Plant Genetic Resources: Our challenges, our food, our future

Thursday 2nd June 2016

The knowledge, conservation and use of plant genetic resources (PGR) have never been as important as now with the risk of climate change and habitat degradation threatening the very species that we depend upon. The challenges we face in food security range from the global to the local perspective; from the identification of global centres of crop diversity to finding hotspots of PGR richness within a country; and from the interdependence of nations upon each other for staple crops, to the cultivation of essential landraces to meet local needs.

Timetable for the day

Time	Event	Speaker
9.30-10.00	Registration/ Tea and coffee provided	
10.00-10.10	Welcome/opening	
10.10-10.20	Brief introduction to PGR conservation and use	Nigel Maxted
10.20-10.45	Adapting Agriculture to Climate Change project	Ruth Eastwood
10.45-11.10	Global *in situ* conservation analysis of CWR	Holly Vincent
11.10-11.35	Southern African CWR Conservation	Joana Magos Brehm
11.35-12.00	Valuing Genebank collections	Dr Mike Jackson

Time	Event	Speaker
12.00-13.00	Lunch provided	
13.00-14.00	**Svalbard Global Seed Vault**	**Åsmund Asdal**
14.00-14.25	Incorporating UK Collection into Svalbard	Åsmund Asdal and UK Collection Managers
14.25-14.50	Heritage Seed Library	Neil Munro
14.50-15.10	Tea and coffee provided	
15.10-15.25	Nature2000 and *in situ* conservation of landraces in Scotland: Machair Life	Maria Scholten
15.25-16.05	Short presentations on the work being undertaken at the university on plant genetic resource conservation around the world.	Aremi Contreras Toledo/ Maria João Almeida/ Sami Lama
16.05-16.30	Potential for Genetic Diversity conservation - the 'Fifth Dimension' - within wider Biodiversity protection	Julian Hosking
16.30	CLOSING	

Conference organisers: **Jade Phillips**- jvp163@student.bham.ac.uk, **Aremi Contreras Toledo**- ARC382@studentbham.ac.uk, **Maria João Almeida**- almeida.mariajoao@gmail.com , **Mouza Nassep**- man566@student.bham.ac.uk

10:10-10:20

Nigel Maxted

Brief introduction to PGR conservation and use

Abstract

Ensuring our future food security is perhaps the greatest challenge of our time. Currently 1 in 9 people worldwide suffer from chronic hunger and with the human population projected to rise to 9.6 billion by 2050, the pressure on the food production is likely to be dramatically increased. In fact, it is estimated that food supplies in developing countries will need to increase by 100%, with a 60% increase globally to meet this growing demand. Food security is also expected to be dramatically impacted by climate change, the IPCC fifth assessment predicts that crop yield losses are projected to rise to up to 25% in the latter half of the century without mitigation action being taken. One potential solution is the production of a new generation of crop varieties that utilise a wider range of genetic diversity that can better withstand the extremes of climate change, endure pest and disease attacks, require fewer resources for growth and provide a greater concentration of nutritional benefits. Such diversity is available within traditional crop landraces (LR) and crop wild relatives (CWR). LR and CWR diversity, conservation and utilization will be introduced and major the major challenges to their effective conservation and use highlighted.

10:20-10:45

Ruth Eastwood

Adapting Agriculture to Climate Change project

Abstract

Adapting Agriculture to Climate Change is one of the most urgent challenges of our time. Crop wild relatives (CWR) are the richest source of untapped diversity available to improve the world's crops.

They have proven used in providing resistance to pest and diseases, greater yields and increasing are being used to provide solutions to abiotic stresses. The Adapting Agriculture to Climate Change project is a global initiative to collect, protect and prepare crop wild relatives. Led by the Royal Botanic Gardens, Kew and the Global Crop Diversity Trust the project focuses on the CWR of 29 crops. They are: African rice, alfalfa, apple, eggplant (aubergine), bambara groundnut, banana, barley, wheat, lima bean (butter bean), carrot, chickpea, common bean, cowpea, faba bean (broad bean), finger millet, grasspea, lentil, oat, pea, pearl millet, pigeon pea, plantain, potato, rice, rye, sorghum, sunflower, sweet potato and vetch. Country partners are being supported to collect their CWR. Collected material will be conserved and passed to pre-breeders to evaluate, characterize and include in breeding programs. Material will also be available for request under the SMTA.

