Enhancing the role of genebanks in facing the challenge of climate change

Michael Abberton

IITA is part of CGIAR
CGIAR is a global partnership that unites organizations engaged in research for a food secure future.

Vision:
To reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience through high-quality international agricultural research, partnership and leadership

Who we are
Africa has complex problems that plague agriculture and people’s lives. We work with partners in Africa and beyond to reduce producer and consumer risks, enhance crop quality and productivity, and generate wealth from agriculture. IITA is an international non-profit organization created in 1967 and governed by a Board of Trustees.

Where we are

What we do
We work with partners in Africa and beyond to reduce producer and consumer risks, enhance crop quality and productivity, and generate wealth from agriculture.
Predicted annual rainfall change under climate change for 2050

Land degradation

Soil degradation

More than 40% of West Africa soils are under moderate to very high degradation

Conservation of the International collections

Conservation of seed crops: Germplasm flow

Over 32,800 Accessions of African major food crops

<table>
<thead>
<tr>
<th>Crop Family</th>
<th>Accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowpea</td>
<td>15,379</td>
</tr>
<tr>
<td>Soybean</td>
<td>4,841</td>
</tr>
<tr>
<td>Cassava</td>
<td>3,499</td>
</tr>
<tr>
<td>Yam</td>
<td>3,156</td>
</tr>
<tr>
<td>Bambara groundnut</td>
<td>1,752</td>
</tr>
<tr>
<td>Maize</td>
<td>1,565</td>
</tr>
<tr>
<td>Miscellaneous legumes</td>
<td>558</td>
</tr>
<tr>
<td>Wild Vigna</td>
<td>1,543</td>
</tr>
<tr>
<td>Banana/plantain</td>
<td>546</td>
</tr>
<tr>
<td>African yam bean</td>
<td>456</td>
</tr>
</tbody>
</table>

IITA Genetic Resources Center

Conservation of the International collections:
- Seed crops
- Vegetatively propagated crops

Conservation of seed crops:
- Medium-term storage -5°C
- Long-term storage -20°C
- Regeneration
- Processing
- International distribution
- Black box 1: CIMMYT/CIM -20°C
- Black box 2: Svalbard (Norway) -20°C

A member of CGIAR consortium

www.iita.org
**Importance of cowpea.**

- Most important food legume in West and Central Africa.
- Represents over 66% of the 12.5 million ha grown worldwide.
- A major source of dietary protein in sub-Saharan Africa.
- Mainly grown with cereals such as sorghum and millet in the dry savanna regions of sub-Saharan Africa.

### Seed Crop Germplasm Collection at IITA

<table>
<thead>
<tr>
<th>Crops</th>
<th>Number of Accessions</th>
<th>Percentage of the seed collection (%)</th>
<th>Number of countries represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowpea</td>
<td>15,379</td>
<td>59</td>
<td>90</td>
</tr>
<tr>
<td>Soybean</td>
<td>4,841</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Bambara groundnut</td>
<td>1,913</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Maize</td>
<td>1,561</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Wild vigna species</td>
<td>1,543</td>
<td>6</td>
<td>62</td>
</tr>
<tr>
<td>African yambean</td>
<td>456</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>25,693</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Cowpea production

- Resistant accessions did not show any striga emergence while there were striga emergence for the susceptible accessions.
- 21 genotypes from 11 wild vigna species showed resistance to *S. gesnerioides*.
- 16 genotypes of the cultivated cowpea land races geographically co-located with the resistant wild relatives were confirmed resistant to *S. gesnerioides*.

### Cowpea production constraints

- Yield losses run into millions of tons by two parasitic flowering plant species.
  - *Striga gesnerioides*
  - *Alectra vogelii*
- Yield reduction up to 100%.
- Need for sources of resistance.
- Strong cross incompatibility between the wild vigna species and cowpea (*Vigna unguiculata*) constitutes a major constraint to moving desirable genes into cultivated cowpea varieties.
• Screening cowpea wild relatives and land races germplasm identified sources of resistance to *S.gesnerioides*.

• Cross incompatibility between wild vigna species and cultivated cowpea land races is a major constraint to transferability of resistance to *S.gesnerioides* from wild vigna species.

• Cowpea land races from geographical locations of resistant wild relatives are sources of resistance to *S.gesnerioides*.

Informal launch of ‘Diversity Seek’ initiative

Diversity Seek (DivSeek): Harnessing the power of crop diversity to feed the future

- linking large-scale sequencing and phenotyping data to publicly available germplasm accessions
- simple, standardized data formats and associated analysis tools
- unified, coordinated and cohesive information management platform for collaboration

‘Big data’ and plant genetic resources

> ‘Omics’ approaches have significant potential for the exploration of genetic diversity contained in genetic resources and for more efficiently moving traits/genes into elite germplasm for use by breeders

> A key challenge is to link up passport, genomic and phenotypic information on genebank accessions, which are typically recorded and managed independently

> The establishment of international data standards and the sharing of such data through a publicly accessible data platform/portal seems key

> create a two-way flow between genebanks and the research community, thereby benefiting future users

Making genebanks more useful

• Designing collections for breeding and research
  – Trait-specific subsets
  – Core collections
  – Focused Identification of Germplasm Strategy (FIGS)

• Pre-breeding 1:
  – Base broadening
  – Wide hybridization

• Pre-breeding 2:
  – Gene discovery: genotyping, phenotyping, association genetics

Vision

“Sequencing technology provides a set of tools that can be used to enhance the quality, efficiency, and cost-effectiveness of genebank operations, the depth of scientific knowledge of genebank holdings, and the level of public interest in natural variation. As a result, genebanks have the chance to take on new life. Previously seen as ‘warehouses’ where seeds were diligently maintained, but evolutionarily frozen in time, genebanks could transform into vibrant research centers that actively investigate the genetic potential of their holdings.”
San Diego meeting  
(January 2014)

- a truly remarkable assemblage of people: breeders, bioinformatics experts, genebank managers, data managers, IT professionals, sequencing service providers, experts on evolutionary theory, policy specialists, donors, private sector participants, lawyers, representatives of international organizations and treaties, phylogeneticists, taxonomists, molecular ecologists, experts on big data, software engineers
- 21 countries, 90 participants, 13 sponsors:

What will it take?

- Searching across large distributed databases: A "Google for germplasm"?
- Data standards
- Bioinformatics tools
- International collaboration
- Private sector buy-in
- IP policies
- Fundraising

Complex landscape

- many stakeholders, many relevant past and ongoing projects

Role of DivSeek

- Community-driven
- Both ends of the crop improvement pipeline (genebanks and breeders)
- Need buy-in by stakeholders, partners and donors

Building bridges

- DivSeek will build bridges:
  - Between genebank managers and the users of germplasm accessions
  - Between the basic plant science community, bioinformaticians, applied plant biologists and breeders
  - Between already existing datasets and the original germplasm held in genebanks

Recent progress

- White paper and website www.divseek.org
- 69 public sector organizations expressed their interest, as well as several private sector entities
- Endorsement by the Third Meeting of G20 Agricultural Chief Scientists
DivSeek meeting San Diego 2015

• 69 member organisations

• Charter

• Mission

• Joint Facilitation Unit: Global Crop Diversity Trust, ITPGRFA, Global Plant Council, CGIAR

• Work Plan for 2015