MandiPlus Stakeholders' Workshop

Kampala-Uganda

September 20-21, 2018

MandiPlus

Workshop Report

Disclaimer

This report documents the MandiPlus Stakeholders' Workshop that was held from September 20-21, 2018 at the National Crops Resources Research Institute (NaCRRI) and Skyz Hotel in Kampala, Uganda. The report is not a thesis, but a documentation of the proceedings and outcomes of the workshop without interpretation. It serves as a reference document for MandiPlus project management and workshop participants by providing details of workshop proceedings reported as they were presented with slight or no modifications. The opinions expressed herein are those of workshop participants and do not reflect the views of the compiler—they are a compilation of participants' contributions.

Compilation

This report was compiled by Joshua Raymond Muhumuza from Uganda Biosciences Information Center (UBIC).

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List of Acronyms

ACWP	African Cassava Whitefly Project
ACT	Active Chemical Trace
AfrII	Africa Innovations Institute
BEST	Building an Economically Sustainable Seed System in Tanzania for Cassava
BMGF	Bill and Melinda Gates Foundation
CAMAP	Cassava Mechanisation and Agro-Processing Project
CBO	Community Based Organization
CBSD	Cassava Brown Streak Disease
CHAIN	Coalition for Health Agriculture and Income Networks
CIAT	International Center for Tropical Agriculture
CSE	Cassava Seed Entrepreneur
CSS	Cassava Seed System
CMD	Cassava Mosaic Disease
Embrapa	Brazilian Agricultural Research Corporation
FAO	Food and Agriculture Organization
GT4SP	Genomic Tools for Sweet Potato
IITA	International Institute for Tropical Agriculture
MAAIF	Ministry of Agriculture Animal Industry and Fisheries (Uganda)
MEDA	Mennonite Economic Development Associates
NaCRRI	National Crops Resources Research Institute (Uganda)
NARO	National Agricultural Research Organization (Uganda)
NAROCASS	NARO Cassava
NARS	National Agricultural Research System
NASE	Namulonge Selection
NBT	New Breeding Techniques
NextGen	Next Generation Cassava Breeding Project
NGO	Non-Governmental Organization
NRI	Natural Resources Institute
QDPM	Quality Declared Planting Materials
SAH	Semi-Autotrophic Hydroponics
SASHA	Sweetpotato Action for Security and Health in Africa
SFSA	Syngenta Foundation for Sustainable Agriculture
SHF	Small Holder Farmer
SOFI	State of Food Security and Nutrition (as used in FAO SOFI Report)
SSA	Sub-Saharan Africa
TARI	Tanzania Agricultural Research Institute
TOSCI	Tanzania Official Seed Certification Institute
VC	Value Chain
ZARDI	Zonal Agricultural Research and Development Institute

Introduction

Uganda's National Agricultural Research Organization (NARO) through the National Crops Resources Research Institute (NaCRRI) in collaboration with Embrapa and the Syngenta Foundation for Sustainable Agriculture has for the past three years been testing and validating the suitability of a cassava seed treatment technology—called MandiPlus—for African farmers.

MandiPlus technology involves coating every seed piece with a combination of protectants and stimulants. This technology enables producers to cut much shorter seed stakes, and thus significantly increase multiplication rates with an aim of developing a commercially sustainable delivery system for quality declared cassava planting material.

The project stakeholders' workshop held from September 20-21, 2018 in Uganda brought together participants from all partner institutions as well as external collaborators. The aim of the workshop was to take stock of progress made, share information and results of the project and assess the potential to integrate MandiPlus technology into existing cassava seed systems and identify gaps and opportunities for the technology.

Over the two days, workshop participants deliberated on key issues and shared thoughts on strategic next steps to take the MandiPlus technology "to the next level"—through developing clear plans for technology integration into the existing CSS and scaling to make it available for seed producers and farmers.