Ruth has been working at the Royal Botanic Gardens, Kew since 2007 where she joined as a Seed Information Database Assistant. She then worked on the project European Native Seed Conservation Network (ENSCONET) as a data Assistant from 2008-2009. Currently she is the Project Co-ordinator for the Adapting Agriculture to Climate Change project where she coordinates Kew's activities with partners such as the Global Crop Diversity Trust. This build on her passion for plants and her DPhil entitled "Systematics of Andean *Lupinus* and the origin of *Lupinus mutabilis*."

10:45-11:10

Holly Vincent

Global *in situ* conservation analysis of CWR

Abstract

Crop wild relatives (CWR) are an underutilised resource in the fight for food security under an unpredictable changing climate and growing human population. These wild species have been successfully used as gene donors to crops for decades with traits successfully introgressed including drought tolerance and pest resistance. Despite their importance, CWR remain largely under-conserved both *in situ* and *ex situ*, limiting our future ability to adapt food crops to suit our needs.

Only a handful of reserves dedicated to CWR conservation are in existence globally. However, most of these do not meet the quality standards for *in situ* genetic conservation. To improve the outlook for both global food security and CWR populations *in situ*, we present the first attempt at systematic *in situ* conservation planning of globally important CWR. 173 crops and their associated 1432 CWR were studied with occurrence records acquired from herbaria, online biodiversity datasets and CWR experts. MaxEnt software was used to produce maps of predicted distribution from cleaned and edited occurrence records, for both current and future climates. Analysis of genetic diversity was undertaken by clustering edaphic, climatic and geophysical variables over species native areas, acting as a proxy for population genetic information which was largely unavailable. The reserve planning software Marxan was used to find the most efficient network of reserves for CWR conservation whilst maximising taxon genetic diversity and likelihood of taxon persistence against climate change. Final prioritisation of potential sites was based upon various food security metrics and site rankings.

Holly is a final year PhD student with specialisation in programming, data processing and manipulation. She had previously worked in the computing and telecoms industry before changing her career path and enrolling on the Plant Genetic Resources Conservation and Utilisation MRes at the University of Birmingham. Since then she has contributed to several regional and global projects, key scientific papers and book chapters on crop wild relative conservation and utilisation. Her interests lie primarily in improving conservation planning using holistic and multi-factored approaches.

11:10- 11:35

Joana Magos Brehm

CWR conservation in the SADC region

Magos Brehm J[1], Allen E[3], Bissessur P[2],Dulloo ME[3], Fakim Y[2], Gaisberger H[3], Hammer M[4], Kell S[1],Matlou JM[5], Mpolokeng M[5], Maluleke NL[5], Munkombwe G[6], Ng'uni D[6], Nkuna L[4], Raimondo DC[4], van Rensburg W[7], Thormann I[3],Tjikana T[5]and Maxted N[1]

[1]University of Birmingham, [2] University of Mauritius, [3]Bioversity International, [4]South Africa National Biodiversity Institute, [5]Department of Agriculture, Forestry and Fisheries South Africa, [6]Zambia Agriculture Research Institute, [7]Agriculture Research Council South Africa

Abstract

The Southern African Development Community (SADC) includes 15 countries and is the origin or primary region of diversity of a wide range of crops including cotton, cowpea, melon, millets, sorghum, and watermelon. This region is also particularly diverse in terms of the wild relatives of these crops. Crop wild relatives (CWR) are potential sources of traits for crop improvement due to their relative close genetic relationship to crops. They constitute an important socio-economic resource to maintain food security at national, regional and global levels. The *SADC Crop Wild Relative project – Enhancing the link between in situ conservation and use of crop wild relatives in the SADC region to underpin regional food security and mitigate the predicted adverse impacts of climate change*, an EU-ACP funded project led by Bioversity International, addresses the conservation of CWR of this region via three main components: capacity building, development of national strategic action plans for the conservation and utilization of CWR in the three partner countries: Mauritius, South Africa and Zambia, and regional diversity analysis for priority CWR diversity at the SADC level. In this presentation, I will give a brief overview of this project focusing on these three components, as well as provide the results obtained so far.

