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

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Foreign & Commonwealth Office

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

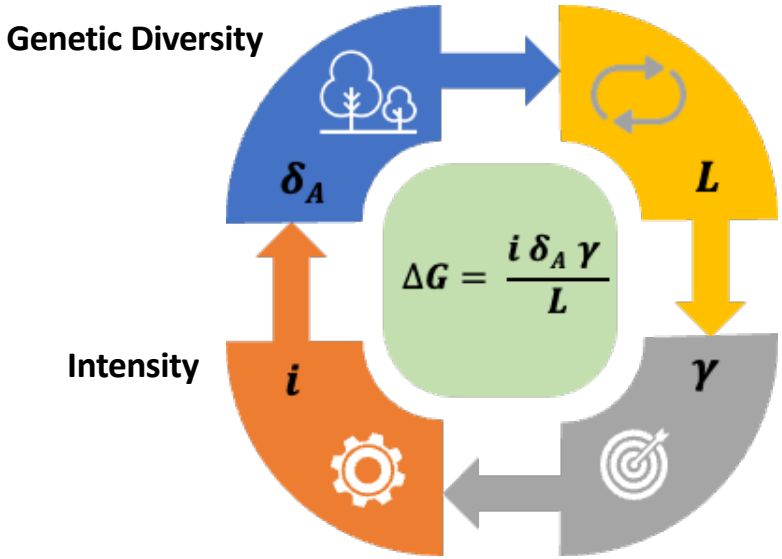
- **Clonal propagation**:
  - Low multiplication rate slowing breeding cycle length and scaling of release varieties
  - Restricted germplasm exchange within and between regions
- **Bulkiness and perishability**:
  - Difficult post-harvest management and handling logistics
  - Phenotyping of quality 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

NEXTGEN CASSAVA

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

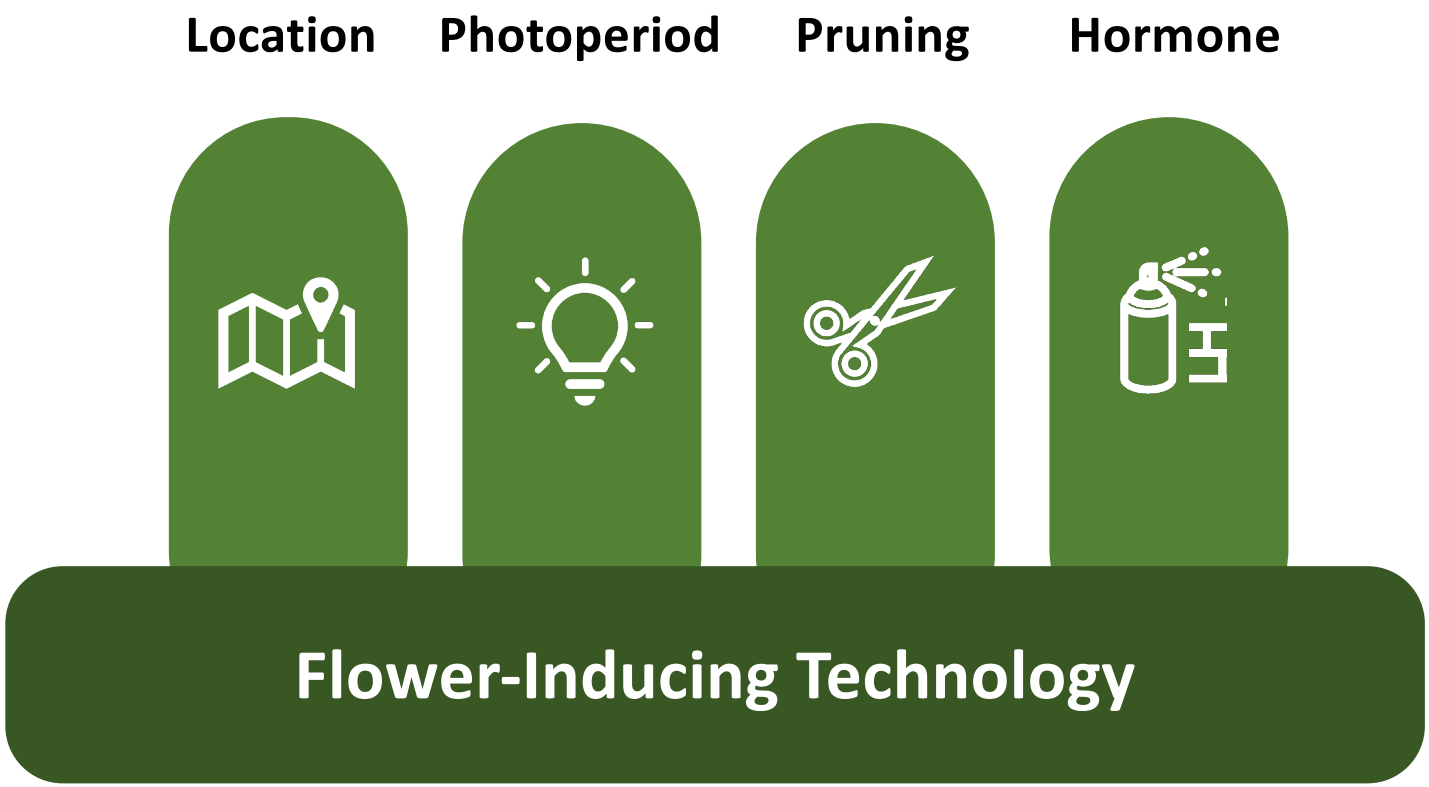
Erika Paola Barinas Rodrmguez [1], Nelson Morante [2], Sandra Salazar [2], Peter T Hyde [3], Tim L Setter [3], Peter Kulakow [4], Johan Steven Aparicio [5], Xiaofei Zhang [2]

