

Crops to End Hunger Project Update Webinar



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

November 14, 2023

CROPS
TO END
HUNGER
(CtEH)



Australian Government
Australian Centre for
International Agricultural Research

BILL & MELINDA
GATES foundation



Federal Ministry
for Economic Cooperation
and Development



Foreign &
Commonwealth
Office

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH



USAID
FROM THE AMERICAN PEOPLE

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, ..

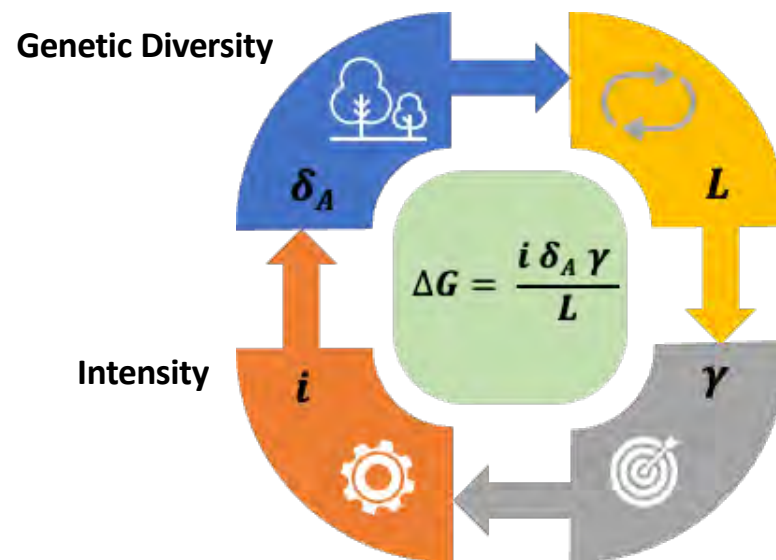
Agenda



- 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

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

> [Front Plant Sci.](#) 2023 May 22:14:1172056. doi: 10.3389/fpls.2023.1172056. eCollection 2023.

Flower-inducing technology facilitates speed breeding in cassava

Erika Paola Barinas Rodrmguez ¹, Nelson Morante ², Sandra Salazar ², Peter T Hyde ³, Tim L Setter ³, Peter Kulakow ⁴, Johan Steven Aparicio ⁵, Xiaofei Zhang ²

Affiliations

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- 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.





