminent threat of climate change, and strengthen future food security.

The initiative, led by GCDT, is the largest ever undertaken with the wild relatives of today's main food crops. These wild plants contain essential traits that could be bred into crops to make them more hardy and versatile in the face of dramatically different climates expected in the coming years. Norway is providing US$50 million towards this important contribution to food security. The work is scheduled to take 10 years, from determining where to collect, through to having material ready for crop breeding programs.

Crop wild relatives make up only a few percent of the world's genebank

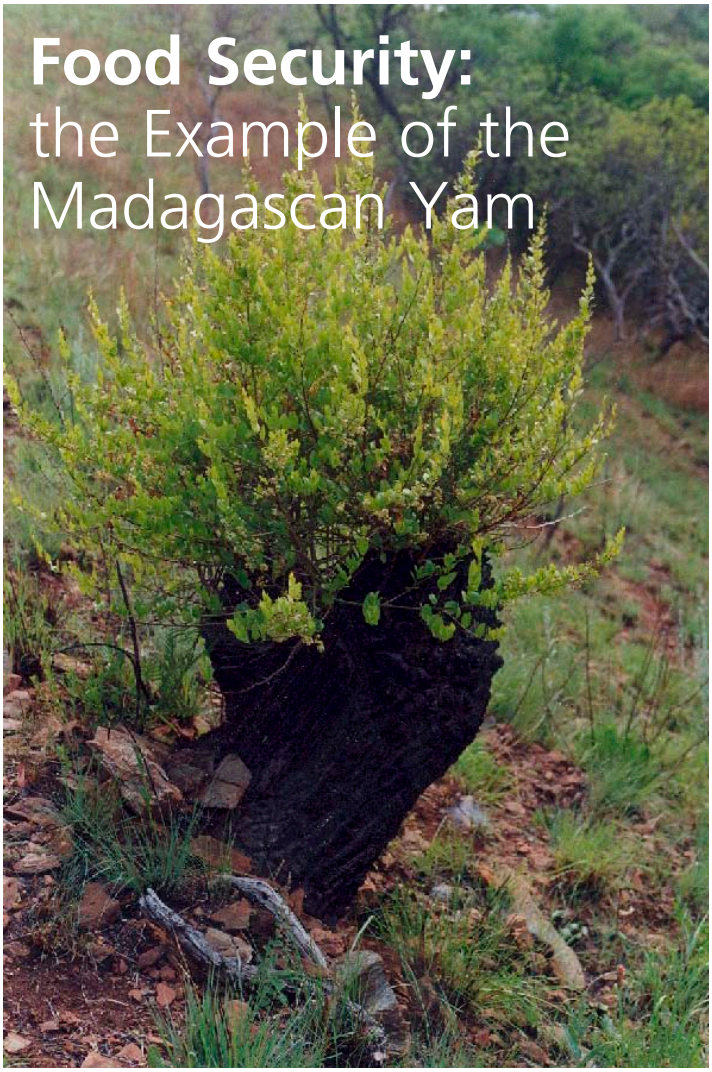
holdings, yet their contribution to commercial agriculture alone is estimated at more than US$100 billion per year. One example dates back to the 1970s, when an outbreak of grassy stunt virus, which prevents the rice plant from flowering and producing grain, decimated rice harvests across Asia. Scientists from the International Rice Research Institute screened more than 10,000 samples of wild and locally-cultivated rice plants for resistance to the disease and found it in a wild relative, Oryza nivara, growing in India. The gene has been incorporated into most new varieties since the discovery.

"Diversity equals resilience in the biological world, which is why this project is vital to the survival of agriculture," says Paul Smith, Director of the Millennium Seed Bank. Kew's unparalleled experience in wild plant collecting and seed biology will be brought to bear not just on a conservation problem, but on the whole issue of food security.

"This project represents one of the most concrete steps taken to date to ensure that agriculture, and humanity, adapts to climate change. At a more fundamental level, the project also demonstrates the importance of biodiversity and genetic resources for human survival," said Erik Solheim, Minister of the Environment and International Development of Norway, which is providing the initial budget to fund the work.

