Report of the 6th Next Generation Cassava Annual Meeting

NEXTGEN CASSAVA

19th – 24th February 2018, Ramada Hotel, Dar es Salaam, Tanzania

MARCH 2018

Emerge-Africa
Partnerships for change

The meeting was facilitated by *Ed Rege* and documented by *David Jakinda* – both of Emerge-Africa.

This report documents the **NextGen Cassava 2018 Annual Meeting** held from 19th to 24th February 2018 at Ramada Hotel, Dar es Salaam, Tanzania. **THIS IS MEANT TO BE A REFERENCE DOCUMENT** for participants and provides details of what transpired. Essentially, all results of the input presentations, plenary sessions, table group discussions and reflections from the work-planning sessions are reported as they were presented. It is not a synthesis report but a verbatim documentation of the proceedings and outcomes without interpretation.

Final edit by Canaan Boyer

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LIST OF ACRONYMS

ACWP	African Cassava Whitefly Project
BMGF	Bill and Melinda Gates Foundation
BSL	Breeding Scheme Language
BTI	Boyce Thompson Institute
CBSD	Cassava Brown Streak Disease
CIAT	International Centre for Tropical Agriculture
CIP	International Potato Centre
CIRAD	Agricultural Development Research
CMD	Cassava Mosaic Disease
DFID	Department for International Development (UK)
DUS	Distinctiveness, Uniformity and Stability
EPAC	External Program Advisory Committee
GEM	Genotype, Environment and Management
GREAT	Gender Responsive equipped for Agricultural Transformation
GS	Genetic Selection
IITA	International Institute for Tropical Agriculture
MaRCCI	Makerere University Regional Centre for Crop Improvement
MARI	Mikocheni Agricultural Research Institute (Tanzania)
NaCRRI	National Crops Research Institute (Uganda)
NPT	National variety Performance Trials
NRCRI	National Root Crops Research Institute (Nigeria)
PICO-EA	Institute for People, Innovations and Change in Organizations – Eastern Africa
QDS	Quality Declared Seed
QMS	Quality Management System
RTB	Roots, Tubers and Banana
SDGs	Sustainable Development Goals
SSA	Sub Saharan Africa
TARI	Tanzania Agricultural Research Institute
TOSCI	Tanzania Official Seed Certification Institute
WACCI	West Africa Centre for Crop Improvement
WAVE	West African Virus Epidemiology

EXECUTIVE SUMMARY

The Bill and Melinda Gates Foundation (BMGF) Next Generation Cassava Breeding project (NextGen Cassava) seeks to modernize partner cassava breeding institutions in Africa and use cutting-edge tools for efficient delivery of improved varieties of cassava. The project initially focused on improving cassava using genomic predictions. In Phase I, the project was able to shorten breeding cycles, improve data collection and management, increase germplasm exchange, improve physical infrastructures of programs, and increase the number and capacity of cassava breeders in partner African breeding programs. Building on these successes, Phase II of the project entails a shift toward implementation for the delivery of improved varieties to smallholder farmers.

The 6th NextGen Cassava Annual meeting also marked the launching of Phase II of the project and was held in Ramada Resort, Dar es Salaam, Tanzania from 19th to 24th February 2018. The purpose of the meeting was to share information on achievements and learnings of *Phase I* and develop a roadmap for *Phase II* of the implementation.

The main areas covered were:

- ***Key achievements of Phase I:***
  - Built capacity: 9 MSc and 11 PhD students
  - Strengthened partnerships with various institutions and added Tanzania Agricultural Research Institute (TARI) to the NextGen project collaborators
  - Created better understanding of cassava genome, flowering and breeding cycle – which helped to enhance breeding by reducing the time to develop new varieties from 8 – 10+ years to 5 – 6 years
  - Developed an open access database for cassava genome information (Cassavabase.org)
  - Established excellence in breeding platform
- ***Main activities planned for Phase II:***
  - Enhance optimization of breeding program
  - Facilitate germplasm exchange
  - Build product profiles
  - Conduct participatory evaluation of small number of clones at large scale with diverse farmer groups
  - Build a gender responsive innovation system
  - Increase awareness of, and build researchers' capacity to use, Cassavabase tools
  - Integrate phenotyping tools into breeding programs

Overarching issues identified:

- How to get germplasm materials through sharing across teams in different locations; in this connection there was also concern about need to move germplasm out of Africa and back – due to lack of specific capacities in the continent. This point arose again during discussions of the EPAC Challenge (see below).

- Providing/establishing a mechanism to ensure ongoing communication between different teams in the overall project
- Need for a communication platform (both formal and informal interaction processes) to synchronize plans of different projects – e.g. online platforms such as zoom and slack
- Need to identify a set of traits that are critical/high priority for the program.

EPAC Challenge

Participants discussed *the challenge areas* identified by the external program advisory committee (EPAC) and suggested possible solutions:

- **Sustainability**: ensure relevance of breeding outcomes to farmers, national ownership and supportive policies, reliable/stable resourcing/financing, strong private sector engagement, and building local capacity to do what needs to be done on their own.
- **Working as a Team**: clarify roles, build mutual trust and respect, have genuine communication and demonstrate willingness and actions that support other teams/members.
- **Vision**: participants suggested some key words that can help the project leadership to come up with a refined the NextGen VISION.
- **Managing Cassava Brown Streak Disease (CBSD):** Suggestions to improve/facilitate CBSD management included: promote collaborative breeding; develop efficient seed systems and manage them well; and build capacity and increase awareness/sensitize farmers about CBSD.

In order to ensure overall success of the breeding process, the importance of ***mindset change, cooperation and communication*** was emphasized, especially to capture the power of diversity for teamwork.

Two special workshops were held as part of the meeting on Friday and Saturday: PhenoApps and Cassavabase teams; and RTBFoods workshop involving a number of project team members. The first workshop involved training on contents of and how to use the Cassavabase system. In the RTBFoods workshop, deliberations focused on how to improve collaborations and research within and between various projects working on roots, tubers and banana crops. The main issues identified as potential next steps in the RTBFoods discussions were: validation of data across sites; improving precision of tests; achieving adequate sample sizes; selection of cassava clones based on good cooking quality; developing a video protocol of RTB foods, for example for boiling cassava; linking RTB Foods and NextGen data; diversifying type of processing by target markets; and enhancing farmer and team trainings.

There was a field trip on Saturday to Chambezi field station and Yombo village in Bagamoyo. At the field station, participants were able to visit a cassava field trial, and learn from *Kiddo Mtunda* and *Heneriko Kulembeka* (team leaders in Tanzania) about the ongoing NextGen trials and research in Tanzania. Participants also saw examples of cassava roots infected with cassava brown streak disease (CBSD). In Yombo village, participants met with farmers from the Kituruma farmers group, were shown cassava fields, and told about the activities of the farmers group, and had opportunity to taste some of their preferred varieties. It was a great opportunity for participants (especially those who spend a lot of time in an office or lab) to interact with the people/communities whom their work is targeting.

1. SESSION ONE: INTRODUCTIONS, OPENING AND PROCESS OUTLINE

1.1 Background

The Next Generation Cassava Breeding project (NextGen Cassava) seeks to use cutting-edge tools for efficient delivery of improved varieties of cassava, and to modernize partner cassava breeding institutions in Africa. The project initially focused on improving cassava using genomic predictions. In Phase I, the project was able to shorten breeding cycles, improve data collection and management, increase germplasm exchange, improve physical infrastructure, and increase the number and capacity of cassava breeders in partner African breeding programs.

Building on these successes, Phase II of the project will shift toward implementation for the delivery of improved varieties to smallholder farmers. The project will facilitate a model cassava breeding organization coordinating four African breeding programs to exemplify effective improvement through optimal breeding schemes, research integration, demand-led breeding goal identification, and sound organizational structure; successful outreach to national breeding programs throughout the sub-Saharan region, enabling them to envision and take steps toward similar effective breeding organization; the release of improved cassava varieties in each breeding program's region that meet criteria for quality acceptability and sustainably; improve smallholder farmer livelihoods through improved yield and disease resistance; sustainable means for the identification and quantification of cassava breeding goals based on survey and adoption evidence from smallholder farmers; the improvement and diversification of cassava breeding program populations to ensure a solid foundation for future genetic gains, and greater understanding of the genetic architecture of traits to increase the efficiency of those gains.

The project will implement and empirically test the application of genomic selection that relies on statistical modeling to predict cassava performance before field-testing, and has potentially to dramatically accelerate the breeding cycle. Major activity areas of the project include: human and infrastructure capacity development of partner breeding program institutions; development of methods to increase flowering and seed set in cassava; creation of a database (Cassavabase) to provide a centralized information tracking, genotypic and phenotypic data, and genomic selection prediction analyses; enhancement of cassava germplasm exchange between Latin American and Africa; and supporting the establishment of a biotechnology/biosafety outreach and training hub at the National Crops Resources Research Institute (NaCRRI) in Uganda.

While the R&D activities are grounded in the three project countries (Nigeria, Uganda, and Tanzania) and led by the NARIs in these countries, the project has a strong set of international partners. It is led by International Programs of the College of Agriculture and Life Sciences at Cornell University, in collaboration with the International Institute of Tropical Agriculture (IITA) and the West African Centre for Crop Improvement (WACCI) in Ghana, the Boyce Thompson Institute (BTI), USDA-ARS, and the U.S. Department of Energy in the United States, and Makerere University Regional Centre for Crop Improvement (MaRCCI). The project is funded by the Bill & Melinda Gates Foundation (BMGF) and the UK Department for International Development (DFID).

The year 2018 is the transition year from *Phase I* to *Phase II*. In this connection, the 6th NextGen Cassava Annual meeting - which was also meant to launch *Phase II* of the project - was held from 19th to 24th February 2018 in Dar es Salaam, Tanzania. The meeting brought together the NextGen teams composed of breeders, geneticists, data analysts, computer programmers, food technologists, social scientists and crop protectionists, to discuss how they would work together in a coordinated and collaborative manner, leveraging germplasm, genotypic and phenotypic data from one another. Several collaborating institutions were also in attendance. The list of participants is provided in *Appendix 1*.

1.2 Workshop Objectives

The specific objectives of the workshop were:

1. Partners to share with each other information about their current state:
    - *What activities they are engaged in or are initiating?*
    - *What they have learned from Phase I and specifically from the past year?*
    - *What resources they need and what resources they can share?*
2. Clarify expectations about the future and specific plans for the near future:
    - *Projects know what they are building towards*
    - *Projects have specific deliverables for the year ahead and plans for them*
    - *Projects know who they would communicate their results to and when*
    - *Projects know who they would get materials, information, and training from*
    - *Collaborative visits/interactions and training schedules are planned.*
3. Leadership to have consensus on priorities and opportunities to build on:
    - *Internal weaknesses that need additional effort and organizing*
    - *Internal strengths that can be shared systematically*
    - *The resources that external cassava research investments can provide.*

1.3 Agenda

A summary agenda is presented in *Table 1*. The detailed agenda is presented in *Appendix 2*.

Table 1: Summary of Workshop Program

Day 1	● Opening, introductions & process ● Scene setting ● Collaborators' corner ● Roadmaps and work-planning
Day 2	● Day 1 recap ● Roadmap presentations & work-planning II & III ● Collaborators' corner ● Knowledge fair poster session
Day 3	● Day 2 recap ● Roadmap presentations & work-planning IV ● Collaborators' corner
Day 4	● Phase II inauguration ceremony ● EPAC challenge & group discussions
Day 5	● Parallel workshop sessions – PhenoApps/Cassavabase & RTBFoods NextGen collaboration ● Open space for work-planning & side meetings
Day 6	● Field trips ● Open space for work-planning & side meetings

1.4 Opening Remarks

The opening remarks were made by *Mansoor Hussein* - the Director of Research and Development in the Ministry Agriculture, United Republic of Tanzania. He welcomed all participants to Dar es Salaam and thanked the collaborators for organizing the event. He emphasized the importance of people in making events succeed by sharing a Swahili saying '*Shughuli ni watu'* (meaning: *Business, event, function or meeting is people*): no matter the amount of effort put in organizing events, they only become successful if invited people attend and contribute positively. *Chiedozie Egesi* from the IITA welcomed participants to the workshop.

1.5 Participants' Introductions and Expectations

The facilitator - *Ed Rege*, asked participants to sit at a table with people they did not know yet – in a max-mix of institutions, teams and countries. While at the table groups, they were asked to perform the following tasks for 10 minutes:

- Take 5 minutes to get to know each other: names and institutional affiliations/teams
- Discuss, agree on and note down (in the 2 blue cards on the table) – two measures of success of this meeting for you.

