J U L Y 2 0 2 1

# Flagship Project 2: Adapted Productive Varieties and Quality seed of RTB Crops

MARIA ANDRADE RTB ANNUAL MEETING

CGIAR RESEARCH PROGRAM ON Roots, Tubers and Bananas

Alliance

LED BY CIP INTERNATIONAL POTATO CENTER · Bioversity International · CIAT · cirad · IITA

# OUTLINE

KEY SCIENTIFIC ACHIEVEMENTS 2020 & 2021

GENDER OVERVIEW

PROGRESS TOWARDS OUTCOMES & IMPACT

OPPORTUNITIES, PLAN AND TRANSITIONAL RECCOMENDATIONS

https://tools4seedsystems.org/

# TOOL BOX

FOR WORKING WITH ROOT, TUBER AND BANANA SEED SYSTEMS

Replicable, open-source, and backed by science.

- ✓Description sheet
- ✓User guide
- ✓Case study
- ✓Tool validation
- ✓Peer-reviewed publication
- ✓Technical support available

# The Toolbox – examples of use

Assess banana seed sources and variety traits in Uganda,

**Create scenarios to manage seed degeneration at different climatic conditions**,

The seed tracker expanded to other crops: sweetpotato for Official Seed Certification Institute (TOSCI) in Tanzania and yam for Plant Protection & Regulatory Services Department (PPRSD) in Ghana.


SWEETPOTATO: 57 varieties released in 10 African countries and Asia, 6 in 5 Latin America countries

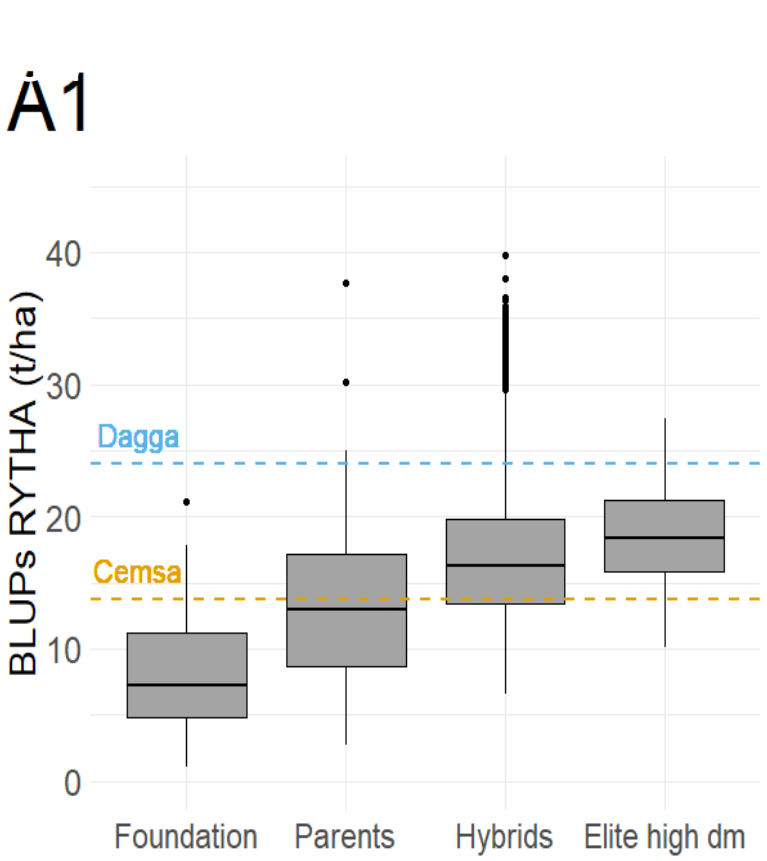
CASSAVA: 5 varieties in Tanzania, 3 in Colombia

YAM: 13 varieties in Nigeria, Cotid'Ivoire and Benin

POTATO: 18 in Kenya, Rwanda, Uganda & Asia

BANANA: 4 NARO (Varieties in Tanzania)

# Sweetpotato- Genetic gains (GG)/Elite crosses



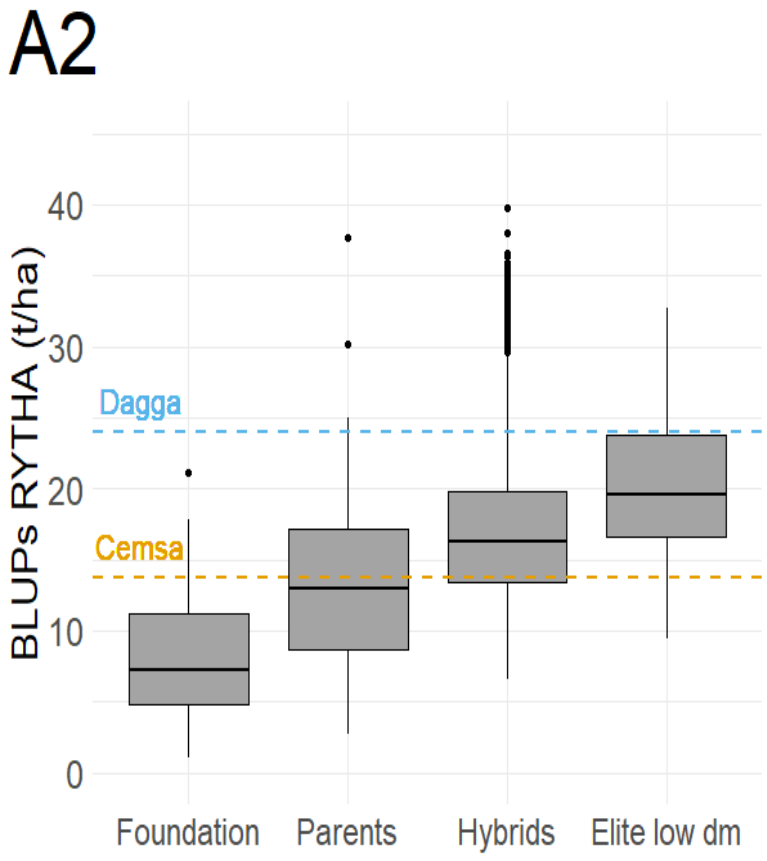
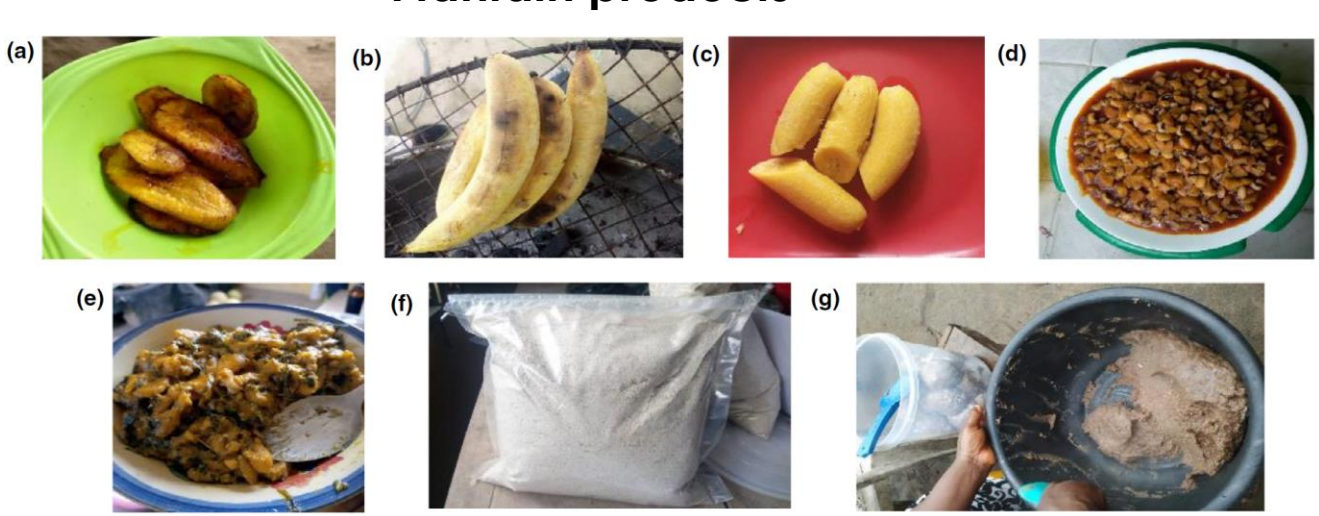