Affiliations – collapse

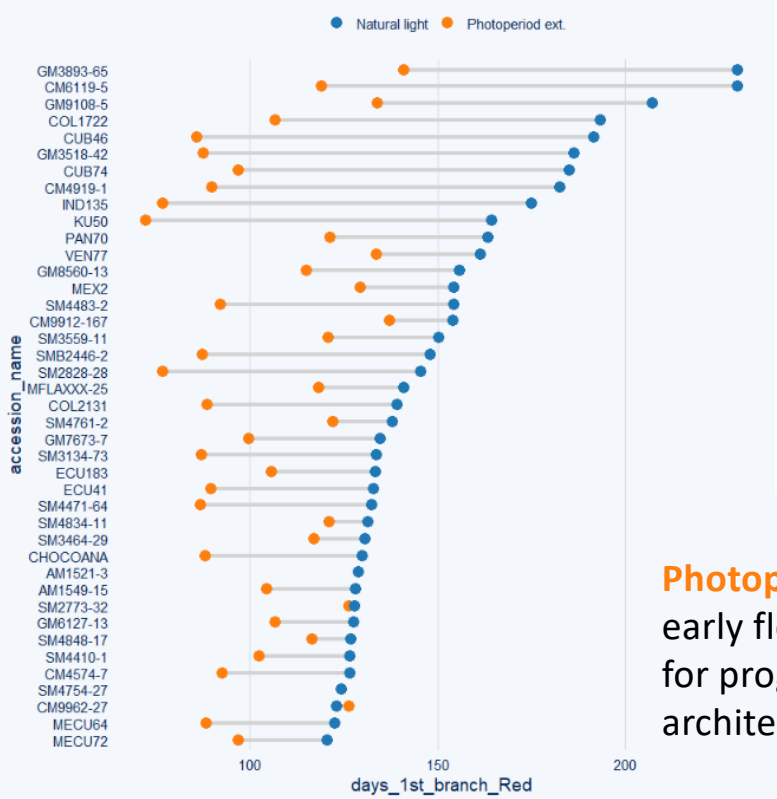
Affiliations

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.

NEXTGEN CASSAVA


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.

