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

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

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Mexico

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Importance of PGRFA

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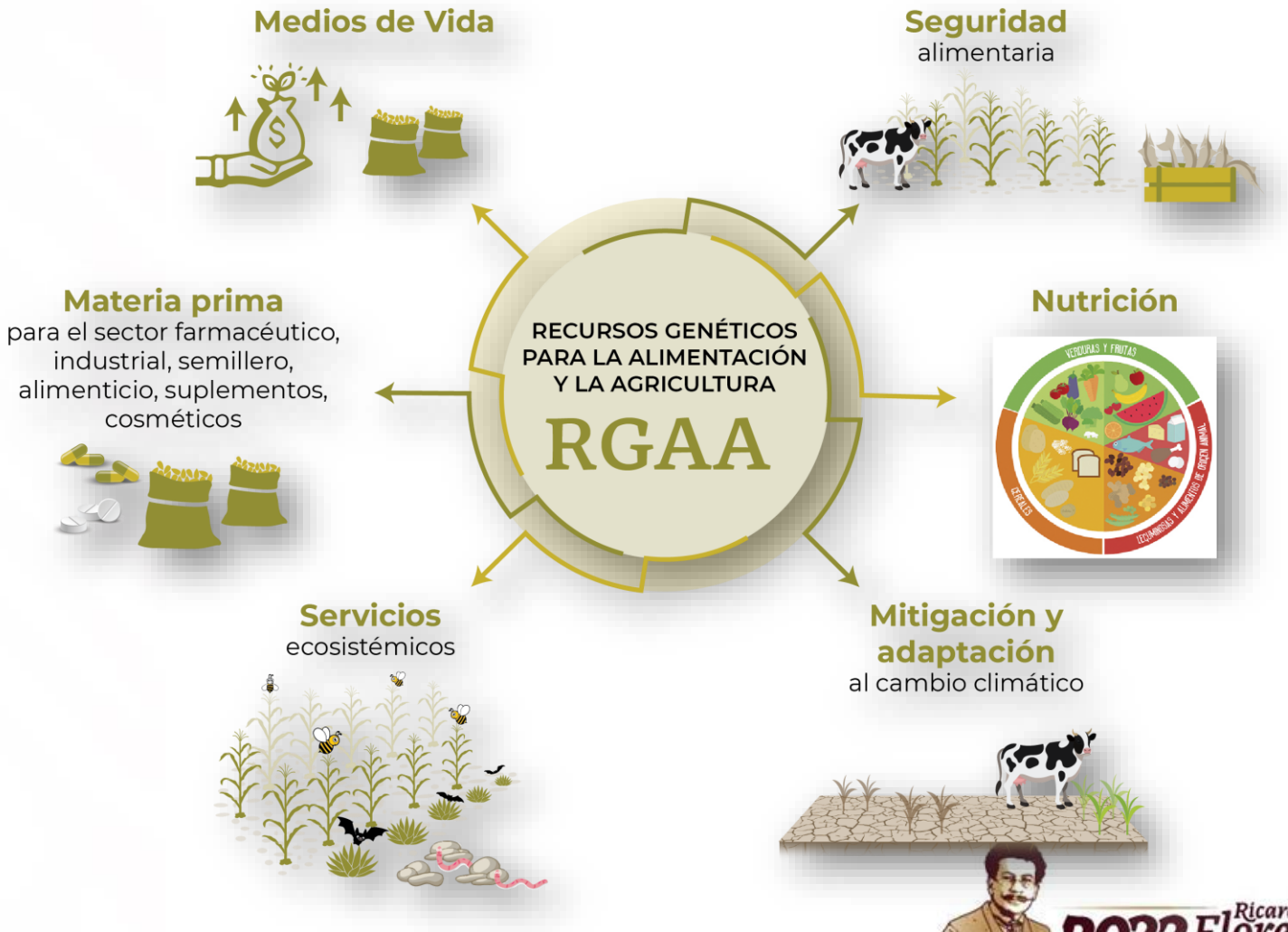
Plant genetic resources for food and agriculture contribute to:

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



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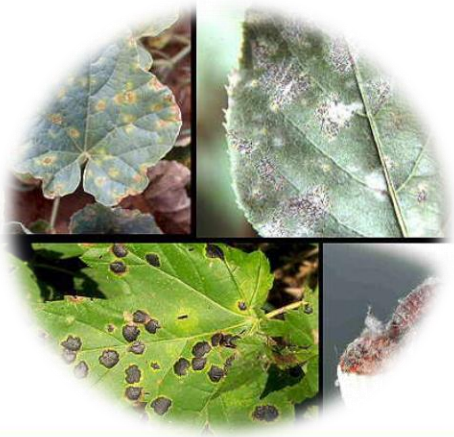
Climate change affects PGRFA