Figure. Genetic gains for storage root yield performance (BLUP estimates) in OFSP for 90 days harvest with high root dry matter (A1) and low root dry matter (A2) estimated via founder clones (Foundation from 2009), PJ' and PZ' hybrid parents (Parents from 2016), offspring hybrid clones (Hybrids from 2017), and elite isolation crosses (Elite from 2019) compared to check clones [Dagga (pale orange) and Cemsa-74-228 (cream fleshed)]; estimates obtained in field trials in Peru at the arid Pacific coast and in the humid tropics of the Amazon basin.

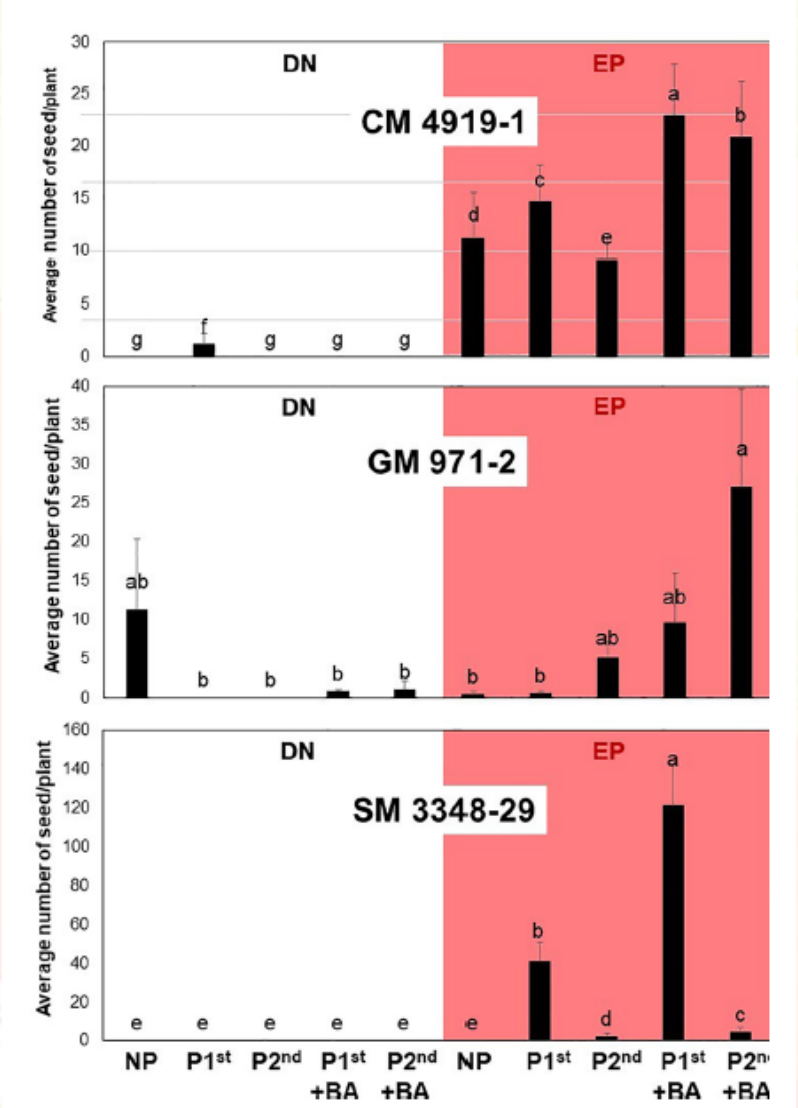
# Banana -End users preferences and fruit quality

## Plantain products




- most critical: fruit size, fruit pulp texture (firmness/softness), colour and taste characteristics
- no gender differences for fresh fruit and food product quality characteristics
- big differences between dessert bananas and plantains and even among plantain cultivars during ripening

# Cassava- flowering inducing technology




**Allows to obtain large number of seeds early for late flowering genotypes**.

implemented at CIAT to shorten the duration of the pollination season from 16 to 10 months and increase the seeds for erect and late flowering progenitors

**The flower inducing technology** includes photoperiod extension, pruning, and application of BA (6-Benzylaminopurine).

**DN**, dark night; **EP**, Extended Photoperiod, **NP**, no pruning;
**P1st**, pruning at the first branch; **P2nd**, pruning at the end branch;
**P1st + BA**, pruning at the first branch and application of BA;
**P2nd + BA**, pruning at the second branch and application of BA;

# Potato - Africa

Support to various levels of national and public institutions, relating to seed regulations and potato strategies across six countries in Africa to guide investments and standardize procedures.

Refine seed certification protocols and alternative quality assurance regulations for potato Quality Declared Seed (QDS) in four countries.

**Numeracy training at potato learning farms, Kenya**

## Productivity gains in Kenya:

- Yields of **17,780 smallholder farmers** increased 50% on average to 11.5 from baseline of 7.7 t/ha after two years of interventions
- Yields **in traditional agro-ecologies averaged 16.0 and 12.8 t/ha**, in Bungoma and Taita Taveta counties

# Potato- Asia


## Breeding/evaluation:

- 6 new purple-fleshed potato clones and one white-fleshed clone have been introduced from CIP's genebank in Lima, Peru
- Participatory varietal selection in Bangladesh and Georgia

## Seed production:

- Apical rooted cuttings. Projects in India, Georgia, and Vietnam, all use this technology for seed production

# Yam- seed production and availability

- improved access and availability of improved varieties planting materials using rapid clonal propagation techniques engaging seed companies in Nigeria Ghana.
  - Seed companies continued producing improved varieties foundation and certified seeds in Ghana and Nigeria using high ratio propagation techniques under the YIIFSWA-II project.
  - Also supplied breeder seed of ~20,000 plantlets of improved varieties, including the newly released ones to the seed companies and NARS in Nigeria and Serra Leon.
- Over 10 scientific publications in high impact journals


# Gender Overview

The introduction and commercialization of OFSP increased income for those women who had access to key factors of production, particularly seed.

A gender-responsive strategy for the delivery of seed technology was developed and tested in Ghana and Ethiopia

A study on gender responsive OFSP nutrition approaches in southern Bangladesh showed that women who participated in training had been empowered and that men who participated were more aware of the relevance of the training and stimulated their spouses to participate.