NEXTGEN CASSAVA

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

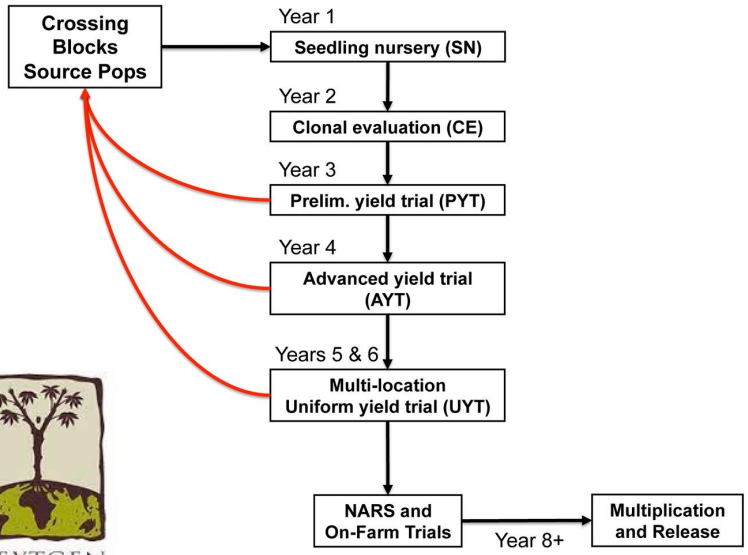
(3) Deliver **training workshops** on *flower-inducing* technology (**2024 Sep**)

(4) Renovate ***seed storage*** rooms (>=20m^2)

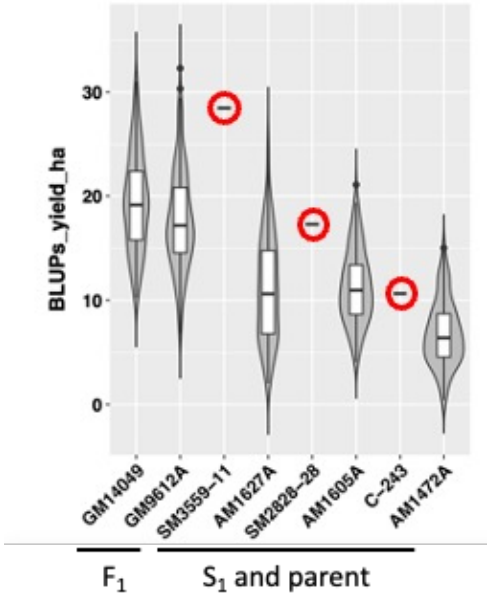
0.5 ha with Photoperiod Extension

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

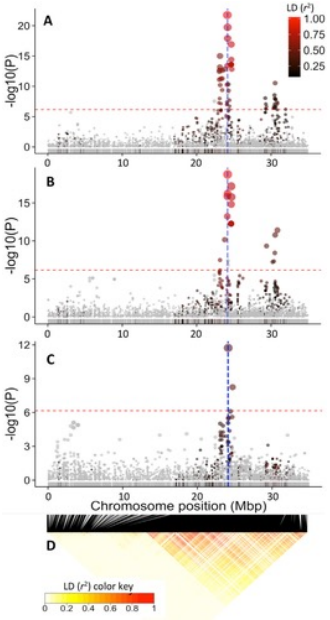
Genomic Selection



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.

Alliance
Bioversity & CIAT

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

2

Alliance Bioversity & CIAT

3

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

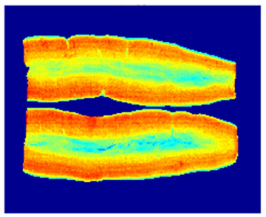
4

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

RESEARCH PROGRAM ON Roots, Tubers and Bananas

PPD Evaluation in Multiple Environments

	Genotype	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	2016Jul_Wild_12	2017Jul_Wild_12	2018Jul_Wild_12	2019Jul_Wild_12	BLUPs
R	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
S	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
S	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