Non-biotic factors

- Rising temperatures
- Changing precipitation patterns
- Increasing frequency of extreme weather events
- Rising concentration of CO_2 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



Effects of climate change in Mexico

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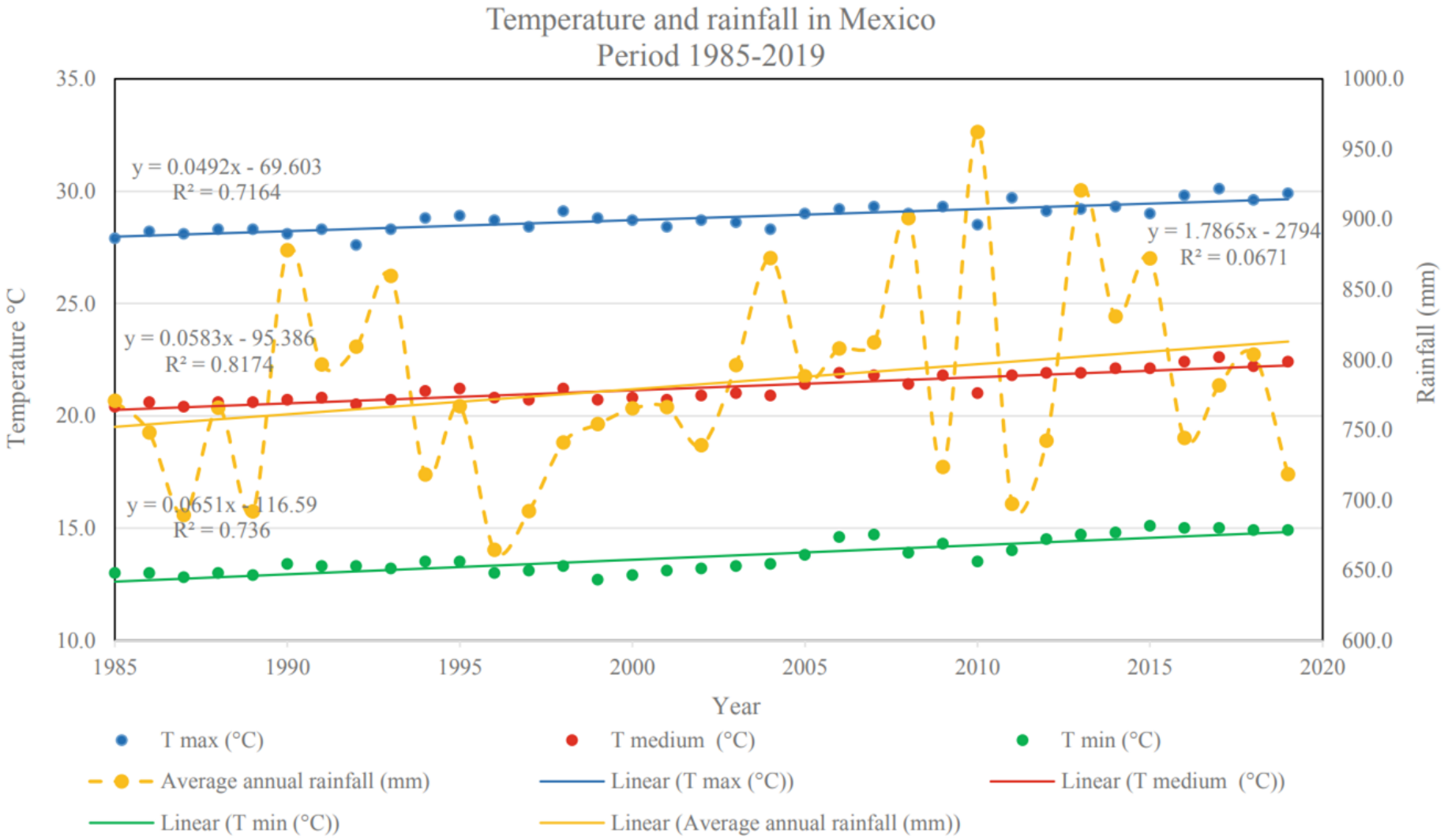

The climate of Mexico presents high variability, with a tendency to temperature increase, recurrent droughts and unpredictable rainfalls

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Source: Michel-Cuello y Aguilar-Rivera, 2022: Climate Change Effects on Agricultural Production Systems in México: https://link.springer.com/chapter/10.1007/978-3-030-87934-1_19

