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 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.
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 diversity, but they are of high potential value to food security, with 1,000 of these species considered of high potential value to food security, with 1,000 of these species 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, but 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 genebanks 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 crops 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:
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 herbaceous 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) and/or Jonas Müller (j.mueller@kew.org)
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.

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


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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