For further information please contact: Ruth Eastwood **(r.eastwood@kew.org)** and/or Jonas Müller **(j.mueller@kew.org)**

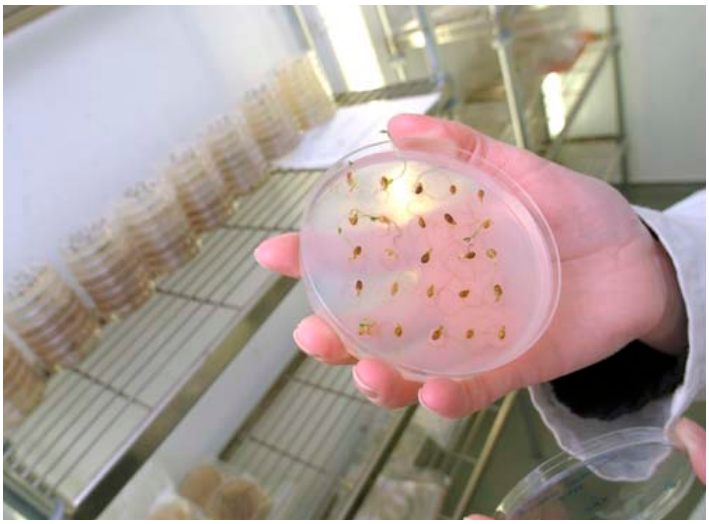
Food Security: the Example of the Madagascan Yam



Far left: **A *Dioscorea* plant in the field**
PHOTO: J.H.P. HUNTER

Left: **Equipment ready for carrying out cut tests.**
PHOTO: RBG KEW.

Below: **Germination test carried out at the MSB**
PHOTO: RBG KEW.



The wild relatives of crop plants constitute an increasingly important resource for improving agricultural production and for maintaining sustainable agro-ecosystems. With continued climate change and greater ecosystem instability, crop wild relatives are a vital resource in ensuring food security for the future.

Dioscorea (Dioscoreaceae) is a genus of over 600 species of tuberous herbaceaous perennial lianas which are native throughout the tropical and warm temperate regions of the world. Several species are known as yams, and are important agricultural crops, particularly in parts of Africa.

In Madagascar there are 32 *Dioscorea* species, 26 of which are endemic. It has been suggested that yams have been in cultivation since 8000 BC so they are of historical, cultural, and economic importance. Yams are an important food source but many of these species are threatened. They are versatile vegetables and can be used to make a variety of products after processing. As well as being an edible, the rhizomes are a rich source of steroidal saponins which are used in the pharmaceutical industry for the manufacture of hormonal medicines. Several species are also used to treat rheumatism and many species have local uses such as the production of arrow poison and in extracts used to stupefy fish.

Kew's Malagasy Millennium Seed Bank (MSB) partner, Silo National des Graines Forestières (SNGF), added their 1000th new species to Kew's MSB in 2009 – *D. maciba*, a yam. *D. maciba* produces one tuber per plant and is harvested in March and April. This period of harvest coincides with the period of rice shortage during the rainy season. The tubers can be stored for up to 6 months without refrigeration which makes them a valuable food source when food is scarce preceding the start of the wet season.

The collection was donated on 24th April 2009 and an initial germination test was carried out in March/April 2010. Germination occurred at 20ºC and 30ºC, but was optimal at 25ºC (8/16 light/dark) with 75% germination over 42 days. These results confirm that the collection is viable and therefore suitable for storage in the MSB. Apart from serving as an *ex-situ* collection, the seeds could be used for regeneration and restoration projects in the future.

For further information please contact Angie Gardener **(a.gardener@kew.org)**

NEWS

Seed Conservation Techniques Training Course, Tanzania

The 2010 Seed Conservation Techniques (SCT) course took place between the 20th September and the 1st October at Morogoro, and was hosted by the Tanzania Tree Seed Agency (TTSA), an MSBP partner. Supported by the Sfumato Foundation's three-year grant to the MSBP's training programme, this was the first time the biennial SCT course had been held outside of the MSB, and TTSA's HQ at Morogoro proved to be the perfect home.