Workshop Participants at NaCRRI


MAIN
ENTRANCE

Day I

MandiPlus Exhibition at NaCRRI

Welcome Remarks

Titus Alicai - NaCRRI

Titus welcomed guests and invited them to make self-introductions. He appreciated guests for coming and led the workshop through the purpose, objectives, outputs and expected outcome of the workshop.

Purpose: Introduce the MandiPlus technology and project to a broader stakeholder audience, develop a vision and plan on how to optimally integrate novel seed treatment technologies in cassava seed systems.

Objectives:

1. Share information and results of the MandiPlus project; overall technology development, application, field validation, laboratory trails and cost benefit analysis
2. Assess the potential to integrate MandiPlus technology into existing cassava seed systems, identify gaps and opportunities and develop clear plans for integration and scaling

Outputs

- Outline and plan on integration of MandiPlus technology into the existing CSS in Uganda
- Partnerships for the validation and integration of the MandiPlus technology in cassava systems
- A research plan on how to address and eliminate identified bottlenecks and apply potential improvements to the overall technology

Outcome:

Partnerships and visions on how to take MandiPlus technology "to the next level" and to make it available for seed producers and farmers at scale.

Michael Robinson – Syngenta Foundation

Dominic briefed the workshop about the SFSA and its role to "create value for small holder farmers". The SFSA is a not-for-profit organization that focuses on supporting the productivity of small-scale farmers in developing countries around the world. The mission is to create value for resource-poor small farmers in such countries through innovation in sustainable agriculture and the activation of value chains.

He talked about the origin of the MandiPlus name which has its roots in the local Portuguese name for cassava in Brazil—mandioca. "The project is looking to develop a technology,

a product and integrate it into the existing seed system. It is fantastic that we are working on this project together, internationally" he said. As the technology was developed together with Embrapa, the Syngenta Foundation wanted to test and validate MandiPlus in collaboration with NaCRRI in Uganda. He appreciated project partners including BMGF, NARO, Embrapa, and spoke about an anticipated collaboration with the NRI.

He further reiterated the objectives of the project to among others improve the availability of clean cassava planting materials and ultimately boost the cassava value chain in Uganda. He called upon participants to be active and involved and to share ideas on how to take this project forward.

Godfrey Asea - NaCRRI

The NaCRRI director welcomed guests and appreciated the work accomplished by the project. He acknowledged the strong NARS-NARS collaboration which he said has been quite unique to this project. Stakeholders were called upon to work out a business case for the project and figure out how to make the project deliver impact. Making reference to the latest FAO SOFI report, Godfrey called upon participants to think through how to reverse the staggering negative hunger and nutrition statistics especially in SSA. He added that cassava was a good place to start to do this.

He was very excited with the progress made on the project and was looking forward learn from experiences from outside Uganda, and sharing insights on how to move forward.

A brief Overview of Embrapa- Herminio Rocha

Embrapa is the federal agricultural research organization founded in 1973 in Brazil. Herminio gave a brief history of Embrapa including reasons for its establishment and objectives. Brazil was a huge food importer in the 1970s with a huge food security problem.

The nation grappled with low agricultural production and low yields with production only in the South and Southeast regions. Food supply crises and rural poverty were rampant. There was a lack of specific knowledge in tropical agriculture and inadequate agricultural development policies. Brazil known as a coffee and sugar producer.

A decision was taken to develop a science based tropical agricultural model for Brazil. Key drivers of agricultural innovation in Brazil were: government commitment and public policies; development of a modern innovation infrastructure; building organizations and improving human capacity; availability of basic infrastructure; suitable landscape for mechanization and farmers' entrepreneurial spirit.

The Brazilian Agricultural Research Corporation (Embrapa) exists to provide research, development, and innovation solutions for the sustainability of agriculture and for the benefit of the Brazilian society. Embrapa's vision is to be a world reference in the generation and supply of information, knowledge and technologies, thus contributing to innovation and sustainability in agriculture and food security. Embrapa has 48 centers in Brazil with 2415 scientists, an annual budget of $1 billion and operations in the US, Europe, Asia, Africa and Latin America.