***Introductions*:** Due to the large number of participants and time constraints, *Ed* asked various groups to stand and wave at the project groups – Tanzania Agricultural Research Institute (TARI), International Institute for Tropical Agriculture (IITA), National Root Crops Research Institute (NRCRI) in Nigeria, National Crops Research Institute (NaCRRI) in Uganda, Makerere University, Cornell University, Boyce Thompson

Institute (BTI), Embrapa, International Centre for Tropical Agriculture (CIAT), BMGF Program Officer (*Jim Lorenzen*), External Program Advisory Committee (EPAC) and collaborators.
From each table group, participants were asked to read their 2 cards of expectations. Five main clusters were noted and these are summarized in *Table 2*.

Table 2: Participants' Expectations

Key Expectation categories	Specific expectations
Lessons/learnings from Phase I	● Learn from *Phase I* things to address in *Phase II* ● Get clarity of *Phase I* achievements ● Gain a good understanding of *Phase I* challenges to spur success in *Phase II* ● Know the lessons and weaknesses of *Phase I*
Information sharing/communication	● Learn as much as possible about NextGen activities ● Establish maximum connections ● Improve communications/information sharing
Project networking/collaborations	● How to integrate activities with other projects e.g. ACWP ● Meet new people and get a deeper understanding of associated projects ● Know new partners, establish collaboration and exposure to new ideas and strategies ● Identify synergies with other projects (e.g., RTBFoods, whitefly) ● Shape innovations as teams
Roadmap/plans	● Establish clear roadmap for *Phase II* x2 ● Understand *Phase II* vision and expectations x2 ● Develop well-defined work-plans for the next 1 year and *Phase II* ● Have a clear picture of where we come from and where we are going
Roles and responsibilities	● Agree on roles and responsibilities of each partner ● Identify incentives and actions for organizations to work together

1.6 Workshop Process

The workshop was conducted in a participatory manner that entailed the use of input presentations[1], poster presentations/knowledge fair (*Figure 1*), buzz groups at the tables, break-out group discussions ("extended work-planning sessions" around specific topics/areas), focused work-planning sessions by individual teams, open-space and plenaries. The work-planning and open space sessions were particularly used by the teams to work on their 2018-2019 plans so that they could sign contracts and begin working immediately after workshop.

Insights from various sessions were shared through PowerPoint presentations and meta-cards. In order to help track progress, guide and recalibrate the meeting as necessary, a process steering group (PSG) was formed. The PSG members were: *Jean-Luc Jannink, Joseph Onyeka, Ismail Rabbi, Richard Ofei, Stephan*

[1] The PowerPoint presentations can be accessed as separate documents from the NextGen Cassava Project team (Canaan Boyer: ceb363@cornell.edu).

Winter, Chiedozi Egesi, Canaan Boyer, Peter Kulakow, Hale Tufan, Robert Kawuki, Ronnie Coffman, Ed Rege and *David Jakinda*. The role of the PSG was to observe the meeting dynamics such as participants' level of engagement in the discussions, energy levels, focus of the deliberations towards the objectives and emerging issues that needed urgent attention and re-orientation of the agenda as the meeting progressed. During the breaks (mid-morning and lunch time) as well as at the end of each day, the PSG members held brief meetings to share their observations and to discuss any modifications necessary on the agenda, content and process of the meeting. Exercises/energizers were performed to re-energize participants whenever their level of engagement was observed to be low. Further, the facilitator asked participants to rotate/change sitting arrangements in order to enable them to network more by interacting with new people every day.

2. SESSION TWO: SCENE SETTING

This session comprised two key presentations to highlight achievements of *Phase I* and clarify the direction of *Phase II*; interactive poster sharing and; insights from two collaborators.

2.1 Accomplishments of Phase I

Chiedozie highlighted the main accomplishments of *Phase I* as shown in *Box 1*.

Box 1: Summary of Key achievements from Phase I

- Proved that genomic selection (GS), a modern breeding method that uses statistics to predict plant performance, is a viable method to improve cassava breeding.
    - NextGen Cassava is the first time GS has been used for cassava. Other breeding programs for under-researched crops around the world could follow a similar model
- Increased capacity for training the next generation of cassava breeders for Africa through training of students and building institution capacity.
    - 9 MSc students from 5 East African countries trained at the Makerere University Regional Center for Crop Improvement (MaRCCRI).
    - 4 PhD students trained at the University of Ghana, West Africa Centre for Crop Improvement (WACCI).
    - 7 PhD students at Cornell University, USA
- Strengthened partnerships with various institutions and added Tanzania Agricultural Research Institute (TARI) to NextGen project collaborators.
- Better understanding of cassava genome, flowering and breeding cycle have enhanced breeding effects – reduced the time to develop new varieties from 8-10+years to 5-6 years.
- Developed an open access database for cassava genome information (Cassavabase.org) which currently holds information from 9.7 million phenotypic observations, 2,488 trials and 34,000 genotypes.
- Began to initiate gender-responsive breeding practices. Successfully identified differences in motivations for preferred cassava traits between different consumers – trials in Uganda and Nigeria show that men and women look for different qualities in cassava. Understanding what makes 'good' cassava lets breeders develop ways to breed for these qualities.

Plenary discussions on this presentation centred on the following issues:

- Participants appreciated the participatory approach used in getting information and organizing the meeting
- Heterogeneity requires higher resolution data – good data quality is necessary for improved prediction ability
- Field preparation is key to getting good data quality
- There is need to clarify timing (appropriateness to their seasons), extent of (location) and level of farmer participation in the breeding process
- Processes can be improved by optimizing variety development and genomic selection, experimentation designs, field capacity, quality assurance and control, data analysis and management, sample-tracking, flow of information and accountability.

2.2 Developments to Inform Work-Planning

Jean-Luc started his presentation by sharing the mission of NextGen: *To develop a sustainable cassava breeding scheme with accelerated genetic gains, leading to the release of improved cassava cultivars that meet the agronomic and end user needs of small holder farmers in Africa.* The rest of the presentation – based contributions from the different project teams – helped to highlight some of the key developments across NextGen that provide important bases for work-planning during the workshop. They included, among others:

- Data and result delivery through Cassavabase in 2018
- IITA – Ibadan: Marker Assisted Selection
- Embrapa: Disease genetics; and flowering
- Gender initiative – Nigeria and Uganda, including phenotyping for root softness
- Updates – various dimensions – on CBSD
- Gore Lab: NIRS for DMC
- Setter Lab: Flowering
- CIAT: Germplasm diversification.

Jean-Luc's presentation was followed by interactive poster sharing session whereby posters were displayed on pin boards in a room and project teams moved from poster to poster for a few minutes as presenters shared key insights about their work to excite participants for further detailed discussions.

2.3 Interactive Poster Sharing

The key themes covered by posters from various teams are shown in *Table 3.* Some of the poster presentations are illustrated in *Figure 1* and *Figure 2*.

Table 3: Main Themes of Posters Presented

Project/team	Poster title
Embrapa	● Genomic-wide association study for resistance to cassava root rot ● Phenological diversity of flowering and fruiting in the cassava Brazilian germplasm
NaCRRI	● Protocol optimization for phenotyping softness of boiled cassava roots ● Gender-responsive PVS for cassava: experiences from Zombo highlands in Uganda ● Enhancing flowering and fruit set in a cassava crossing nursery ● Field screening for CBSD resistance: observations from Uganda field trials
NextGen Cassava	● Gender Initiative Pre-Info
NRCRI	● Genomic-wide association study of resistance to cassava green mite pest and associated traits in cassava
MaRCCI	● Training the next generation plant breeders for Africa
Uganda Biosciences Information Center (Ubic)	● Outreach for impact: the case of biotechnology communication and education in Uganda
CGIAR Gender & Breeding Initiative	● ClimMob digital platform to support triadic comparisons of technologies (tricot)

Figure 1: Participants engaging during one of the poster sessions

Figure 2: NaCRRI team member explaining their work

Following the poster session, participants observed that it had been useful in helping them to know what other projects are doing, learn from these and begin to see possible areas of collaboration.

2.4 Scene Setting by Collaborators

As part of the scene setting, brief presentations were made by two collaborators, *Stephan Winter* and *Enghwa Ng*, focusing on rapid reliable cassava brown streak disease (CBSD) titre evaluation and excellence in breeding, respectively.

2.4.1 Rapid Reliable CBSD Titre Evaluation

In his presentation, *Stephan* observed that extreme resistance against east African cassava mosaic viruses is not virus-specific. Recovery resistance depends on the virus species/strain and the cassava variety. Viruses causing CBSD cannot be discriminated from symptoms they cause on cassava. He noted cassava brown streak virus (CBSV) infections eventually result in root symptoms in all cassava varieties. Participants sought clarifications on:

- How to evaluate and address resistance of clones at farm level and reduce uncertainty.
- The extent to which double grafting would be recommended.

2.4.2 Excellence in Breeding Platform 2017 - 2022

Enghwa explained that this is a new platform that aims to accelerate genetic gains and increase impact for the developing world. Its vision is to ensure that breeding programs are delivering high rates of productivity gain to farmers in the developing world through genetically improved cultivars and breeds that are resilient, nutritious and desired by the market. The platform focuses on building capacity of breeders through five key modules focusing on: breeding program management; optimizing breeding

schemes; genotyping/sequencing tools and services; phenotyping tools and services; and bioinformatics, biometry and data management tools and services[2].

3. ROADMAP PRESENTATIONS AND WORK PLANNING

The discussions on how to develop plans for *Phase II* were guided by roadmap presentations from various projects and sharing of insights by collaborators. Four sessions (session 3, 4, 5 and 6) were specifically dedicated to sharing of insights as precursors and inputs to work planning (in **extended** – or multi-team sessions and **focused** sessions by individual teams). At the end of each of these sessions, project teams held work-planning meetings in break-out rooms to define their activities, implementation process, timelines, resources, potential collaborators and roles and responsibilities.

3.1 Session Three: Roadmaps and Work-planning Part I

Four presentations were made in this session to give an update of what various projects were doing, namely: IITA, Embrapa, Optimization and Germplasm exchange. These are summarized below.

3.1.1 IITA Cassava Improvement

Ismail Rabbi highlighted the key outputs of the IITA's cassava improvement work in *Phase I* and some proposals for *Phase II* as follows:

- *Phase I Outputs*
  - Breeding cycle shortened
  - Selections advanced through testing pipeline
  - Promising clones from GS breeding pipeline cycle 1
  - Field trials implemented
  - Genomic prediction – better 'plotsmanship' and 'plotcraft'
  - Trait-linked markers available for MAS – community resource
  - Tools for genotype ID and QC
- *Moving forward*
  - Continue testing program for variety selection
  - Continue recurrent breeding cycles
  - Optimize integration of MAS and GS – validation
  - Breeding program optimization
  - Ensure well-defined testing

Ismail clarified that selection is based on standard phenotypes and that only a few excellent varieties - 1 or 2 can be released in the next 15 years.

[2] Details on the platform can be obtained from: excellence-in-breeding@cgiar.org.

3.1.2 Embrapa's Next Generation Cassava Breeding

Eder Oliveira noted that Embrapa's support to the NextGen process involves two phases: *Phase I* (2016 – 2019) and *Phase II* (2019- 2022), which focus on three main aspects:

- Improving genomic selection
- Enhancing phonological diversity of flowering and fruiting in Brazilian germplasm. The key observations here are that – actions to extend photoperiod in crossing field may increase flowering and; accessions G6 and G7 are very interesting for breeding and genomics.
- Wild cassava germplasm exchange – about 2,500 sexed seeds of 11 cassava wild relatives from Embrapa seed bank are in the process of being transferred to Africa.

Eder informed participants that sequenced data is available for further analysis.

3.1.3 Optimization

Jean-Luc explained that the primary goal of this project is to put in place methods and infrastructure that will dramatically increase the rate of genetic improvement of cassava varieties in sub-Saharan Africa, starting with programs in Nigeria and Uganda. He emphasized the need for adequate preparation by quoting *Abraham Lincoln*'s inspiring message, *'If I had 6 hours to chop down a tree, I would spend the first 4 hours sharpening the axe'*.

Jean-Luc reported that so far the optimization set of activities have accomplished the following:

- Continued development of the breeding scheme language (BSL)
- Hired *Mohamed Somo Ibrahim* to simulate purging scenarios
- *Moshood Bakare* started as PhD student from IITA – estimating error and GxE variances in the IITA network.