Three gender assessment studies were published, **1.** **featuring women's opportunities in commercialized sweetpotato value chains in Kenya**. **2.** **the role of community nutrition scholars in promoting improved OFSP consumption of children in Bangladesh;** **3.** **the role of OFSP interventions on increased consumption of female headed households in Rwanda**.

Women engagement in projects remain high (e.g., 47% for Georgia); e-learning program about gender equality in potato production was aired over local TV, with **503,765 viewers and a potential audience of 1.6 million people.**

# Progress towards outcomes & Impact

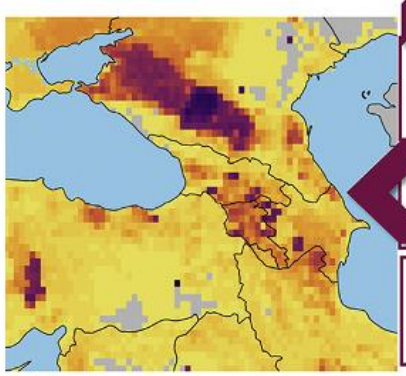
# Ensuring seed health and stopping the spread of disease

**System Characterization**

**Expert elicitation workshop**

Farmers and other key seed system actors were characterized in each region, along with sources and sinks of potato

Key pests and diseases, frequency of occurrence and annual yield losses were mapped to the country by experts

Municipalities within Adjara and Samtskhe-Javakheti identified as high risk for the introduction of *S. endobioticum*, causing potato wart

**Simulation analyses for pathogen spread**

We identified the region where Adjara, Azjerbijan, and Armenia meet as high risk for local spread of seedbor pathogens such as *S. endobioticum*

**Cropland connectivity risk analysis**

Several countries that export seed and ware potato to Georgia have *S. endobioticum* present and may pose a risk for reintroduction

**International trade risk analysis**

**Highland potato producing region in Georgia**

Phytosanitary risk assessment in a system characterization to support a new integrated seed health strategy for potato in the Republic of Georgia

**Multi-stakeholder framework**

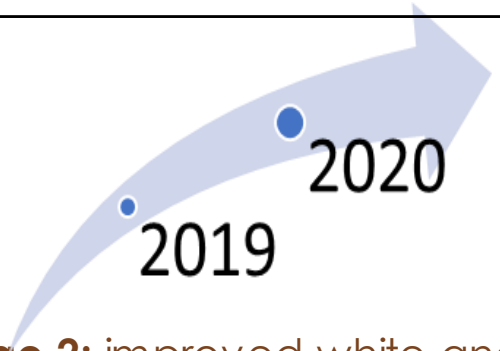
**Impact network analysis (INA)**

**Integrated seed health approaches and models**

https://doi.org/10.1016/j.agsy.2021.103144

# Innovations & Progress in FP2

| Type | Stage 1: Discovery/ proof of concept | Stage 2: Successful piloting | Stage 3: Available/ ready for uptake | Stage 4: Uptake by next user |
|---|---|---|---|---|
| Biophysical Research | 1 | 2 | | |
| Genetic (variety and breeds) | 2 | 5 | 5 | 2 |
| Production systems and Management practices | 1 | | 4 | 2 |
| Research and Communication Methodologies and Tools | 3 | 1 | | 1 |
| Social Science | | | 1 | 1 |
| **Total** | **7** | **8** | **10** | **6** |




**2019-Stage 2:** improved white and water yam clones identified and selected, having high and stable tuber yield and superior quality for pounded yam

**2020- Stage 3**: Two new white yam and three new water yam varieties selected for release in Nigeria


Released water and white yam varieites.
Obidiegwu JE et al., 2020

# Triple S allows over 67,000 smallholders to produce sweetpotato seed in areas with a long dry season across 8 Sub-Saharan African countries

- low-cost, practical method to store sweetpotato roots in sand during long dry seasons to use as planting material

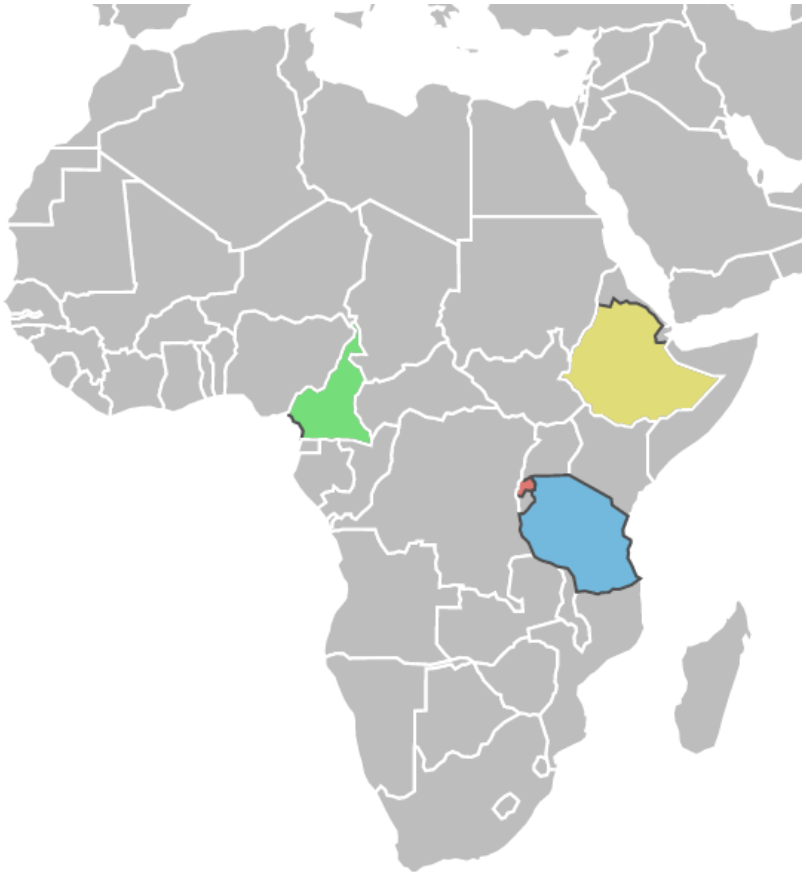
- enables farmers to adapt to semi-arid areas climate change
- scaled to 57,655 farmers (66.5% women) in Ghana and to 9,958 farmers (25% women) in Ethiopia
- having seed ready to plant when the rains begin increases yields by 25% to 300%

- women farmers find Triple S especially easy to manage

Photo credit: Sam Namanda, CIP

# Varieties and seed systems regulations

- Distinctness, Uniformity, Stability (DUS) and Value for Cultivation and Use (VCU) test protocols for the homologation of new potato varieties in Cameroon
- CGIAR supported the Ethiopian Government to prepare the National Potato and Sweetpotato Strategy aiming a guiding decisions and investments in the potato value chain
- Cassava seed standards launched by Rwanda Standards Board to enhance competitiveness of cassava products
- Tanzania passed into law seed certification standards for all classes of seed, from pre-basic to quality declared seed (QDS) for cassava, potato and sweetpotato



# Looking ahead: opportunities, plans and transitional issues for One CGIAR

**FP2 is participating in the design of OneCGIAR:**
with CGIAR Community of Excellence for Seed Systems Development, EiB, Crops to End Hunger (https://tools4seedsystems.org/; McEwan et al. (2021); https://www.cassavabase.org/; http://seedtracker.org/).

On simulation exercise to enhance genetic gain by increasing accuracy and reducing recycling time. Developed KPI for quantitative optimization breeding at CGIAR and NARS.

