Development and identification of high-value cassava clones

- Increasing incomes from cassava
- High-value cassava: materials and methods
- High-value cassava: results

Introduction: imported corn in Colombia

Millions t/year:
- 1990: 0.0
- 1992: 0.4
- 1994: 0.8
- 1996: 1.2
- 1998: 1.6
- 2000: 2.0

Increasing incomes from cassava

- Increasing productivity
  - Clones with high and stable yields
  - Disease and pests management (i.e., biological control)
  - Soil management. Terraces. Adequate fertilization.

- Reducing production cost
  - Mechanization of planting and harvest
  - Biofertilizers
  - Efficient marketing

- Higher value for the products of the crop
  - High-value products
  - Exploitation of the foliage
  - High-value clones

Most processed cassava targets four end-uses

- Animal feed
- Starch
- Ethanol/bioplastics
- Processed food
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Increasing incomes from cassava

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Why don’t we have useful mutants in cassava starch?

Mutations are generally recessive and therefore we have to self-pollinate cassava to find them.

Even if the mutation expressed itself, it is difficult to identify those roots with useful traits.

Economic traits: amylose content

Amylose Content (% of total starch)

Number of Clones

Source: Teresa Sánchez
Strategies to create cassava clones with new types of starch and higher commercial value

1. "Brute force": genetic transformation

2. The persistent way: recurrent selection

Genetic transformation: waxy cassava starch

- Adenosine diphosphate glucose pyrophosphorylase
- Starch branching enzymes
- Anti-sense of granule bound starch synthase

Source: Martin Fregene

1. "Brute force": genetic transformation
2. The persistent way: recurrent selection
Recurrent selection to gradually reduce (or increase) amylose content in cassava starch

- 29 clones
  - Average = 11.2%
  - Range = 9.7 to 12.1%

- 35 clones
  - Average = 22.7%
  - Range = 21.8 to 26.4%

1. "Brute force": genetic transformation
2. The persistent way: recurrent selection
3. The gambler’s way: induced mutations & TILLING

Induction of mutations

1. "Brute force": genetic transformation
2. The persistent approach: recurrent selection
3. The gambler’s way: induced mutations & TILLING
4. Following maize’s "early fathers": fun in the inbreeding world
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1. “Brute force”: genetic transformation
2. The persistent approach: recurrent selection
3. The gambler’s way: induced mutations & TILLING
4. Following maize’s “early fathers”: fun in the inbreeding world
5. The wild strategy: looking at other Manihots
6. The boring task: finding a needle in the haystack

**Current evaluation system**

<table>
<thead>
<tr>
<th>Stage</th>
<th>N° of clones</th>
</tr>
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<tbody>
<tr>
<td>Elite clones are crossed and botanical seed is obtained</td>
<td>10,000 - 15,000</td>
</tr>
<tr>
<td>F1: botanical seed is germinated (1 plant)</td>
<td>2500</td>
</tr>
<tr>
<td>In target environment (i.e., Barranquilla)</td>
<td>2000</td>
</tr>
<tr>
<td>Clonal Evaluation: Row with 7-8 plants/clone</td>
<td></td>
</tr>
<tr>
<td>Preliminary Yield Trial: 3 reps x 10 plants</td>
<td>300</td>
</tr>
<tr>
<td>Advanced Yield Trial : 3 reps x 20 plants</td>
<td>80</td>
</tr>
<tr>
<td>Regional Trial: 3 reps x 25 pl. x 3 locs</td>
<td>20</td>
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</tbody>
</table>

**Variation in pasting properties of starch**

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Viscosity (Brabender units)</th>
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<tbody>
<tr>
<td>0</td>
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<tr>
<td>10</td>
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<td>20</td>
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<td>90</td>
<td>90</td>
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**Approaches for identifying high-value cassava**
Creation of genotypes with higher probability for the expression of useful traits (6 strategies)

Root quality lab with high throughput capacity (15,000 samples/year)

Identification of high-value cassava clones

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High-protein

High-carotenoids
March 1st, 2006: A historic date for cassava

Average amylose content 0%-2.9%

Source: Fernando Calle / Nelson Montiel

Most processed cassava targets four end-uses

Animal feed
Starch
Ethanol/bioplastics
Processed food

Source: José A. Arroyave

SDS – PAGE GEL OF NORMAL AND WAXY STARCH

Source: Janeth P. Gutierrez

Considerable reduction in cost of fermentation
Easier access to enzymes

Source: José A. Arroyave
**Variation in different pigments**

**Variation in starch quality:** sugary cassava

Source: Carbalho et al., 2000. EMBRAPA, Brasilia, DF
Most processed cassava targets four end-uses

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- Acyanogenesis
- Reduction of PPD
- "Resistant" starches

Concluding remarks

Pre-breeding provides excellent results
- Cassava still being domesticated
- New market opportunities promotes this work
- New technologies facilitate this work (i.e. NIRs, TILLING)

The introgression of traits difficult
- We need to implement the back-cross scheme
- Inbreed parents would facilitate introgression
- In some cases the trait is simply inherited

The strategy for the future
- Continue breeding for high and stable productivity
- Quality also offers opportunities
- Need to interact with processing technologies

The Rockefeller Foundation
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HarvestPlus
IAEA
Generation Challenge Program

Asentí sã…. !
Thank you!
Danke !
Obrigado !
Gracias !
Merci !