How Embrapa combines different approaches to optimize conservation and use of Plant Genetic Resources in Brazil

Arthur Mariante
Brazilian Agricultural Research Corporation
Due to its dimension, Brazil has a huge environmental diversity, and to cope with this diversity, Embrapa had to establish Research Centers in all its regions.

Total area: 8,516,000 km²
EMBRAPA

Brazilian Agricultural Research Corporation

- 42 Research Centers
- Embrapa Genetic Resources and Biotechnology - CENARGEN, located in Brasilia, coordinates the Conservation Program
Conservation Program in Embrapa

- 1976 – establishment of 10 Active Germplasm Banks
- 2018 – 142 AGBs, some of them in more than one Center
- Successive management conservation programs have been created.

- The most recent, launched in 2016, is the Portfolio of Projects on Strategic Management of Genetic Resources for Food, Agriculture an Bio-industry.

- The Portfolio is composed by three Networks:
  - Plant Genetic Resources
  - Animal Genetic Resources
  - Microorganisms Genetic Resources
Networks of the G.R. Portfolio

Animal, Microorganism and Plant Genetic Resources
Projects of the Plant G.R. Network

- General Management
- Medium and Long Term Collections
- Cereal Crops
- Oily, Fiber and Legumes
- Vegetables and Flavoring
- Forages
- Exotic Fruits
- Native Fruits
- Medicinal, Aromatic, Dye and Insecticides
- Ornamental

- Forest Trees
- Palm Trees
- Roots and Tubers
- Reference Collections
- In Situ/On Farm Conservation
- Germplasm Collection
- Documentation
- Quality System
- Exchange
- Quarantine
Relationship among the Projects of the Plant G.R. Network

Active Germplasm Banks

Conservation Projects

Horizontal Projects

Management of the Network
General Objective of the Portfolio

To maintain, in an organized structure, Embrapa’s germplasm collections with the highest possible genetic variability.
Specific Objectives of the Portfolio

- Maintenance of the *Active Germplasm Banks*
- Maintenance of germplasm collections at *Medium* and *Long Term* (Gene Bank)
- A very active *Curatorship System*
- *Characterization* (genetic and phenotypic)
- *Enrichment* through germplasm collection & exchange
- Maintenance of an updated *Data Base* of GR
- *Quarantine* germplasm of the Gene Bank / Research
- Keep researchers updated about *Legislation on GR*
- Implementation of a *Quality System*
Structure of the Plant G.R. Network

- 20 Component Projects
- 158 Action Plans
- 821 Activities
- 29 Embrapa Research Centers
- > 450 Researchers
- 3 Partner Institutions
Examples of Active Germplasm Banks
Cereal Crops

Among the crops being conserved:

Barley, Maize, Millet, Oats, Rice, Rye, Sorghum, Triticale and Wheat (4 Research Centers)
Oily, Fiber and Legumes

What is being conserved:

Beans, Canola, Castor bean, Cotton, Cuphea, Green peas, Jatropha, Olive, Peanut, Sesame, Sisal, Soybean and Sunflower (11 Research Centers)
Vegetables

Among the vegetables being conserved: Brassicas, Capsicum, Cucumber, Eggplant, Garlic Lettuce, Melon, Onion, Pumpkin, Tomato and Watermelon (3 Research Centers)
Forages

What is being conserved:

Alfalfa, Brachiaria, Cenchrus, Lolium, Panicum, Paspalum, Pennisetum, Stylosanthes and native forages specific to the different regions of Brazil (10 Research Centers)
Exotic Fruits

What is being conserved:
Apple, Avocado, Banana, Citrus, Grape, Kiwi, Mango, Papaya, Peach, Pear, Plum, Strawberry
(6 Research Centers)
Native Fruits

What is being conserved:

Brazil nut, Cashew, Pineapple, and many other native fruits specific to the different regions of Brazil

(11 Research Centers)
Ornamental

What is being conserved:

Bromeliad, Cacti, Orchids and other ornamental plants specific to the different regions of Brazil.

(6 Research Centers)
Forest Trees

What is being conserved:

Cedar, Conifers, Eucalyptus, Hardwood, Pinus, and Pará Rubber tree (3 Research Centers)
Palm Trees

What is being conserved:
Coconut, Palm Oil, Acrocomia, Astrocaryum, Attalea, Bactris, Euterpe, Mauritia, Orbygnia.