Product-based population development strategy with project partners.

Protocols for food quality analysis RTBfoods project

Breeding innovation, modernization and services such as mechanization, digitization


# Golden Egg: RTB Toolbox

## Tools4SeedSystems.org

- **Communication strategy** to raise awareness about the RTB Toolbox
  - Webinars & virtual conference,
  - Creation of sub-committee on seed quality assurance (Africa)

- **Training and mentoring** – hybrid of virtual sessions and in-country teams

- Discussions with **potential collaborators** – adding new tools to Tools4SeedSystems website

- **SeEdQUAL** (seed delivery initiative) within Genetic Innovations Action Area
  - Crop type Work Packages
  - African Center of Excellence for innovation in RTB seed systems (ACE-I-RTB Seed Systems)
  - interest from **potential donors**

- **Clarifications** still needed on synergies required

# RTB FP2 transitioning to One CGIAR

**FOOD, LAND & WATER SYSTEMS LEVEL**

**ST:** Transforming food systems from **net carbon sources to sinks**

**ST:** Realizing gains across the **water-energy-food-forest-biodiversity** nexus

**ST: Agroecology** across food, land & water systems

**ST:** Building systemic resilience to **climate extremes**

**FARMING SYSTEMS LEVEL**

**RAFS: Climate-resilient dryland** crop-tree-livestock systems – dealing with climate variability & risks

**RAFS: Urban and peri-urban** agri-food systems – delivering safe healthy food sustainably

**THEMATIC LEVEL (COMPONENTS OF SYSTEMS)**

**RAFS:** Protecting human health through a **One Health** approach

**RAFS: Resilient aquatic foods** in food, land & water systems

**RAFS: Climate smart livestock** – policy & practice

**RAFS: Nature-positive agriculture** for agrobiodiversity, water & environment

**RAFS:** Sustainably improving **livestock productivity** for improved livelihoods

**RAFS:** Excellence in **agronomy**

Var. for new ecologies

**ST:** Food systems transformation for **healthy, safe & affordable diets**

**ST: Informing sustainable development pathways** with foresight & metrics

**ST: National strategies & policies** for driving transformation

**ST: Rethinking markets and value chains** for inclusion & sustainability

**ST:** Levering **gender & social equality** in agrifood systems

G+ breeding tools

**RAFS: Sustainable intensification** of mixed crop-tree-livestock systems – reducing environmental footprint & improving livelihoods

**RAFS/ST/GI:** Harnessing **digital technologies** for timely decision-making across food, land, & water systems

Seed Systems Toolkit

**GI:** Farmer-preferred **crop varieties**

RTB varieties

**GI:** Breeding innovation, **modernization** & services

**GI: Gene banks**

e.g. apical cuttings

**GI:** Delivering genetic **gains in farmers' fields**

new RTB varieties

TRICOT

**GI:** Market intelligence & **product profiling**

**RAFS: Plant health** & rapid response protecting income & food supply

**GI:** Strategic innovation – **gene editing** & novel technologies

# Thank you

# Complementary material

TOOL BOX

FOR WORKING WITH ROOT, TUBER AND BANANA SEED SYSTEMS

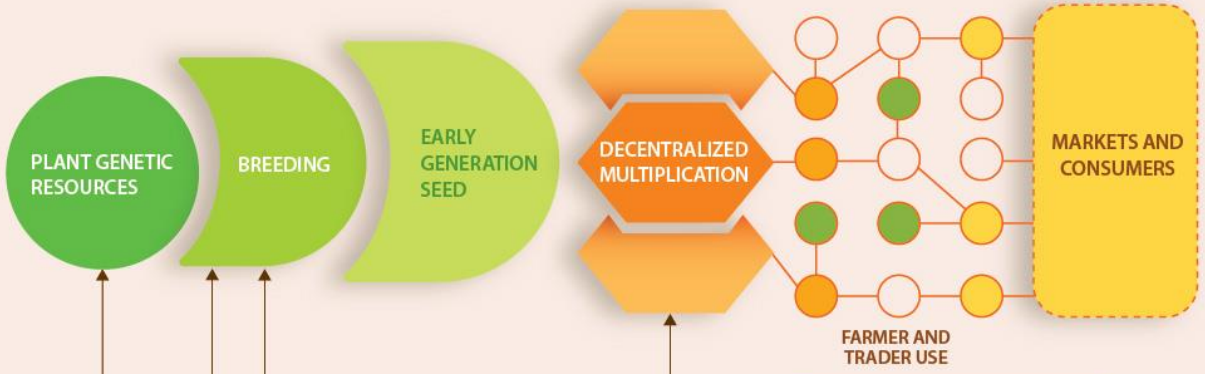
1 Multi-stakeholder framework (MSF)

2 Impact network analysis (INA)

3 Seed Tracker (ST)

4 Integrated seed health (ISH) approaches and models

5 Seed tracing (STg)




6 Small N exploratory case studies (SN)

7 Four-square method (FSM)

8 Means-end chain analysis (MEC)

9 Experimental auctions (EA)

10 Seed regulatory framework analysis (SRFA)

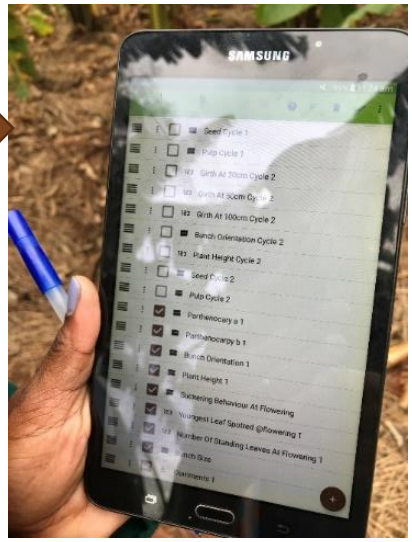
11 Sustainable early generation seed business analysis tool (SEGSBAT)

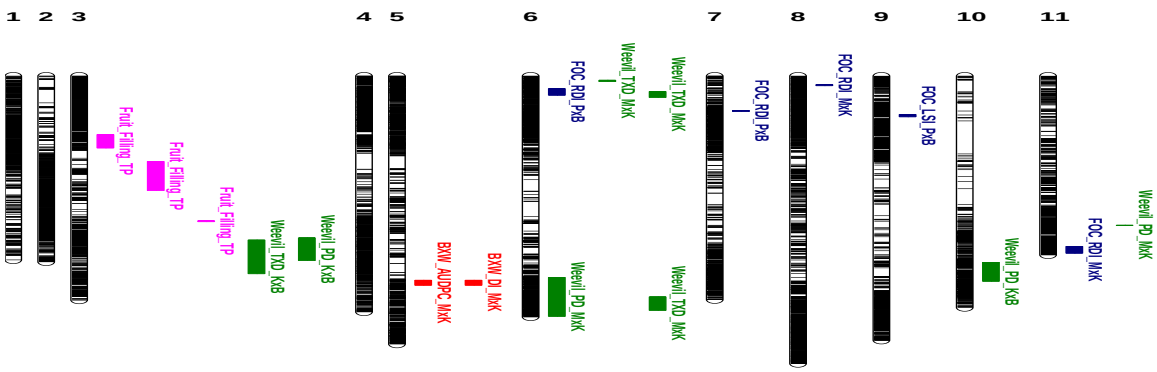
12 Glossary of root, tuber and banana seed systems