The target deliverables for *Phase II* for this work are to:

- know phenotyping and crossing resources for each program – number of locations, plots and controlled crosses
- optimize breeding parameters (error variance, genetic correlations, costs and accuracies) continuously
- have properly grouped target environments
- do analyses to justify, at different stages; selection intensity and traits selected, replication and location numbers, and allocation to variety versus training population pipelines.
- put in place processes to understand the impact and integrate technologies that change breeding schemes, for example MAS and SAH.
- maximize selection intensity while constraining diversity loss
- use proper multivariate methods
- ensure breeders have a culture of and mutual support for optimization.

Participants emphasized the need to consider traits that matter to farmers – spend time understanding what matters to farmers.

3.1.4 NextGen Germplasm Exchange

Peter Kulakow explained that the purpose of this project is to transfer germplasm (*Figure 3* and *4*) for key traits and to broaden the African breeding population with germplasm from cassava's center of diversity. It involves collaboration between CIAT and EMBRAPA with NextGen partners in Africa to establish germplasm transit opportunities with strategic partners in Hawaii and Germany to increase efficiency and enhance safe germplasm transfer using the best available phytosanitary procedures.

Figure 3: Exchange of Tissue Culture Plantlets

Figure 4: Seed Exchange

In the plenary discussions, participants were concerned about:

- ensuring reliability of CMD marker data
- diversifying exchange patterns
- building local capacity and systems in Africa to reduce/avoid future movement of germplasm from IITA to Germany and back – to ensure independence and neutrality in the breeding process, and safety of materials
- ensuring cleanliness of the immune system to prevent spread of virus.

3.1.5 Work-Planning Session I

After these presentations, participants went into two rounds of work-planning (see for example *Figure 5*), each lasting about one hour; starting with concurrent ***extended work-planning*** group discussions where participants could move out/into different groups and the focus was on deepening understanding of what had been presented in the roadmap sessions and exploring collaborations.

Figure 5: Illustration of a Work-Planning Session

Groups were formed around the four presentations above, with each presenter being the moderator and resource person, with an additional overall support person from the Senior Project Leadership Team. This was followed by another hour of ***focused work-planning*** within teams. However, the point has to be made here that the extended sessions on this day – and subsequent days – took more time than had been planned, as participants seemed quite engaged in trying to understand what these sub/projects had learned and the relevance of these to the work of their own teams. Consequently most of the focused (within team) conversations happened in "open space" sessions. The specific guidelines for the work-planning discussions were as follows:

- *Leads for each session:*
  - During Roadmap presentation in plenary: include a slide that lists *3-5 points that will kick off the extended work-planning* discussion
  - Be an inclusive moderator – not allowing domination by a few
  - Prepare a summary of key points from the discussions
- *Team Leads need to ensure ongoing convening of team members* to collate/integrate ideas emerging from work-planning and other interactions
- Team Leads: start *putting together a growing list of activities*; towards the end of the week this will form basis of a GANTT Chart for phase II (with focus on first year).

3.2 Session Four: Roadmap Presentations and Work-planning II

This session began with reflections on the previous day's work-planning discussions. *Ed* asked the participants to reflect individually in 60 seconds about day 1 especially the work-planning session – i.e.

'*what comes to your mind as you think about that session – learnings/content and process*'. Thereafter, buzz groups (at tables) were asked to perform the following group task:

Reflections on Monday (day 1) work-planning sessions
- Learnings (content) that will influence your team plans?
  - What you will do/do differently
  - What you will stop pursuing
  - Collaboration you are exploring
- Reflections on the work-planning process

(2 comments per table – one per card – pink cards)

The feedback from the reflections is summarized in *Table 4*.

Table 4: Participants' Reflections on Day One's Work-Planning Sessions

Learnings	● Broad collaboration with expertise on diverse issues such as the excellence in breeding project ● Focus more on specific objectives ● Optimization of breeding processes ● Need prior information/input from all stakeholders ● Germplasm exchange and validation – have timelines for implementation and structures on the ground ● Coordination and consolidation of work plans for MAS ● Quality control ● More realistic priorities ● More collaboration needed with virologists ● Work vigorously on CBSD validation and utilization ● Opportunities to improve processes - breeding processes and tissue culture
Process	● Establish regional crossing blocks in Africa for germplasm exchange ● Work closer with RTB food on quality ● Improve communication between groups ● Stronger leadership in work plan sessions ● Work planning groups had a good representation i.e., self-selection went well ● Focused traits for product profiles – narrowing down to list of traits ● Limiting grouping and framing of the questions ● Provide room in discussion for people to contribute – be inclusive, not dominating

After the participants' reflections, four roadmap presentations were made followed by two collaborators' presentations. The roadmap presentations are summarized in sections *3.2.1, 3.2.2, 3.2.3* and *3.2.4*, while the collaborators' insights are presented in section *3.3*.

3.2.1 NaCRRI Cassava Improvement

Robert Kawuki gave a highlight of what NaCRRI did in *Phase I* (2012 – 2017). He explained that the project aims to:

- Improve cassava reproduction
- Implement better tools for genomic selection
- Develop effective database for designing trials and making breeding decisions

- Develop germplasm
- Develop infrastructure and train plant breeders – 9 MSc graduates have been trained so far
- Improve education and awareness on biotechnology/biosafety
- Undertake special gender initiatives in breeding

Robert pointed out that the long-term desires of NaCRRI cassava project are to:

- Ensure breeding targets are defined and qualified
- Clarify when and how to measure genetic gain
- Work towards continued Improvements in:
    - Lab experimentation (sample storage, tracking and data capture)
    - Field experimentation (sites, plot capacity, stages to skip)
    - Data (less-drudgery collection methods, curation, storage and analysis capacity)
    - Research infrastructure capacity
    - Human personnel
        - Scientists and Technicians along cassava value-chain; *re-tooling*
        - Graduate students; *the engine of research, thus willing to host*
- Ensure elite parent conservation in the face of rapid recurrent selection schemes
- Assess the relevance of breeding work to society through feedback mechanisms along the value-chain
- Build and sustain partnerships.

He pointed out that in transitioning from *Phase I* to *Phase II* (*Figure 6*) the emphasis will be on addressing the following key needs across research, breeding and survey divisions (*Table 5*).

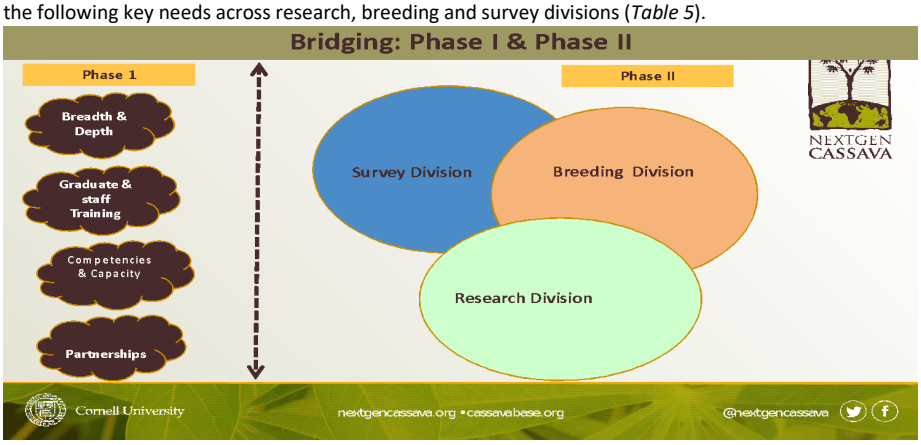

Figure 6: NaCRRI's Focus Areas in Phase I and Phase II

Table 5: Breeding Needs Across Survey and Research Division

Breeding needs from survey division	Breeding needs from research division
● Product profiles and ranking ● Economic weights (value) of selected traits ● Breeding targets ● Farmer recruitment for on-farm trials ● Innovative ways of conducting PVS ● Outreach and communication along impact pathway	● Flowering enhancement technologies ● Phenotyping tools to test-run and/or adopt ● Quality control in labs and fields ● Genetic gain assessments ● Efficient thermotherapy and seed bulking ● Statistical analysis re-tooling ● Increased Cassavabase utility

3.2.2 Flowering: Effective Crossing

Tim Setter from Cornell University explained that the project focuses on developing methods for cassava floral induction and enhanced seed set. He noted that the main successes recorded so far are: improving flowering through long day length with dim red light; providing optimum temperature for early flowering (about 25^0C); and stimulating profuse flowering and increasing percent females through STS+BA. Considering the challenge/uncertainty on the best methods to use, *Tim* highlighted the key areas for future work to include: optimization of STS+BA application and timing; determining the threshold and general utility of dim light extension of day length; developing field scale methods to extend day length; obtaining breeders' input on the most appropriate stage in the breeding cycle (seedling or recalcitrant stages) for these tools; and seeking support for adoption of these methods in cassava breeding programs.

3.2.3 Gender Initiative Survey in Phase II

Hale Tufan from the Survey division of the NextGen cassava emphasized the need to understand the diversity of end-users and to equitably address their needs in order to increase adoption and impact. She noted that there are significant differences in attributes described by men and women. Successful adoption depends on identifying and meeting the spectrum of different user preferences and acceptability criteria. She reported that the key activities in *Phase II* will be:

- Building product profiles – product profile workshops and 1000 minds study
- Screening breeding populations using high throughput phenotyping platforms for quality
- Participatory evaluation - large scale (250-300 farmers in each country), small number of clones (3-4) per farmer; work with diverse farmer groups for dissemination and data collection; AYT-UYT NextGen materials, released elite varieties and local landrace checks; trace how varieties are disseminated informally in nearby fields; simple ranking and scoring genotypes and; digital data collection.
- Building a gender responsive innovation system - gender analysis of participatory research process; comparative gender study and; gender training.

3.2.4 High Throughput Pest and Disease Phenotyping

Ernest Mwebaze from the Artificial Intelligence and Data Science Lab in Makerere University emphasized that to be successful, projects must be guided by the *7 habits of effective projects*, which are:

- Be proactive
- Begin with the end in mind

- Put first things first
- Think win-win
- Seek first to understand then to be understood
- Synergize
- Sharpen the saw.

He noted that the immediate plans will focus on: fail-fast/quickly methodology; multi-site validation of tools for whitefly count and necrosis measurement; development of as-a-service phenotyping platforms; integration protocols for Cassavabase and Fieldbook and; meta-data collection and analysis protocols and deployments.

The issues that this project proposed for the work-planning sessions were:

- Validation tests - how, when, where
- As-a-service model - pros and cons
- Activities to automate whitefly count, necrosis measurement, data cleaning, data upload and verification
- Meta-data collection and analysis - what, how
- Integration with Cassavabase and Fieldbook - how, when, who

3.2.5 Insights from Collaborators

3.2.5.1 Breeding RTB products for end user preferences

Dominique Dufour from Agricultural Research for Development (CIRAD) in France informed participants of a new initiative that seeks to deploy roots, tubers and banana (RTB) varieties that meet user-preferred quality traits to increase the adoption and impact of improved RTB varieties (cassava, yam, sweet potato, banana, potato) in sub-Saharan Africa (SSA). He explained that the RTB project scope and approach entails a cycle of iterative problem-solving work packages (*Figure 7*).[3]

[3] Details of this project can be accessed at: https://url.cirad.fr/pr/RTBfoods; https://url.cirad.fr/cp/RTBfoods

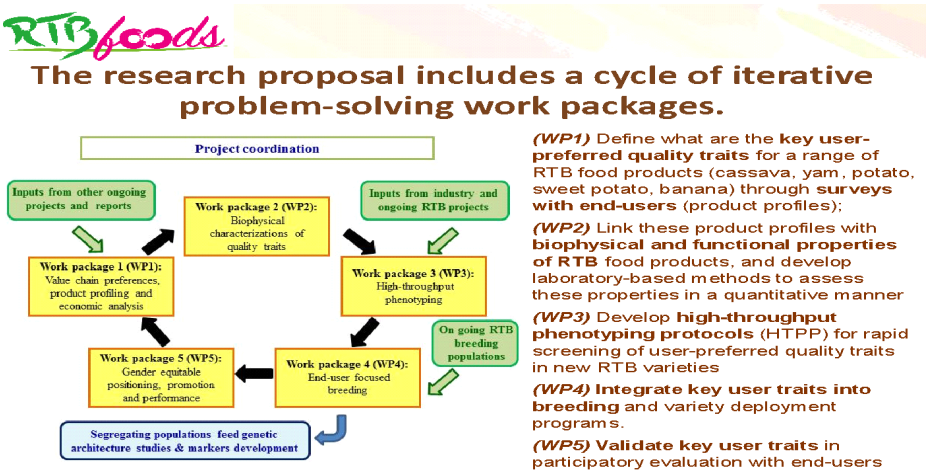

Figure 7: RTBFoods Project Scope and Approach

3.2.5.2 African Cassava Whitefly

John Colvin from the Natural Resources Institute in the United Kingdom explained that the African Cassava Whitefly Project (ACWP) aims at prevention of food insecurity and famine. He noted that the key achievements of the ACWP over the last 3 years are:

- Twenty-seven detoxification genes significantly overexpressed in SSA1-3 were identified as potential RNAi targets
- Six genes in *B. tabaci* are being silenced in planta using the virus-induced gene silencing (VIGS) technology
- Submitted paper to a journal, paper entitled, "Are *Bemisia tabaci* - plant associations involved in the species diversification: a detoxification perspective revealed by RNAseq analyses?"
- Stable transformations of tomato with the dsRNA constructs against the dehydration genes have been completed
- Human scientific-capacity being built successfully.