Course particpants PHOTO: KATE GOLD

The course was opened by Professor Peter Gillah, Dean of the Faculty of Forestry and Nature Conservation at Sokoine University and chair of the TTSA board. Professor Gillah suggested that the course would be a period of learning for everybody, and so it proved, as 11 participants from seven countries shared their varied experiences of working with seeds. Trainers also improved their understanding of one another's specialist areas. The new friendships and useful networks established will be especially important as participants put into practice what they have learnt.

Feedback from participants showed that they had captured a great amount of new information. Everyone became more aware of seeds as living entities in their own right, and not just as inanimate objects gathered, bagged-up, sold or planted. Participants left Morogoro with a better understanding of the climatic conditions that seeds encounter. The concept of equilibrium relative humidity (eRH) was a new one to most participants, but by the end of the course all were talking about how to control and measure eRH in the field or laboratory and how to use eRH to manage seeds in storage.

In a change from previous courses, participants did not undertake an assessment, but instead drafted plans for specific actions they would take to improve procedures within the seed targeting, collection, processing, banking and management continuum in their own institution. These actions were presented to the whole group and participants pledged to share their questions and challenges with each other as they go about putting their actions into effect.

As Kew's Tim Pearce emphasised in his closing remarks, participants should be more comfortable knowing that they are not alone. They can be sure that their particular challenge - whether it's a germination or a species targeting problem - has been, or is being, tackled by others. He noted that seed conservation practice has been a rapidly changing discipline over the past decade, and that participants should not accept old style thinking and should have the confidence to put their action plan ideas into practice. The Kew resource persons – Tim Pearce, Kate Gold, Lindsay Robb and Bev Maynard - will be working with participants and their managers to help implement modifications or changes to standard procedures.

Thanks are due to TTSA's Director, Dr. Msanga, and all of his staff for making everyone feel so welcome, and well fed. Particular thanks are due to Ludovic Uronu for the behind the scenes organisation, and for making the weekend trip to Mikumi so enjoyable. Fandey Mashimba showed professionalism and tireless enthusiasm in executing his duties as resource person. Vanessa Sutcliffe's excellent organisation with Uronu and Fandey brought the course to fruition. Finally, thanks to Jon Gillespie who ensured that everyone had a lasting memory of the course in the form of a "Mbegu ni Hazina" ("Seeds are Wealth" in Swahili) T shirt.

Kate Gold k.gold@kew.org

Millennium Seed Bank Partnership: progress report

Following our meeting with partners at the MSB in October of last year, co-inciding with our 10% celebration, we have made considerable progress in developing and implementing the next phase of the programme. A ten year business case has been approved by Kew's Board of Trustees with the aim of:

- collecting and conserving high quality seeds from 25% of the world's plant species by 2020;
- enabling the use of those collections in habitat restoration and sustainable use programmes, and;
- ensuring the long-term financial security of seed conservation efforts in the network.

Over the past year, the MSB's international team has been working with partners to design project proposals that reflect these aims and are consistent with national and local priorities. At the same time, Kew's fund raising arm – the Kew Foundation – has carried out a fund raising feasibility study and has been developing a case for support for the Millennium Seed Bank Partnership. Against the backdrop of the global financial downturn and a squeeze on public funding in many countries, our fund raising efforts will be spread between a number of potential sources. These will include governments, philanthropic individuals, trusts and foundations and the commercial sector. There have already been some notable successes within the partnership, for example with the New South Wales seed bank at Mt Annan raising 15.5 million Australian dollars towards a brand new facility, and Germplasm Bank of Wild Species' in Kunming securing Chinese government funding for 10 years for seed collecting. We look forward to continuing to work with you as the new phase develops and, based on our track record, we have every chance of succeeding!

Paul Smith p.smith@kew.org

The European Native Seed Conservation Network continues...

