In situ conservation and participatory breeding of cacao with indigenous communities of the Soconusco Region in Chiapas, Mexico
"An Institute of Science and Technology Innovation"

Serving Mexican Agriculture and Society
Topics

Origin and History

The worldwide cocoa

Cocoa situation in Mexico

Strategies:

- Rescue and conservation of criollo cocoa
- Participatory Breeding

Challenges and perspectives
“Look, there’s no metaphysics on earth like chocolate. ” Chocolate is a substance long regarded as magical, even supernatural, not to mention salubrious, today for its heart - healthy properties, yesterday because of a solid medicinal reputation as well as an aphrodisiacal one. Chocolate begins as seeds in a pod, that pod the fruit of the cacao tree *Theobroma cacao*. Not incidentally, the scientific name means “drink of the gods,” by way of continuing the metaphysical.

Fernando Pessoa  (Portuguese poet)
The Mesoamerican peoples cocoa, and foods made with it, were a sacred element and part of their ritual life.

Much of the discussion of cacao in ancient Mesoamerica centers on Classic Maya culture, especially the period between 500 and 800 CE, because of the abundance of ceramics that reference cacao (kakaw) in their texts, and painted scenes that depict its use.
Offering of frothy cocoa drink (Chocolate)

Glyph for cacao (maya culture)
Origin and distribution of cacao proposed by Bartley (2005)
THE 5 MAJOR EXPORTERS TO EUROPE

COTE D’IVIOIRE
462,539,1

GHANA
285,786

NIGERIA
189,228,7

TOGO
70,167,2

CAMEROON
187,883,3

Source: Library of Parliament, ICCO, Eurostat, 2010
Prices of cacao

<table>
<thead>
<tr>
<th>Previous Prices</th>
<th>05 May 2016</th>
<th>04 May 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICCO daily price (SDRs/tonne)</td>
<td>2271.16</td>
<td>2280.69</td>
</tr>
<tr>
<td>ICCO daily price (US$/tonne)</td>
<td>3217.39</td>
<td>3238.39</td>
</tr>
<tr>
<td>London futures (£ sterling/tonne)</td>
<td>2260.67</td>
<td>2279.00</td>
</tr>
<tr>
<td>New York futures (US$/tonne)</td>
<td>3154.67</td>
<td>3171.67</td>
</tr>
</tbody>
</table>

Source: ICCO, 2016
Chiapas state situation of cocoa production, before (2003) and after (2013) of moniliasis

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area (ha)</strong></td>
<td>21,351.1</td>
<td>20,299.4</td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td>16,746</td>
<td>9,080</td>
</tr>
<tr>
<td>(Ton of dry beans)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Yield (ton)</strong></td>
<td>0.82</td>
<td>0.44</td>
</tr>
</tbody>
</table>

*Source: SIAP, 2015*
VIII Soconusco Region, Chiapas, Mexico.
Mames indigenous group
Varieties

- Criollo type
- Criollo and other varieties
- Calabacillo type
- Guayaquil type
- Ceylán type
- Calabacillo and other varieties
- Pataste and other varieties
Age of planting

- 0-5 years: 4.00%
- 5-10 years: 5.33%
- 10-15 years: 12.00%
- 15-20 years: 17.33%
- 20-25 years: 20.00%
- More of 25 years: 41.33%
Age of producer

- 30-40 years: 38.36%
- 41-50 years: 16.44%
- 51-60 years: 16.44%
- More of 60 years: 28.77%
## Characteristics between genetics groups

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Criollo</th>
<th>Forastero</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree</td>
<td>Weak and small</td>
<td>Robust, very large</td>
</tr>
<tr>
<td>Leaves</td>
<td>Small, light green</td>
<td>Large, dark green</td>
</tr>
<tr>
<td>Pod</td>
<td>Cundeamor, angoleta</td>
<td>Amelonado, calabacillo</td>
</tr>
<tr>
<td>Exocarp thickness</td>
<td>Fine, soft</td>
<td>Thin, hard</td>
</tr>
<tr>
<td>Fruit surface</td>
<td>Very rough</td>
<td>Smooth</td>
</tr>
<tr>
<td>Seed</td>
<td>White, rounded</td>
<td>pigmented flat</td>
</tr>
<tr>
<td>Diseases</td>
<td>Susceptibles</td>
<td>Resistant</td>
</tr>
<tr>
<td>Flavor</td>
<td>Fine</td>
<td>Ordinary</td>
</tr>
<tr>
<td>Adaptation</td>
<td>Poor, limited</td>
<td>Very good, wide</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Autocompatible</td>
<td>Autoincompatible</td>
</tr>
</tbody>
</table>

Source: Cuatrecasas, 1964; CIRAD, 2008
Selection: natural or artificial process by which the best individuals in a population are separated. It is one of the oldest improvement procedures and constitute the basis of plant breeding.
Strategies:

Collect and evaluation of criollo cocoa

Participatory Breeding
Strategias:

✓ Collect and evaluation of criollo cocoa

✓ Participatory Breeding
Collect criollo cacao in different places of Mexico
Collect criollo cacao

Collecting Diversity was found in the shapes and colors of the fruit and seed of Mexican criollo cocoa.
Now it preserved in the Gene Bank criollo cocoa of INIFAP
Caracterization and evaluation
Molecular characterization

Figure. Grouping criollo cacao accessions, based on 28 microsatellite loci
Strategies:

✓ Collect and evaluation of criollo cacao

✓ Participatory Breeding
Participatory Breeding (PB)

The aim of **Participatory Breeding** is to link the formal and informal systems of crop development, procuring a combination productivity and strengthening the agrobiodiversity necessary for producer.