Using an illustration of animal behaviour (*Figure 8*), *John* observed that working in teams to achieve success might sometimes appear to be an 'impossible task' but requires a change of mindset, cooperation and communication.

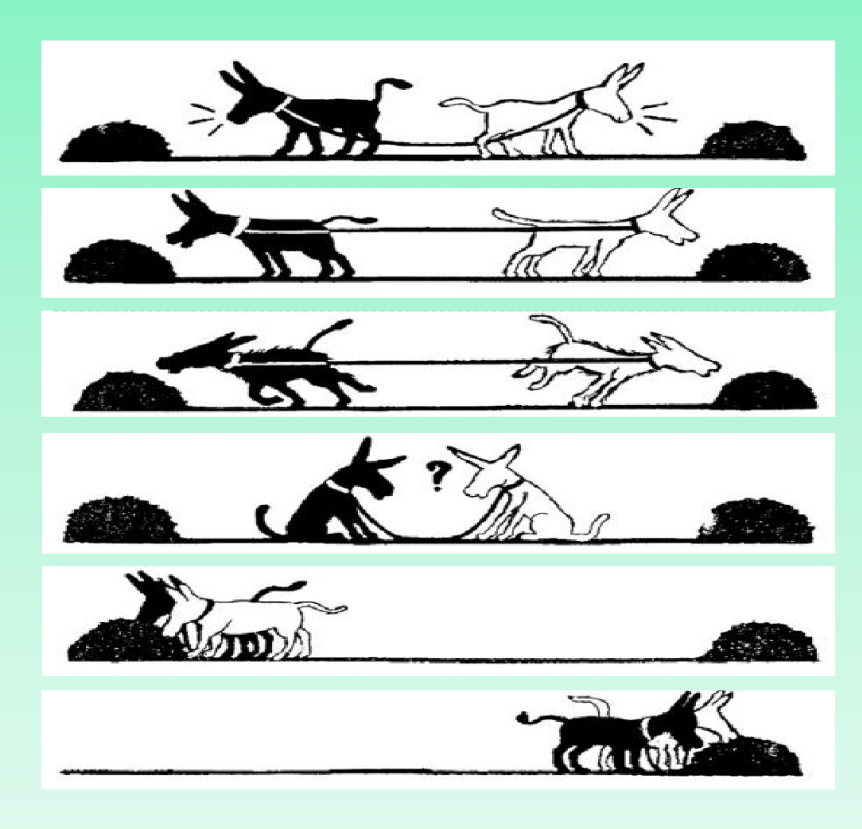

Figure 8: Working Together Effectively – Mindset Change From Competition to Collaboration

This session ended with focused work-planning by the teams for about one hour.

3.3 Session Five: Roadmaps and Work-Planning III

In order to help recast the work-planning discussions, the facilitator asked participants to reflect on the activities of the previous session held in the morning of workshop day 2 and share their feedback. Specifically, they were asked to:

- Reflect on the work-planning activities done in session four:
    - What comes to mind as a highlight with regards to value of the session and how it is influencing your project plans for phase II?

From the participants' feedback, it was noted that:

- There were crucial connections between NextGen and RTBfoods
- *Tim*'s presentation on 'flowering' drew a lot of interest from many groups
- As new entrant in the NextGen program, Tanzania team observed they were benefiting greatly from the extended planning sessions
- Emphasis was placed on the need to focus and align goals
- The concern on 1 year breeding cycle versus longer periods was emerging as an important issue for further conversation.

3.3.1 NRCCRI Cassava Improvement

Joseph Onyeka from the NRCRI in Nigeria reported the key roadmap activities to include:

- Inclusion of the materials derived by IITA and NRCRI into the national cassava research program and on-farm evaluation in 2019 – 2021
- WAVE project working with NaCRRI (Uganda) to evaluate farmers' varieties from 6 west African countries in Uganda for sources of CBSD resistance
- Assessment of CIAT resistance lines for population development – joint progeny testing with east Africa
- NIRS initiatives focusing on: developing models for more end-user traits; updating existing models; extended phenotyping to other crops and other breeding projects in Africa, Brazil and Colombia and; integrating the processed traits in genomic studies
- Application of STS+BA in the crossing block for validation
- Repeating the photoperiod experiment
- Farmers' participatory study with the survey division.

3.3.2 CIAT – Induction of Flowering

Hernan Ceballos from CIAT informed participants that one of the main activities planned by CIAT is to translate a manual on Quantitative Genetics and Biometry for cassava (and other root and tuber crops) from Spanish into English. He noted that based on past experience on introgressing the recessive waxy starch trait, one or two rounds of recombination crosses are suggested to allow breaking undesirable linkages that will still be present in the pseudo F2.

3.3.3 Future of Cassavabase

Lukas Mueller explained that Cassavabase[4] is a global database for cassava breeding data; used to manage breeding programs, breeding decision support (solGS) and is part of a family of RTB databases. Other such databases include the Musabase, Sweetpotatobase and Yambase. It ensures data quality through:

- Integrated electronic data capture using the Android Fieldbook and other tablet-based solutions
- Digital data that never "leaks" into "analog" domain
- Use of barcoding
- Quality filtering upon upload
- Well defined "Process Maps".

Cassavabase is implemented as enterprise-level database system compiling breeding data from all NextGen projects; 9.7 million phenotypic observations, 2,488 trials and 34,000 genotypes. *Lukas* pointed out that the *new and upcoming features in Cassavabase* are as shown in *Table 6*.

Table 6: New and Upcoming Features in Cassavabase

New features	Upcoming features
● Vastly improved barcode integration - barcode scanning in Fieldbook supported and flexible barcode printing ● Improved crossing manager - crossing wishlist and ODK cross tool integration ● Trial generation and field map improvements - physical field map upload, field map viewer with heatmap and improved randomization ● Incorporation of treatment and factors ● Seed inventory (tracking seedlots) ● Trial comparison tool ● Graphical filtering tool ● Progeny and accession usage page ● Manage Locations page improvements ● Trait post-composing ● New trial and traits search page ● Database direct phenotyping ● ANOVA analysis for trials ● BrAPI support	● Improve how Genomic predictions are managed – store metadata about predictions, store prediction results in the database ● Improved genotyping trials ● Improved quality checks and manual removal of low quality plots from data ● GOBII backend for genotyping data ● Improved genotype search ● More Brapification of tools ● Improved handling and tracking of "samples" ● Interfacing drone data and AI systems with support of geotagged plots and plants ● Farm-based trials & questionnaires ● Post material release tracking ● NIRS support ● Support for OAuth 2.0 authentication

[4] https://cassavabase.org/

Lukas noted that Cassavabase can be improved if the following challenges are addressed: obtain great collection of breeding data from breeding centers - more data needed from other domains of the project; expand use to new project partners; include participatory trials; and adapt to new genotyping protocols.

3.3.4 Reliable Rapid Genotyping

Ramu Punna from Cornell University mentioned that the next steps will focus on onsite genotyping (*Figure 9*). The main messages from this presentation were that:

- Even multiple genotyping options are available, DArTseqLD – as immediate solution
- Quick and inexpensive DNA extraction methods will be available soon
- 6 – 8 weeks turnaround time (if good planning is done)
- Genotyping services will be available soon through the vendors like Intertek, DArTseq
- Key element in using skim sequence technologies is PHG, which is a bioinformatics pipeline to call genotypes from any kind of skim sequences like GBS, Nextera, DArTseq, Nanopore, rAmpSeq and rhAmpSeq.

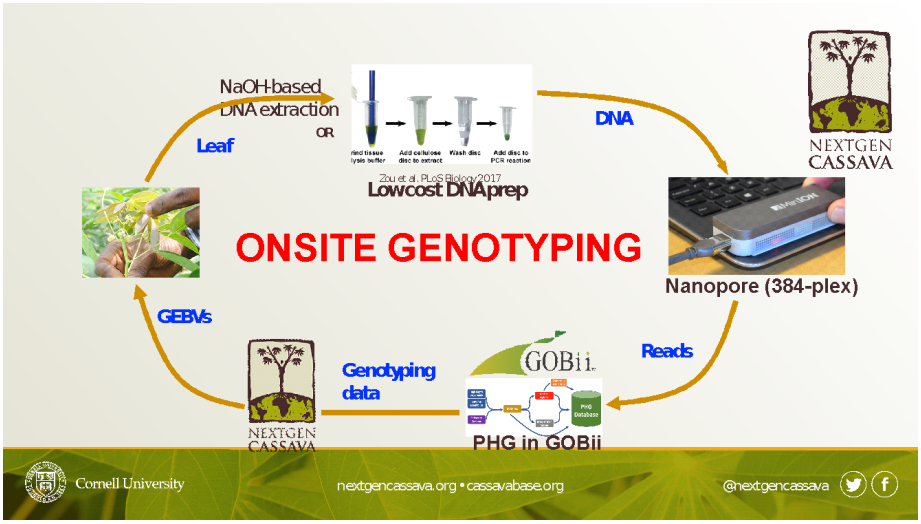

Figure 9: Next Steps in Onsite-genotyping

Ramu indicated that, in the work-planning sessions, they were keenly looking for insights on:

- How to sample tissues for genotyping – guidelines and genotyping method
- Planning the work and execution
- Bioinformatics pipeline
- Capacity building – PHG training.

3.4 Session Six: Roadmaps and Work-Planning IV

At the beginning of Day 3, it was noted through participants' reflections that the main emerging issues from the work-planning sessions were:

- How to get germplasm materials through sharing in different places
- Providing/establishing a mechanism to ensure ongoing communication between different teams in the overall project
- Need for a session/platform (both formal and informal interaction processes) to synchronize plans of different projects – e.g. online platforms such as zoom and slack
- Need to identify a set of traits that are critical/high priority for the program.

The roadmap presentations and collaborators' insights in this session are discussed below.

3.4.1 TARI Cassava Improvement

Heneriko Kulembeka from the Tanzania Agricultural Research Institute (TARI) outlined plans for Phase II as:

- Germplasm acquisition and maintenance
- Continue testing the GS of training population
- Optimization of flowering and seed set
- Integration of phenotyping tools like NIRs into breeding programs
- Working with survey division to implement on-farm/gender responsive activities
- Capacity building - training of MSc and PhD students, training on Cassavabase, training on phenotyping tools, training on flowering and environment characterizations, training/workshop on breeding schemes, training/workshop on statistical tools and process maps, and quality controls.

The key talking points for extended work-planning were identified as:

- How do you run/implement 1 or 2 year cycle?
- How do you make crosses (cross combination) for GS?
- Validation of flowering protocol
- PVC on farm trials;
- How to use NIRS; calibration and validation
- Optimization of designs and processes
- Fast tracking initial evaluation from botanical seed to seedling nursery to CET.

Participants noted in the plenary that it is important to consider cost implications and budget for activities and sites when designing breeding programs.

3.4.2 Quality Management to Improve NextGen Cassava Breeding

Marnin Wolfe highlighted the role of quality champions in developing and implementing quality management system (QMS) in the breeding process. Quality of the data depends on the weakest points, hence the need to focus on strengthening them especially the quality of phenotypic data. This calls for investments to build capacity of people working in quality data generation – scheduling of this is essential.

The QMS is an iterative system comprising quality assurance, quality control and quality management (*Figure 10*).

Figure 10: Quality Management System

3.4.3 Participatory Evaluation

The aim of this project is to conduct participatory trials and processing as social action research that considers the preferences of different men and women. *Bela Teeken* reported that the main activities carried out in and those planned for the next phase are:

- Breeding and evaluation with participants of the baby trials at 1, 3, 6 and 9 months - general scores and reasons for scoring (**ongoing initial analysis presented)**
- In-depth questionnaire on the age of the plant at harvest in relation to product quality **(finished ongoing analysis)**
- In-depth life history questionnaire to determine positionality of participants and their spouses **(almost completed, analysis started)**
- Focus Group Discussions with participants in relation to baby trial evaluations: agronomic preferences **(scheduled for March 2018)**
- Participatory processing of baby trial material into food products and ranking of varieties at each step **(scheduled in May 2018)**
- Sensory evaluation with different social groups (including the participants) based on material from the mother trial; develop *gari* descriptors **(scheduled in May-June 2018: very detailed protocol in development)**
- Physio-chemical and food science analysis on the roots and food products from the trials **(scheduled in May-June 2018: very detailed protocol in development**).