Herminio discussed Embrapa's international cooperation activities including partneships like the MandiPlus and NextGen Cassava projects in Uganda. The organization is sharing knowledge and technologies with developing countries, joining scientific efforts to develop better solutions. Cooperation with NARO started as early as 2012.

One of the cassava varieties released by NARO

Perspectives on Cassava Research in Uganda – Titus Alicai | NaCRRI

Titus introduced his presentation with an overview of NARO and her institutes and discussed her national mandate. Guests were briefed on the research work at NaCRRI which is divided into four programs—root crops, legumes, cereals and horticulture.

He discussed the history of cassava in Uganda. The crop is of strategic importance and holds a special place in the national plan for improving food and nutrition security as well as industrial development. The biggest challenge currently is low productivity—an average of 13t/ha, compared to Asia (19t/ha), due to pests, diseases, poor quality planting material. The crop, introduced in the 1850s with current per capita consumption of 120kg, grows well in over 80% of Uganda's arable land.

Commercial applications of cassava in Uganda were discoursed. Titus shared about plans to transform cassava into a major industrial crop in Uganda. The crop generated over $5bn from 2015-2017 through the sale of over 300,000 bags of cassava seed. Growing private sector demand for cassava in industries for beverages, starch, ethanol and bakeries was pointed out.

Key challenges—pests and diseases; lack of a formal seed system; complex crop genetics and difficult breeding; limited range of superior varieties with high genetic potential; inherent deficiency in essential nutrients; inadequate and poor quality seed were

underscored.

Cassava Brown Streak Disease (CBSD), the most devastating constraint to cassava production was discussed at length. The disease, first reported in 2004, was present in 51 of 54 districts in the country by 2014. In contrast CMD has a national incidence of 18%, a significant reduction 64% in 1994. These phenomena are reinforced by year round presence of vectors, emergence of new viruses, and farmer attachment to susceptible landraces. Currently, the best improved varieties are only tolerant to CBSD.

Current cassava research priority areas brought to the audience's attention. They included genetic improvement; understanding pests and diseases; biotechnology; genetic resource management; biochemistry and physiology; crop management and agronomy; socio-economics research; adaptation and dissemination of improved varieties; seed system development; knowledge management; and capacity building.

Key recent achievements in cassava research comprise new knowledge; accelerated breeding and participatory variety development approaches; control of CMD epidemic with national incidence reduced to 17% by 2013 from 67% in 1994, and a framework developed for CSS in the country; dissemination of improved varieties; production of clean early generation seed; and increased proportion of improved varieties in farmers' fields from 12% in 1997 to over 80% in 2015.

Trends in CMD and CBSD were shared. Incidence of CBSD is going down which is largely attributed to tolerant varieties. Progress in breeding for beta carotene rich cassava was also discussed.

Strategic priorities for cassava were brought to the meeting's attention. Accelerated superior variety development, boosting yield, and using NBTs to improve breeding efficiency, pest and disease control and management, microbiome prospecting, outreach, knowledge management, and capacity building among others were listed.

Agricultural Development - Jim Lorenzen | Gates Foundation

The BMGF senior program officer introduced current priority programs in global

development, global growth and opportunities, health, policy and advocacy at the foundation. Jim discoursed on global challenges in small holder agriculture. Highlighted challenges

A farmer examines a cassava plant in her garden. Photo by Jim Lorenzen/BMGF

were low productivity exacerbated by climate change, low profitability from agriculture, systems and policies that fail to meet farmer needs, lack of opportunity and resources for women, and food systems that do not provide adequate nutrition.

The Gates foundation's vision for agriculture—agricultural transformation led by countries to support small holder farmers—was brought to guests' attention. "We want farmers to be empowered with the knowledge, tools and technologies to improve their livelihoods and lift themselves and their families out of poverty," he asserted.

Jim elaborated the theory of inclusive agricultural transformation as adapted from P. Timmer. Agricultural transformation is the process by which an agri-food system changes from being subsistence-oriented to more commercialized and productive; farm-centered to more off-farm centered; diversified at the farm-level but relatively undiversified at the system level, to more specialized at the farm-level but diversified at the system level.