Location



Photoperiod



Pruning



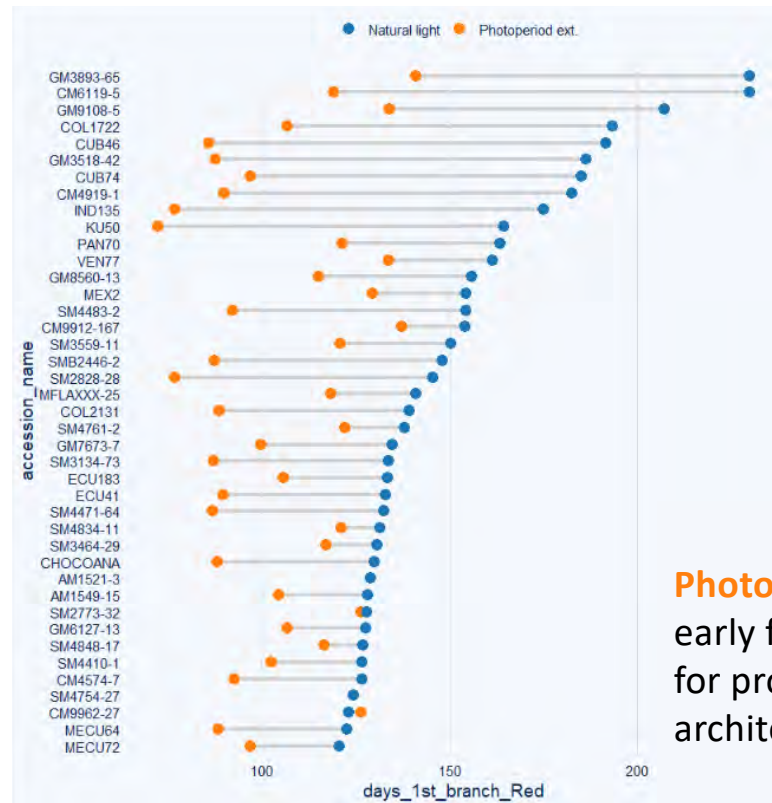
Hormone



Flower-Inducing Technology



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*

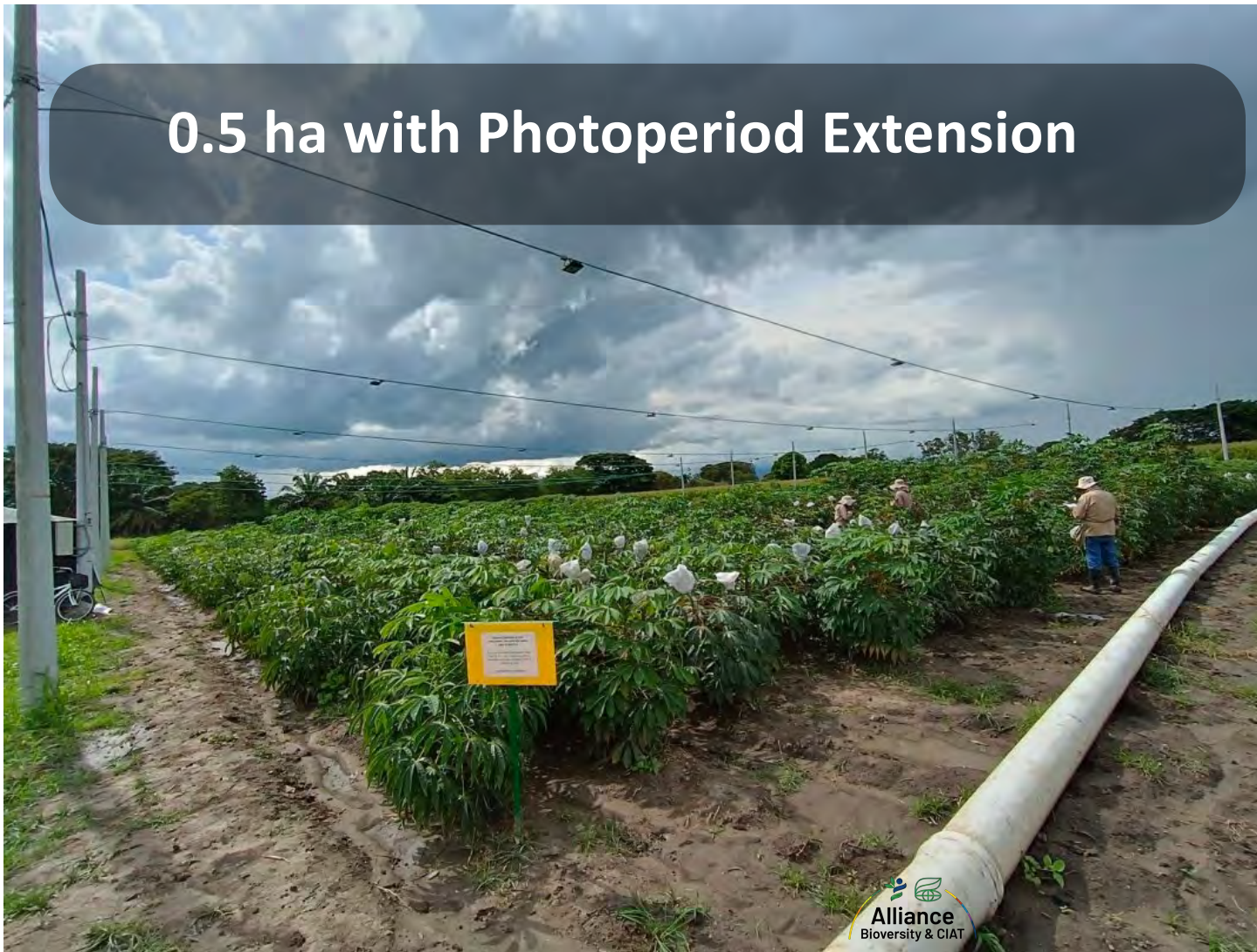
(2) Establish the **red light system** at IITA and CIAT

(3) Deliver **training workshops** on *flower-inducing technology* (**2024 Sep**)

(4) Renovate **seed storage** rooms ($\geq 20\text{m}^2$)