# BA2.2 Breeding efficiency in matooke increased

1. Progressive heterobeltiosis: 248%
2. Genetic gain: 1.4%

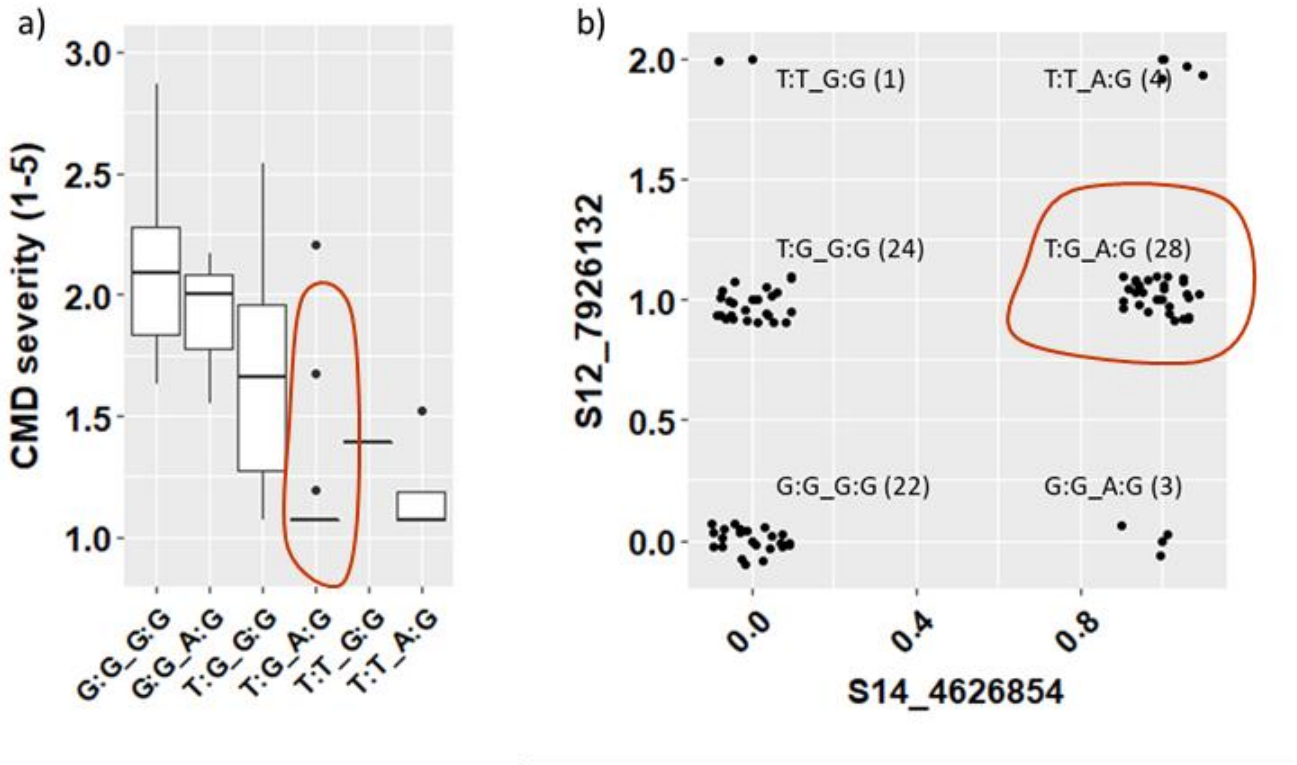
2. All steps digitalised: BTracT




4. Chr map integrating the different QTLs

# CA 2.3 Achievements




**Validated the effect of *CMD2* markers in South East Asia**

Combining two markers S12_7926132 and S14_4626854, provided the better prediction of CMD resistance. The genotypes with resistant alleles, T and A showed high resistant to CMD (red circle).

MAS is being used to accelerate the variety development with CMD resistance in South East Asia.

# PO2.4 2020 Achievements

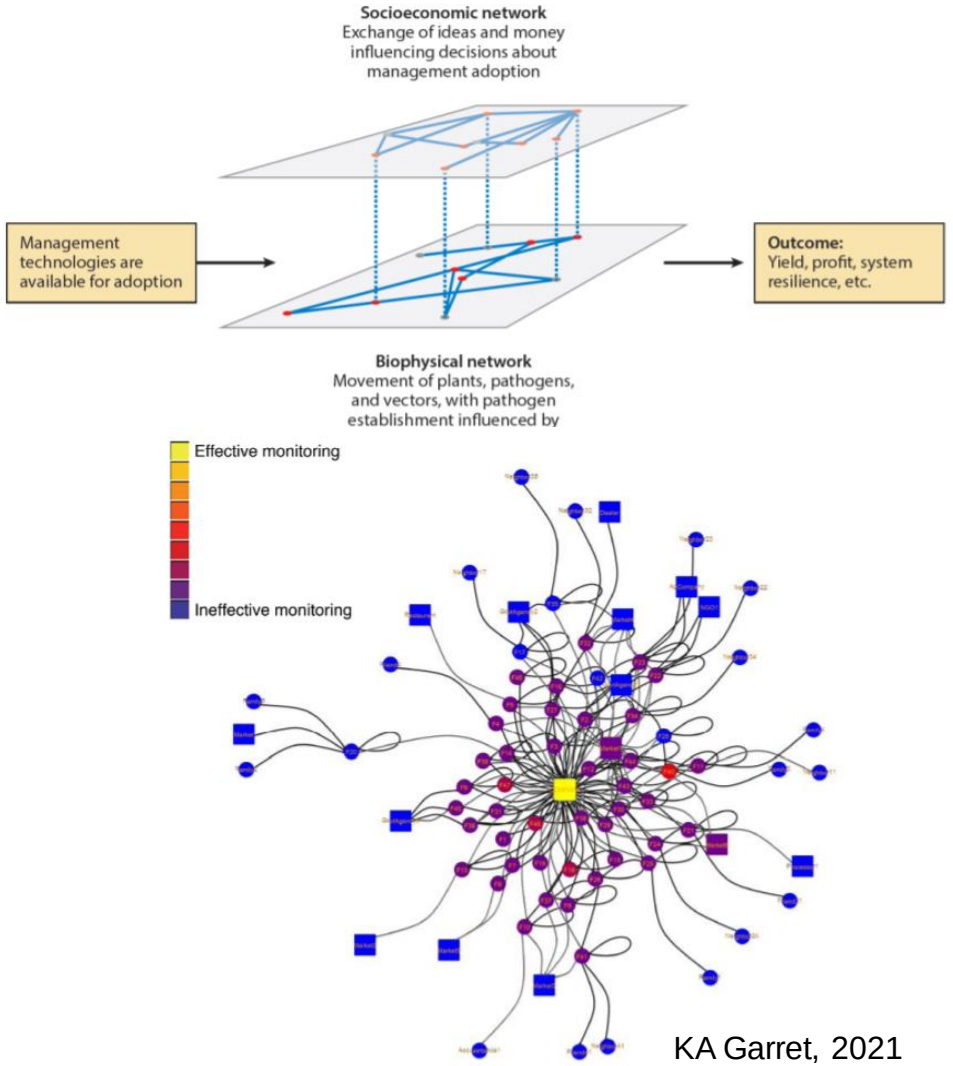
**Expanding potato to non-traditional agro-ecologies**

- Yields in **non-traditional agro-ecologies** averaged at 15.8 and 9.6 t/ha in Bungoma and Taita Taveta counties

