The role of plant breeding for adaptation to climate change in Mexico

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Seminar on the role of plant breeding and plant variety protection in enabling agriculture to mitigate and adapt to climate change
Importance of PGRFA

Plant genetic resources for food and agriculture contribute to:

- Food security
- Nutrition
- Adaptation and mitigation of climate change
- Ecosystems services (provision)
- Raw material for many products
- Economic development and livelihoods
Climate change affects PGRFA

Non-biotic factors

- Rising temperatures
- Changing precipitation patterns
- Increasing frequency of extreme weather events
- Rising concentration of CO₂ in the atmosphere

Biotic factors

- Emergence of new pests and diseases
- Changes in distribution range of pest
- Changes in the virulence of existing pests
- Reduced pollinator populations
The climate of Mexico presents high variability, with a tendency to temperature increase, recurrent droughts and unpredictable rainfalls.
Mainly, native varieties are used in rainfed agriculture whereas improved varieties are used in irrigated crop land.
The main agricultural areas of Mexico are those that will experience greater climatic variability (considering the 2015-2039 scenario and an RCP 4.5.)

It is necessary to promote actions for the adaptation of agriculture to climate change.

Source: Own elaboration with data from CONABIO, IB-UNAM, CONANP-SEMARNAT, UNDP, INECC. Climate Change and Biodiversity Explorer, version 1.0. National Commission for the Knowledge and Use of Biodiversity, Mexico. Available in: http://www.biodiversidad.gob.mx/pais/explorador_cambio-climatico
Regions with the largest area planted

High climatic variability expected

Cereals

Vegetables

Legumes
1.- Achieve food self-sufficiency by increasing production and productivity of agriculture, livestock, and aquaculture-fishing.

2.- Contribute to the well-being of the rural population through the inclusion of historically excluded farmers in rural and coastal productive activities, taking advantage of the potential of the territories and local markets.

3.- Increase sustainable production practices in the agricultural and aquaculture-fishing sector in the face of agro-climatic risks.
Importance of plant breeding

Actions to promote plant breeding and seed quality to face climate change

1. Take advantage of existing varieties
2. Adopt and use new varieties
3. Generate varieties according to needs
National Seed Policy

1. Take advantage of existing varieties

5,409 registered varieties (139 crops)
- 1,903 PBR
- 1,110 PBR & NLI
- 2,396 NLI

PBR: Plant Breeder’s Right
NLI: National Listing (CNVV)

26 countries

Origin of plant varieties protected in Mexico with breeder’s title

- United States: Corn (278), Strawberry (147), Chili (87), Vine (76), Sorghum (72)
- Mexico: Corn (311), Wheat (70), Sorghum (55), Beans (45), Potato (26)
- Netherlands: Rose (69), Anthurium (64), Chrysanthemum (52), Daisy (43), Lettuce (37)
- France: Blueberry (38), Cotton (9), Peach (8), Mango (3), Apple (2)
- Germany: Rose (40), Tomato (8), Chili (6), Lettuce (4), Raspberry (2)
- Australia: 63 (2.2%)
- Germany: 46 (1.6%)
- France: 63 (2.2%)
- United States: 1,024 (36%)

Take advantage of existing varieties: 1,903 PBR, 1,110 PBR & NLI, 2,396 NLI

26 countries
Adopt and use new varieties

Yield stability in an unpredictable and variable climate can be maintained through **phenotypic plasticity**, **diversity within the population**, and **traits** that directly **confer resistance to biotic or abiotic stresses**.

- In commercial crops
- In local landraces

**Plant breeding**

**Use of improved varieties**
Breeding varieties adapted to drought, salinity, resistance to local pests and diseases, or low soil fertility.

**Local seed systems**
Selection for self-consumption
Community seed banks
Participatory breeding
Native seed production

Integrate scientific, technical, local and traditional knowledge
3 Generation of varieties according to needs

Take advantage of public research institutions

46 public research institutes with improvement programs and 253 active researchers

INIFAP* Program of genetic improvement in vegetables:

» Different breeding strategies are applied to increase the yield of bulb, fruit, and tuber.