The main highlights/lessons from this project are:

- Diverse, highly motivated participants maintained high quality trials
    - Task group selection and self-selection worked

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    - Targeting minority groups enhanced diversity
    - There however is a difference in **motivation** of the participants: degree of involvement in cassava production/processing influences motivation.
    - A task group approach recruits more knowledgeable participants and therefore yields concrete insights on traits that breeders can work on.
- NextGen material is competitive with local and common farmer varieties (two rounds of agronomic evaluation for suitability by farmers)
- Acknowledging participants as peers and research partners triggered motivation and curiosity.

The key points for discussion in the work-planning sessions were identified as:

- Linking farmer groups with pre- release evaluation trials
- Limited results from verbal consultation necessitates on-farm evaluation - examining choices gives more direct information on traits and relative importance
- How do we motivate people to participate?

3.4.4 Update from Makerere University

Paul Gibson highlighted how the Makerere University Regional Centre for Crop Improvement (MaRCCI) – a World Bank supported Centre of Excellence trains and mentors young scientists in plant breeding and seed systems. He noted that in Phase I of the NextGen program, 2 PhD students have been trained in Purdue University and Michigan State University; and 9 Msc students from Kenya, Uganda, Rwanda, South Sudan and Tanzania had been trained at MaRCCI. He observed that the key benefits of the training are: valuable breeding material generated and characterized, and information generated to help in improved breeding strategies. Going forward, *Paul* indicated that 3 new Msc students have been selected in 2018 to be supported in collaboration with NaCRRI, NRCRI and TARI. It was noted in the plenary that such co-funding approaches involving multiple donors should be explored further to enhance the sustainability of the training.

3.4.5 Sharing of Insights by Collaborators

3.4.5.1 Examples of Participatory Evaluation: On-farm Testing at Scale

Jacob van Etten from Bioversity International noted that on-farm trials help to: test varieties directly in target environments, test varieties against farmer preferences, expose farmers to a range of varieties for diffusion and generate adequate variety recommendations for extension. Doing the trials at scale helps to solve the problems of: high costs, low number of on-farm trials/limited scale, low data quality in spite of substantial effort and limited learning from on-farm trials. *Jacob* explained that in participatory evaluation, the focus is on solution-direction approach that entails:

- Variety evaluation in the hands of farmers – cost reduction
- Farmers volunteering as “citizen scientists” – invert incentives
- Rethinking the statistics – should work for farmer observation
- Making it extremely simple – little supervision and training
- Going digital – reduce errors, staff needs, ensure feedback

He observed that the 'Wisdom of crowds' concept hypothesized by Galton (1907) works in participatory evaluations to enhance reliability and validity of on-farm testing (*Figure 11*).

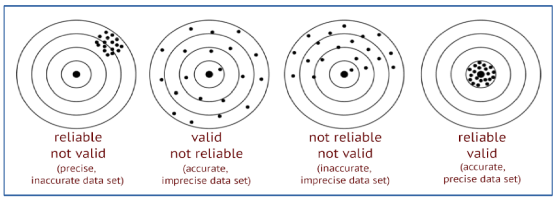

Figure 11: Wisdom of Crowds in Participatory Evaluation

He noted that some achievements from participatory on-farm trials include training over 20,017 wheat and rice farmers in India (2013-2017) and covering 60,000 farmers through the national extension system in Ethiopia.
In the plenary, participants were concerned about the level of education that farmers need to be able to collect simple data on their breeding practices. Further, it was noted that the triad ranking approach (best, worst and median) should be adopted at the farm-level.

3.4.5.2 West African Virus Epidemiology (WAVE) Project

Justin Pita explained that the WAVE project aims to achieve disease free crops for food and income security for all Africa by increasing the productivity and sustainability of tuber crops in West and Central Africa through improved understanding and coordinated management of virus disease threats. He emphasized the need to collaborate by all stakeholders – multidisciplinary approach in managing CBSD disease rectangle (*Figure 12*).

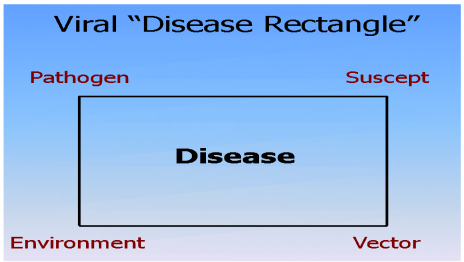

Figure 12: CBSD Viral Rectangle

Justin explained the WAVE works in collaboration with both internal and external partners by sharing roles and responsibilities (*Figure 13*).

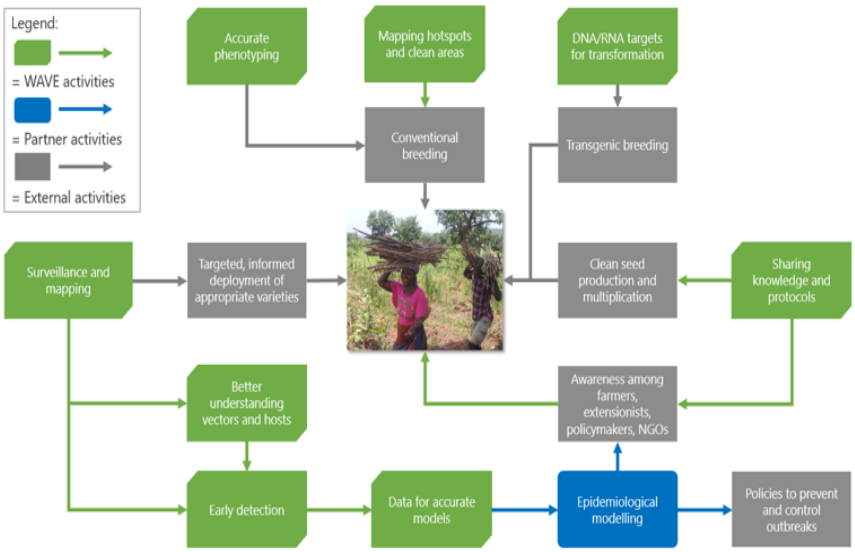

Figure 13: WAVE Operational Approach

He noted that national and regional capacities to respond to cassava virus threats have been improved through establishing and equipping high-tech laboratories in the partner country institutions. Strong ties with national and local leaders have fostered an exceptional level of buy-in, for example: local emirs in northern Nigeria have joined the project and will play a role in future disease control efforts and, Côte d'Ivoire's Minister of Higher Education and Scientific Research chaired a WAVE awareness campaign on cassava disease. In addition, WAVE has led to better understanding of vectors - surveys have shown conclusively that cassava mosaic disease (CMD) in West Africa does not correlate with whitefly populations, as in other regions, but primarily spreads through cuttings. This indicates the importance of providing virus-free planting materials.

Moving forward, *Justin* noted that WAVE needs to collaborate with other projects on the following aspects:

- NextGen - pre-emptive breeding (Uganda), Resistance virus vs Resistance disease, Genotyping, DNA fingerprinting in routine workflow (Guinea, Sierra Leone, Liberia, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Burkina Faso, Cameroon, Gabon, DRC) and naming convention.

- RTBFoods - example of Variety Bocou-1.

It was observed that there is need to lay foundations for common guidelines for engaging breeders in the project involving virologists.

3.4.5.3 Cassava Disease Diagnostics Project

Joseph Ndunguru from Mikocheni Agricultural Research Institute (MARI) in Tanzania highlighted the key achievements made so far to be: capacity building of scientists/teams working in national programs; improved disease surveillance; identification and characterization of emerging viruses; development and validation of diagnostic tools; training of students - MSc and PhD on various scientific skills; establishment and upgrading of research facilities especially laboratories in partner institutions and; improved farmers' access to clean material that increased their incomes. He emphasized that the key to success depends on linking/working with farmers well. *Joseph* noted that just like mixed birds fly in V-shape (*Figure 14*) to gather momentum for collective energy – capturing the power of diversity is crucial for team work to succeed.

Figure 14: Harnessing Diverse Strengths for Team Success

3.4.5.4 High-throughput Cassava Phenotyping

Anna van Doorn from Forschungszentrum Julich in Germany noted that due to the considerable fluctuations in environmental conditions on different temporal and spatial scales, it is important to consider quality and cost implications when working with genotype-environment-management (GEM) nexus.

3.4.5.5 Working with other BMGF Investments

Jim Lorenzen explained that the BMGF supports initiatives that help to address global challenges in smallholder agriculture – low productivity, low profitability, system and policy failures, and food systems in order to provide adequate nutrition to farmers. The ultimate aim is to advance agricultural transformation (for instance, by increasing access to safe and nutrient-rich foods by poorer households) in order to improve rural economies and reduce poverty. The BMGF supports various cassava projects focusing on the following areas led by different institutions:

- *Crop improvement*
  - Next Generation cassava breeding - DFID-DF
  - Screening new sources of CBSD resistance - LI-DSMZ
  - Reducing genetic load in cassava - CU
  - Breeding RTB products for end user preferences - CIRAD
  - Doubled haploid breeding for cassava enhancement, Phase II; CIAT
  - High throughput phenotyping early stage root bulking in cassava using ground penetrating radar - NSF BREAD
- *Crop health*
  - Enabling research tools for cassava and yam virologists and breeders - NRI
  - CMD susceptibility and resistance: translation from arabidopsis to cassava - NCSU
  - Cassava diagnostics research program Phase II - DFID – DF, MARI
  - WAVE for root and tuber crops - DFID – DF, UFHB
  - NextGen Phytosanitation: rapid elimination of viruses from RTB plants for crop improvement and seed systems - CIP
  - African Cassava Whitefly: outbreak, causes and sustainable Solutions - NRI
- *Seed and crop management*
  - Building an economically sustainable, integrated seed system for cassava in Nigeria - RTB-CIP
  - BEST Cassava: building an economically-sustainable seed system in Tanzania for cassava - MEDA
  - Developing a superior cassava seed piece - SFSA
  - Cassava monitoring survey for Nigeria (CMS) - IITA
  - Sustainable weed management technologies for cassava systems in Nigeria - IITA
  - ACAI: African cassava agronomy initiative - IITA
  - Cassava Adding Value for Africa Phase II (CAVA II) - NRI
- *Biotechnology*
  - VIRCA Plus: Virus Resistant Cassava for Africa plus Iron and Zinc Enhancement - Danforth Center
  - Metabolic Engineering of Carbon Pathways to Enhance Yield of Root and Tuber Crop - FA-UEN
  - Targeted Epigenetic Silencing of Cassava Disease Susceptibility - UCLA
  - HT Cassava: Conventional Mutagenesis; ETH. HT Cassava: Targeted Mutagenesis; Cibus. HT Cassava: Targeted Genome Editing - UM
  - RIPE: Realizing Increased Photosynthetic Efficiency for Sustainable Increases in Crop Yield (DFID/FFAR-DF) – UIUC.

4. NEXTGEN CASSAVA PHASE II INAUGURATION CEREMONY

The NextGen Cassava *Phase II* inauguration ceremony was held on Thursday 22nd February 2018 from 9.00am to 12.00noon in the Grand Ocean meeting room at Ramada Resort, Dar es Salaam, Tanzania. The inauguration program is shown in *Appendix 3*. The NextGen Project Manager – *Chiedozie Egesi* opened the session and invited *Joseph Ndunguru* from MARI, who welcomed participants to the inauguration event. The inauguration presentations and speeches are summarized below.

4.1 NextGen Cassava in Brief

On behalf of the NextGen Project, *Ronnie Coffman* made the inauguration remarks. His speech is reported verbatim in *Appendix 4*. Some of the key points from Ronnie's presentation were:

- NextGen project exemplifies successful partnerships in agricultural development
- Investments in improving resilience and adoption of new varieties of climate-smart cassava is key to addressing poverty and hunger in Africa
- Deliberate focus and commitment in building human and technical capacity for plant breeding are important steps towards sustainability, and is part of the investments by the project
- Consider end-users' needs in Phase II work:
  - Gender dynamics – different needs of men, women and marginalized groups
  - Multiple uses of cassava – food, feed, markets
  - Region-specific needs and agro-ecological conditions
- Enhance participatory needs assessment, breeding and evaluation to tap local knowledge
- Promote continuous learning and sharing of new methods, tools and databases by researchers and other stakeholders.

