Crops to End Hunger Project Update Webinar

Roots, Tubers, and Bananas, Phenotyping and Germplasm Exchange Hub Facilities Upgrade

November 14, 2023
Importance of RTBs

- **Food security:** More than three billion people in developing countries consume RTB crops.
- High yielders in terms of calories produced per hectare
- **Nutrition security:** Often rich in key nutrients such as provitamin A
- **Climate resilience:** Many RTB crops can be grown with few inputs and often under harsh conditions, yet respond well to intensification
- **Poverty alleviation:** Frequently grown and/or marketed by women for income generation.
Challenges that are peculiar to RTBs

- **Clonal propagation:**
  - Low multiplication rate slowing breeding cycle length and scaling of release varieties
  - Restricted germplasm exchange within and between regions

- **Bulkiness and perishability:**
  - Difficult post-harvest management and handling logistics
  - Phenotyping of quality traits is a challenge

- **Flowering and crossing:**
  - Asynchronous flowering, limited number of seeds per cross, ..
Agenda

• Introductions (10 min)

• Upgrading Infrastructure and Facilities for Accelerated Breeding and Genetic Gain in Cassava (Xiaofei Zhang, Ismail Rabbi) (30 min)

• Regional Germplasm Hub for Vegetatively Propagated Crops @ KEPHIS Muguga (Morag Ferguson) (30 min)

• Investing in (sweet)potato breeding networks to mitigate climate change; Upgrading CIP-NARS East Africa potato breeding hub infrastructure (Hannele Lindqvist-Kreuze) (30 min)

• Discussion / Q&A (20 min)
Upgrading Infrastructure and Facilities for Accelerated Breeding and Genetic Gain in Cassava (Xiaofei Zhang, Ismail Rabbi)
Upgrading Infrastructure and Facilities for Accelerated Breeding and Genetic Gains in Cassava

Duration of Selection Cycle
- Obj. 1, Flower Inducing
- Obj. 2, Genomic Selection
- Obj. 4, Rapid propagation

Genetic Diversity

Intensity

ΔG = \frac{i \delta_A \gamma}{L}

Accuracy
- Obj. 3, Cooking quality protocols
Dilemma:

Farmers prefer varieties with erect plant architecture, which produce few flowers as parents in breeders’ crossing nurseries.

Solution:

*Flower-inducing technology*
Flower Inducing Technology

Flower–inducing technology facilitates speed breeding in cassava

Erika Paola Barinas Rodríguez, Nelson Morante, Sandra Salazar, Peter T Hyde, Tim L Setter, Peter Kulakow, Johan Steven Aparicio, Xiaofei Zhang

Affiliations

1 Universidad Nacional de Colombia, Sede Palmira, Palmira, Colombia.
2 Cassava Program, International Center for Tropical Agriculture (CIAT), Cali, Colombia.
3 Section of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY, United States.
4 Cassava Program, International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria.
5 Beans Program, International Center for Tropical Agriculture (CIAT), Cali, Colombia.
Flower Inducing Technology

Photoperiod Extension induced early flowering by 2-3 months for progenitors with erect plant architecture.
Objective 1: *Deliver improved breeding populations to the CGIAR-NARES cassava breeding networks.*

1. **Mainstream** cassava flower-inducing technology
2. Establish the *red light system* at IITA and CIAT
3. Deliver **training workshops** on flower-inducing technology *(2024 Sep)*
4. Renovate **seed storage** rooms (>=20m²)
0.5 ha with Photoperiod Extension
Objective 2: Enhance IITA and CIAT breeding hub genomic analysis and selection capacity.
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**Approach:** The *computing servers* will be installed at CIAT and IITA for the breeding teams to perform routine analysis in *genomic selection* and genome-wide association mapping.

10x coverage for discovering genome-wide markers (8Gb/sample)

**Populations:**
- Parents, GS, inbreeding, trait discovery

- 3,000 samples
- ~24TB data/year
Objective 3: Scale RTBfoods protocols that accurately analyze high-priority quality and nutritional traits in cassava.