Agriculture and modalities of water use in Mexico

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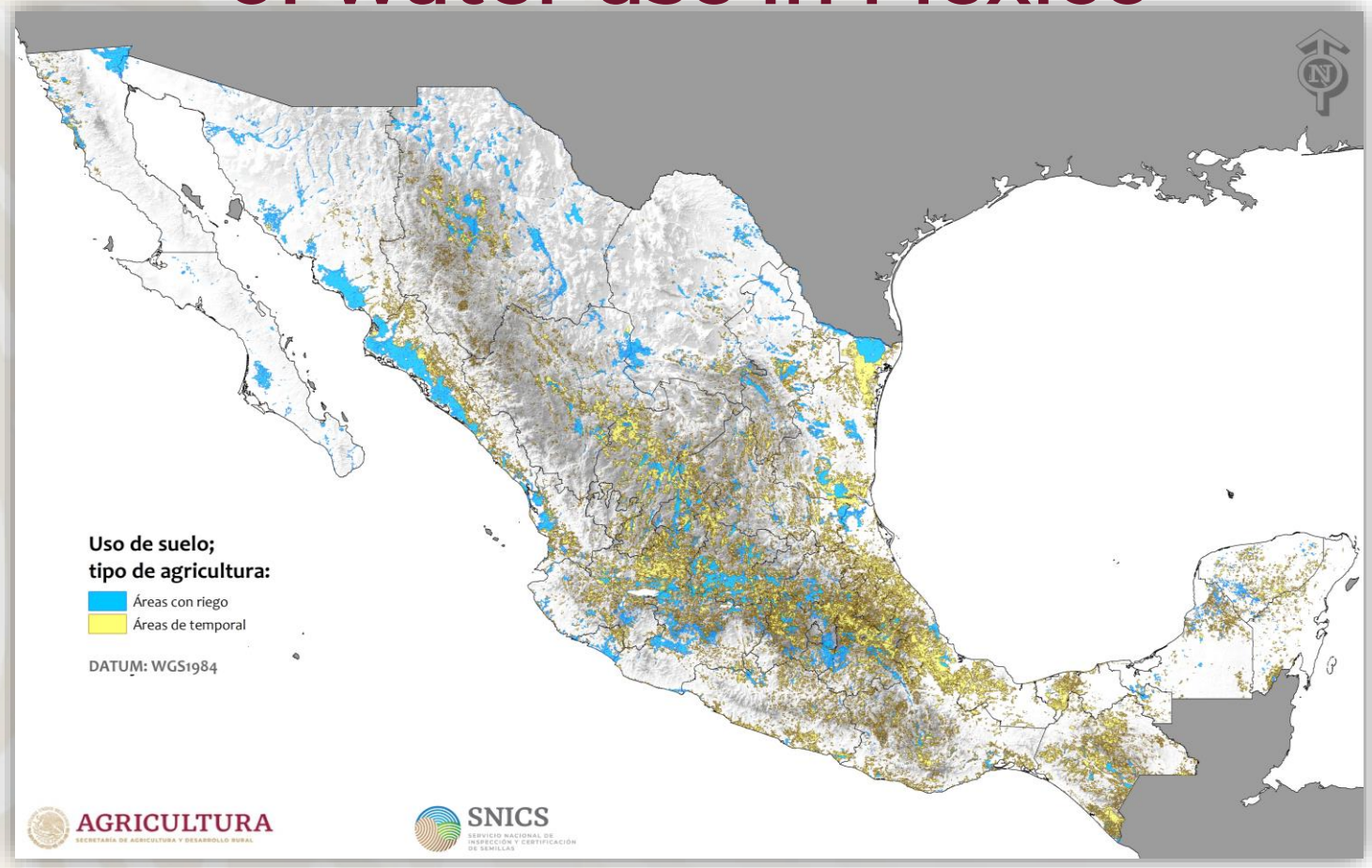
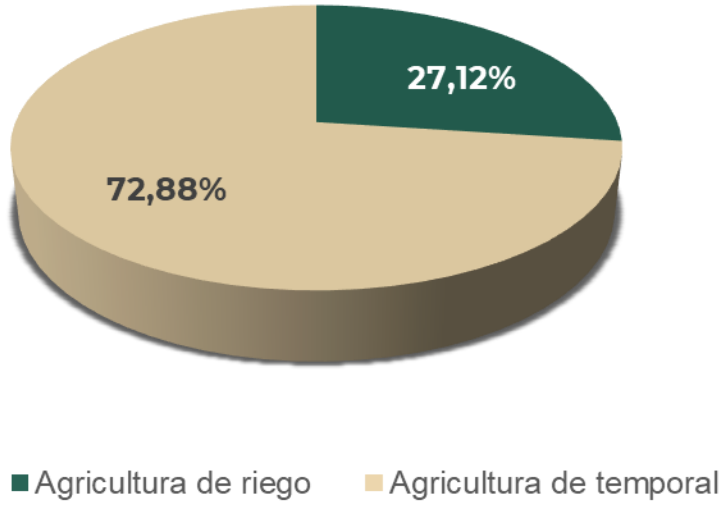
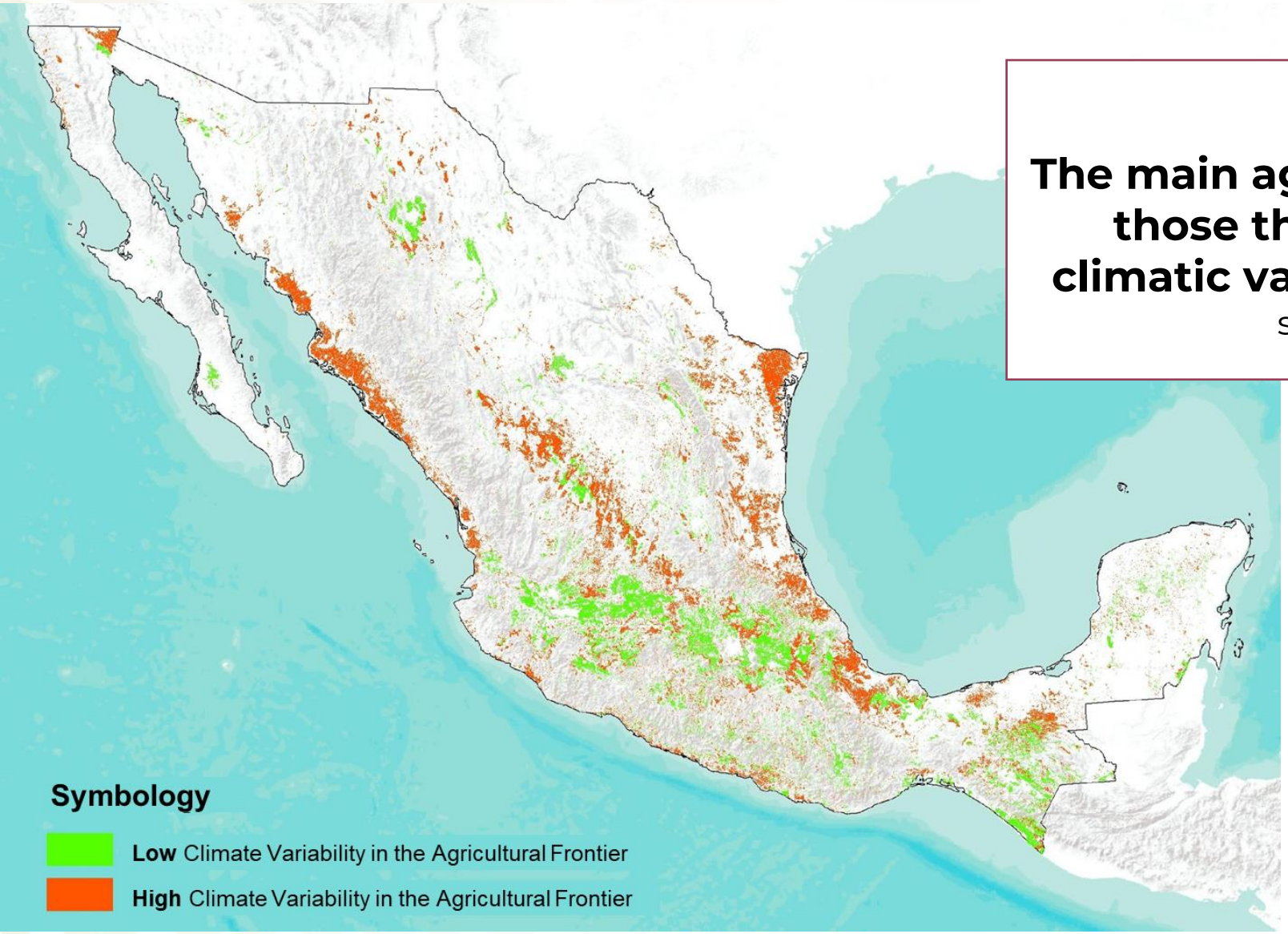


