A novel strategy to discover and use climate-adapted germplasm

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Between 2012 and 2015, 150 researchers, research managers, genebank managers, extension agents, university professors and staff of non-governmental organizations from Bhutan, Burkina Faso, Costa Rica, Côte d'Ivoire, Guatemala, Nepal, Rwanda, Uganda, Zambia and Zimbabwe acquired new knowledge and skills about the use of climate and crop modelling tools and data sources including the climate analogue tool introduced through the CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS). For about 90% of them, learning about and using these tools and data sources was a novel experience.

Applying these tools and data to their national context, they assessed the changing needs for national and foreign-sourced plant genetic resources for food and agriculture in the context of climate change adaptation.

Research teams are now designing and implementing strategies to deploy germplasm that is better adapted to future climatic changes and that could contribute to increased food security. They are integrating these strategies into their organizational agendas that will be implemented with their own resources.

Photo: Bioversity International/C.Zanzanaini and R.Vernooy


Photo: Bioversity International/R.Vernooy

Resilient seed systems resource box

Training teams led by staff of Bioversity International produced training materials in English, Spanish and French consisting of PowerPoint presentations, reference materials, examples of distribution maps and practical exercises. These materials and the lessons learned from the series of training workshop are currently being integrated in a 'Resilient seed systems resource box', an on-line tool available soon at www.seedsresourcebox.org.

The resource box is a one-stop address for finding selected resources supporting the research process that helps countries adapting their seed systems to climate change. It is a flexible learning tool for building capacity in facilitating, conducting and/or participating in such a research process, and offers educational material for higher education classes or on-the-job training workshops.

The resource box has eight modules that represent the eight steps of the participatory research process to build more resilient seed systems:

1. Situational analysis and planning
2. Data preparation and selection of software
3. Climate change analysis and identification of appropriate germplasm
4. Germplasm acquisition
5. Field experimentation
6. Germplasm conservation
7. Participatory evaluation
8. Knowledge sharing and communication

The results of the training workshops were documented in ten training workshop reports. The evaluation reports include trainees' assessment of the degree by which their own knowledge and skills improved, the utility of the tools and data sources introduced, the quality of the key features of the learning approach and methods used, and suggestions for improvement of the training activities. Project partners from Costa Rica, Côte d'Ivoire and Nepal and Bioversity International staff wrote a total of nine blogs about the training process, the various training events organized since 2012 and their plans to use the new knowledge and skills after the training.

Research activities in support of capacity building

The training activities are embedded in a much larger initiative led by Bioversity International focused on strengthening national capacities to implement the International Treaty on Plant Genetic Resources for Food and Agriculture in the eight of the ten mentioned countries. Under this umbrella, the training process contributes to and strengthens research on germplasm interdependence and flows which maps and quantifies patterns of germplasm exchange from the international to the national level and vice-versa (CGIAR centres, national genebanks, national breeding programmes, community gene/seedbanks) and explores the changing needs for germplasm and its exchange in the context of adaptation to climate change. The results of this research are used to demonstrate to national policymakers and other stakeholder groups related to agriculture the usefulness of being able to access germplasm from other countries, rather than focusing narrowly on their obligations as providers.

The training activities also benefit from research and capacity development activities carried out under the 'Seeds for Needs' umbrella. Seeds for Needs is an initiative led by Bioversity International in collaboration with CCAFS and other partners that aims to give farmers more access to crop diversity to strengthen their capacity to adapt to climate change and mitigate the risks related to climate change. Trainers involved in, training materials produced for and practical experiences gained from the Seeds for Needs initiative were used as inputs for the capacity development activities in the eight countries.

Training inputs: tools and data sources

ArcGIS and DIVA-GIS were used to process multiple site climate data and generate maps of crop diversity richness, distribution of particular crops and their wild relatives and their useful traits, and locations of areas with complementary diversity. MaxEnt was used to complement DIVA-GIS to do crop habitat modeling based on species diversity in ecology. The climate analogue tool introduced through CCAFS was used to identify analogous climates across space and time – i.e. in the past, present or future.

Among the data bases used were GENESYS, Grin Global, the Crop Wild Relatives Global Portal and the Collecting Missions Files Repository. Weather data used were from WorldClim as well as from national meteorological services insofar as access was obtained.

Data analyses were done using R, an open-source software that has multiple functions including generating climate maps, and crop suitability modeling.