H^2 is **0.67**

14 environments

7 years

Protocol

Field

3 plants per genotype
Commercial Root size

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

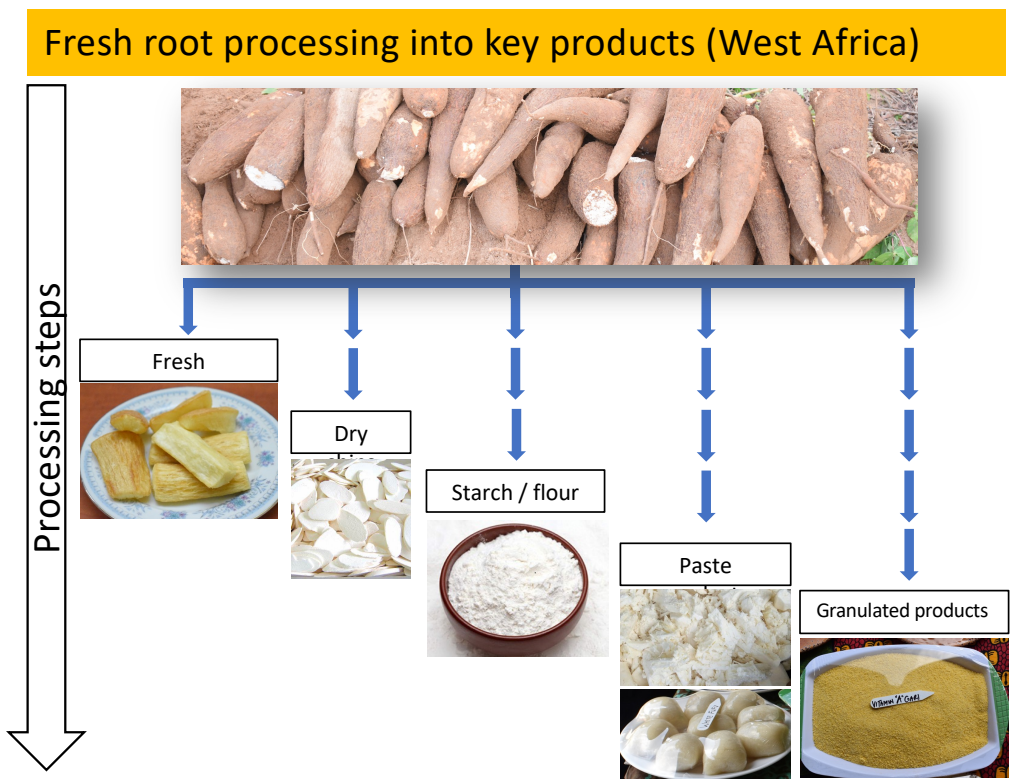
Net house facility to keep the planting materials pest and disease-free.