Rainfed and irrigated agriculture in Mexico (2021)



Mainly, native varieties are used in rainfed agriculture whereas improved varieties are used in irrigated crop land.

Source: Land use and vegetation vector data set obtained from INEGI, 2018



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

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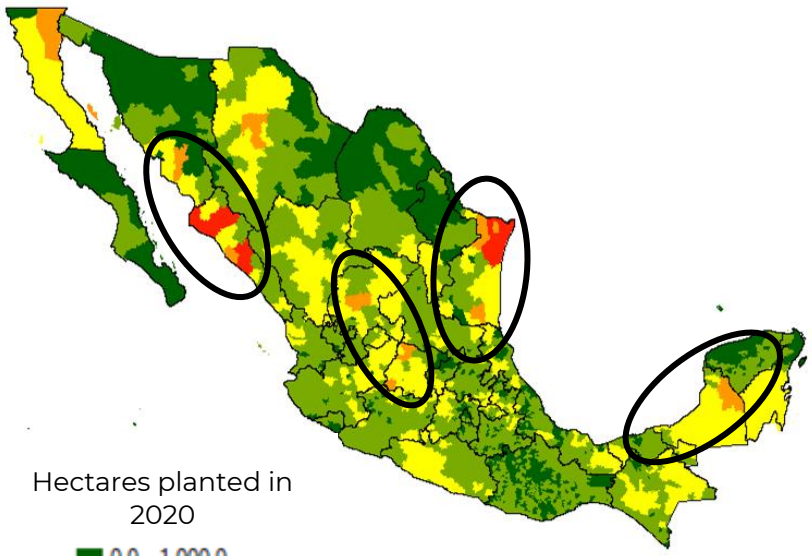
High climatic variability expected

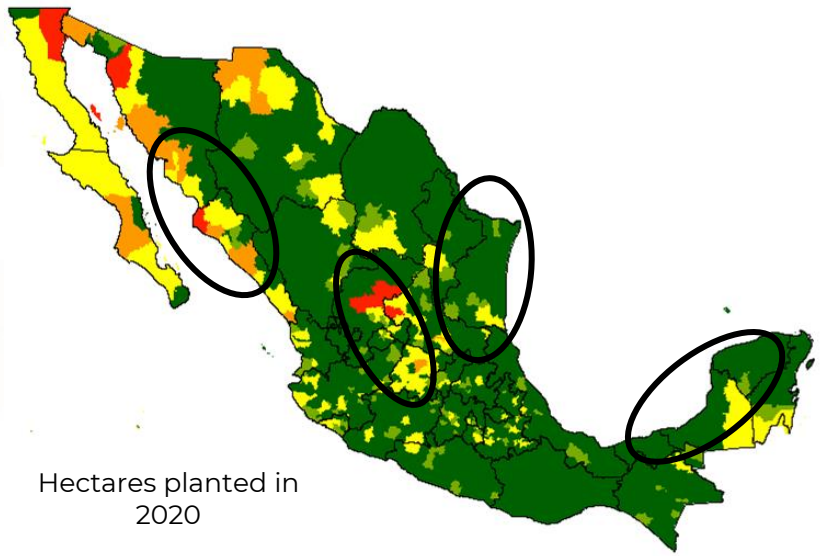
Cereals



Hectares planted in 2020

- 0.0 - 1,000.0
- 1,000.1 - 10,000.0
- 10,000.1 - 50,000.0
- 50,000.1 - 100,000.0
- 100,000.1 - 214,742.75

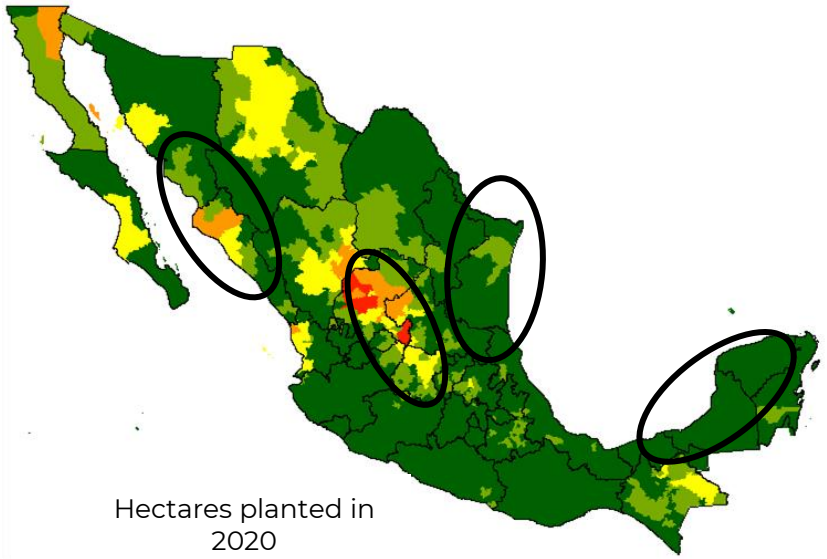
Vegetables



Hectares planted in 2020

- 0.0 - 500.0
- 500.1 - 1,000.0
- 1,000.1 - 5,000.0
- 5,000.1 - 10,000.0
- 10,000.1 - 18,224.0

Legumes



Hectares planted in 2020

- 0.0 - 1,000.0
- 1,000.1 - 5,000.0
- 5,000.1 - 20,000.0
- 20,000.1 - 50,000.0
- 50,000.1 - 105,565.0