Joana Magos Brehm For the last 12 years I have been working on different aspects of conservation of plant genetic resources, namely on *ex situ* and *in situ* conservation, and development of national conservation strategies for the conservation of crop wild relatives and landraces. I did my degree at the University of Lisbon (Portugal) and my MSc and PhD at the University of Birmingham (UK). I have been employed by the National Museum of Natural History and Science of Lisbon (Portugal), and worked as a consultant for Bioversity International, IUCN and FAO. I'm currently a Programme Officer of the IUCN SSC Crop Wild Relative Specialist Group and a research associate at the University of Birmingham working in the SADC Crop Wild Relative project.

11:35-12:00

Dr Michael Jackson OBE

Valuing Genebank Collections

Abstract

How do you place a value on gene bank collections? Is it aesthetic, monetary, or biological? And how would some of these values be calculated?

Gene bank collections (or biodiversity in general) have an 'existence value', although this is difficult to quantify. It's intangible to some extent. It makes us feel good. We also delight in the aesthetics of germplasm diversity. However, it is also appropriate to ask if too much diversity is conserved in gene banks. Why? Because many gene banks lack the resources to ensure its long-term survival. Germplasm also has an 'option value' to be realized at some future date when it is used for the benefit of society. Adequate provenance data, as well as characterization and evaluation all add value to conserved germplasm. But it is the use of this germplasm to enhance agricultural productivity or enhance ecosystem services that brings its value, both monetary and biological, into focus. In this talk, the value of rice and potato gene bank collections will serve as examples.

Mike's career in genetic resources began in 1970 when he joined the MSc course on *Conservation and Utilization of Plant Genetic Resources* at The University of Birmingham. From January 1973 he spent over eight years at the International Potato Center (CIP) in Peru, collecting and studying landrace varieties of potatoes and, in Costa Rica, breeding potatoes adapted to hot environments and resistant to bacterial diseases. In April 1981 he joined the Department of Plant Biology at Birmingham with most of his teaching focused on the MSc course on genetic resources. In July 1991 he moved to the International Rice Research Institute (IRRI) in the Philippines to manage the world's largest genebank for rice as program leader for genetic resources and first head of the Genetic Resources Center. From 2001 until his retirement in 2010, he served as IRRI's Director for Program Planning and Communications.

He has over 40 years research experience, with more than 125 scientific papers and book chapters on genetic resources conservation, evaluation and use, and biosystematics, as well as pre-breeding, agronomy, and plant pathology. He is author/co-editor of four books on genetic resources, the most recent (in 2014, with Brian Ford-Lloyd and Martin Parry) about genetic resources and climate change.

He has a BSc (botany and geography, 1970) from the University of Southampton, and MSc (1971, genetic resources) and PhD (1975, potato biosystematics) degrees from The University of Birmingham. He was made an OBE in the 2012 New Year's Honours for services to international food science.

13:00-14:00

Åsmund Asdal

The Svalbard Global Seed Vault (SGSV)

Abstract

The Svalbard Global Seed Vault (SGSV) was opened in 2008 and provides a safety facility for the international conservation system of plant genetic resources (PGR). At present, 66 gene banks and research institutes have deposited 881,473 accessions of seeds in The Vault, representing more than 5000 species of crops and their wild relatives. This means that about 40% of the known diversity of crop plants conserved in gene bank collections globally are duplicated in SGSV. Plant genetic material, held by gene banks and research institutes all over the world, is instrumental for plant breeding, and perhaps the most vital resource for increasing global food production. The idea of having security storage of gene bank seeds in Svalbard was initiated during the 1980s. In 2006, after finalized negotiations on the International Plant Treaty, it was proclaimed that Norway would build a seed vault and offer free of charge space for seed deposits from the international community of gene banks. The initiative was launched in accordance with Norwegian commitment and contribution to international endeavor on biological diversity and genetic resources in particular, and after extensive support for the idea from international bodies. The vault is managed through cooperation between The Norwegian Ministry of Agriculture and Food, Crop Trust and NordGen. Svalbard is considered to be a perfect location for a global seed conserving facility. Permafrost is present in Svalbard, and it is a remote place, far away from regions suffering from conflicts. At the same time, the location benefits from good infrastructure, such as an airport with frequent flight connections. The importance and need for the SGSV as a security facility was proven in 2015, when the International Centre for Agricultural Research in the Dry Areas (ICARDA) claimed for the first retrieval of deposited seeds, as their gene bank collections in Aleppo, Syria needed to be multiplied and conserved in another location.