After the successful completion of the European Native Seed Conservation Network (ENSCONET) Co-ordination Action in October 2009 (funded by the European Commission Framework Programme 6), the consortium members have decided to continue their collaboration on a continental level. The ENSCONET will further improve quality, co-ordination and integration of European seed conservation practice, policy and research for native plant species. The network will, for example, exchange information, equipment and staff and share data. Currently, 30 institutes from 18 European countries are members of the ENSCONET consortium. The Millennium Seed Bank Partnership will continue to provide the Secretariat.

For more information, visit the network's website www.ensconet.eu or contact Jonas Mueller **(j.mueller@kew.org**).

Congratulations!

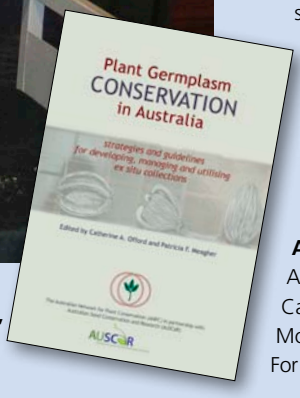
In September 2010, Professor LI Dezhu, the Director of Kunming Institute of Botany (KIB) of the Chinese Academy of Sciences, was awarded an honorary OBE by HRH the Duke of York, for his personal contribution to furthering the UK/China botanical collaborations and biodiversity conservation. The ceremony took place in Shanghai as part of a series of events organised to celebrate the UK's National Day at the World Expo. The British Ambassador to China and officials of the UK National Pavilion also attended the ceremony.

Professor LI Dezhu photographed with Lord Selbourne. PHOTO J. MUELLER

The Order of the British Empire was originally established by King George V in 1917, as an order of chivalry to honour those who had achieved outstanding merit in fields outside of the military and civil service. It has been given in the past to individuals from fields as diverse as the arts, diplomacy, humanitarian, education, law and medicine.

"A Message of Hope" – Launching the Germplasm Conservation Guidelines

Book editors Cathy Offord and Patricia Meagher 'scarify' the *Daviesia cordata* seed cake at the launch. PHOTO L.SEED



Cover of "Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising *ex situ* collections".
IMAGE: ANPC WEBSITE.

Australian partners of the Millennium Seed Bank Project recently participated in the launch of the book "*Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising ex situ collections*". The book reflects the substantial increase in knowledge and technical expertise in the areas of seed biology and plant reproductive biology, and was produced by the Australian Network for Plant Conservation (ANPC) in association with AuSCaR, the Australian Seed Conservation and Research network. Many of the authors have been involved in Phase 1 of the Millennium Seed Bank Project.

In launching the guidelines at the Native Seed Forum in Melbourne on 4th September 2009, Professor Lesley Hughes said the book provides "a message of hope" giving examples of what individuals and groups can do to look after biodiversity when so many messages of doom are pressing upon us.

Ex situ germplasm (usually seed) supports *in situ* conservation efforts and "provides research material to unlock the secrets of seed dormancy in the lab and in the wild; it allows us to establish new wild populations of threatened species with the best chance of success; and it provides an 'insurance policy' of genetically representative samples, to guard against the risk of extinction and the new threat of rapid climate change".

The new guidelines give detailed practical methods for collecting and storing germplasm as seeds, tissue cultures, through cryopreservation or as living plants; includes a flow chart for deciding which storage method is most appropriate for a particular project; and details case studies showing how techniques can be applied to conserving Australia's precious plant diversity.

Copies of the guidelines can be purchased through CSIRO Publishing (http://www.publish.csiro.au/pid/6188.htm)

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Plant and Seed Bank for New South Wales

The 2016 Botanic Bicentenary program of the Royal Botanic Gardens and Domain Trust, Sydney has provided an opportunity to significantly enhance scientific programmes of the organisation. Over the last few decades, our contributions to plant conservation, through seedbanking, tissue culture and associated research, have increased through major international collaborations such as that with the Millennium Seed Bank Project.

The development of PlantBank, a world-class science facility located at Mount Annan Botanic Garden, will improve delivery of the Trust's diverse scientific programs in horticultural research, conservation and education.