"The foundation's means of engagement is primarily through countries as the scaling unit working with both private and public partners," he said.

Inclusion has three components: social, geographic, and economic. In order to be inclusive, the process must include all farmers, including women and those at all economic

levels. BMGF focus is on ensuring the inclusion of rural SHF's making less than $2 a day and those who are undernourished in the growth process.

The foundation invests primarily in strengthening country systems and developing global public goods, which countries and scaling partners deliver for farmer impact. "We see our role primarily as catalyzing country-led inclusive agricultural transformation, and ensuring that this transformation is inclusive in that it benefits the poor and women," Jim noted. "We recognize that the goal of inclusive agricultural transformation is a long-term goal for countries, and our role is specific to catalyzing short- and medium-term actions towards this goal," he added.

He shared the vision, challenges, objectives, approaches and expected outcomes of the foundation for inclusive agricultural transformation.

BMGF has a vision to support growth from subsistence to commercial/semi-commercial agriculture. Jim highlighted the impact of climate variability on agricultural productivity. The importance of women in agriculture as vital drivers of food systems, their families and communities was underscored.

Objectives of the foundation for global ag were discussed. These were; boosting productivity, empowering women famers, increasing safe and affordable access to nutrient-rich food and rising small holder incomes. Portfolios and leadership at the foundation were briefly expounded upon. Priority crops for the foundation were brought the knowledge of the audience.

Jim stressed the significance of scant, immature knowledge of genetics, breeding systems, poor seed systems in Africa, floral biology etc. of vegetatively propagated staples—cassava, yam, banana and sweet potato. Major grants—NextGen, SASHA II, GT4SP, AfricaYam and MandiPlus—from the Gates Foundation to improve productivity in such staples were listed.

Other grants to unlock various opportunities in small legumes and grains, cross-crop investments in tools toward genetic gains, translational biotech traits, and translational research to support seed systems were brought to guests' attention.

"How can cassava be made inherently more productive?", he asked. Understanding the crop and using science will be key to unlock the potential of cassava and other crops. "The foundation is pleased to be engaged as small part of a bigger global effort to combat food and nutrition insecurity" Jim concluded.

Introduction to the MandiPlus Technology

Dominik Klauser | Syngenta Foundation

Syngenta Foundation's Program officer for Research and Development listed key tenets of seed systems for clonally propagated crops. Dominik also discussed challenges in seed systems for clonally propagated crops; low multiplication rate, slow dissemination of new varieties, bulky, and perishable planting material. The consequences of such challenges—no intrinsic value for 'seed pieces', lack of business case and lack of entry points for quality control were pointed out.

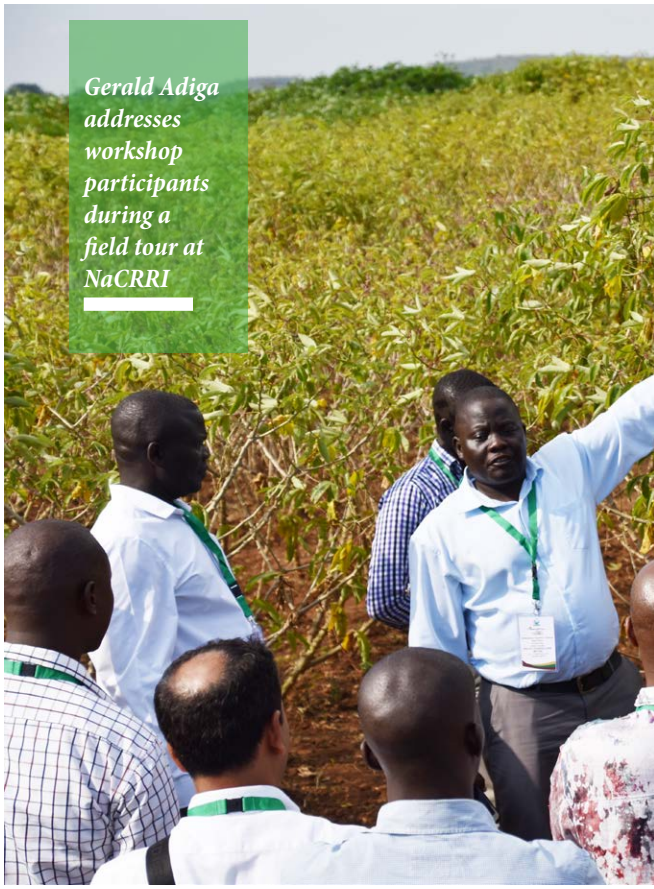
The rationale of the MandiPlus project was to make the production of cassava material more efficient by decreasing size of seed pieces, increasing multiplication rates, improving crop handling and shelf life, and providing opportunities for pest and disease control.