**Participatory Breeding** strategy is to introduce and maintain genetic diversity in local systems, taking advantage of producer in developing, adapting and adopting new varieties.
Phase 1: Socialization Participatory Breeding Program

✓ Participation of producers and researchers

Objectives of the initiative in the short and medium term

Expected results
Phase 2: Defining the characteristics to select

1. High yield
2. Resistant Diseases Moniliasis
3. Quality and flavor (white seeds)
4. Tree with good vigor
5. Drought resistant
Phase 3: Field trips for identification and selection of promising trees
Field trips and tree identification
Phase 4: Diagnosis of the parcel to determine production efficiency
Selection of high yielding trees

Tree SGP-01
128 Fruit /harvest
12 Inoculated fruit
8 Fruits escala 0
4 Fruits escala 1-2
Incidence moniliasis: 10 %
Selection of genotypes with quality and flavor
Selection of genotypes with tolerant diseases (moniliasis)
**METODOLOGY**

Spores of 11 to 15 days
Fruits two months

Inoculum: $1.2 \times 10^{-5}$ spores per ml
moist chamber
Incubation pathogen 9 weeks.
Harvest fruits and data logging
Incidence(%,)
External severity
Internal severity

External and internal symptoms

Deformation

Premature maturity

Esporulation

Necrosis

Necrosis internal (seeds)
Symptomatic Scale: External Severity

It measures the ability of the fungus to cause damage and to produce propagules infectives

(Sánchez, 1982 y Brenes, 1983)
Symptomatic scale: Internal Severity

It measures the ability of damage that the fungus can cause in almonds. In longitudinal section of the fruit

0 = 0% completely healthy  
1 = 1-20%  
2 = 21-40%  
3 = 41-60%  
4 = 61-80%  
5 = >80%, fully necrosed

(Sánchez, 1982 and Phillips, 2003)
## Determination of resistance

The results of internal security are compared with the scale

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Internal Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistent</td>
<td>0.0 - 1.25</td>
</tr>
<tr>
<td>Moderadamente resistente</td>
<td>1.26 - 2.50</td>
</tr>
<tr>
<td>Moderadamente susceptible</td>
<td>2.51 - 3.75</td>
</tr>
<tr>
<td>Susceptible</td>
<td>3.76 - 5.0</td>
</tr>
</tbody>
</table>

*Phillips, 2003.*
## EVALUACION DE FRUTOS INOCULADOS EN PARCELA

<table>
<thead>
<tr>
<th>ARBOL</th>
<th>FRUTOS INOCULADOS</th>
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<th></th>
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<tbody>
<tr>
<td></td>
<td>SANOS</td>
<td>ENFERMOS</td>
<td></td>
</tr>
<tr>
<td>RDD1</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>RDD1-C1-1</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RDD1-C1-2</td>
<td>6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RDD1-C1-3</td>
<td>6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RDD1-C1-4</td>
<td>7</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RDD1-C1-5</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RDD1-C1-6</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RDD1-C1-7</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>RDD2</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Testigo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rojo Samuel</td>
<td>0</td>
<td>2* y 4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

* RDD1-C1-1, RDD1-C1-2, RDD1-C1-3, RDD1-C1-4
## Field evaluation

<table>
<thead>
<tr>
<th>No. Evaluacion</th>
<th>No. Frutos inoculados</th>
<th>Muertos</th>
<th>Resistentes</th>
<th>Susceptibles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18</td>
<td>3</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
<td>0</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>0</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
<td>3</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>18</td>
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<td>18</td>
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<tr>
<td>6</td>
<td>25</td>
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<td>25</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>22</td>
<td>1</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totales</strong></td>
<td><strong>147</strong></td>
<td><strong>7</strong></td>
<td><strong>138</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td><strong>Porcentajes</strong></td>
<td><strong>100</strong></td>
<td><strong>4.7619</strong></td>
<td><strong>93.8776</strong></td>
<td><strong>1.3605</strong></td>
</tr>
</tbody>
</table>