**Samburu County, Kenya field day with 350 farmers to observe potato production in non-traditional agroecologies for potato production.**

# Impact network analysis is used to explain the movement of planting material, information and pathogens

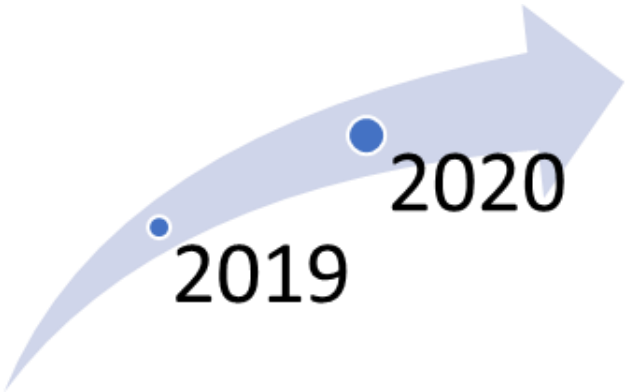
- Uganda-sweetpotato -found the communities that were more central than others for managing the spread of sweetpotato diseases
- SEA-follow-up studies being used to evaluate key target regions for distributing clean seed to slow the spread of cassava mosaic disease
- Ecuador- potato- evaluated the benefits social networks sharing seed for men and women farmers, while identifying ways to prevent disease with monitoring and training
- Now new INA package in the R programming environment-provides decision support tools for scenario analysis to evaluate the likely outcomes from a range of regional management strategies




KA Garret, 2021

# Innovations & Progress in FP2

| Type | Stage 1: Discovery/proof of concept | | | Stage 2: Successful piloting | | | Stage 3: Available/ready for uptake | | | Stage 4: Uptake by next user | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Newly Reported | Continous Work | Advanced | Newly Reported | Continous Work | Advanced | Newly Reported | Continous Work | Advanced | Newly Reported | Continous Work | Advanced |
| Biophysical Research | | 1 | | 2 | | | | | | | | |
| Genetic (variety and breeds) | 2 | | | 4 | 1 | | 1 | 2 | 1 | | 2 | |
| Production systems and Management practices | | 1 | | | | | 3 | 1 | | | 2 | |
| Research and Communication Methodologies and Tools | 3 | | | | 1 | | | | | 1 | | |
| Social Science | | | | | | | | 1 | | | 1 | |
| **Total** | **5** | **2** | **0** | **6** | **2** | **0** | **4** | **4** | **1** | **1** | **5** | **0** |




Two new white yam and three new water yam varieties for Nigeria with strong yield stability and high tuber yields and improved cooking and nutritional qualities

From Stage 2 to Stage 3:

The released varieties had high and stable fresh tuber yield, expressed superior boiled & pounded yam quality compared to standard varieties



Obidiegwu JE et al., 2020

# Example of building the first gender-responsive value chain for OFSP processed products in Rwanda

Identify potential partners… **Private sector processor** needs to be willing to take risk & show evidence of commitment to social responsibility…

CIP, NGO & government partners must be willing to jointly develop intervention & agree to common monitoring tools & commitment to


Smallholder landholding size very small (0.2 ha). Increasing productivity essential for having surplus for sale. Disease-free or "quality" seed is critical

## Designing a new potato seed system in the Republic of Georgia to protect seed health

**Strategies for seed health management**

**Tools:**

Multi-stakeholder framework

Integrated seed health approaches and models

Impact network analysis (INA)


Contents lists available at ScienceDirect

Agricultural Systems

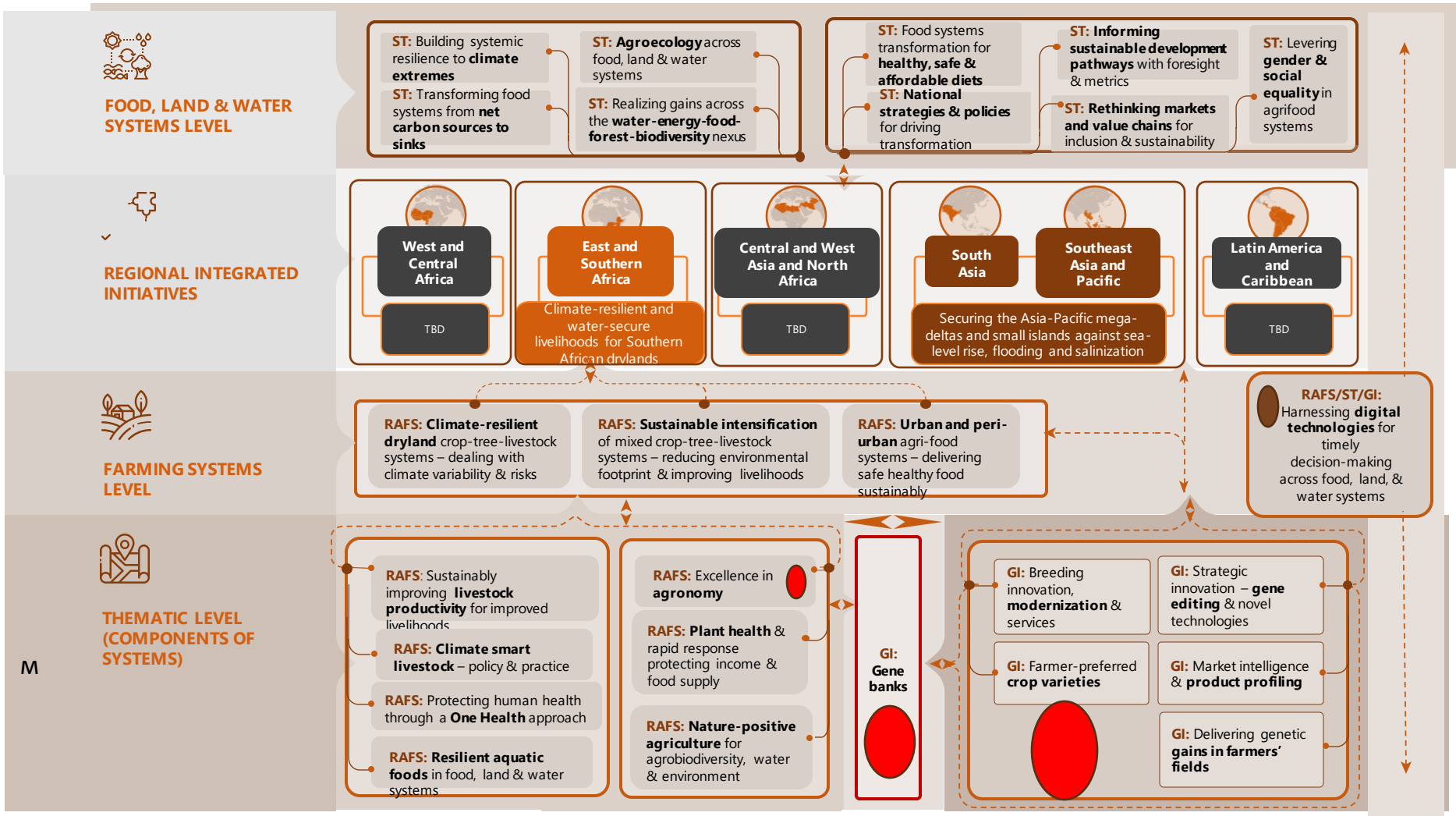
journal homepage: www.elsevier.com/locate/agsy