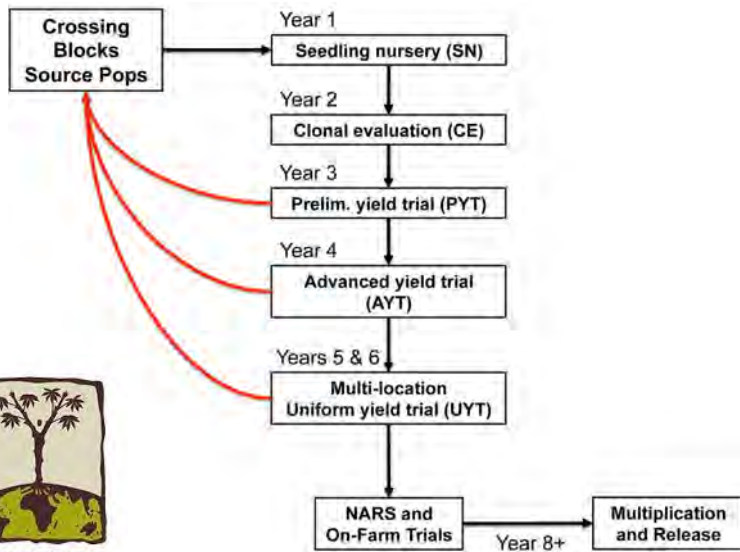


0.5 ha with Photoperiod Extension

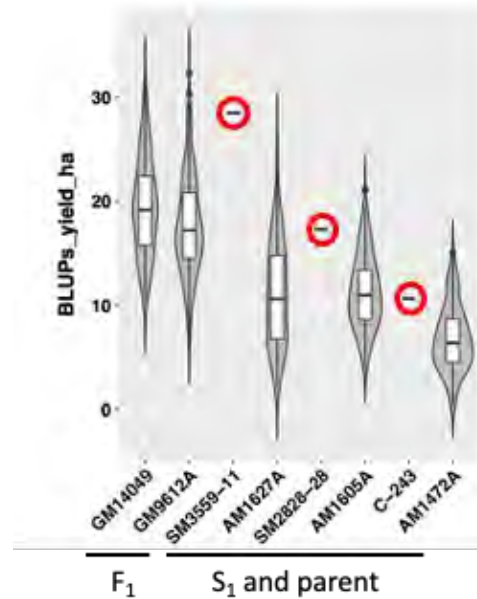


Objective 2: Enhance IITA and CIAT breeding hub genomic analysis and selection capacity.

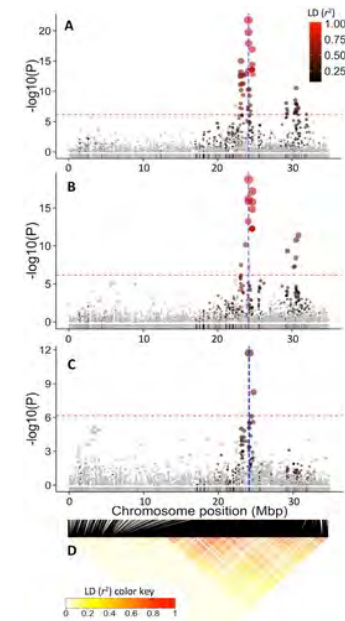
Genomic Selection



Inbreeding Depression Hybrid Breeding



Discovery



Objective 2: Enhance IITA and CIAT breeding hub genomic analysis and selection capacity.

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

Capacity Building in Genomics-assisted Breeding

1



UFIFAS   **AGRONOMY DEPARTMENT**

Multi-Omic Integration for AI Genomic Prediction Breeding Short Course

July 10-14, 2023 Gainesville, Florida

This course is intended for research scientists from the private sector and public institutions interested in learning the foundations of different prediction frameworks considering the integration of multiple omics of information (or layers) with applications in plant and animal breeding.

- Genomic Selection GS aided by Genomic Prediction GP models
- Artificial Intelligence Methods Implemented for GP
- GP aided by high-throughput phenotyping platforms
- Multi-Omics Integration for Continuous and Categorical Data
- Estimation and Prediction of Genotype-by-Environment (G×E) Interactions
- Multi-Trait Prediction
- Sparse Testing Designs
- Prediction of Time-Related Traits
- Crop Growth Models (CGM) for Integrating the Genotype-by-Environment-by-Management (G×E×M) Interaction in Whole Genome Prediction (WGP)
- Predicting Resistance, Virulence and Host by Pathogen Interactions

To register:
<https://conference.ifas.ufl.edu/maiaj/index.php>

Sponsorship Opportunity



2



IPBO  **VIB-UGENT CENTER FOR PLANT SYSTEMS BIOLOGY**  **PLANT BREEDING CENTER**

SUMMER INSTITUTE IN PLANT BREEDING, 2023

A large group of diverse individuals, including students and faculty, are posed for a group photo in front of a modern building with large glass windows. The group is arranged in several rows, with some individuals standing on a small set of steps.



3

Genomic Selection training at CIAT, 2023 Oct 25- Nov 2



4

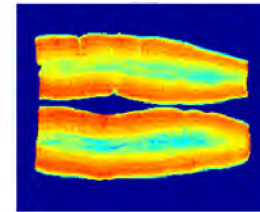
Quantitative Genetics at CIAT, 2023 Nov 14-18