4.2 Variety Release and Seed System Regulation in Tanzania

Levini Msimbira from TOSCI highlighted the seed laws and regulations on variety release in Tanzania. He explained that TOSCI carries out variety evaluation by conducting distinctiveness, uniformity and stability (DUS) tests, national variety performance trials (NPT) and pre- and post-control tests. He noted that in terms of variety release and registration, the amended Seed Regulations Act 2017 (4) states that:

- "No variety shall be released in Tanzania unless it has passed DUS test, evaluated through the NPT and recommended for release by the National Seed Committee, except for vegetable variety which may be released after it has passed DUS test"
- Tanzania may accept DUS test result from a recognized authority or organization of any country which is in agreement on seed regulations and/or quality control."

The variety testing and registration process is summarized in *Figure 15*.

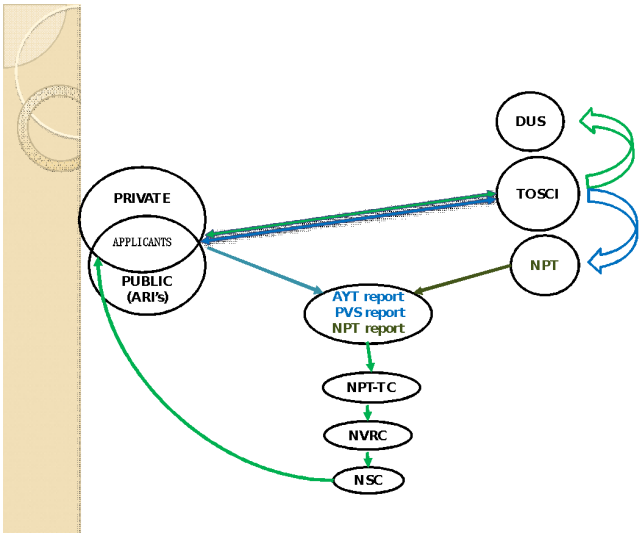

Figure 15: Summary of Variety Testing and Registration Process in Tanzania

There are 2 seed systems in Tanzania:

- *Semi-formal seed system*, is also known as Quality Declared Seed (QDS) production
  - Category of seed produced by farmers/NGOs
  - Administered by local governments
  - Authorized inspectors are responsible for quality control
  - Seed quality control mostly vested to farmers
- *Formal seed system*
  - All components of seed industry exist which include:
  - Agricultural research centers
  - Seed companies
  - Seed certification authority
  - Promotion and advisory services
  - All components work together as team

Root crops certification covers cassava, sweet potato and round potato. Cassava seed certification in Tanzania was started in 2013. Together with stakeholders, TOSCI has developed cassava seed certification standards and modalities of certification which are approved by the Ministry of Agriculture, incorporated into the Seeds Regulations and gazetted.

The following issues were raised in the subsequent plenary discussions:

- It was noted that a minimum of 2 seasons and 3 recognized sites are needed in the variety release process

- It is important to clarify the role of TOSCI and farmer participation from diverse backgrounds and locations before variety release
- Even if varieties are released in a neighboring country, they must be retested following harmonized regulations for 1 season they enter Tanzania. Where there is no set criteria, approval from known institutions must be obtained to verify the products before release
- It is important to consider implications of climate change on cassava breeding – emergence of new diseases and their spread, resistance patterns, post-harvest losses and costs
- Supporting the role of cooperatives and farmer associations in ensuring clean seed system – this can be done by use of cassava seed entrepreneurs linking farmers, agro-dealers, quality and certification officials and researchers at IITA and NARs
- Make quality seed multiplication an economic process where farmers see incentives to continue beyond project duration
- Accessibility of clean seed is still a challenge to farmers. Also motivation for farmers to change from their local variety is still a challenge – incorporate what farmers prefer in the breeding process.

4.3 Cassava Breeding and Value Chains Development in Tanzania

Geoffrey Mkamilo gave a brief presentation on the status of cassava breeding in Tanzania. The breeding priorities are: root yield, disease and pest resistance, value addition and nutrition, end user preferences
He informed participants that there are a number of on-going cassava projects:

- Building an Economically Sustainable Seed System for Cassava in Tanzania (BEST Cassava)- led by MEDA
- African Cassava Agronomy Initiative (ACAI) - led by IITA
- Cassava Adding Value for Africa - led by NRI
- Next generation Cassava breeding - led by Cornell University

4.4 Official Launch of NextGen Phase II

The NextGen *Phase II* was officially launched by *Hussein Mansoor*, Director for Research and Development, Ministry of Agriculture in Tanzania. His speech is in *Appendix 5*. The key messages are summarized here:

- NextGen cassava project is an important investment for the farmers in partner countries; Nigeria, Tanzania and Uganda
- Phase II of the project can help to link upstream and downstream value chains for agricultural transformation
- Potential for industrialization and processing of cassava in Africa requires scientific innovations
- Breeders should explore how to produce cassava varieties that have high starch content for industrial use
- Strong partnerships are needed to address low agricultural productivity.

5. THE EPAC CHALLENGE

In this session, the External Program Advisory Committee (EPAC) presented some challenges which they expected the NextGen project teams to reflect on as they planned their activities for *Phase II*. *Chiedozie* introduced the session by highlighting what NextGen does in summary as:

- Improve cassava through breeding cycles that involve generating and identifying improved progeny that we take through to release
- Improve the understanding of the gender-responsive product profiles desired by end users through communication with stakeholders
- Improve the ability to deliver higher-valued varieties rapidly and efficiently by technological advance driven by research.
-

Chiedozie noted that the NextGen Cassava program is managed by collaboration of 3 key divisions: communication, breeding and research, with two-way feedback mechanism between different partners (*Figure 16*).

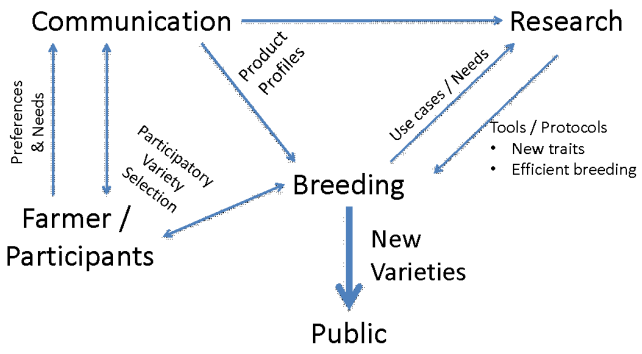

Figure 16: Three Divisions Management of NextGen

The EPAC team (*Ben Hayes*, *Carlos Iglesias*, *David Meyer*, *Steve Rounsley* and *Maria Andrade*) presented some challenges/posed some questions that impact on the project. These are:

- Are we getting the right varieties out and are they reaching farmers in good time for planting?
- What are the big things we are creating in *Phase II*? – quick variety release and reaching farmers
- How do we ensure sustainability of what we do?
- How will success look like – farmers bragging about quality, timeliness of varieties released; capacity building and being used well or what?
- What do we do to be successful?

- Sense of urgency by students to complete their studies and move NextGen ahead
- What is your role in achieving common vision and mission?
- Managing and coordinating the complexity of the NextGen Cassava program – many countries, collaborators and research program
- Need for clear communication strategy – vertical/horizontal, communication for visibility to influence policy – need rules and common language in institutions to ensure everyone understands what you are doing.

Following a brief plenary discussion the challenges were summarized into four key areas: **Sustainability, CBSD, vision and team work**. The facilitator then asked the participants to discuss at the table groups and report on the possible strategies to address each challenge area. The specific task for the group discussions were:

- What steps can we take to ensure sustainability of cassava breeding programs in Africa?
- What steps would you take to act as one team?
- Its 2023, *Phase II* is winding down. CBSD has arrived in Nigeria, and 40% of farmers in the country are affected. What do you wish you had done in 2018?
- Come up with a **vision statement** for NextGen phase 2 that is shorter than 9 words.
- Each group to report its feedback on meta cards – **sustainability** (white cards); **team work** (blue cards); **vision** (green) and; **CBSD** (pink cards).

The feedback from the groups is presented in *Table 7*.

Table 7: Group Feedback on how to Address EPAC Challenge Areas

Challenge	Actions
Sustainability	***Relevance to farmers*** ● Useful germplasm with "*must have*" traits e.g. CBSD resistance that warrant future success of breeding program ● Understand the socio-economic factors that drive the demand for cassava ● Delivery of good useful products recognized by farmers and policy makers ● Research which produce varieties which are adopted by farmers ● Farmer buy-in ***National ownership (and supportive policies)*** ● Engagement with policy makers and other stakeholders to gain buy-in and support x 3 ● Integration of cassava breeding into national programs ● Efficient and well-functioning breeding programs ● Well trained breeders with broad knowledge and competencies, well facilitated ● Engage with policy makers and other stakeholders to gain support and buy-in ● Diversification of investor/donor portfolio ● Locally driven innovations ***Reliable/stable resourcing/financing*** ● Identify potential alternative sources of funding for activities ● Strengthening our collaborators/networking

	● Germplasm exchange among partners ***Private sector engagement (can be combined with relevance under 'Demand-led R&D'?)*** ● Integrate cassava breeding into commercially driven, private sector systems ● Produce marketable cassava varieties ● Breeding system optimization ● Feedback system from the farmers/tech development teams: improve multi-way communications to achieve this ***Building local capacity*** ● Enhanced breeding infrastructure and human capacity ● Plans to maintain the infrastructure e.g. breeders, building ● Training breeders/field workers on short courses ● Employing students after training them ● Protocols/resource generated be made available for reference e.g. SOPs
Team	***Role Clarity*** ● Clearly define tasks, responsibilities so everyone knows what they are expected to do, and they expect others to do ● Boots on the ground and in the lab – visit other sites to know what is going on in each team ● Understand how team's work fits into overall project ● Ownership of well-defined vision ***Mutual trust and respect*** ● Practice respect for expertise and views without relying on formal hierarchy ● Mutual trust and respect ***Policies*** ● Policies, and procedures for key sticking points ***Communication*** ● Have well-defined communication strategy ● Common communication platform fully adopted and regularly used by all staff across all levels especially between African institutions – to improve communication ● Communicate regularly to ensure we share the same vision and work to the same goal ● Appreciate and express it: let others know when you appreciate their work/contributions ● Staff visits/exchange ● Transparent communication ● Regular meetings ***Willingness and Actions that support other teams/members*** ● Willingness to help others ● Data sharing ● Contribute: making contributions to the project as much as you are able to
Vision	***Four Candidates*** ● *Farmers empowered by innovative, sustainable cassava breeding* ● *Sustainable, transformative, demand-driven cassava breeding* ● *Super cassava varieties for producers and consumers in Africa* ● *Empowering farmers through improved cassava*

	Project Leadership to use these as basis for developing NextGen Vision
CBSD	***Breeding*** ● Collaborate with VIRCA ● Validate forward markers ● Plantlets west to East Africa testing ● West to East Africa seed progeny testing ● In 2018 we implemented a corporate strategy to breed and deliver CBSD resistant varieties in 4 years ● Identify several sources/mechanisms of resistance to CBSD ● Pre-emptive breeding ● Every released line (to be) CBSD resistant ***Seed systems and Management*** ● Efficient seed systems in West Africa for delivery ● Better understanding of the CBSD infection pathway ● Develop clean seed system infrastructure ● Collaborations and leveraging on research activities on CBSD and whitefly in Africa ● Germplasm exchange under strict phytosanitary compliance ***Capacity building and awareness*** ● Training and capacity building ● Capacity building for CBSD in Nigeria ● Awareness and policy ● Sensitizing farmers about CBSD

6. NEXT STEPS

Chiedozie informed participants that in *Phase II*, the NextGen Cassava program will facilitate the achievement of the following:

- Optimal breeding schemes, research integration and demand-led breeding.
- Outreach to national breeding programs enabling them to envision and take steps toward similar effective breeding organization.
- Release of improved varieties that meet criteria for quality acceptability and sustainably improve farmer livelihoods.
- Identification and quantification of breeding goals based on survey and adoption evidence from smallholder farmers.
- Broaden diversity of breeding populations to ensure future genetic gains, and greater understanding of the genetic architecture of traits to increase the efficiency of those gains.