At the core of PlantBank is the NSW Seedbank which will store representatives of the majority of NSW seed bearing species. This collection will be used as a reference and research collection. It will complement the National Herbarium of NSW and the living plant collections across the Trust's four estates. Plant scientists will be able to contribute to and work with the germplasm of NSW flora, primarily in the form of seed.

Many species, perhaps as many as 20% of NSW species, cannot be seedbanked because they don't produce seed or their seed cannot be stored by conventional means. For these species some form of living plant material will be conserved in tissue culture, cryostorage or, indeed, form part of the garden collections.

Seeds, cuttings or plants will be available for scientific studies or for conservation activities such as reintroduction of threatened species and ecosystem restoration.

PlantBank laboratories will be used for a range of activities including growth studies, providing a valuable opportunity for the unique flora of NSW to be documented. The building will support up to 50 staff, visiting scientists, volunteers and students.

PlantBank – Artistic impression Lahznimmo Architects

PlantBank will incorporate viewing galleries and interactive displays in the public spaces which will engage visitors with horticulture and science activities within the laboratories, glasshouses and the surrounding landscape.

Modern design elements such as energy harvest, thermal efficiency, water capture and recycling and an intelligent building management system will blend with horticultural elements such as a green laboratory on the roof.

Building will commence in 2011 and will be completed by early 2013.

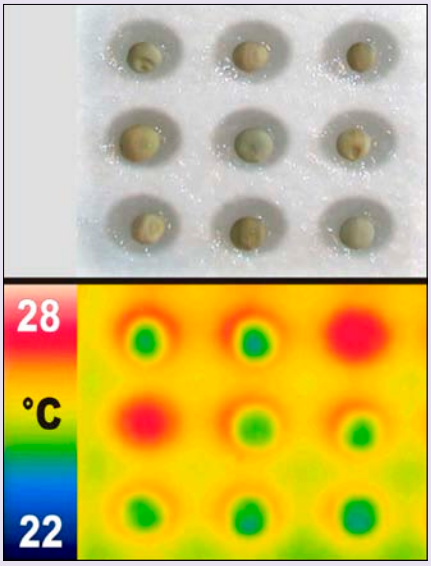
For more information, please contact: Dr Cathy Offord – Manager Horticultural Research/Senior Research Scientist **Cathy.Offord@rbgsyd.nsw.gov.au**
John Siemon – Project Manager – PlantBank

Non-invasive diagnosis of seed viability **using infrared thermography**

The assessment of seed quality through germination testing is not only time-consuming but destructive, which is undesirable for the seeds of rare and endangered plants. Alternative non-invasive techniques are currently being developed to dramatically change the diagnosis of seed quality. Led by Dr. Ilse Kranner, scientists from the Seed Conservation department, together with colleagues from the University of Graz, Austria, have developed a new method using infrared cameras to detect subtle changes in temperature when seeds take up water. These changes vary with viability. Pea (*Pisum sativum*) was chosen as a model species and the thermal profiles of hundreds of pea seeds were recorded. For each individual seed 22,000 images were analysed to construct a library of "thermal fingerprints" that allowed the scientists to distinguish viable and dead seeds in less than two hours.

When a dry seed takes up water, the sugar within the seed dissolves, and this process cools the seed down. The temperature of a single pea seed falls rapidly by 2 to 3°C. Viable seeds maintain cool temperatures because they break down storage reserves into sugar. Aged and dead seeds fail to break down their reserves, or can only break them down after a phase of repair, delaying the thermal profile. Using infrared thermography, viable and dead seeds can be distinguished within three hours of water uptake, a time period short enough to re-dry the seeds and store them again.

The method was validated for wheat (*Triticum aestivum*) and rape (*Brassica napus*) seeds and the applicability to a range of wild species will be tested in future studies. Importantly, the opportunity to select live and dead seeds prior to germination is a useful tool to improve studies into the fundamental principles of ageing and cell death, which are similar in plants, animals and humans.