» Species that have been studied: garlic, onion, chili, tomato, potato, and husk tomato.

» As a result of these investigations, 19 varieties for garlic, 10 for onion, 21 for chili, 29 for potato and 2 for husk tomato.

Creation of the Sectorial Committee on Genetic Resources for Food and Agriculture (CSRGAA)

• Legally established on July 16, 2020.
• Multiannual Work Program: Genetic Diversity for sustainable production, adaptation to climate change, and wellbeing.
• Consolidation of 4 Subcommittees on GRFA

General objective:
Promote the conservation, management, fair and equitable distribution of benefits, and sustainable use of these genetic resources, through inter-institutional and interdisciplinary coordination in the sector.

Specific objectives:
Contribute with technical elements for the management of financial resources and national and international technical cooperation that promote the conservation, management, and sustainable use of genetic resources for food and agriculture.

Importance of plant breeding

Multiannual Work Program of the CSRGAA:

Line of action 1: Conservation of genetic diversity
Line of action 2: Characterization of genetic resources
Line of action 3: Genetic improvement
Line of action 4: Technology transfer
Line of action 5: Capacity building
Line of action 6: Added value and sustainable use
Line of action 7: Access and distribution of benefits

With the genetic resources that have characterization at some level, breeding programs will be developed to optimize productivity, resistance to biotic and abiotic factors and to improve nutritional qualities, guaranteeing the maintenance of genetic diversity in end products, which have the potential to be transferred to producers for the generation of food and other products.
Sectoral Committee on Genetic Resources for Food and Agriculture (CSRGAA)

Conservation of GRFA:

Network of Germplasm Banks

Seed Conservation for native crops

64,000 accessions from 1,301 species
Genomes of Mexican crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Common name</th>
<th>Species</th>
<th>Size</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agave</td>
<td>Agave tequilana</td>
<td>2.7 Gbp</td>
<td>Finished</td>
<td></td>
</tr>
<tr>
<td>Avocado</td>
<td>Persea americana</td>
<td>920 Mbp</td>
<td>Published</td>
<td></td>
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<tr>
<td>Chili*</td>
<td>Capsicum annum</td>
<td>3.5 Gbp</td>
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<tr>
<td>Beans</td>
<td>Phaseolus vulgaris</td>
<td>590 Mbp</td>
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<td>Mexican lime</td>
<td>Citrus aurantifolia</td>
<td>350 Mbp</td>
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<tr>
<td>Maize</td>
<td>Zea maize</td>
<td>2.3 Gbp</td>
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<tr>
<td>Papaya</td>
<td>Carica papaya</td>
<td>507 Mbp</td>
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<tr>
<td>Vainilla</td>
<td>Vanilla planifolia</td>
<td>3.2 Gbp</td>
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<tr>
<td>Blackberry</td>
<td>Rubus ulmifolius</td>
<td>246 Mbp</td>
<td>Finished</td>
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</tr>
</tbody>
</table>

Genomics to accelerate the characterization and improvement of strategic crops in Mexico

*Not generated by Mexicans*
Papaya

GBS for domestication traits, disease resistance, abiotic stresses, and fruit characteristics.

- Maradol (5 accessions)
- Mulata (9 accessions),
- Red Passion (6 accessions),
- Intenzza (6 accessions):
  - Biotic and non biotic stress, maturation
- Wild relative (8 accessions):
  - Domestication
- Hybrids and segregants (154 accessions):
  - Pathogen resistance (fungi, bacteria & virus), non biotic stress.
- Other species (10 accessions):
  - Evolution analysis and variation of genes of interest.
What else is needed for adaptation to climate change

➢ **In situ conservation** of genetically diverse populations to allow evolution to continue and the generation of adaptive traits;

➢ **Ex situ conservation** to ensure the maintenance of diversity of species, populations and varieties, including those from areas expected to be highly affected by climate change;

➢ **Diversified farming systems**: management practices that increase diversity tend to increase resilience to the various effects of climate change;

➢ **Sustainable soil management** practices that also contribute to mitigation;

➢ Knowledge, coordination, communication, collaboration, connection & commitment (6C).
¡Thank you!

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