A considerable amount of time in Day 5 of the meeting was spent in two workshops and open space discussions between various project teams. Participants were asked to choose which workshop they were interested in attending: PhenoApps/Cassavabase or RTBFoods. The PhenoApps workshop involved training on contents of and how to use the Cassavabase system. In the RTBFoods workshop, deliberations focused on how to improve collaborations and research within and between various projects working on roots, tubers and banana crops. The main issues identified as potential next steps in the RTBFoods discussions are:

- Validation of data across sites: multi-stakeholder cooperation
- Improving precision of tests: how to reduce delays between extraction of cassava samples and actual experiments on cyanide levels
- Getting adequate sample sizes to improve robustness of analysis/experiments and allow replicability of results
- Selection of cassava clones based on good cooking quality: the need to consider this in future trials was emphasized
- Develop a video protocol of RTB foods, for example for boiling cassava
- Linking RTB Foods and NextGen data for ease of sharing, dissemination/use and contribution by diverse teams and insights
- Diversify type of processing by target markets
- Enhance farmer and team trainings.

APPENDICES

Appendix 1: List of Participants

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Appendix 2: Workshop Agenda

Sunday February 18, 2018		
Time	**Agenda Item**	**Responsible**
Whole Day	**Arrivals**	
1600h	**Planning Meeting (*Venue: Main Meeting Room*)**	**Process Steering Group**
1900h	**Cocktail reception *(Ramada Resort)***	
Monday, Feb 19, 2018		
Time	**Agenda Item**	**Responsible**
0700h	**Breakfast**	*All [EPAC Breakfast at same time]*
	Session 1: Opening, Introductions and Process	
0830h	Welcome Remarks	*Kiddo Mtunda and Chiedozie Egesi*
0845h	Introductions, objectives, agenda and process for the week	*Ed Rege*
	Session 2: Scene-Setting	
0940h	Accomplishments of Phase I (20 mins)	*Chiedozie Egesi, NextGen Cassava*
1000h	***Coffee/Tea Break & Group Photo***	
1030h	**Session 2: Scene-Setting (cont'd)**	
1100h	Developments to inform work-planning (30 mins)	*Jean-Luc Jannink, USDA-ARS*
	Interactive sharing: Interactive Poster Session Format – **Big Picture**) – to facilitate speedy x-team sharing among the 14 Roadmap Teams (60 mins)	*All*
	Collaborators' Corner: Rapid reliable CBSD titre evaluation (20 mins)	*Stephan Winter, Leibniz Institute Germany*

	Collaborators' Corner: Excellence in Breeding (20 mins)	*Enghwa Ng, ICRISAT, Hyderabad, India*
1300h	***Lunch Break***	
1400h	**Session 3: Roadmaps and work-planning**	
	Roadmap: IITA Cassava improvement (20 mins)	*Ismail Rabbi, IITA Nigeria*
	Roadmap: Embrapa (20 mins)	*Eder de Oliveira/Alfredo Alves, Embrapa Brazil*
	Roadmap: Optimization(20 mins)	*Jean-Luc Jannink*
	Roadmap: Germplasm exchange (20 mins)	*Peter Kulakow, IITA Nigeria*
1540h	***Coffee/Tea Break***	
1600h	**Extended work-planning** (*60 mins concurrent sessions – participants can move out/in to different sessions after 30 mins) – Focus of this session is on responding to the questions/needs of other teams!*	*Team Leads (as above)* *[Note: I addition, there will be an overall Support Person supporting these sessions every day]*
1700h	**Focused work-planning** session within teams *(60 mins concurrent sessions)*	*Team Leads (as above)* *[Note: As above]*
1800h	Close	
1900h	**Open dinner**	

Tuesday Feb 20, 2018		
Time	**Agenda Item**	**Responsible**
0700h	**Breakfast**	*All*
0800h	**Session 4: Roadmap presentations & work-planning II**	
	Reflections onprevious work-planning sessions (20 mins)	*Ed Rege*
	Roadmap: NaCRRI cassava improvement (20 mins)	*Robert Kawuki, NaCRRI Uganda*
	Roadmap: Effective crossing (20 mins)	*Tim Setter, Cornell University*
	Roadmap: Survey in Phase II (20 mins)	*Hale Tufan, NextGen Cassava*

	Roadmap: High Throughput Pest and Disease phenotyping (20 mins)	*Ernest Mwebaze, Makerere University, Uganda*
	Collaborators' Corner: RTBFoods project (20 mins)	*Dominique Dufour, CIRAD, Montpellier*
1000h	***Coffee/Tea Break***	
1030h	**Collaborators' Corner: African Cassava Whitefly project (20 mins)**	*John Colvin, Natural Resources Institute, UK*
1050h	**Extended work-planning** (*60 mins concurrent sessions)*	*Team Leads (as above)*
1150h	**Focused work-planning**(*70 mins concurrent sessions)*	*Team Leads (as above)*
1300h	***Lunch Break***	
1400h	**Session 5: Roadmap presentations and work-planning III**	
	Reflections on previous work-planning sessions (20 mins)	*Ed Rege*
	Roadmap: NRCRI cassava improvement (20 mins)	*Joseph Onyeka, NRCRI Nigeria*
	Roadmap: CIAT (20 mins)	*Hernan Ceballos/Luis Augusto Becerra, CIAT Colombia*
	Roadmap: Future of *Cassavabase*(20 mins)	*Lukas Mueller, BTI*
	Roadmap: Reliable rapid genotyping (20 mins)	*RamuPunna, Ed Buckler Lab, Cornell University*
1540h	***Coffee/Tea Break***	
1600h	**Extended work-planning** (*60 mins concurrent sessions)*	*Team Leads (as above)*
1700h	**Focused work-planning** (*60 mins concurrent sessions)*	*Team Leads (as above)*
1800h	**Evening event: "Knowledge Fair" poster session/cocktail**	*Canaan Boyer, Cornell University*
1930h	**Open dinner**	

Wednesday Feb 21, 2018		
Time	**Agenda Item**	**Responsible**
0700h	**Breakfast**	*All*
0800h	**Session 6: Roadmap presentations & work-planning IV**	
	Reflections on previous work-planning sessions (20 mins)	*Ed Rege*
	Roadmap: TARI cassava improvement (20 mins)	*HenerikoKulembeka/Kiddo Mtunda, TARI Tanzania*
	Roadmap: Participatory Evaluation (20 mins)	*Bela Teeken, IITA Nigeria*
	Roadmap: Quality Champions (20 mins)	*Marnin Wolfe, Cornell University*
	Collaborators' Corner: Examples of participatory evaluation (20 mins)	*Jacob van Etten, Bioversity International, Costa Rica*
1000h	***Coffee/Tea Break***	
1030h	**Extended work-planning***(60 mins concurrent sessions)*	*Team Leads (as above)*
1130h	**Focused work-planning***(60 mins concurrent sessions)*	*Team Leads (as above)*
1230h	**Update from Makerere University (10 mins)**	*Paul Gibson, Makerere University*
	Collaborators' Corner: West African Virus Epidemiology project (20 mins)	*Justin Pita, WAVE, Côte d'Ivoire*
1300h	***Lunch Break***	
1400h	Reflections on previous work-planning sessions (20 mins)	*Ed Rege*
1420h	**Collaborators' Corner:**	
	Cassava Disease Diagnostics project (20 mins)	*Joseph Ndunguru, MARI Tanzania*

	High-Throughput Cassava Phenotyping (20 mins)	*Anna van Doorn, ForschungszentrumJülich, Germany*
	Working with other BMGF investments (20 mins)	*Jim Lorenzen, BMGF*
1520h	***Coffee/Tea Break***	
1550h	**Breakout Session *[Process and structure to be provided]***	
1700h	***Open space***	
1830h	**Evening event: EPAC/NextGen Leaders Meeting (Open dinner for the rest)**	
Thursday Feb 22, 2018		
Time	**Agenda Item**	**Responsible**
0700h	**Breakfast**	*All*
0830h	**Session 8: Phase II Inauguration Ceremony &Reception**	
	NextGen Project: Moving Forward	*Chiedozie Egesi, Jim Lorenzen, Ronnie Coffman*
0930h	Phase II Inauguration Ceremony	*See separate detailed program*
1130h	Group photo/Displays/Exhibition	
1200h	***Inauguration Luncheon***	
1500h	**Session 9: EPAC Challenge**	
	EPAC Challenge Talk (with Q&A at the end) (*30 mins total)*	*Ben Hayes, Carlos Iglesias, David Meyer, Steve Rounsley, Maria Andrade*
	Challenge discussions (NextGen community - in groups)	*Chiedozie Egesi and Jean-Luc Jannink*
1630h	***Coffee/Tea Break***	
1900h	**Evening Event: Official Dinner and Closing Ceremony, White Sands Hotel**	

Friday Feb 23, 2018			
Time	**Agenda Item**		**Responsible**
0700h	**Breakfast**		*All*
0830h	• PhenoApps/Cassavabase Workshop • RTBFoods NextGen Collaboration Workshop	Open space for work-planning & side meetings	*See separate program*
1200h	***Lunch Break***		
1330h	• PhenoApps/Cassavabase Workshop • RTBFoods NextGen Collaboration Workshop	Open space for work-planning & side meetings	*See separate program*
1800h	**Open dinner**		

Saturday Feb 24, 2018				
Time	**Agenda Item**			**Responsible**
0700h	**Breakfast**			*All*
0900h	Field trip – see separate detailed program	• PhenoApps/Cassavabase Workshop	Open space for work-planning & side meetings	*See separate program*
1200h		**Lunch**		
1330h	Field trip – see separate detailed program	• PhenoApps/Cassavabase Workshop	Open space for work-planning & side meetings	*See separate program*
1800h	**Farewell Dinner, Location TBD** **Departures**			

Appendix 3: NextGen Phase II Inauguration Program

Time	Activity	Responsible
0900	Ceremony opening	*Taj Liundi* – Master of Ceremony *Chiedozie Egesi* – Project Manager NextGen Cassava
0910	Welcome message	*Joseph Ndunguru* – Officer in charge, Mikocheni Agricultural Research Institute
0925	NextGen Cassava in brief	*Ronnie Coffman* – Principal Investigator, NextGen Cassava/Cornell University
0945	Goodwill messages	*Jim Lorenzen* – Senior Program Officer, BMGF *Victor Manyong* – Director R4D, IITA East Africa Hub (away on mission travel in Madagascar)
1010	Variety release procedures and seed system regulation of vegetatively propagated crops in Tanzania	*Levin Msimbiri* for *Patrick Ngwendiaji* – CEO, TOSCI
1025	Cassava breeding and value chains development in Tanzania	*Geoffrey Mkamilo* – Coordinator, Root and Tuber Crops Research, Tanzania
1045	Introduction of Hussein	*Joseph Ndunguru*
1050	Official launch of Phase II	*Mansoor Hussein* – Director of Research and Development, Ministry of Agriculture, Tanzania
1100	Group photographs/displays/exhibitions	
1200	Luncheon	

Appendix 4: Ronnie Coffman's Inauguration Speech

"I want to honor all protocols in my remarks today. In particular, I welcome the Honourable Director of Research and Development of the Ministry of Agriculture of Tanzania, Dr. *Mansoor Hussein*; Dr. *Betty Maeda*, Research and Production Advisor for USAID Tanzania; Dr. *Victor Manyong*, Director R4D, IITA East Africa Hub; and Mr. *Patrick Ngwendiaji*, CEO of the Tanzania Official Seed Certification Institute (TOSCI). I extend a warm welcome to the distinguished scientists and students from the Next Generation Cassava Breeding project. I am enormously proud of your dedication and the progress we have made together over the last 5 years. I also welcome members of the press.

Ladies and gentlemen, it is a privilege and an honour for me to be here in Dar es Salaam, in Tanzania, at our 6th annual meeting, to address you at the inauguration of *Phase II* of the NextGen Cassava Breeding project. Last year we were celebrating year 5 of NextGen and the 50th anniversary of the IITA. This year we are celebrating the launch of Phase II. Cornell University and the other partners involved in NextGen Cassava are proud to be among the many global collaborators working to generate the agricultural innovations needed to meet Africa's pressing challenges. The NextGen Cassava Breeding project, which is now in its 6th year, is a remarkable example of a successful partnership in agricultural development. NextGen works with 11 institutional partners across seven countries on three continents. I commend

Chiedozie Egesi, for his leadership, and the many, many scientists in the USA and in Africa who work on this project, many of whom are in this room. NextGen is a remarkable model for the kind of collaborative, open-source, shared-data networks that are needed to improve agricultural crops globally in the 21st century.

Let's take a few moments to publicly recognize the scientists from the various institutions — those of you who are able to successfully collaborate across scientific precepts, across cultures, and across oceans. As I name your institution, please stand. In Africa, NextGen collaborators include scientists from the IITA and NRCRI in Nigeria; WACCI in Ghana; NaCRRI and Makerere University in Uganda; and TARI. In South America, collaborators include Embrapa in Brazil and CIAT in Colombia. In the USA, collaborators are Cornell University (which leads the project), the BTI, the University of Hawaii and USDA-ARS. We are also very pleased to have present today representatives from NextGen-linked projects and institutions: the RTBFoods Project, ACWP, Excellence in Breeding, PhenoApps, New Sources of CBSD Resistance in Cassava, WAVE Project, Disease Diagnostics for Sustainable Cassava Productivity in Africa, Cassava Source Sink, NARO Uganda, and Bioversity International.