Åsmund Asdal is a Norwegian horticulturist and ecologist who, for the past 20 years, has mainly been involved with projects on conservation and use of plant genetic resources on a national and Nordic regional level. From 2000 to 2015, he was in charge of the Norwegian national Plant Genetic Resource programme at the Norwegian Genetic Resource Centre. From the mid-1990s, he has conducted projects and working groups within the Nordic Gene Bank, and in 2015 he was appointed as Coordinator of Operation and Management for the Svalbard Global Seed Vault at the Nordic Genetic Resource Centre (NordGen, former Nordic Gene Bank). Main tasks are handling of seed deposits and liaising with current and potential gene banks and research centres holding collections of seeds important for global food security.
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14:25-14:50

Neil Munro (nmunro@gardenorganic.org.uk)

Heritage Seed Library, Garden Organic

Abstract

Garden Organic's 'Heritage Seed Library' is a seed collection of vegetables, begun as a response to EU Seed Legislation that was introduced in 1973. The founder Lawrence Hills had begun to see varieties diminish and began to collect seed of these. This collection grew and 'The Heritage Seed Library' produced its first catalogue for members in 1986.
We currently have close to 800 'varieties' (with more to trial) and we make a selection of these available to members each year. We produce seed of these vegetables at Ryton Gardens near Coventry and are supported in this by 200 volunteer growers as well as a handful of professional growers across the UK who produce seed for us. All our accessions have been donated to us and we have also carried out two projects to track down seed, the first, 'Seed Search' in 1997 & the other, 'Sowing New Seeds', focussing on unusual/non-traditional species in 2010.We also collaborate with seed collections/savers and organisations across Europe that similar to us, lobbying on legislation, exchanging best practice on managing seed collections and teaching others how to save and produce seed.
For more information contact: hsl@gardenorganic.org.uk or visit website at: http://www.gardenorganic.org.uk/hsl

15:10-15:25

Maria Scholten

Nature2000 and *in situ* conservation of landraces in Scotland: Machair Life

Abstract

A film will be shown that was produced during the Machair LIFE project (http://machairlife.org.uk/). Machair Life was a four-year project which ran from January 2010 to June 2014, and aimed to demonstrate that traditional crofting practices have a sustainable future. Machair Life was supported by the European Union LIFE+ scheme, and managed by The Royal Society for the Protection of Birds (RSPB) in partnership with Scottish Natural Heritage (SNH), Comhairle nan Eilean Siar (CnES) and the Scottish Crofting Federation (SFC). The project, while broadly aiming at habitat conservation, included a work package on local landrace seed production. The inclusion in the project of seed production showed the crucial role of local cereal landraces for wildlife and its acknowledgement by the conservation agencies. The film will show the complexities of habitat conservation in a habitat that largely includes arable fields. The small scale extensive form of agriculture prevailing in the Outer Hebrides (and the rest of the Highlands and Islands) is 'crofting', the 130 year-old land tenure system that is regulated in crofting law. Involved as consultant for the seed work package, I will explain how the work package was designed and implemented.