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Public policies to achieve food security

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Mexico. Sectorial Program for Agriculture and Rural Development 2020-2024

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

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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

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1 Take advantage of existing varieties

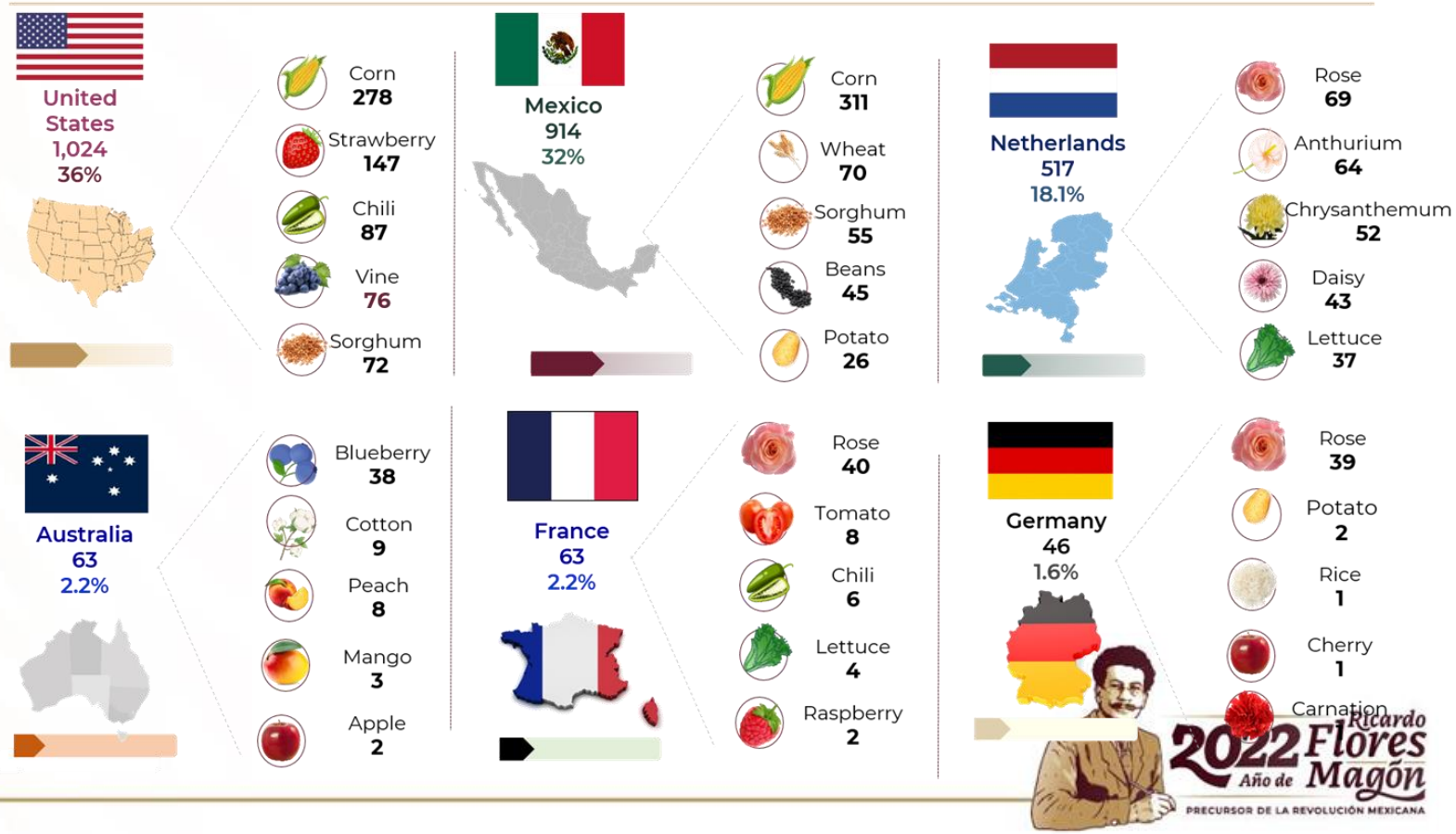
5,409 registred varieties (139 crops)

1,903	1,110	2,396
PBR	PBR & NLI	NLI

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

26 countries

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



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National Seed Policy

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2 Adopt and use new varieties

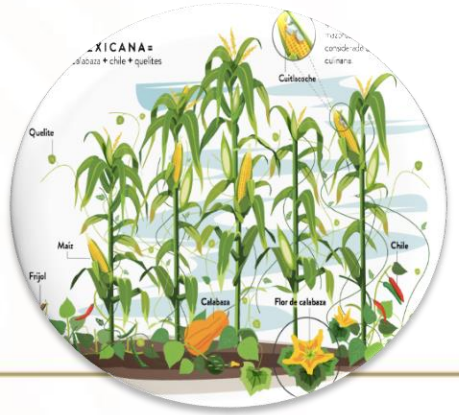
Yield stability in an unpredictable and variable climate can be maintained through **phenotypic plasticity, diversity within the population**, and **traits** that directly **confer resistance to biotic or abiotic stresses.**

Plant breeding

- In commercial crops

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

- In local landraces



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

Integrate scientific, technical, local and traditional knowledge

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National Seed Policy

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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.