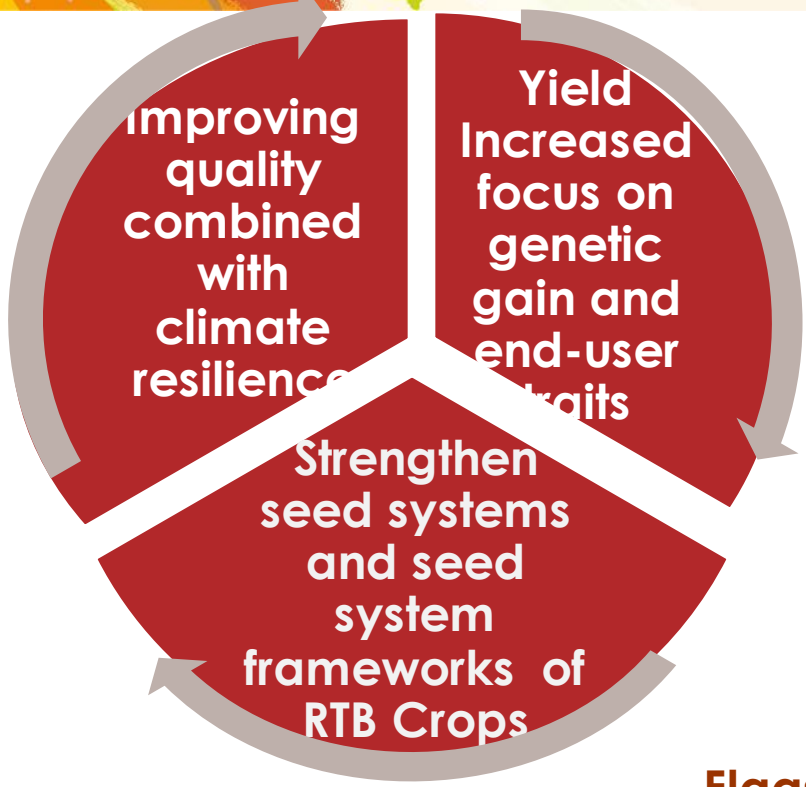
### An integrated seed health strategy and phytosanitary risk assessment: Potato in the Republic of Georgia

Kelsey F. Andersen Onofre [a,b,c,d,*], Gregory A. Forbes [e], Jorge L. Andrade-Piedra [e], Chris E. Buddenhagen [a,b,c,f], James C. Fulton [a,b,c], Marcel Gatto [g], Zurab Khidesheli [h], Rusudan Mdivani [i], Yanru Xing [a,b,c], Karen A. Garrett [a,b,c,*]

https://doi.org/10.1016/j.agsy.2021.103144

# Positioning of FPx in the Initiative Structure






The FP2 sub-clusters appear to the independent reader as a collection of projects that do not gel into a structure within the whole FP2. How does the overall programme better describe its purpose and therefore more clearly demonstrate the value of the results?

**Flagship 2** focuses on breeding better RTB crop varieties and making sure that these varieties match the needs and preferences of end users. Flagship 2 *is implementing strategies to accelerate genetic gains, improve the efficiency of RTB breeding pipelines, and shorten the breeding cycle. It is also addressing bottlenecks in production and distribution of quality seeds which are reduced using rapid multiplication and integrative systems-oriented, gender-equitable, and evidence-based seed systems.*

***Under CC2.1*** *they study* the current seed regulatory framework and its implementation meet the need for increased availability and access to quality seed. For who, and with what consequences? There is on-going dialogue among seed system stakeholders & regulatory bodies. Complex social, political and technical trade-offs. It also underlines importance of consultative processes :What level of quality ("clean seed"/certified) is appropriate to minimise spread of disease? what are associated costs of risk mitigation; crop and context specific

**The FP2** *has seven clusters.* CC2.1 is a cross cutting cluster and PO2.4 is a crop and regional specific cluster (potato seed systems in Africa) - both dedicated to seed systems research and development.

**Crop improvement is carried out in six distinct clusters, one for each of the five RTB crops.**

Breeding program optimization have been working very closely with Excellence in Breeding (EiB) on simulation exercise to enhance genetic gain by increasing accuracy and reducing recycling time. Also on connecting decisions between breeding stages and pipelines. On developed KPI for quantitative optimization breeding at CGIAR and NARS. Product-based population development strategy with project partners. Protocols for food quality analysis RTBfoods. Project.

**This is done intensively on all 5 RTB Crops**

# What is the business model for the Seed Tracker and who is it being made available to?

## Seed Tracker



Seed producers in vegetatively propagated crops and seed regulatory agencies lack capacity to promote and enforce quality seed regulations. There is also lack of awareness and information on seed availability and production.

Scientists from RTB envisioned '**Seed Tracker** to address these barriers. It is a web-app that focuses on improving cassava seed production and access, usable on any internet-enabled device. It is a fully featured program for real-time tracking of seed.

It provides a database for ready access to information, such as seed quantity, location, variety, geography, and availability.

It can also help seed producers understand national regulations and register their seeds.

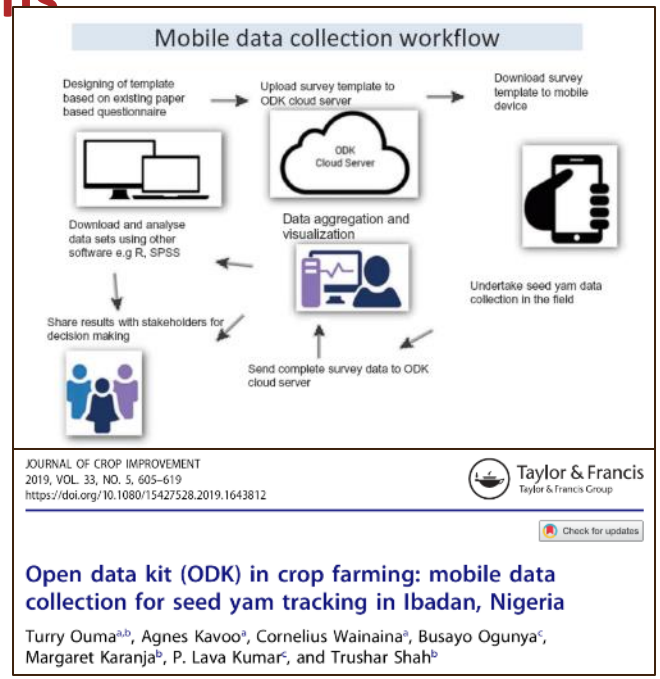
ST adopted for official certification of cassava seed in Nigeria (NASC) and Tanzania (TOSIC) by the national seed regulatory authorities. Over 500 cassava seed fields of breeder, foundation, certified and QDS categories registered on ST.