Maria is Independent researcher working in the Highlands and Islands of Scotland and a free-lance collaborator and advisor on seed projects and policy with the Scottish Crofting Federation (SCF). Recent work includes a workshop on landraces for Common Good Food's Seed and Trees Festival in Glasgow 2016; project manager for SCF of the EU funded projects *Hungry for Rights* about alternative food systems and *Farmers' Seed* project which included the*Let's Liberate Diversity* international seminar on agricultural biodiversity in Strathpeffer in 2012 and produced a book on Farmers' Rights Best Practice case studies; advisor on local seed on the Hebridean islands of Uist for the *Machair LIFE+* project (2009 -2013); involved in the educational project Crofting Connections (2009 -2015) delivering landrace seed learning packs and workshops for schools; involved in the Crofting curriculum for S5 and S6 at Lionacleit Community School on Benbecula with classes on seed, arable weeds and landraces (2009 -2010); research project on Scottish landraces (2009 – 2012); advisor for Slow Food Scotland's Arke of Taste. *Civil society action on plant genetic resources in Scotland 2014*, country report submitted to the FAO in 2014.

15.25-16.05

Maria João Almeida

A National Strategic Action Plan for Portuguese Landraces Conservation

Almeida, Maria [a]; Maxted, Nigel [b]; Magos Brehm, Joana [c]; Barata, Ana Maria [d]

[a, b, c] University of Birmingham, United Kingdom [d] Banco Português de Germoplasma Vegetal / Instituto Nacional de Investigação Agrária e Veterinária, I.P., Portugal

Abstract

The knowledge, use and conservation of landraces (LR) are being neglected even though these genetic resources are important to human welfare and sustenance. Overall, there is a need for a systematic approach to LR active conservation in Europe. Despite Portugal's systematic *ex situ* conservation of LR, a pressing outline of a National Strategic Action Plan is needed to prevent the loss of this genetic resources due to present and future agricultural and environmental changes. A National Strategic Action Plan will contain measures, strategies, plans to LR conservation and sustainable use. The current presentation will summarize this Ph.D. work that aims at increase Portuguese LR knowledge thus securing their effective conservation and use by the development of a National Strategic Action Plan.

15.25-16.05

Aremi Contreras Toledo

Development of a crop wild relative conservation strategy for Mexico

Contreras-Toledo, Aremi R[1, 2]; Cortes-Cruz, Moises A[2]; Costich, Denise[3]; Magos Brehm, Joana[1]; Rico-Arce, Lourdes[4] and Maxted, Nigel[1]

[1]School of Biosciences, University of Birmingham, UK; [2]National Genetic Resources Centre-INIFAP, Mexico; [3]International Maize and Wheat Improvement Centre (CIMMYT), Mexico, [4]Royal Botanic Gardens, Kew, UK

Abstract

Crop Wild Relatives (CWR) are plant species closely related to the crops and they have been particularly useful as sources of variation for conferring resistance to plant pests and diseases, improving agronomic traits and productivity as well as for gaining adaptability to abiotic stresses. CWR represent potential genetic resources to help mitigate the threats to agrobiodiversity and food security. However, the diversity of CWR globally and specifically in Mexico, an important center of agrobiodiversity, is threatened by the impacts of climate change, habitat destruction, human population growth, among other factors. Thus, the objective of this research is to analyze the diversity of the CWR related to the most important crops in Mexico as a basis for the development of a national conservation strategy for their systematic long term conservation. The main procedures are: a) development of a national CWR inventory, b) *in situ* and *ex situ* gap analyses, c) threat assessments, d) climate change impact assessments and e) predictive characterization of priority CWR. By applying a series of criteria related to the socio-economic value and energy supply of the related crops, geographical distribution, threat status and the level of relationship to the crop, 313 CWR taxa were identified as a priority. These taxa form the national CWR inventory and are the basis of the analyses towards the development of the national CWR conservation strategy.

15.25-16.05

Sami Lama

Developing methodologies of genetic conservation for crop wild relatives in North Africa

Abstract

Crop wild relatives (CWR) are wild species that are more or less genetically related to crops. CWR harbour useful genes that can be used for improvement of productivity, resistance to biotic and abiotic stresses and quality of cultivated crop. Therefore, they are an important key to achieve food security of increasing population and to overcome the challenges caused by climate change and the new virulence of major diseases and pests. These resources are increasingly threatened in their natural habitats through over-exploitation and land reclamation and degradation.