**EVALUACION CONTROL**

<table>
<thead>
<tr>
<th>No. Evaluacion</th>
<th>Numero de frutos</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1    2  3  4  5  Total frutos</td>
</tr>
<tr>
<td>1</td>
<td>SE   3  4  3  4  3  5</td>
</tr>
<tr>
<td></td>
<td>SI   5  4  4  5  4</td>
</tr>
<tr>
<td>2</td>
<td>SE   4  3  4  3  4  5</td>
</tr>
<tr>
<td></td>
<td>SI   5  4  5  4  4</td>
</tr>
<tr>
<td>3</td>
<td>SE   3  5  3  4  4  5</td>
</tr>
<tr>
<td></td>
<td>SI   4  5  4  4  4</td>
</tr>
<tr>
<td>4</td>
<td>SE   2  3  2  4  2  5</td>
</tr>
<tr>
<td></td>
<td>SI   4  5  4  5  4</td>
</tr>
<tr>
<td>5</td>
<td>SE   3  4  2  5  3  5</td>
</tr>
<tr>
<td></td>
<td>SI   5  5  4  5  4</td>
</tr>
<tr>
<td>6</td>
<td>SE   3  4  3  4  4  5</td>
</tr>
<tr>
<td></td>
<td>SI   4  5  4  5  5</td>
</tr>
<tr>
<td>7</td>
<td>SE   4  3  5  4  3  5</td>
</tr>
<tr>
<td></td>
<td>SI   5  4  5  5  4</td>
</tr>
</tbody>
</table>
Phase 5: Criollos cocoas that will be planted in the local system of farmers to increase the biodiversity
Producer: Samuel Guillen Díaz
Location: Ejido Hidalgo
Tapachula, Chiapas
Altitude: 50 m
Clones introduced:
  Regalo De Dios I (a)
  Arcoiris(b)
  Rojo Samuel (c)
  Lacandon 17
  Carmelo
Producer: Isidro López
Parcel: “El encuentro”
Location: El vado
Municipality: Tuzantán, Chiapas

Altitude: 365 m

Clones introduces:
Regalo De Dios I
Arcoiris II
Rojo Samuel
Producer:
Anselmo Munguerza Zesma

Parcel “San Antonio”

Location: Ejido la Rioja
Cacahoatán, Chiapas

Altitude:
507 m (Primera sección)
518 m (Segunda sección)

Clones introduced:
Regalo De Dios I
Arcoiris
Rojo Samuel
Parcel: “Rosario Izapa”
Campo Experimental Rosario Izapa
**Municipality:** Tuxtla Chico, Chiapas
**Altitude:** 439 m

**Clones introduced:**
- Regalo De Dios I
- Regalo De Dios II
- Rojo Samuel
- Lagarto
- Rojo Gustavo
- Verde Gustavo
Producer:
Gustavo Rodas Monzón
Parcel “El Coquito”
Municipality: Suchiate, Chiapas
Altitude: 15 m
Clones:
Regalo De Dios I Arcoiris
Rojo Samuel
a) Rojo Gustavo
b) Verde Gustavo
Parcel “El coquito”
Grafted patterns after 5 months of desvende.

a) Grafting method taquito
   Grafting side plating method
Producer:
Israel Gutiérrez Ruiz

Parcel: “La Plata”

Localization: Finca “La Plata no. 3”

Municipality: Cacahoatán, Chiapas

Altitude: 507 m

Clones:
Ragalo de Dios
Arcoiris
Rojo Samuel
## Phase 6: Evaluation in different environments in the Soconusco, Chiapas

<table>
<thead>
<tr>
<th>MUNICIPIO</th>
<th>LOCALIDAD</th>
<th>ALTITUD</th>
<th>ARBOL</th>
<th>R. DE FRUTOS</th>
<th>SE</th>
<th>SI</th>
<th>FOTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAPACHULA</td>
<td>EJIDO HIDALGO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUCHIATE</td>
<td>EJIDO GENERAL MANUEL AVILA</td>
<td>15 m</td>
<td>RDDI-6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td>RDDI-18</td>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>5</td>
<td></td>
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<tr>
<td></td>
<td>RDDI-21</td>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>2</td>
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<td>15</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>3</td>
<td>0</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>CACAHOTAN</td>
<td>LA RIOJA</td>
<td>507 m</td>
<td>RDDI-17</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>2</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>TUXTLACO CHICO</td>
<td>ROSARIO IZAPA</td>
<td>438 m</td>
<td>RDDI-12</td>
<td>1</td>
<td>1</td>
<td>15</td>
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<td></td>
<td>2</td>
<td>2</td>
<td>15</td>
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</tr>
</tbody>
</table>
Challenges and perspectives

✓ Generate and implement public policies to conserve and utilize the diversity of Mexican criollos cocoas renowned for their high quality to make cultivation a profitable and sustainable activity.

✓ Making the producer regain confidence in cocoa farming as a source of income that allows you to maintain and use the diversity of criollos cocoas to improve their quality of life.

✓ Successfully face the problem of current and emerging diseases, through selected and adapted to the conditions of the region, by using this genetic diversity in their fields materials.
The producer of cocoa empower your plot and perceived as a profitable company in the present and in the future.

Create local, regional and international strategic alliances (research institutions, corporations, governments, financial sources) that allow the conservation of biodiversity, sustainable production and an economic impact that energizes the local and regional economy.

Cocoa now has a strong demand with acceptable prices and the trend is to increase and Latin America is still a focus to invest in the cultivation of cocoa, because Africa is having strong environmental and social problems in production.
The footprint (dedication, hard work) of the producer is the best fertilizer of cocoa

Don Samuel Guillén Díaz

Clon Regalo de Dios

Clon Rojo Samuel
Thanks...