When a seed imbibes, a 'thermal fingerprint' can be detected using infrared thermography. Thermal profiles are associated with biophysical and biochemical changes within the seed and vary with viability. Hence, infrared thermography can non-invasively predict whether a seed will germinate or die upon water uptake, here shown for *Pisum sativum* seeds IMAGE: COURTESY OF PROF. GERALD KASTBERGER.

Kranner I, Kastberger G, Hartbauer M and Pritchard HW. (2010). Non-invasive diagnosis of seed viability using infrared thermography. *Proceedings of the National Academy of Sciences* 107: 3912-3917.

For further information, please contact: Ilse Kranner
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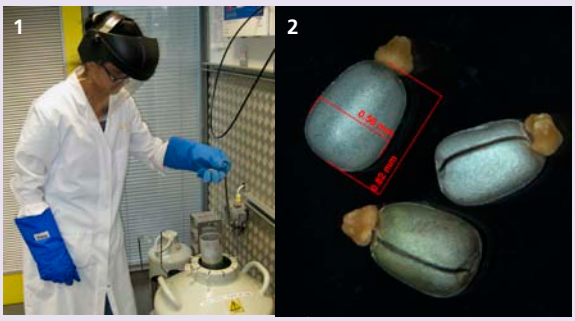
Visiting researchers during the summer of 2010



MSc student projects investigated seeds that are difficult to store under seed bank conditions. 1. cryopreservation of *Citrus reticulata* embryos. PHOTO: ASMA AKTER**. 2. seeds of *Euphorbia characias* in which intracellular ice formation was studied.** PHOTO: SAZZAD MAHMOOD **3. post viability staining of *Carica papaya* seeds** PHOTO: HARSHA VARDHAN **4. Seeds of the halophyte *Suaeda maritima* were investigated in relation to the mechanisms of salt tolerance at the germination stage.** PHOTO: JOHN WALLER

Summer is always a busy time for visiting research collaborators and students at the MSB. Beatriz Fernández-Marín (University of Bilbao, Spain), Lyuben Zagorchev (University of Sofia, Bulgaria; funded by COST Action FA0901 'putting halophytes to work – from genes to ecosystems') and Tanja Emmerich (Ecole Supérieure de Biotechnologie Strasbourg, France) came to investigate antioxidants in seeds, salt stressed cell cultures and resurrection plants (supervisors Drs. Ilse Kranner, Louise Colville and Charlotte Seal). Toni Devis Lopéz (post-graduate from Spain), Michelle Furlong (University College Dublin, Ireland) and João Cesar Lourenço Silvério (University of Lavras, Brazil) worked with Dr Peter Toorop on molecular aspects of seed dormancy in a number of species, including material from the MSB. Khaled Abulaila (National Center for Agricultural Research and Extension, Jordan) visited PhD co-supervisor Dr Tim Marks to continue research on the conservation and ecology of Jordan's wild terrestrial orchids. Finally, Cecilia Amosso (University of Pavia, Italy) visited Drs. Tiziana Ulian and Charlotte Seal to assess the viability of seed collections from the Dominican Republic.

For several years, the Research Section has supported the MSc Biotechnology course at the University of Bedfordshire by offering laboratory based projects. In June 2010, four students arrived to start their projects, staying until mid-September. Asma Akter (supervisor Dr Jayanthi Nadarajan) investigated the long-term storage of the species *Citrus reticulata* by using cryopreservation techniques; Sazzad Mahmood (supervisor Dr Jayanthi Nadarajan) investigated intracellular ice formation at sub-zero temperature during the cryopreservation of 11 species of Euphorbiaceae; Harsha Vardhan (supervisor Dr Tim Marks) used tissue culture to determine which components of the desiccation tolerant seeds of *Carica papaya* are involved in storage induced dormancy; and Farzana Yasmeen (supervisor Prof. Hugh Pritchard) investigated the effect of cooling rate and seed mass on viability after the cryopreservation of 5 species from the Fabaceae, Linaceae and Asteraceae families. The next intake of five students arrived in October.