Therefore, their efficient and effective conservation would be taxonomically and genetically valuable, and will contribute in maintaining and promoting the sustainability of crop diversity, facilitating agricultural production and supporting the increasing demand for food, feed and natural resources. North Africa is well-known for its floristic richness and endemism. It is a centre of diversity of some globally important species, including many cereals, food legumes, vegetables, forages, and fruit trees and nut crops. The objectives of this project are identification and prioritization of CWR in the North Africa, establishment of a base-line database including ecogeographic data, *in situ* and *ex situ* gap analysis using DIVA-GIS to establish hotspots of diversity, and *in situ* and *ex situ* conservation priorities, and assessment the effect of climate change on priority species distribution patterns. The outcomes will form the basis of a regional strategy for *in situ* and *ex situ* CWR conservation in North Africa.

16.05-16.30

Julian Hosking

Potential for Genetic Diversity conservation - the 'Fifth Dimension' - within wider Biodiversity protection

Abstract

CWRs are undoubtedly part of the wider concept of 'Biodiversity' but are not yet recognised as such in our national or international biodiversity designations. They also need to be conserved alongside landraces, wild harvested plants (WHPs), fungi, woodland trees, algae, etc. both *in situ* and *ex situ* (including in seed/gene banks) for their full range of potential future uses. Likewise, their place in holistic genetic resources diversity conservation* is an essential part of the context. [*Cultivated Plant Genetic Resources (PGR), Farm Animal GR, Forest GR, Aquatic GR, and Microbial & Invertebrate GR.] Current UK biodiversity conservation programmes focus primarily on the *in situ* protection and management of 1,150 'priority' species and 65 'priority' habitats. There is no mention of genetic diversity or potential utility in these assessments and the '5th Dimension' of biodiversity preservation objectives is consequently absent. Nevertheless, current agri-environment schemes do provide some support for the *in situ* maintenance and creation of traditional orchards, native breeds at risk grazing, and species-rich grassland and woodland. National Nature Reserves (NNRs) and other protected areas (e.g. SSSIs and SACs) may contain significant plant and fungal genetic diversity but this is normally only incidental and passive conservation.

The Lizard NNR is the first to embrace CWR conservation as part of its Management Plan and this presents an opportunity to begin to bridge the otherwise widening gap between standard nature conservation approaches and the sustainable perpetuation of agricultural, horticultural and silvicultural biodiversity. Using the rapid developments in DNA and genomic analyses, the '5th Dimension' of biodiversity conservation (i.e. Within-species and taxon genetic diversity) is now within our reach.

Julian was brought up on family farm (dairy, sheep and arable) in East Kent and worked on a wide variety of farms in Kent, Devon, Cornwall, Northern France and Southern Germany. He studied Agriculture at Seale-Hayne College, Newton Abbot, Devon; Rural Estate Management at the Royal Agricultural College, Cirencester, Gloucestershire; and Town & Country Planning at the University of the West of England, Bristol. He was then employed as a Rural Surveyor and Land Management Adviser by MAFF/ADAS in Kent 1982-1989; as a Senior Lecturer in estate management subjects at the Royal Agricultural College 1989-1994; as a Land Agent/Lead Regional Surveyor and Regional Land Management Adviser for English Nature in the South West 1994- 2006; and by Natural England as a Senior Specialist in Rural Land & Estate Management in the South West 2006-2011. Julian is currently employed as a Senior Adviser in Invasive Non-native Species, Plant Diseases, and Genetic Resources Conservation for Natural England (since 2011).
Member of the UK Farm Animal Genetic Resources Committee (appointed by Defra) 2008 to present, and chairman of its Monitoring and Conservation sub-group.

Recent and current projects include:

- Promotion of the value and importance of the conservation of farm animal and cultivated plant genetic resources in agriculture (e.g. UK native livestock breeds, orchard tree varieties, thatching material plants & varieties, & crop wild relatives.).
- Innovative agri-environment scheme developments (e.g. supplements for UK native breeds grazing*, invasive species control, small fields, difficult sites, etc.).
- Prevention and control of invasive non-native species and plant diseases in the wider environment.
- Biodiversity policy enhancements (especially in respect of Agricultural, Horticultural and Silvicultural genetic diversity), CAP reform, rural development programmes, and State Aid improvements.