International and regional partnerships are an important element of sustainable development. In *Phase II*, NextGen researchers are reaching out to their counterparts in Ghana, Rwanda, Mozambique, Sierra Leone and the Democratic Republic of Congo to create a broader network of researchers who can work together to improve livelihoods and food security through a Community of Practice Partnership program.

I also want to thank the donors: the BMGF and UKaid who are visionary in their commitment to funding international development projects. The world is a much better place due to their generosity. The BMGF and UKaid understand the importance of agricultural development in the fight against poverty and hunger. And they understand the need to improve the world's staple crops to meet the biotic and abiotic stresses of the 21st century. They are making the critical investments necessary to fund the objectives of NextGen Cassava to improve the production, resilience and adoption of new varieties of climate-smart cassava and to build human and technical capacity for plant breeding in sub-Saharan Africa. Please stand, *Jim Lorenzen*, our dedicated NextGen program officer from the BMGF so we can thank you. Last but not least, I would also like to recognize the members of our External Project Advisory Committee: *Carlos Iglesias*, Syngenta; *David Meyer*, Dow AgroSciences; *Steve Rounsley*, Genus PLC; *Ben Hayes*, University of Queensland, who unfortunately could not join us this time; and I would like to give a special welcome to our newest committee member, *Maria Andrade*, Country Director of the International Potato Centre (CIP) in Mozambique. I would also like to remind the scientists and students here today that science is under siege in this day and age. Please speak up for the science you do and acknowledge donors, partners and supporting institutions every chance you get - in social media, PowerPoint presentations, papers, and when talking with the media.

NextGen Cassava and our donors are particularly committed to six of the United Nations Sustainable Development Goals (SDGs). Number 1, which is to end poverty; number 2, which is to end hunger; number 3, which is to promote good health and well-being; number 4, which is to promote quality education; number 5, which is Gender Equality and; number 17, which is in developing partnerships towards achieving the SDG goals - that countries and organizations must cooperate across international boundaries to create sustainable development projects.

Since 2012, partners in the NextGen multi-stakeholder partnership have been sharing knowledge,

expertise, technology and financial support. Cornell University is the lead institution. *Chiedozie Egesi*, as project manager and myself, as principal investigator, thank you for all you have done and hope you are energized to continue. In this meeting you have been establishing "road maps" for the next 5 years, discussing how to better coordinate and leverage the exchange of germplasm and genotypic and phenotypic data from each other towards our ultimate goal, which is the delivery and adoption of improved varieties of cassava by farmers and end-users who are men – but also, very importantly — women.

In *Phase I*, NextGen researchers have been using a state-of-the-art plant breeding approach known as genomic selection to improve cassava productivity, shorten breeding cycles, provide more accurate evaluation at the seedling stage, and give plant breeders the ability to evaluate a much larger number of clones without the need to plant them in the target environment. *Jean-Luc Jannink*, from the USDA-ARS, is the leader of this objective — and I would like to take a moment to recognize him for his visionary leadership of this objective. Another goal of *Phase I* was to make cassava genomic information publicly accessible on an open database. Cassava researchers all over the world can now compare results and improve breeding programs without duplicating efforts by using Cassavabase. And we can thank *Lukas Mueller* for his outstanding leadership there. We also have made progress in improving flowering, for which we thank *Tim Setter* and his team.

Going forward, I want us all to pay particular attention to the gender dynamics of this project. A key goal in *Phase II* is to identify traits important to a diverse range of users - including women and marginalized groups - and to engage farmers as research partners to breed new varieties that are adopted and equitably impactful. It is to everyone's benefit to hear women's voices and tap into their knowledge about product quality to breed better cassava for everyone.

In all breeding programs, we must avoid releasing new varieties that do not meet the needs of end-users. Whether the cassava is being used for home consumption, sold at market, or used for processing - ignoring traits valued by end-users limits varietal adoption and negates return on investment. Trait preferences are frequently region-specific, which makes it difficult for one breeding program to address all farmer and end-user needs. Also, some of these traits do not have robust phenotyping protocols, which can at times discourage breeders from evaluating and using them in selections. The Survey Division of NextGen - led by *Hale Tufan* of Cornell University - recognizes the need to work closely with multidisciplinary teams, public-private partnerships, and a diverse range of users and stakeholders to ensure the closest possible match between the developed varieties and demand. With her leadership, we have on-farm varietal evaluation trials mindful of diverse target groups, end-use and environments.

Interestingly enough, this emphasis on gender-responsive breeding in BMGF and UK aid-funded projects grew out of the Cornell-led Borlaug Global Rust Initiative, beginning in 2008, with our work on breeding rust-resistant wheat varieties in SSA. It led to an emphasis on gender in NextGen when it was launched in 2012, and further led to the establishment of Gender-responsive researchers equipped for agricultural transformation (GREAT), in 2014, under the leadership of Dr. *Tufan* and Dr. *Margaret Mangheni* of Makerere University. Some of you participated in the "GREAT Gender-responsive Roots Tubers and Banana Breeding" training in 2016-17 in Kampala. If you are here, please stand so we can recognize you and encourage your commitment.

And let's take a minute to talk about lingo here - when we talk about 'surveys' and 'decentralized participatory evaluation trials' and using 'a gender lens,' what we are really talking about is gender

equity. Researchers must talk but particularly ***LISTEN*** to men and especially women farmers and end-users, and address gender-based constraints in experiment design to determine what characteristics are most desirable.

Using the kind of statistical predictive analyses offered through genomic selection and the gender-responsive survey work, new varieties of cassava, which used to take a decade or more to develop, can be produced in as little as six years. Now, after 5 years, some of the best clones from this upstream work are in Uniform Yield Trials due to be released to farmers in the next two years. As a long-time plant breeder, I want to emphasize another aspect of the NextGen project. It is extremely important that we train the next generation of plant breeders. Without that important pipeline, long-term sustainable improvements in crop production will wither in the face of future challenges. I am very proud that NextGen has been working to educate the next generation of cassava breeders in Africa - men and women. NextGen provides education and training for Ph.D. students (some of whom are at Cornell and some of whom are at the WACCI), and additional Masters students who are being trained at Makerere University in Kampala. If any of you are here today, please stand so we can recognize you. This training pipeline increases the efficiency of breeding staple crops for African smallholder farmers.

In closing, let me congratulate you all on the inauguration of *Phase II* of the NextGen Cassava Breeding. Another five years will allow NextGen plant breeders and objective leaders to make more progress in delivering improved cassava varieties to smallholder farmers and end-users throughout SSA. Another five years will help us strengthen the long-term global sustainability of cassava — a crop important for food security and predicted to stand up to climate change and extended periods of drought or rain.

In closing, I would again like to recognize our donors, the BMGF and UKaid.

And I know *Chiedozie Egesi* and everyone in this room would join me in thanking our Tanzanian hosts - TARI and IITA - and the NextGen staff who have been working so hard to make this conference a success. As Norman Borlaug would say, keep up the good work!'

Appendix 5: Hussein Mansoor's Speech on Official Launch of the NextGen Phase II

'Representative from BMGF – Dr. *Jim Lorenzen*; Representative of UK's DFID; the NextGen Project Manager, Dr. *Chiedozie Egesi*; Other Next Generation Cassava Project Management team; the IITA Director for East Africa hub - Dr. Victor Manyong; representative from USAID; meeting organizers; members of the EPAC; renowned scientists; ladies and gentlemen: it gives me a great pleasure to officially welcome you all to *phase II* inauguration ceremony of a five years NextGen cassava project (2018-2023) aimed at increasing the rate of crop improvement using new technologies in Nigeria, Uganda and Tanzania, which is co-funded by BMGF and DFID and coordinated by the Cornell University.

In addition, to those who have travelled from out of the country, I first welcome you to our beautiful country. Holding this event in Tanzania marks another milestone for us as a major destination for international conferences. The PSG, the secretariat and the IITA administration worked hard to ensure we are all here this week and I take this opportunity to thank them for a job well done!

This event has brought together about 86 scientists from all over the world and development partners to discuss cassava crop in Africa. I have been informed that the Next Generation Cassava Breeding Project is a global consortium of partners aimed at increasing the rate of crop improvement using new technologies in Nigeria, Uganda and Tanzania. The project is working with Division of Research and

Development, Ministry of Agriculture to develop cassava varieties that will sustainably drive growth of the cassava sub-sector in industrial utilization as a means of helping farmers make best use of their crop values. I consider this a very important investment for the people of Tanzania, Nigeria and Uganda especially the farming community. Agriculture plays an important role in Tanzania's economy employing over 75% of the country's workforce and accounting for 25% of the national gross domestic product. In our development vision 2030, we recognize that the agriculture sector is one of the key drivers of our economic growth. In the second National Five Year Development Plan (2016/17-2020/21) and the Agricultural Sector Development Plan 2 (2016/17-2026/27) the government prioritizes agro-process in the economic development and Tanzania's 2025 vision of becoming middle income country. It is from this motive that we need to develop cassava varieties that are demand driven in terms of quality and quantity. I believe that through this second phase of NextGen, Tanzania can deliver to farmers' varieties that are suitable for the fresh use and for agro-processing value chains, hence linking the upstream and downstream value chains for the Agricultural transformation.

And similar to many African countries, while we recognize the importance of the agriculture sector, we continue to face many challenges. Despite having adequate land and a good climate, the production and productivity of major crops is still low. Farmers lack modern agricultural production skills and knowledge and do not have access to financial and other supportive services. Consequently, majority of the smallholder farmers continue to be poor and food security is threatened as well our efforts to build the economy.

These problems are compounded when it comes to the production of roots crops, which are versatile staples that can enable us to meet our food and nutrition security for the increasing population. Cassava crop produces more food per unit area of land than most crops including cereals. The crop is also drought tolerant and therefore we rely on it as our 'insurance' crop when our main staple, maize, fails in times of drought. Beyond this, root crops in Tanzania particularly cassava bring to resource-limited rural households much needed income to cover other essentials like medication, clothing, shelter, education among others. We can process the roots into flour for home consumption and even for industrial use such as in bakeries. The flour has great health properties as they are gluten free and have low glycemic Index and therefore suitable for people with diabetic. The potential for industrialization and processing of cassava in Africa in general and Tanzania in particular is vast and requires scientific innovations for transformation into a cash economy.

We also recognize an organization such as the IITA working with the Ministry to improve the nutritional profile of these crops through bio-fortification. We are in the process of evaluating and selecting yellow-fleshed cassava in Tanzania. In recent years, the cassava crop has been identified as one of the important economic drivers as it emerges and become an industrial cash crop. In Tanzania, we are seeing many factories interested in processing cassava into starch for industrial use. These will definitely provide ready market for the crop, therefore suitable varieties are needed for starch extraction. We hope that this project will take on board breeding cassava varieties that have high starch content for the industrial use.

But for us to tap into this potential, we have to address the many challenges we face in cassava production, as the yields are currently very low. For example the average cassava productivity in Tanzania is only six tons per hectare. This is well below the potential yield of at least 20t/ha for cassava. Low yields arise due to the fact that, majority of farmers use local preferred varieties with low yield, and

their susceptibility to major diseases and insect. These include Cassava green mites (CGM), CMD and CBSD. The two viral cassava diseases are the major threats to cassava production and productivity. These diseases are hard to control due to lack of access to clean planting materials of improved varieties by small holder farmers. The crops have poorly developed seed systems. Farmers rely on exchanging stem material with neighbours thus spreading diseases from one farm to the other.

Farmers also continue to use poor farming practices. They use little or no inputs such as fertilizers when it comes to roots production and little or no mechanization either. Production of root crops is labor intensive and yet we know that young people are running away from agriculture leaving behind aged farmers. They also suffer from high-post harvest losses – they spoil very easily and storage, transportation to markets and marketing area pose a challenge.

These challenges require a critical mass of scientists to tackle them. Therefore, during this week I urge you scientists from all over the world to interact with farmers and private sector, and learn as much as possible on what is going on so that we can find sustainable solutions to some of the challenges.

The Tanzania team is committed to contribute to the inputs, outputs and outcomes of the project for the benefit of the farmers in the country and beyond. To date agricultural transformation is on top of development agenda of the current government.

Let me register my sincere gratitude to our donors, the BMGF and UK's DFID for their generous support. And now it gives me great pleasure to declare the second phase of Next Generation Cassava project officially launched, and I wish you fruitful deliberations.'