Lastly, we said farewell to John Waller (University of Leeds) who joined the Research Section in the summer of 2009 as a one year college-based sandwich course student (CBSCS) supervised by Prof. Hugh Pritchard and Dr Charlotte Seal. John completed a project on seeds and salt and gave a presentation at the CBSCS day at the Jodrell, Kew. This year we have two CBSCS placements: Ros Fraser (University of York) took over from John at the end of July and Richard Smith (University of the West of England) started in August in the Conservation and Technology Section. All in all, another busy summer for research at the Seed Conservation Department!

For further information, please contact: Charlotte Seal **c.seal@kew.org**

Project MGU – The Useful Plants Project

Above: **Participants at the Project Review Workshop "MGU/Useful Plants Project" held on 20 to 24 June 2010 in Bamako, Mali.**
Far left: **Tree planting event organised during the Project Review Workshop "MGU/ Useful Plants Project", in the plot of the Yanfolila's community.** Left: **Tsetseng lady holding Kalahari melons (*Citrullus lanatus*), priority species growing in the community garden in Tsetseng (Botswana). The oil is extracted and the pulp and rind are processed for use in the communities.**
PHOTO: T.ULIAN

The Useful Plants Project now bears fruits of success and sustainability.

In June 2007, the Seed Conservation Department secured funds for a pioneer project on conservation and sustainable use of important species to rural communities' livelihoods in Africa and Latin America. Three years on, a review workshop provided an opportunity for the five partners in the Useful Plants Project (Project MGU) to meet and assess how well the difficult-to-measure higher level objective of 'contributing to human well-being of rural communities' had been met. Using the evidence they presented to the meeting, the skills and experience of the two external evaluators, Professor Paul van Gardingen (from the UNESCO International Development Centre, UK) and Dr. Hans Wahl (Senior Associate Director for Social Entrepreneurship Initiative at the Business School for the World, France) greatly helped this process.

The successes of the UPP stem from exceeding all target collections for numbers of species in seed banks in Botswana, Kenya, Mali, Mexico and South Africa, with duplicates at the MSB. Priority species selected by communities have been raised as seedlings and planted in communal gardens and enriched village forests. A refined list of 1200 species of interest to communities has been compiled from initial surveys, including mainly medicinal species and species used for food security and other amenities. Equally, the UPP collections helped complete the 10% overall target of banking seeds of wild species at the MSB. This target was reached in December 2009.

The sustainability of this project is first highlighted by the experience of the national partners in selecting the right groups of communities for the implementation of the project activities on the ground. The review workshop recognised that UPP had been successful in a strong engagement with communities in Botswana, Kenya and Mali: they have contributed time, effort and land used for planting and growing the useful plants. One good example is the Yanfolila case, where the UPP organic cotton grower community has been the role-model and created an interest for another 70 communities in the region. The successful generation of funds by the Botswana communities from government for the continuation and increase of the UPP activities, also underline the endorsement of the project by these partners. All partners have suggested developing income generation through the project activities in order to secure continuous dedication and increase the value of the UPP to human well-being in rural communities.

UPP has struck the right tone of using knowledge of plant science to address communities' needs to improve their livelihoods. Funds permitting this programme will go a long way to producing fruits of living improvements and poverty alleviation for future generations in those communities.

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A message from Paul Smith

Greetings from the MSB. We hope you like our new, electronic format Samara, which is more environmentally friendly, is cheaper to produce and which we are able to disseminate more widely. In this new format we will devote more space to advances in seed technology and research, and we will explore relevant themes in the seed conservation world.

In this edition, we are specifically looking at food security and the role of wild species seed conservation and use. I have just returned from a conference in Italy, hosted by the Global Crop Diversity Trust, in which the role of crop wild relatives in breeding crops for the future was discussed. The overwhelming conclusion was that crop wild relatives have been and will continue to be essential to crop breeders for conferring resistance to pests and diseases, improving yield, and increasing tolerance to abiotic stress.

Future Samaras will deal with similar big issues for which plants provide a significant part of the solution – deforestation, water scarcity, energy, climate change, habitat restoration and sustainable development. As seed conservationists, our role is not just to conserve plant diversity but to make it available to as wide a range of users as possible to enable both innovation and adaptation.