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

RTBfoods



PPD Evaluation in Multiple Environments

H^2 is **0.67**

14 environments

7 years

Genotype	Environments														
	2012Sep_Wild_10	2012Sep_Wild_12	2013Oct_Wild_10	2013Oct_Wild_12	2014Oct_Wild_10	2014Oct_Wild_12	2015Aug_Wild_10	2015Aug_Wild_12	2016Aug_Wild_10	2016Aug_Wild_12	2017Jul_Wild_10	2017Jul_Wild_12	2018Jul_Wild_10	2018Jul_Wild_12	BLUPs
PER183	1.23	1.98	3.21	2.14	0.10	0.74		0.27	0.55	0.15	0.09	1.52	0.58	0.63	0.98
CPDCR5B-036	0.74	0.99	0.27	0.06		1.31	0.03	0.21	2.14		1.02	1.46			1.03
CPDCR5B-069A	0.56	2.00	0.02	0.66	0.80	2.27		0.86	1.10	0.49		0.84	1.07		1.06
CPDCR1B-080	0.61	0.51	0.67	1.33	1.49	2.65	0.26	1.17	0.78		0.84	0.17	0.65	2.06	1.07
CPDCR5B-102	0.66	0.75	0.35	0.63	0.15	3.17	0.32	0.94	1.53		1.04				1.07
CPDCR5B-055	2.47	1.83	0.84	0.68	1.00		0.80	1.17			1.04				1.51
B1PD280-040	0.40	1.32	1.58	0.41	0.59	2.32		2.04							1.54
CPDCR1B-052	1.82	0.69	1.44	0.94	2.48	3.71	0.38	0.70	1.13		3.02	0.70	0.75	1.96	1.55
AM206-5	1.80	0.42	0.32	0.59	1.42	0.30	0.07	0.26	4.77	0.29	5.10	0.42	1.63	5.94	1.58
CPDCR5B-041	1.89	2.54	0.80	0.68	1.99	3.63	1.21	0.67	2.33						1.78
COL22	1.63	2.06	3.44	3.69	1.11	1.15	0.88	1.60	1.42	1.02	1.24	3.10	0.38	3.19	1.85
CPDCR1B-075	0.01	2.03	0.60	1.01	0.99	3.98	0.54	0.27	4.05			2.38			1.86
CPDCR1B-065	0.39	0.90	1.34	1.67	4.44	3.25	1.00	0.97	1.75	1.30		2.00	0.69	2.43	1.87
CPDCR5B-053	0.80	2.19	0.71	0.17			0.36	0.40				2.87	1.72		1.88
HMC-1	0.42	0.64	3.02	4.42	1.71	4.47	0.74		1.72	1.20	1.55	2.70	0.69	1.00	2.00
CPDCR5B-096	1.73	1.80	0.61	0.56	2.21	3.94	0.37	2.38	3.78	1.79		3.65	1.49	1.34	2.08
B1PD280-008	0.37	0.70	0.44	2.71	1.82	5.80	0.67	1.24	3.61	1.74		2.25	0.19	2.94	2.08
CPDCR1B-046	1.14	1.94	2.56	3.78	3.60	0.88	4.50	0.57				1.24	0.69	5.12	2.36
CPDCR1B-048	1.09	1.89	2.08	2.08	3.96	5.21	1.21	3.07	2.21		3.38	0.51	0.67	2.82	2.39
CPDCR1B-026	1.27	1.38	1.82	3.74	4.52	4.41	0.50	1.38	3.57		4.66	1.79	0.23	2.79	2.60
CPDCR1B-078	1.22	2.12	1.34	3.86	3.32	4.52	0.61	0.92		4.62					2.63
CPDCR1B-064	0.51	0.45	1.73	1.64	4.97	7.61	0.67	4.00	1.56		4.62	1.51	0.64	2.34	2.70
CPDCR5B-016	2.64	0.71	0.77	1.21	0.36		2.50	5.67	3.57	8.40		2.52	0.63	1.41	2.94
CPDCR5B-043	1.74	1.90	1.73	0.46	5.63	0.20	0.71	3.13		8.63		1.41			2.99
CPDCR1B-019	1.09	2.83	2.91	2.63	3.67	3.98	1.29	2.61			6.23	2.21			3.01
CPDCR1B-062	1.62	2.22	1.09	3.38	5.43	3.92	1.02	5.05	3.50		2.88	1.37	0.41	6.17	3.04
CPDCR1B-054	1.35	1.98	3.42	2.09	5.43	6.85	0.67	2.48	3.68		4.00	1.96	1.47	3.04	3.05
CPDCR1B-028	0.70	1.33	1.57	1.63	4.21	6.49	0.90		6.45		3.51	1.78	0.36	5.45	3.10
CPDCR5B-109	1.71	2.02	1.30	2.71	2.46	4.35	0.70	2.47	4.71		9.08	1.92	1.43	3.82	3.12
C4	4.39		2.58	1.37	2.78	7.44	0.62	3.41		3.56			1.51	5.44	3.20
CPDCR1B-027	1.31	1.62	0.73	1.22	5.40	3.79	0.29	1.43	7.18	8.71		1.86	2.28	4.15	3.28
CPDCR1B-043	1.70	0.90	1.59	1.80	6.39	8.28	1.82	2.69		5.23		3.00	1.29	3.30	3.48
CPDCR1B-034	1.85	3.62	3.50	2.51	6.65	4.32	0.64	2.08	5.45		7.00	1.29			3.51
CPDCR1B-015	2.50	2.66	3.43	2.84	5.21	7.04	1.11	3.53	3.01	2.23		6.37	1.51	5.32	3.59
CM523-7	1.84	4.82	4.17	7.39	2.86	5.34	1.34	2.23	3.52	2.06	4.68	6.36	1.35	6.58	3.75
CPDCR1B-013	1.42	2.22	4.69	4.81		1.64	1.62	2.77			8.52	5.51	3.24	3.90	3.83
CPDCR5B-013					6.36										3.84
CPDCR1B-068	1.25	1.98	1.47	4.59	2.40	7.84	0.80	4.19	4.76	5.07		5.99	4.44	5.40	3.91
CPDCR1B-074	6.33	3.52	4.15	5.11	7.47	5.65	3.64	5.17	4.37		2.45	2.86	1.09	4.00	4.17
CPDCR1B-008	2.41	0.97	6.03	6.61	6.90	8.54	2.78	4.82	4.63	6.80		5.95	1.88	4.46	4.98
CPDCR1B-076	3.13	2.72	5.95	5.37	5.86	8.03	5.53	6.68			6.54	6.48	5.02	3.46	5.41