* Gonzalez –Perez et. al., 2021. Revista Mexicana de Ciencias Agrícolas publicación especial número 25. 13p

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

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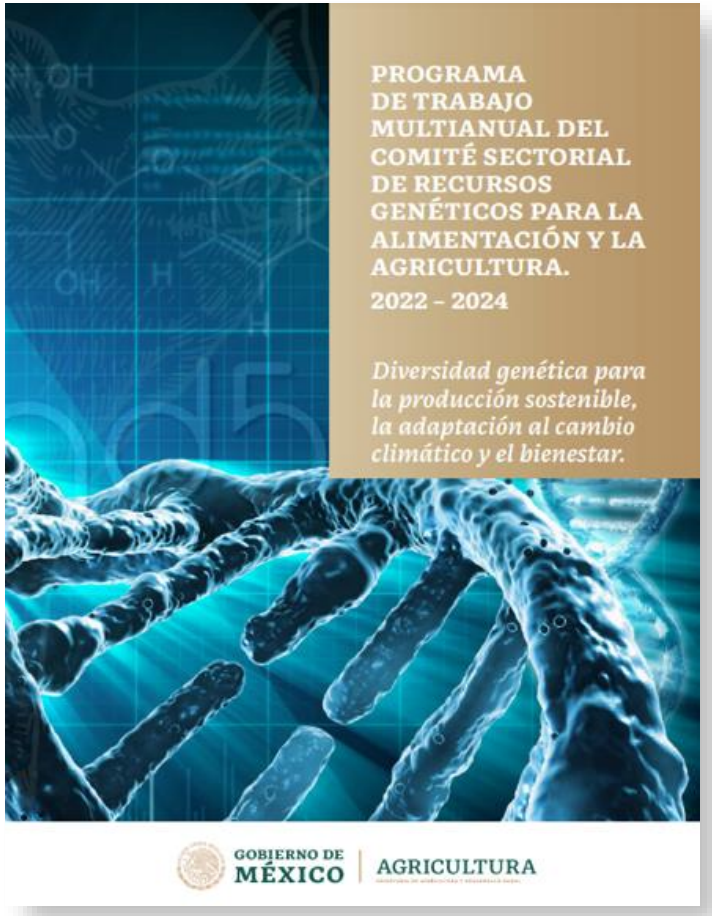
- Legally established on July 16, 2020.
- Multiannual Work Program: Genetic Diversity for sustainable production, **adaptation to climate change**, and wellbeing.
- Consolidation of 4 Subcommittees on GRFA
  - GR Agriculture
  - GR Livestock
  - GR Fisheries and aquaculture
  - GR Invertebrate and microorganisms



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.**

Available in:
https://www.gob.mx/cms/uploads/attachment/file/759874/Recursos_geneticos_extendido__1__compressed.pdf

Importance of plant breeding

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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