CC2.1

# ICT tools for RTB seed systems

**Cross-crop research**

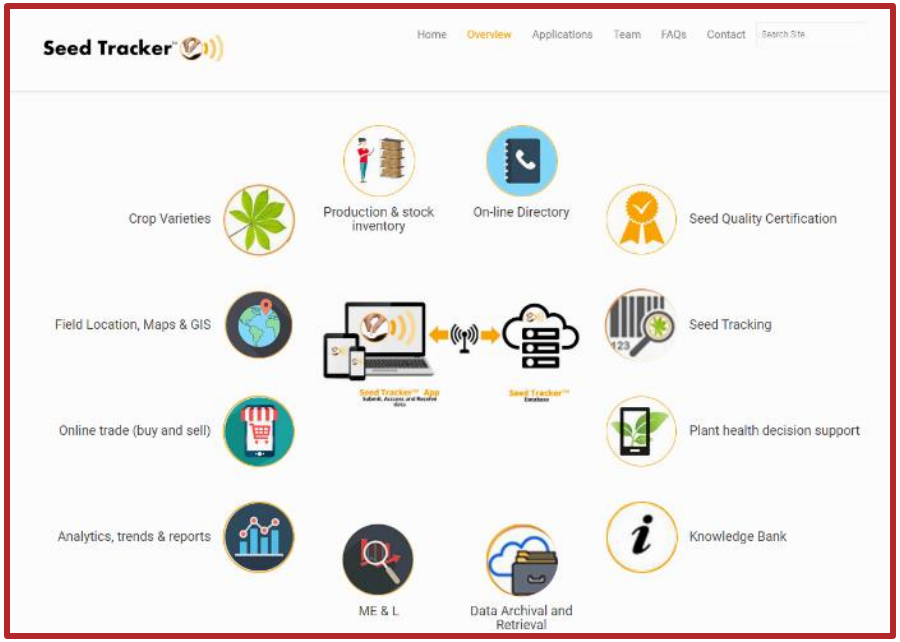
- Research
- Market linkages
- Certification schemes

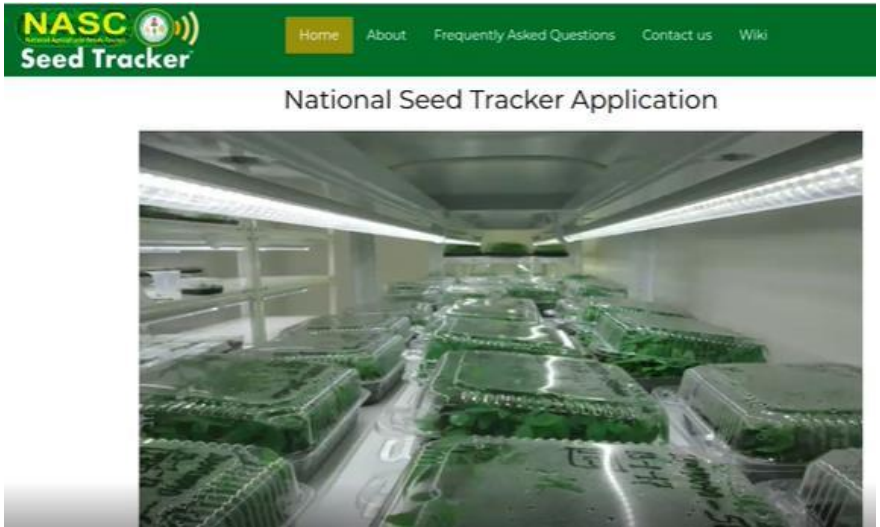



JOURNAL OF CROP IMPROVEMENT
2019, VOL. 33, NO. 5, 605–619
https://doi.org/10.1080/15427528.2019.1643812
Taylor & Francis
Taylor & Francis Group
Check for updates

**Open data kit (ODK) in crop farming: mobile data collection for seed yam tracking in Ibadan, Nigeria**

Turry Ouma[a,b], Agnes Kavoo[a], Cornelius Wainaina[a], Busayo Ogunya[c], Margaret Karanja[b], P. Lava Kumar[c], and Trushar Shah[b]



**Tissue culture capacity building is being carried out and what progress is being made into making it widely available and financially sustainable in the future?**

Detailed costings of steps in TC micro-propagation have been developed based on KEPHIS and CSIR- CRI (Ghana). At CRI it was clear that a large proportion of costs incurred at TC lab due to heavy electrical costs and hence they have made following changes

Changed electrical system into fluorescent lamp, Solar system;

Reduced the space for keeping plantlets and remaining empty space was closed and electrical power turned off;

Reduced number of plantlets and used multiplication calendar to measure exact requirement of the TC plantlets and also keeping minimum stock for the future requirement and/or emergency need.

It is a misconception that TC should be widely available. Need to do better seed requirement planning (tool available), reduce TC plantlets needed and optimise screenhouse production capacity.

Cassava – example – use of SAH for hardening and transfer to field (but it is very difficult to get the real costings for this)

There is sandponics and other ways of reducing TC costs:
Use of MS stock solutions in place of pre-mixed MS salts
Use of agar in place of phytagel to solidify the media
Use of sugar as a carbon source in place of research grade sucrose
Use of cling film rather than parafilm

In summary: good to keep minimum stocks (TC plantlets) at TC lab which is financially viable and able to multiply quickly in a short duration. A maximum 100 plantlets more than enough to keep them as a stock to meet raising demand.

However, it is always good to estimate seed requirement at every stages of the seed production in the seed supply chain (i.e., from EGS to quality declared seed).

For the future financial sustainability is concerned, it is always good to focus RTB crops as a whole to avoid any unwanted risks might happen due to market shocks.

To understand local landrace demand and identifying appropriate best fit improved variety(s) for the local landrace is necessary for the future - which will make TC lab more financially sustainable and to react quickly for the farmers' preferences to ensure there is a strong linkage between EGS and QDS/roots producers through formal and informal link

**A very exciting development of creating a new seed system for a new improved variety in a new agro-ecology. This ought to be one of the great success stories. What efforts are being made to expand this other similar ae-zones and how will this be done sustainability?**

There is great potential to take new robust varieties to non-traditional agro-ecologies using cuttings as planting material. We are scoping this in Northern Uganda and Sudan with private sector nursery producing cuttings.

Sustainability is assured with good intervention support to bring the nurseries and seed system operating autonomously – through scaled down support

**Two different approaches to scaling; the first being market-led (commercial production of cuttings) and the second presumably being donor-led (the OFSP programme). Could the business models of these be compared and contrasted? For example, who are the "beneficiaries" of the OFSP planting material; individual farmers or cuttings producers?**

The "beneficiaries" of the OFSP planting material is the individual farmer. What can be contrasted is how is the multiplication done:

At the research station or at the decentralised commercial vine multiplier, DVM.

At the station good quality vines are produced with material from tissue culture or specialised greenhouse by CIP and /or the National program, to provide the DVM or any other multiplier.

The DVM are trained on how to produce the Vines.

The DVM produces the vine under contract with CIP or NGOs.

The DVM are paid either by CIP if it an emergency project or another NGO.

Lot of DVM found selling the vines a profitable business and they have maintained their business since 2012 in Central Mozambique.

They are also conserving the vines off season.

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# Priority areas for research and scaling to continue on RTB crops in One CGIAR

Advocacy with policy makers

Transforming RTB value chains to make more nutritious food cheaply available in cities and rural markets

More Gender research integrated with biological research to improve women and men's equitable access to and benefits from innovations for production and processing of RTB crops,

Sustainable intensification of RTB agri-food systems

Strengthening and enabling seed systems for increased access to improved varieties and encouraging improved quality in dominant informal seed systems.

Accelerating availability of user demanded new varieties with climate resilient traits of drought and heat tolerance, salinity and waterlogging through mainstreaming of genomic tools and high throughput phenotypic screens,

Improved management of breeding programs to increase efficiency and effectiveness, and enhanced use of crop genetic diversity.