Protocol



Field



Harvest



10 Roots



Pretreatment to **accelerate** deterioration



Proximal cut



Distal cut



Wrap with plastic film



Tying the plastic film with rubber bands



7 days of storage

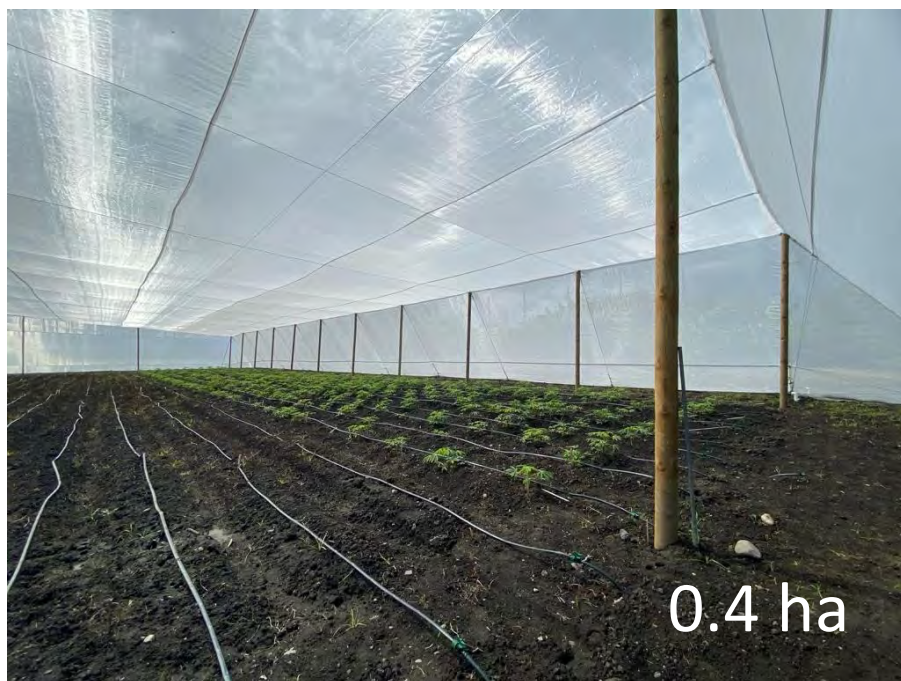