This is being done by adapting existing technology from sugarcane for cassava. These efforts have achieved 3-fold increase in multiplication rates, improved planting and logistics as well as pest and disease control.

Eder Jorge de Oliveira | Embrapa

Eder presented on using smaller cuttings pieces; combining chemistry, plant genetics, agronomy and application technology to increase multiplication rates in cassava.

He presented results from the MandiPlus project in brazil. Increased rooting and sprouting, early protection against pests and diseases, better agronomic performance for some traits such as germination, vigor, above ground biomass as well as fresh root yield and starch yield were among the positives noted during the research activities.



Gerald Adiga addresses workshop participants during a field tour at NaCRRI

Eder noted that the benefit of this technology will be that MandiPlus can help dissemination efforts for new tolerant planting material.

In conclusion, Eder noted the benefits of the MandiPlus technology. Seed treatment (with MandiPlus) will enable shorter seed stakes (down to 8cm), ensuring the same germination and similar initial vigour (compared with standard). By shortening the seed stakes, the multiplication rate can be increased by a factor of 2 to 2.5 (Brazil) to 3 (Africa). This can help to the dissemination of planting material of new, tolerant varieties more rapidly. This technology also holds potential for the establishment of an improved, formal seed system for clean planting material through extension of existing seed systems towards more rapid multiplication and improved dissemination of planting material

Discussion

A concern was raised on the effectiveness of MandiPlus treatment against stake dehydration especially during dry seasons. The workshop learnt that research was ongoing to establish if MandiPlus treated stems can minimize losses to dehydration during dry periods/seasons.

Validation of MandiPlus Technology in Uganda-Gerald Adiga | NaCRRI

Gerald informed the workshop that one of the biggest challenges in cassava production in Uganda today is low rates of multiplication in cassava seed. It is anticipated that MandiPlus will help solve this problem. MandiPlus technology was developed in Brazil and is just being evaluated in Uganda.

Capacity building on the project in Uganda was critical. It included construction of the only seed treatment facility in Uganda. The facility is located at NaCRRI. Staff have also been trained. Environmental impact of the MandiPlus is being evaluated. Rotary seed cutter (using a prototype from Brazil) and draining table have been fabricated.

On germination and vigor trials, local varieties—NASE14, NAROCASS 1 and NASE 19 were used as test materials. The materials were treated with different plant protection products at different cutting lengths. Shorter, treated pieces achieved similar vigour and sprouting as untreated, long (24cm) pieces. Also, the plant development from the treated, shorter seed stakes did not show any negative effects or impairments when compared to the plants from long, untreated pieces. Overall, the MandiPlus treatment seems to enhance shoot yield as well as delivering equal if not slightly better root yield in comparison to plants originating from untreated seed stakes.

Termites are a huge hindrance germination due to damage by the termites themselves and resultant fungal attack. In termite control trials, MandiPlus treatment was found to be very effective against termites. MandiPlus also enhanced plant vigor and sprouting.

No difference was observed in sprouting and plant vigor between 8cm MandiPlus stems and 24cm untreated stems.