Obituary – Dr Wazael Ntundu

It is with great sadness that I have to announce the untimely death of our friend and colleague Dr. Wazael Ntundu. A trained agriculturalist, Dr. Ntundu secured his MSc. in Conservation and Utilization of Plant Genetic Resources from the University of Birmingham in 1997 and in 2003 received his doctorate in plant genetic resources from the Royal Veterinary and Agriculture University in Denmark. He returned to the National Plant Genetic Resources Centre where he headed the PGR Conservation and Management Section for a number of years before being seconded to the position of Millennium Seed Bank Project Co-ordinator for our Tanzanian partnership in 2006.

Equally at home in the laboratory, the committee meeting room or the field, Ntundu was a professional "all-rounder" who brought true coordination to our four partner institutes in Tanzania. He was Vice-Chairperson for the Southern and Eastern Africa Network for Underutilized Crops, an executive committee member of the Plant Breeders Association of Tanzania and was recently appointed as a board member of the Tanzania Tree Seed Agency.

As well as the sense of loss shared by his professional colleagues, Ntundu was a strong family man and I had the pleasure of meeting Ntundu's devoted wife and three lovely children. Our thoughts are with them at this sad and difficult time.

Pumzika kwa amani rafiki yetu mwema.

Tim Pearce t.pearce@kew.org

Key Research Publications from the MSBP in 2010

1. Kranner I, Kastberger G, Hartbauer M and **Pritchard HW**. (2010) Non-invasive diagnosis of seed viability using infrared thermography. *Proceedings of the National Academy of Sciences* 107: 3912-3917.

2. Kranner I, Minibayeva FV, Beckett RP and **Seal CE**. (2010) What is stress? Concepts, definitions and applications in seed science. *New Phytologist* 188: 655-673.

3. Roach T, Beckett RP, Minibayeva FV, **Colville L**, Whitaker C, **Chen H**, Bailly C and **Kranner I**. (2010) Extracellular superoxide production, viability and redox poise in response to desiccation in recalcitrant *Castanea sativa* seeds. *Plant, Cell and Environment* 33: 59-75.

4. Seaton PT, Hu H, Perner H and **Pritchard HW**. (2010) *Ex situ* conservation of orchids in a warming world. *Botanical Review* 76: 193-203.

5. Santamaría ME, **Toorop PE**, Rodríguez R and Cañal MJ. (2010) Dormant and non-dormant *Castanea sativa* Mill. buds require different polyvinylpyrrolidone concentrations for optimal RNA isolation. *Plant Science* 178: 55–60.

6. Kranner I and **Colville L**. (2010) Heavy metals and seeds: Biochemical and molecular implications and their significance for seed germination *Environmental and Experimental Botany*. doi:10.1016/j.envexpbot.2010.05.005.

7. Colville L and **Kranner I**. (2010) Desiccation tolerant plants as model systems to study redox regulation of protein thiols. *Plant Growth Regulation*. 62: 241-255.

8. Seal CE, Zammit R, Scott P, Nyamongo DO, **Daws MI** and **Kranner I**. (2010). Glutathione half-cell reduction potential as a seed viability marker of the potential oilseed crop *Vernonia galamensis. Industrial Crops and Products* 32: 687-691.

9. Seal CE, Zammit R, Scott P and **Kranner I**. (2010) Glutathione half-cell reduction potential and α-Tocopherol as viability markers during the prolonged storage of *Suaeda maritima* seeds. *Seed Science Research* 20: 47-53.

10. Kranner I, **Roach T**, Beckett RP, Whitaker C and Minibayeva FV. (2010) Extracellular production of reactive oxygen species during seed germination and early seedling growth in *Pisum sativum. Journal of Plant Physiology* 167: 805-811.

Millennium Seed Bank Collection Figures November 2010

Total collections	55,877
Number of species	29,907
Number of genera	5,157
Number of families	341
Number of countries represented	165

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