Users of the outputs: examples from the field

In Burkina Faso, researchers from the Université de Ouagadagou are applying the new knowledge and skills obtained to acquire new millet accessions that are better adapted to the changing climate. They are currently planning on-farm experiments in three contrasting agro-ecological regions of the country and have already mobilized farmers interested to take part in the research. They have collected weather data of the last 30 years to underpin their analysis about future trends. They are now in the process of identifying promising new accessions from both inside and outside Burkina Faso that respond to current and future climate changes.

In Bhutan, the country's two only plant breeders and staff of the National Biodiversity Centre identified five different agro-ecological sites in the country for the analysis of future climate changes based on the presence of weather stations (availability of longer term weather data) and on-farm conservation programmes implemented in the past or present (availability of farmers interested and experienced in on-farm crop experimentation). Based on the new knowledge and skills acquired, they recently completed climate change scenario analyses using DIVA-GIS and the climate analogue tool for each site for the major crops in Bhutan (rice, maize, potato and chilli) taking 2030 as reference year. The team is producing a synthesis of the results at this moment to decide about which possible analogue sites to target for further analysis and possible acquisition of promising germplasm.

In Guatemala, staff of the Instituto de Ciencia y Tecnología Agrícolas (ICTA) has used the new knowledge and skills gained to realize collection, characterization and conservation projects for bean, maize, *Amaranthus*, *Capsicum*, cassava and several tubers. They also produced distribution maps of the accessions collected in the country and maps of potential collection sites of accessions still to be collected. These maps will be used for the planning of future collection missions.

In Rwanda and Uganda, following the training in the classroom, a team of scientists and extension agents interacted with farmers and their communities in selected sites to identify local climate-related challenges. Climate change scenario analysis resulted in the identification of present and future analogue sites. Using DIVA-GIS and crop suitability modelling applied to beans (a key crop for farmers' livelihoods), the team then identified bean accessions with good climate adaptation potential from three sources: (i) the national genebanks in Rwanda and Uganda, (ii) communities in both countries and (iii) international genebanks. In 2014, the first phase of participatory field trials with farmers was carried out using materials from the national genebanks and locally adapted material was identifies. A total of 20 varieties in each country were evaluated (and ranked) by farmers for climate resilience and other desirable traits. Accessions from international genebanks have been requested and are currently being multiplied and will soon be tested. In addition, farmers from community seedbanks in Rwanda and Uganda organized an exchange visit during which they identified varieties of beans that they would like to

Photo: Bioversity International/R.Vernooy exchange. Modalities for this exchange are still being worked out by the two countries.

In Zimbabwe, results from training exercises reveal that farmer communities in selected communities in the Uzumba-Maranga-Pfumbwe (UMP) and Tsholotsho districts are facing increased minimum and maximum temperatures and shorter rainy days.

Modeling results also indicate that mean, minimum and maximum temperatures will increase and although rainfall will increase slightly, it is likely to be more erratic with shorter rainy days. Farmers identified the following traits, in order of importance, as some of the characteristics that they would want to see in a variety being bred for future climates: 1) early maturing, 2) high yielding and 3) resistant to pests and diseases. Through an analysis of crop accessions conserved in national and international genebanks, trainees identified accessions of finger millet, sorghum and pearl millet with promising traits for local adaption. Researchers are planning to acquire some of these accessions and test them in farmers' fields in the two districts.

For more information, visit http://bit.ly/seeds-resource-box

Research and capacity development partners

CIAT, Cali, Colombia

National Biodiversity Centre, Thimpu, Bhutan

Ministère de la Recherche scientifique et de l'Innovation, Ouagadougou, Burkina Faso

Université de Ouagadougou, Burkina Faso

Institut de l'Environnement et de Recherches Agricoles, Ouagadougou, Burkina Faso

Commission Nationale de Gestion des Ressources Phytogénétiques, Ouagadougou, Burkina Faso

CATIE, Turrialba, Costa Rica

National Plant Genetic Resources Commission, San Jose, Costa Rica

Centre National de Recherche Agricole, Abidjan, Côte d'Ivoire

Université Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire

CATIE, Guatemala city, Guatemala

Ministry of Agriculture and Livestock, Guatemala city, Guatemala

Local Initiatives for Biodiversity, Research and Development, Pokhara, Nepal

Ministry of Agriculture and Cooperatives, Kathmandu, Nepal

National Agriculture Genetic Resource Centre, Khumaltar, Lalitpur, Nepal

Rwanda Agriculture Board, Huye, Rwanda

Entebbe Botanic Gardens, Entebbe, Uganda

National Agricultural Research Organisation, Entebbe, Uganda

National genebank of Zambia, Lusaka, Zambia

Southern African Development Community Plant Genetic Resource Centre, Lusaka, Zambia

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