Other studies conducted were pathology trials. From these studies, fungal isolates were collected, pathogenicity tests completed, pathogenic isolates preserved and cup trials conducted. All stakes treated with MandiPlus germinated during trials demonstrating that MandiPlus treatment also protects against fungal infection.

Another study examined the business case

of the project. Cost modelling of MandiPlus technology is ongoing. Data collection was completed for 2017A trial. Data collection is ongoing for 2017B and 2018A trials. Ex-ante studies and ACT analysis on options for scale up have been conducted. First data set has been collected from cassava seed entrepreneurs.

Gerald noted that the MandiPlus technology is still at research level in Uganda and requires publicity. There is also a need to scale up the technology for large scale production, and for a technology dissemination strategy.

To sum it up, he asserted that MandiPlus technology enhances both root and shoot production and holds great potential for the Ugandan cassava seed system.

Discussion

Question/Concern	Response
Can this technology help the small scale farmers?	The technology was developed to help small holders by increasing seed multiplication rates. It has also been found to improve both shoot and root yield.
How long does the chemical persist in the soil?	No residues were detected in root samples sent to South Africa for residual chemical analysis.
How safe is the MandiPlus chemical for human consumption?	The active ingredients of MandiPlus are already in wide use and should not constitute a major safety concern. Residue chemical analysis is expected to answer this question too.
What is the relationship between increased vigor as a result of MandiPlus treatment and nutrient uptake?	This will be a future research question.

The Cassava Seed System in Brazil- Herminio Rocha & Helton Fleck

Herminio's presentation expounded on cassava and reasons for developing the CSS in Brazil (Reniva), basic principles and sequence tasks to establish Reniva, challenges faced and strategies to overcome them, and cassava mini cuttings. The workshop was updated on cassava production trends in different regions of Brazil. Food and industrial applications of cassava in Brazil were highlighted.

On reasons to invest in Reniva he listed low adoption of Embrapa varieties, constant demand for cuttings from small holder farmers, lack of disease free planting material, mismatch between harvest and next planting season, lack of cassava seed organizations, capacity to produce cassava plantlets in high volumes and large number of partners willing to make it happen.

Limitations of conventional cassava stems discoursed comprised diseases particularly Cassava Common Mosaic Virus (CsCMV) and Cassava Vein Mosaic Virus (CsVMV). Basic principles of Reniva were discussed. The sequence of tasks to be part of Reniva include plant virus indexing, selection of genotypes to be propagated, transfer of basic plants to cassava seed entrepreneurs, and production of cassava cuttings by the entrepreneurs. Herminio stated that there are no aphid vectors for cassava viruses in Brazil.

The Reniva network was explained with roles

of partners highlighted. The network aims to promote profitability, sustainability and entrepreneurship. Rapid multiplication and tip cutting have been helpful to avoid the high costs of tissue culture. The tips are cut off to encourage budding, ease logistics of plant transportation and the tops can be used in tissue culture/replanted.

The concept of minicutting to produce cuttings from tissue culture plantlets was presented. Minicuttings reduced bulkiness, have similar yield capacity as conventional stakes, are capable of producing both roots and conventional stems and can be produced in three different ways—tissue culture, rapid multiplication and in field planting.

On future considerations, scientists are looking to integrate the budding system with MandiPlus treatment. Semi-Autotrophic Hydroponics (SAH) system needs other technologies to overcome high whitefly incidence; minicuttings and MandiPlus treatment may be one strategy to achieve this. Herminio added that Reniva's strategies and technologies can reasonably be implemented in Africa and, certification ought to be the backbone of any seed system. "This system has worked in Brazil and can work in Africa" said Herminio as he wrapped up his talk.

Reniva (Cassava Seed System in Brazil) cases of Success-Helton Fleck da Silveira | Embrapa

Helton briefly shone the spotlight on the first cassava seed entrepreneur (CSE)—Rozildo Rodrigues—a CSE who doubles as the first CSE in Brazil. CSEs in Bahia state are supported by a public bank. Embrapa supports the farmers by providing seed and technical assistance. CSEs in the states of Tocantins, Parà and Mato Grosso do Sul were briefly discussed. New startup companies are producing cassava plantlets after adopting Reniva principles, and are able to deliver to the market. Helton was excited that people who adopt basic principles of Reniva are able to "go straight to the market."