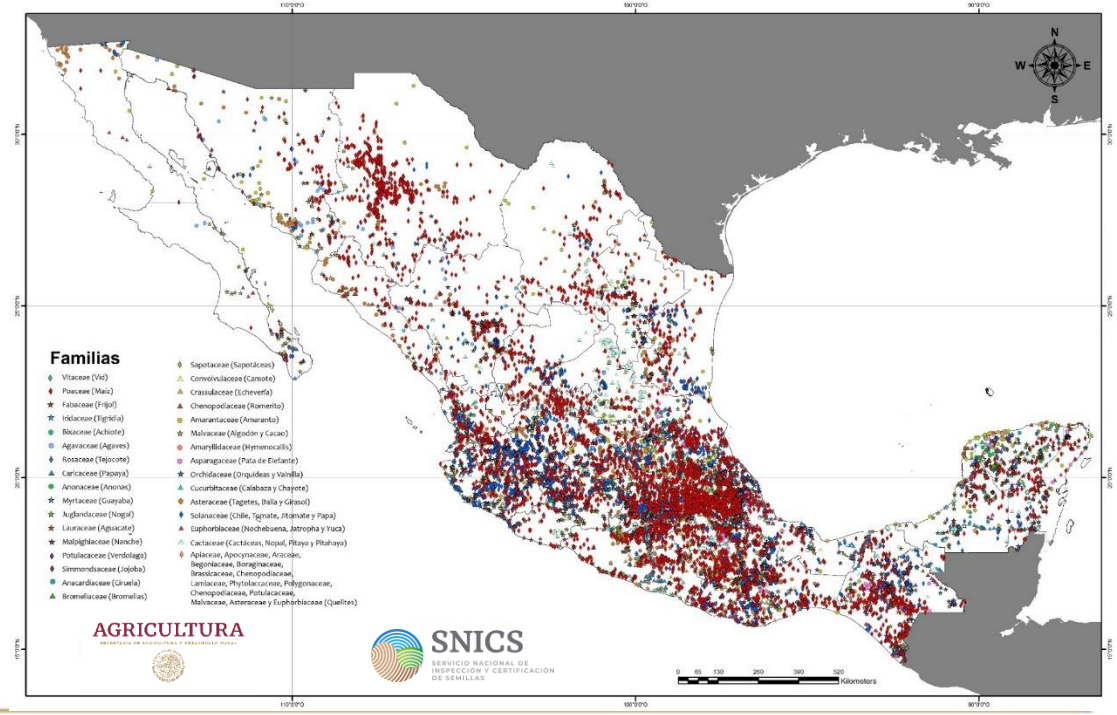
With the genetic resources that have characterization at some level, **breeding programs will be developed to optimize productivity, resistance to biotic and abiotic factors and to improve nutritional qualities**, guaranteeing **the maintenance of genetic diversity** in end products, which have the potential **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:

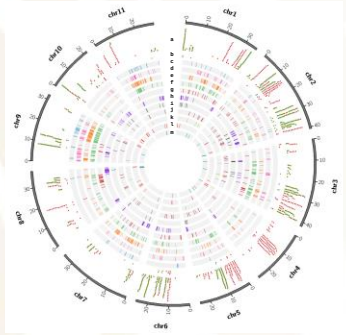
Network of Germplasm Banks

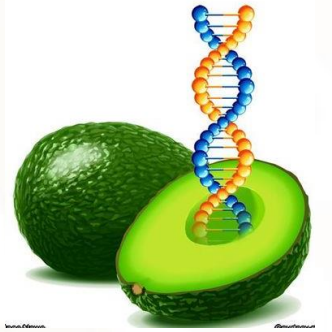
Seed Conservation for native crops



64,000 accessions from 1,301 species

Genomes of Mexican crops





Crop		Genome	
Common name	**Species**	**Size**	**Status**
Agave	*Agave tequilana*	2.7 Gbp	Finished
Avocado	*Persea americana*	920 Mbp	Published
Chili*	*Capsicum annum*	3. 5 Gbp	Published
Beans	*Phaseolus vulgaris*	590 Mbp	Published
Mexican lime	*Citrus aurantifolia*	350 Mbp	Finished
Maize	*Zea maize*	2.3 Gbp	Published
Papaya	*Carica papaya*	507 Mbp	Finished
Vainilla	*Vanilla planifolia*	3.2 Gbp	Finished
Blackberry	*Rubus ulmifolius*	246 Mpb	Finished

*Not generated by Mexicans

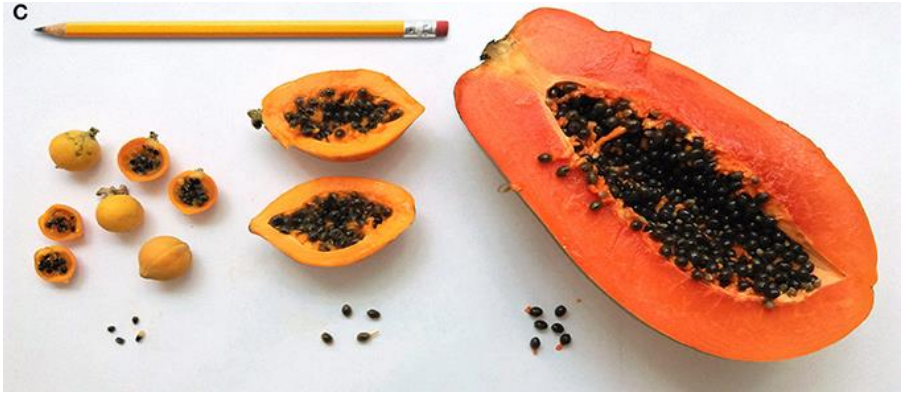
Genomics to accelerate the characterization and improvement of strategic crops in Mexico

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.

Wild papaya



Commercial Papaya Maradol

Wild papaya tree (Veracruz)

Domesticated papaya tree

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What else is needed for adaptation to climate change

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- **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).

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¡Thank you!

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