7 slices (per root); Thickness. 2 cm









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

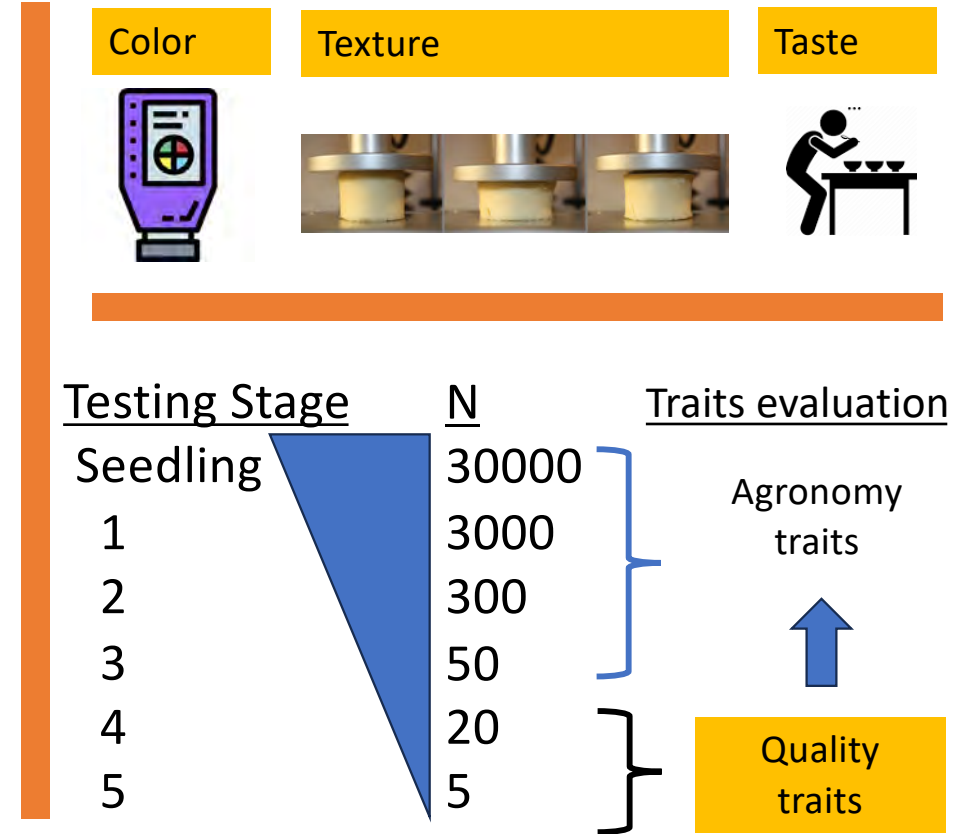
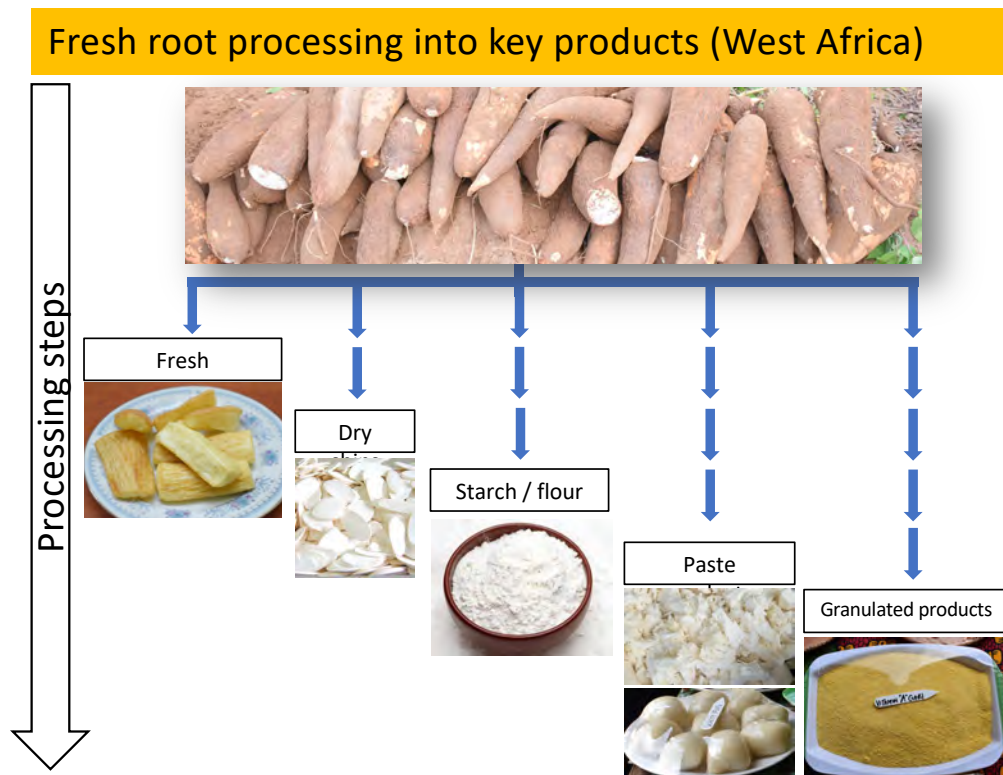
Net house facility to keep the planting materials pest and disease-free.