Discussion

Question/Concern	Response
Where is the market for all the cassava produced in the country if we are already planning to produce more?	The value chain has a lot of players and it is important to share experiences to figure out how to streamline it; this is one of the expected outcomes of this workshop. Government has to take firm decisions to support value addition and industrialization e.g. investors in starch production. A number of investors have set up ethanol plants in Northern Uganda but many more such establishments should be encouraged. The production end of the value chain also needs to ensure that it can support demand from industries.
Is there any plan for extending the seed treatment plants to the grassroots?	Plans are underway to streamline the seed treatment process

The Cassava Seed System in Uganda; Opportunities and Challenges-Charles Liri | NaCRRI

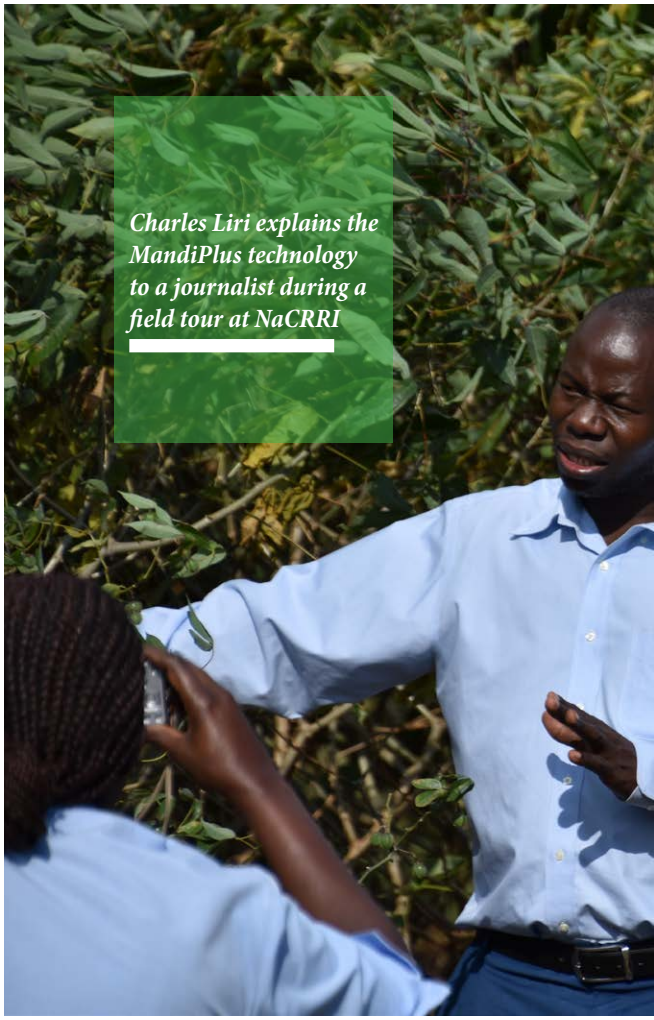
Charles' presentation featured constraints of CSS; rationale for formal seed system; goals, objectives, key outputs, and outcomes of CSS; Seed System Model; lessons learned, opportunities, challenges, and approaches for improving the CSS as well as entry points for MandiPlus in CSS.

Discussing constraints, he informed the audience that cassava is vegetatively propagated leading to accumulation and spreading of systemic diseases notably CMD and CBSD. The crop has a low seed multiplication ratio of 1:10 limiting access to early generation seed while stems are bulky with short shelf-life. Further, the formal seed sector in Uganda has shunned cassava seed business. Over 95% of farmers access planting material informally, quality of planting material accessed informally is poor, and there is inadequate capacity for inspection and certification.

