A Transit Center for Cassava Breeding: Need to Enhance Genetic Gain in Cassava


10 June 2014
Need for a Cassava Transit Center

1. Cassava is an important crop on Latin America, Asia and Africa
2. Breeding methods are needed that are efficient, safe and rapid
3. Each region has diseases and pests that should not be used to other regions
4. Germplasm exchange has been the foundation of breeding success in cassava. This will continue.
5. Germplasm from Latin America generally has super susceptibility to CMD that serves as a barrier to effective use of germplasm
6. Plant quarantine systems limit movement of germplasm, sometimes but not always with good rationale
2. Efficient and rapid breeding

Rapid annual breeding cycle enabled by marker technologies

Cross → Seedlings → Genotype → clonal

Select

One Year

Phenotype → Predict

Breeding Value

How good are the predictions?

PYT → AYT → AYT-UYT
Selection based of GEBVs – Genomic Estimated Breeding Values

Selected clones

FYLD – Fresh Root Yield     MCMDS – Mean CMD Severity
One year GS breeding cycle pushing the cassava breeding to the limits

<table>
<thead>
<tr>
<th>Objective</th>
<th>Activity 1</th>
<th>Activity 2</th>
<th>Activity 3</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>Recombination (Annual cycle)</td>
<td>Crossing block</td>
<td>crossing</td>
<td>Harvest seeds</td>
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<tr>
<td>Seed germination &gt;10,000</td>
<td>Transplant (5000-10000)</td>
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<tr>
<td>DNA (&gt;2500)</td>
<td>GBS</td>
<td>Genomic selection of 150 parents</td>
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<tr>
<td>Phenotyping</td>
<td>2500 seedlings</td>
<td>Ibadan +ratoon</td>
<td>•Disease, morphology, plant type</td>
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<tr>
<td></td>
<td>2400 clonal</td>
<td>3 locations</td>
<td>•Disease, productivity, nutrition</td>
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<tr>
<td></td>
<td>100 parents AYT</td>
<td>2 location +irrigation</td>
<td>•Yield and root quality</td>
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A member of CGIAR consortium  www.iita.org
Cassavabase.org

Cassava (Manihot esculenta), a major staple crop, is the main source of calories for 300 million people across the globe. No other continent depends on cassava to feed as many people as does Africa. Cassava is indispensable to food security in Africa. It is a widely preferred and consumed staple, as well as a hardy crop that can be stored in the ground as a fall-back source of food that can save lives in times of famine. Despite the importance of cassava for food security on the African continent, it has received relatively little research and development attention compared to other staples such as wheat, rice and maize. The key to unlocking the full potential of cassava lies largely in bringing cassava breeding into the 21st century. [More...]

All Data Available with Open Access with agreement to observe the Toronto Protocol regarding use of unpublished data
Cassava Trait Ontology

- 150 traits defined for with partners in ongoing dialogue to add new traits
- Ontology defines trait properties, scales and methods
- Methods and data accessible to global cassava community
- Used in cassavabase, breeding management system, agtrials

Stem Color

Root Neck Length

Root Shape

Outer Skin Color

Root Number

CO_334:0000062

CO_334:0000022

CO_334:0000020

CO_334:0000064

CO_334:0000011
3. Regional disease and pest threats

Need to Avoid Exchange of Important Regional Threats between Important Cassava Production Zones

- Latin America
- African West
- East Africa

Diseases:
- EACMV-UG, CBSVs super abundant white flies
- ACMV, EACMV
- Frogskin disease
- Super elongation disease

Witches Broom
Asia
## New Clones Produced by the IITA Breeding Program with Parents Introduced from CIAT in Tissue Culture or Botanic Seed

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of New Clones at IITA</th>
<th>CIAT Parents</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>2001</td>
<td>1819</td>
<td>311</td>
<td>17.1</td>
</tr>
<tr>
<td>2002</td>
<td>37</td>
<td>10</td>
<td>27.0</td>
</tr>
<tr>
<td>2004</td>
<td>169</td>
<td>3</td>
<td>1.8</td>
</tr>
<tr>
<td>2005</td>
<td>2727</td>
<td>190</td>
<td>7.0</td>
</tr>
<tr>
<td>2006</td>
<td>3245</td>
<td>152</td>
<td>4.7</td>
</tr>
<tr>
<td>2007</td>
<td>1593</td>
<td>79</td>
<td>5.0</td>
</tr>
<tr>
<td>2008</td>
<td>8588</td>
<td>207</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>952</td>
<td>5.2</td>
</tr>
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</table>
4. Traits needed for exchange

1. Industrial traits
   • waxy starch, sugary ..... 

2. Nutritional traits
   • Enhanced carotenoids – proVitamin A 

3. Sustainable intensification
   • fertilizer responsiveness, suitability for mechanization, herbicide tolerance 

4. Disease and pest resistance
   • CMD, CBSD, white flies, witches broom .... 

5. Improvement in yield and dry matter production
   • Unique heterotic combinations
   • Shared regional achievements 

6. Shared products of advance research
   • Products of genetic engineering, gene editing ....
Cassava Mosaic Disease –
Selection and Diversifying Resistance
Cassava Brown Streak Disease
CBSD
Leaf, Stem and Root Symptoms
High leaf retention capacity five months after planting increases fresh yield by 7 tonnes per ha
Genetic mapping of CBSD resistance to aid Marker Assisted Selection

Namikonga
Resistant ♀

Albert
Susceptible ♂

• Phenotype segregation in 190 progeny over two years.
• Genotyped with 216 polymorphic SSR markers
• Preliminary analysis showed one SSR with 0.66 correlation to segregation for resistance from Namikonga
5. Super susceptibility to CMD
5. Super susceptibility to CMD

It is possible to cross in resistance.
Cassava Transit Center Requirements

1. Favorable growing conditions for cassava cultivation, flowering and seed production
2. Cassava can be received and maintained as tissue cultures and botanic seed from cassava growing regions
3. Major cassava diseases are absent
4. Strong plant diagnostic capacity
5. Strong and favorable plant quarantine office
6. Cassava breeders from different regions can receive botanic seed from the transit center location
7. Strong technical staff to manage transit center functions
1. Hawaii – USA
   • Currently under evaluation in the Nextgen Cassava Project
   • Starting Partners – Cornell University, CIAT, IITA, NRCRI, USDA, APHIS, Univ. of Hawaii, others....

2. Reunion – France
   • To be considered in this meeting
   • Starting Partners – CIRAD, GCP21, CIAT, IITA, others....

3. One location may not satisfy all functions and multi-location strategy may be needed

4. Other suggestions