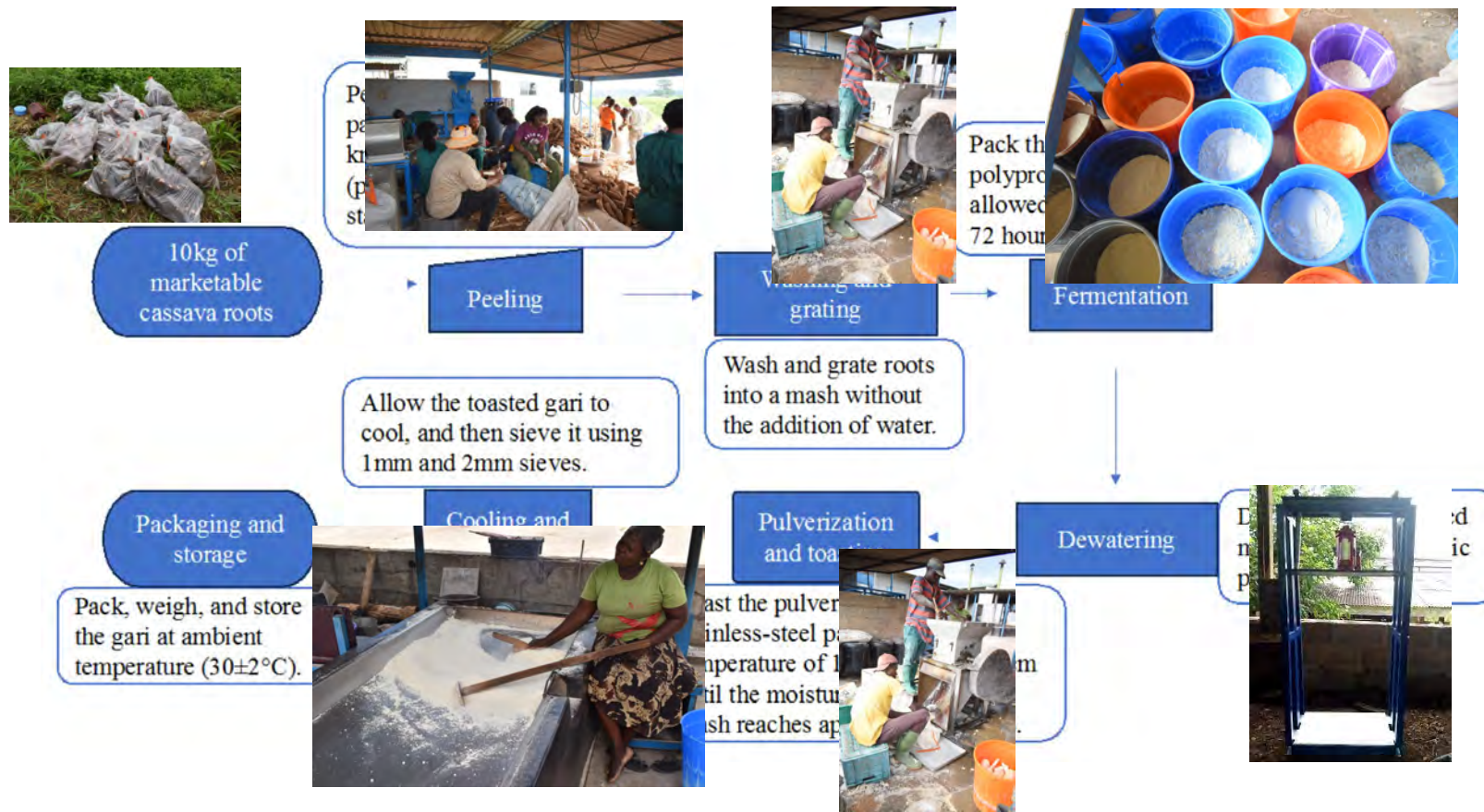
Objective 3: RTB processing and quality phenotyping

SN	Product Pipeline Name	Traits for product profiles	Baseline traits	Current Breeding Pipeline	Product samples
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)	 
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)	
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)	 
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)	

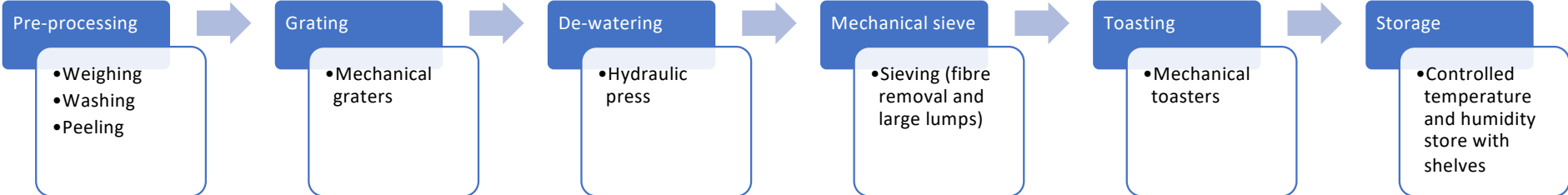
Complexity of cassava products, processing steps and current evaluation stages for quality traits