**Equipment:**
- *hyperspectral imaging* at CIAT
- *freezer* and *freeze dryer* at CIAT for *PPD* samples

**Facility:**
- *commercial kitchens* for boiled cassava at CIAT and IITA
- Renovate facilities at CIAT and IITA for *PPD* evaluation

**Workshop:**
- A one-week *training* on high-priority *quality and nutritional traits* at CIAT and IITA
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### Environment

#### PPD Evaluation in Multiple Environments

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### H²

H² is 0.67

14 environments

7 years
Protocol

Field

Harvest

3 plants per genotype
Commercial Root size

10 Roots

Pretreatment to accelerate deterioration

Proximal cut

Distal cut

Wrap with plastic film

Tying the plastic film with rubber bands

7 slices (per root); Thickness. 2 cm

7 days of storage
Objective 4: Reduce the duration of the cycle between crossing, trialing, and scaling out to the seed system

Net house facility to keep the planting materials pest and disease-free.
## Objective 3: RTB processing and quality phenotyping

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<th>SN</th>
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<th>Traits for product profiles</th>
<th>Baseline traits</th>
<th>Current Breeding Pipeline</th>
<th>Product samples</th>
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| 1  | Processed Products (Gari and fufu) | High quantity and quality of processed product (% conversion rate, colour and texture) | Yield, dry matter, resilience to common biotic and abiotic stresses, flexible time of harvest | West Africa (Nigeria)  
Central Africa (DRC) | ![Image](image1.jpg)  
![Image](image2.jpg) |
| 2  | Cassava for Fresh Markets | Root mealiness after boiling, Low cyanogenic potential, Sweet taste | Yield, dry matter, resilience to common biotic and abiotic stresses, flexible time of harvest | East Africa (Uganda and Tanzania)  
Central Africa (DRC)  
Southern Africa (Zambia)  
West Africa (Nigeria, Ghana) | ![Image](image3.jpg)  
![Image](image4.jpg) |
| 3  | Biofortified cassava for enhanced nutrition | β-carotene, suitability for gari and fufu products | Yield, dry matter, resilience to common biotic and abiotic stresses, flexible time of harvest | West Africa (Nigeria)  
Central Africa (DRC) | ![Image](image5.jpg)  
![Image](image6.jpg) |
| 4  | Cassava for Industry | High starch and flour content, mechanizable plant architecture. | Yield, dry matter, resilience to common biotic and abiotic stresses, flexible time of harvest | West Africa (Nigeria) | ![Image](image7.jpg) |
Complexity of cassava products, processing steps and current evaluation stages for quality traits

Fresh root processing into key products (West Africa)

Processing steps
- Fresh
- Dry
- Starch / flour
- Paste
- Granulated products

Testing Stage
- Color
- Texture
- Taste

Testing Stage
- Seedling
  - 1
  - 2
  - 3
  - 4
  - 5

Traits evaluation
- Agronomy traits
- Quality traits

Traits evaluation
- N
  - 30000
  - 3000
  - 300
  - 50
  - 20
  - 5
Cassava garri processing

1. Peeling
   - 10kg of marketable cassava roots

2. Washing and grating
   - Wash and grate roots into a mash without the addition of water.

3. Fermentation
   - Pack the polypropylene allowed for 72 hours.

4. Pulverization and toasting
   - Toast the pulverized stainless-steel pan at a temperature of 120°C until the moisture of the mash reaches an.

5. Cooling and slaughtering

6. Packaging and storage
   - Pack, weigh, and store the gari at ambient temperature (30±2°C).
Proposed facility upgrade to streamline root processing

**Pre-processing**
- Weighing
- Washing
- Peeling

**Grating**
- Mechanical graters

**De-watering**
- Hydraulic press

**Mechanical sieve**
- Sieving (fibre removal and large lumps)

**Toasting**
- Mechanical toasters

**Storage**
- Controlled temperature and humidity store with shelves
What we would achieve by facility upgrade

**Customer focus:**
- Deliver smallholders benefits
- Deliver varieties that are suitable for the major product value chain

**Operational excellence (root phenotyping):**
- Implement high-throughput root/tuber phenotyping (intermediate & finished product).
- Evaluate more entries at earlier stages of selection
- Standardize processing to increase data quality (increase genotype-effect to noise ratio).

**Organizational leadership:**
- Occupational health
  - Ensure worker operational safety and health
- Facility hygiene
  - Product quality and safety