(7 Research Centers)
Roots and Tubers

What is being conserved:

Cassava, Potato, Sweet Potato, and wild relatives of them all, besides Carrots. (7 Research Centers)
Medium and Long Term Germplasm Collections
Gene Bank

In 2014, Embrapa opened its new building to host the Gene Bank, with a total capacity of 750,000 accessions in the form of seeds.
Gene Bank

Besides the long term storage at -20°C, the building has laboratories for \textit{in vitro}, cryo-conservation, and ultra-freezers for DNA storage.
In Vitro Collections

What is being conserved *in vitro*:

Among others: Cassava, Orchids, Potato, Strawberry and Sweet Potato.
## Plant G. R. Nework in Numbers

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>Long Term - Colbase</strong></td>
<td>109,216 accessions; 1,019 species&lt;br&gt;Total of 127,783 samples</td>
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<tr>
<td><strong>IN Vitro</strong></td>
<td>1,467 accessions; 22 genera and 72 species&lt;br&gt;4,392 potato accessions (CIP duplicate collection)</td>
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<tr>
<td><strong>DNA</strong></td>
<td>&gt; 7,000 new samples included in 2017</td>
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<tr>
<td><strong>Documentation</strong></td>
<td>An Information System was recently developed;&lt;br&gt;60% of the Active Gene Banks already documented</td>
</tr>
<tr>
<td><strong>Recent Collections</strong></td>
<td>Recent collection expeditions for cassava, sweet potato, rice wild relatives and faba bean</td>
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Use of Genetic Resources

- A great number of Embrapa Centers has breeding programs and doing the characterization of the genetic material of the Active Germplasm Banks;

- Once the desired traits or genes are identified, the accessions are used in the development of new products;

- These new products are then transferred to a branch of Embrapa known as Products and Markets, that releases the improved material to multipliers, and finally to the producers.
<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Arachis</strong></td>
<td><em>Arachis</em> used as forage – to increase the sustainability of livestock production systems.</td>
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<tr>
<td>Banana</td>
<td>Belluna is a naturally fortified cultivar; high production level</td>
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<tr>
<td>Cassava</td>
<td>Yellow – high content of beta-carotene, precursor of vitamin A</td>
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<tr>
<td></td>
<td>Pinkish – high content of lycopene, an anti-oxidant</td>
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<tr>
<td>Eucalyptus</td>
<td>60k chip has been developed, allowing to predict the future genotype, in terms of growth, productivity, etc.</td>
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<tr>
<td>Melon</td>
<td>Parental lines of a highly productive hybrid melon have been released to producers.</td>
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<tr>
<td>Passion fruit</td>
<td>Cerrado Star – ornamental cultivar released to the market</td>
</tr>
<tr>
<td>Rice</td>
<td>The core collection has been genetically characterized and genes responsible for resistance to diseases are being used to identify lines in breeding programs.</td>
</tr>
<tr>
<td>Potato</td>
<td>BRS F63 cultivar; resistant to the Y virus.</td>
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The Most Successful Story of Re-Introduction
In 1997, the Head of a tribe of indigenous people of Central Brazil came to Cenargen, looking for some varieties of maize they had lost;

Fortunately some of these varieties had been collected and were stored at the Gene Bank;

He entered into the chamber and became very emotional when the aluminum foil bags, containing the seeds, were opened;

He told the previous use of each one of those varieties in specific dishes, as well as in dances that went along with the food;

Half the seeds were given back, and after one year, they were able to restore part of the culture they had lost.
One year later, he brought back seeds of those 15 varieties, asking us to store them again:

“Our grand children may need them in the future, and we trust you”, he said!
Final Comments

- We believe that the Portfolio of Genetic Resources is achieving the proposed Objectives:
  - Maintaining and enriching the AGBs as well as the Medium and Long Term Gene Banks;
  - Strengthening the Curatorship System;
  - Characterizing the genetic material;
  - Updating the Data Base using a new Information System developed by Embrapa known as Allele;
  - Submitting to Quarantine all material entering the Gene Bank;
  - Keeping the research team aware about national and international legislation on GR;
  - Implementing the Quality System;

- And above all, stimulating the use of the stored material in breeding programs, aiming at the development of new products to be released to the market.
Thanks
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