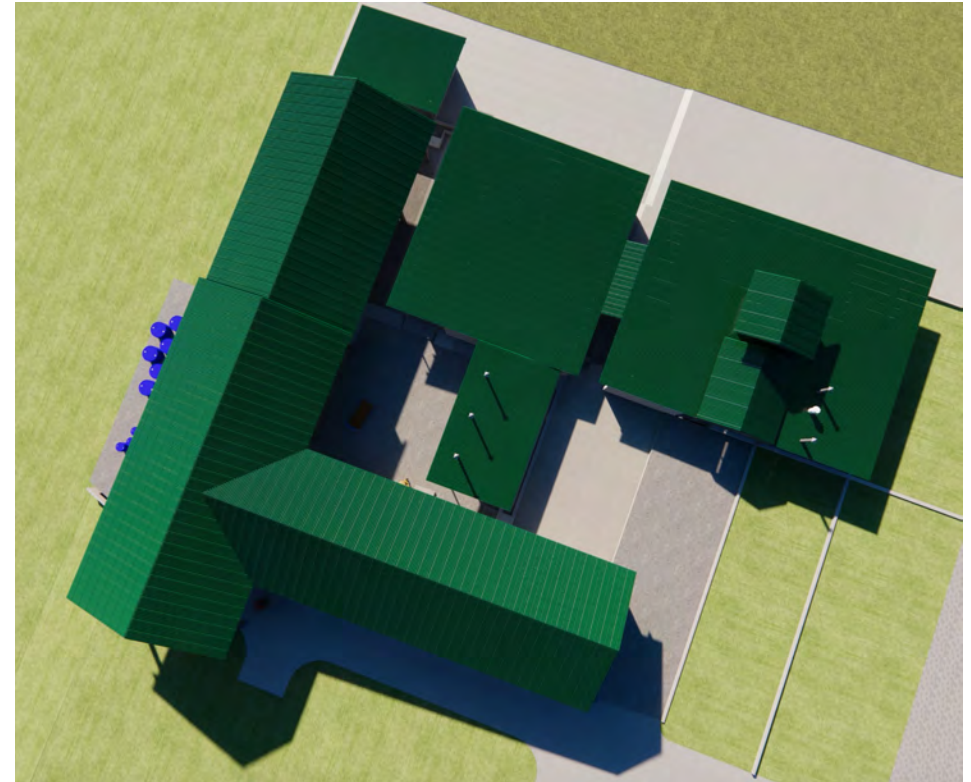
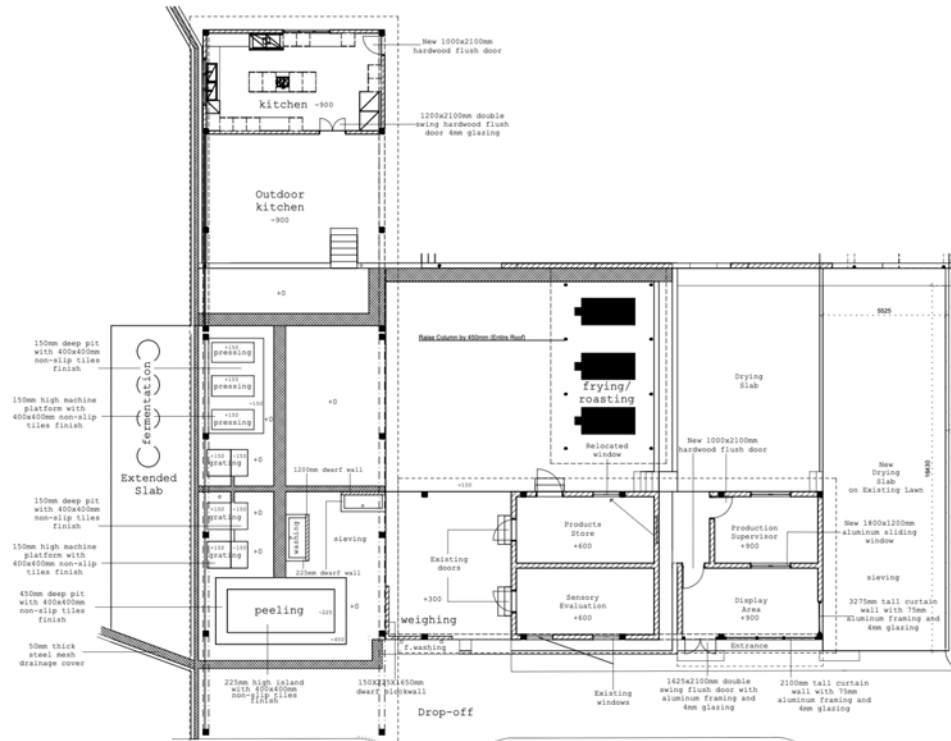


Cassava garri processing



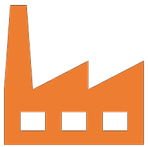
Proposed facility upgrade to streamline root processing





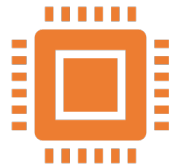


What we would achieve by facility upgrade



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