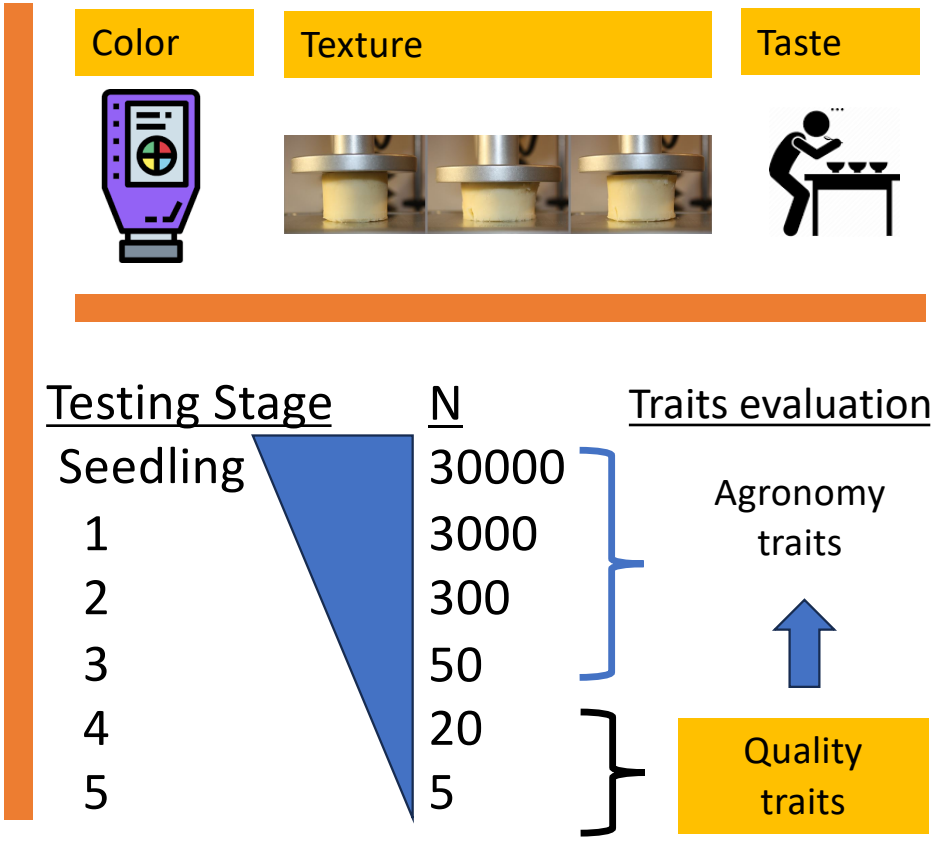
Alliance
Bioversity & CIAT

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



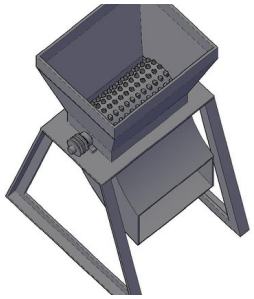


Cassava garri processing

Proposed facility upgrade to streamline root processing

Pre-processing
- Weighing
- Washing
- Peeling

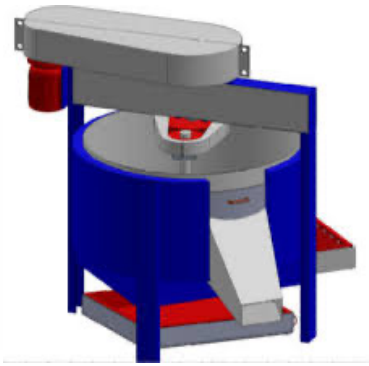
Grating
- Mechanical graters



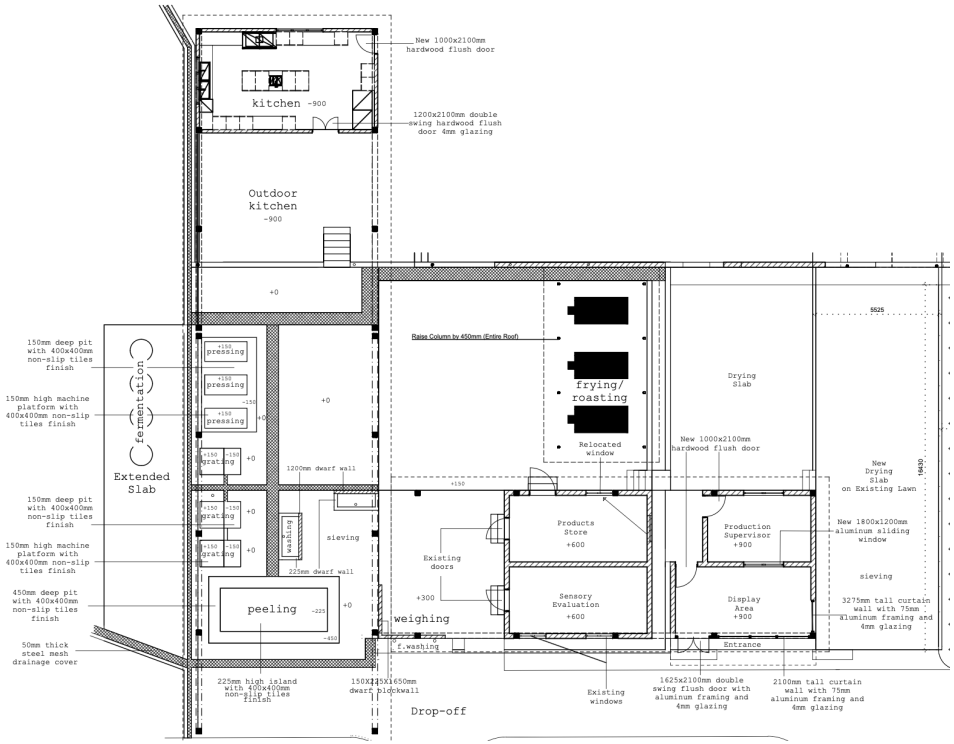
De-watering
- Hydraulic press

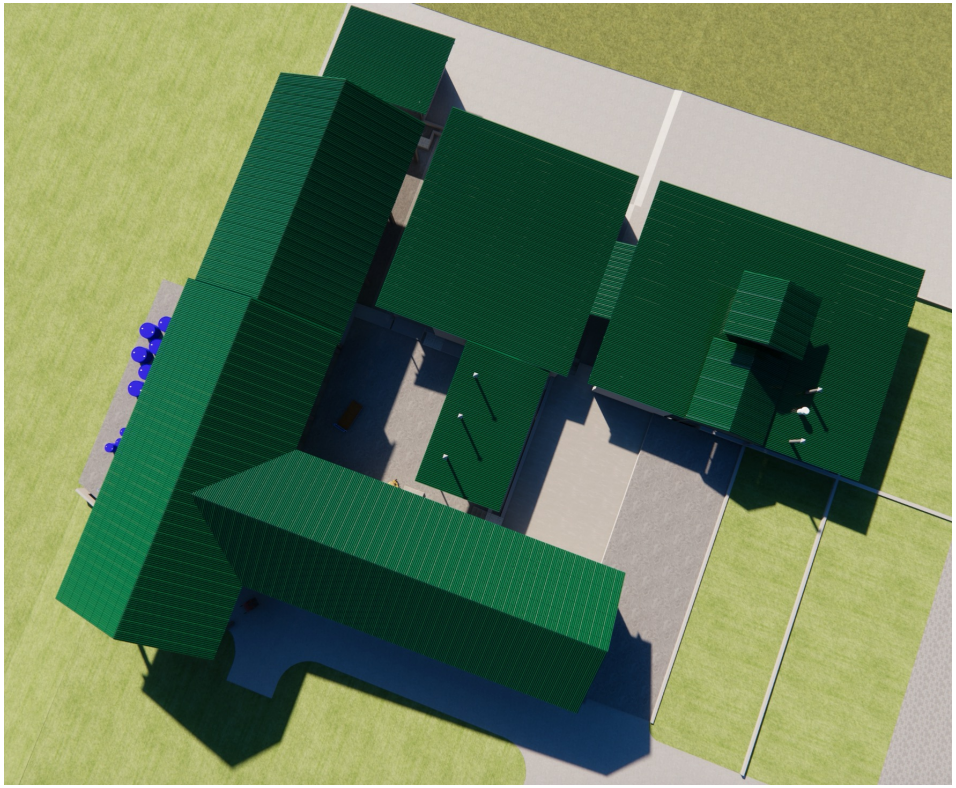
Mechanical sieve
- Sieving (fibre removal and large lumps)

Toasting
- Mechanical toasters



Storage
- Controlled temperature and humidity store with shelves


New 1000x2100mm hardwood flush door
kitchen -900
1200x2100mm double swing hardwood flush door 4mm glazing
Outdoor kitchen -900
+0
Raise Column by 450mm (Entire Roof)
frying/ roasting
Drying Slab
5525
150mm deep pit with 400x400mm non-slip tiles finish
fermentation
pressing
150mm high machine platform with 400x400mm non-slip tiles finish
Relocated window
New 1000x2100mm hardwood flush door
1200mm dwarf wall
Extended Slab
grating
Products Store +600
Production Supervisor +900
New 1800x1200mm aluminum sliding window
New Drying Slab on Existing Lawn
5940
150mm deep pit with 400x400mm non-slip tiles finish
washing
sieving
150mm high machine platform with 400x400mm non-slip tiles finish
225mm dwarf wall
Existing doors
Sensory Evaluation +600
Display Area +900
sieving
450mm deep pit with 400x400mm non-slip tiles finish
peeling
-225
+300
3275mm tall curtain wall with 75mm aluminum framing and 4mm glazing
weighing
f.washing
Entrance
50mm thick steel mesh drainage cover
225mm high island with 400x400mm non-slip tiles finish
150X115X1650mm dwarf blockwall
Drop-off
Existing windows
1625x2100mm double swing flush door with aluminum framing and 4mm glazing
2100mm tall curtain wall with 75mm aluminum framing and 4mm glazing

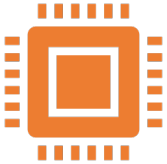


What we would achieve by facility upgrade

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