The rationale for formal CSS with key components—research, seed production, quality assurance and commercialization—was presented. Charles briefed the workshop on the CSS project in Uganda. The project had six implementers in six districts in Uganda. It aimed to establish a functional cassava seed system in Uganda. He added that during the project implementation, a CSS model was worked out streamlining roles of different players along the CSS. Stages of certified cassava seed production was discussed.

Project outputs: 18 ministry seed inspectors trained, 10 partner staff trained in tissue culture management, 65 CSEs trained to produce and sell planting materials profitably, over 22 million cuttings enough to plant 5,503 acres with certified seed, 48 extension workers trained in cassava seed quality management. 1 PhD and 2 MScs trained. Manuals were also produced by CSS and are widely used as reference for cassava seed production

CSS has been a learning model of vegetative seed production system in the region. The project has also enhanced large scale cassava production and value addition due to easy access to clean seed.



Charles Liri explains the MandiPlus technology to a journalist during a field tour at NaCRRI

Lessons learned included:

- Public Private Partnerships enhance large scale pre-basic and basic seed production
- There was a synergistic partnership and collaboration among the implementing partners (MAAIF, NARO, MEDA, CHAIN, AfrII, Biocrops)
- Cassava value addition is a key driver of demand for certified seed
- The new variety (NAROCASS1) created demand for seed and increased sales of the CSEs

- Commercial cassava farmers are on increase
- Complementary ongoing projects such CAMAP (Improving production scale of CSEs) and MandiPlus (Developing superior seed)

Challenges presented were:

- Access to basic seed for CSEs has largely remained a challenge
- CSEs are few and far apart. Distribution cost is high which increases cost of seed
- Overwhelming demand for clean planting material in the wave of CBSD epidemic
- In vitro propagation by sub-culturing is expensive and time consuming, need for new approaches e.g. SAH, Minicuttings
- Development programs disrupt commercial seed system by distributing free seed
- Inadequate policy enforcement—e.g. moving planting materials without permits—affects input quality
- Myths about disease e.g. Some farmers believe that improved varieties spread diseases

Approaches to improve efficiency of CSS:

- Improve efficiency of Tissue Culture labs using rapid multiplication techniques e.g. SAH, minicuttings
- Enhance efficiency in multiplication of pre-basic, basic and certified seed by adopting MandiPlus technology
- Expand the seed distribution network; recruit more CSEs and reach out to other districts
- A value chain approach where demand for seed is driven by output market; Organize cassava subsector into cooperatives, put emphasis on value Advocate for sustainable seed policy; discourage handouts
- Increase productivity through mechanization and agro-processing

The CSEs are the primary entry point for delivering MandiPlus technology. The technology can be applied to enhance survival of minicuttings in screen houses, treat pre-basic, basic and certified seed and increase multiplication rate. MandiPlus has further potential to create numerous job opportunities for youth, women and many underprivileged people.

Charles noted some take home points from his presentation:

- Uganda has a young seed system that still requires some support to grow into a fully-fledged, self-sustaining "Functional Seed System"
- The numerous challenges identified need to be addressed and the emerging opportunities tapped to achieve national and international development goals
- MandiPlus technology has a huge potential to improve and revolutionize the Cassava Seed System

As a parting note, he added that NARO has intensified early generation seed production as a result of the CSS intervention. NARO has also established a seed processing plant at Kigumba to facilitate value addition along the value chain.

NARO has also established a seed processing plant at Kigumba to facilitate value addition along the value chain.

Discussion

Question/Concern	Response
Are there alternative stake cutting technologies with probably higher throughput?	Prototype with higher throughput is available
Is the project considering all steps of the cassava value chain?	This project is biased to the production end of the value chain but all stages of the value chain are key
Which of the major advantages of MandiPlus technology should be prioritized?	Increasing germination/multiplication rates from shorter planting materials
Is there a danger of mixing different fungicides with a potential 'chemical backlash'/adverse effects?	No concrete answer for this as different formulations might have different effects. However, most available formulations have been found safe. The technology will be commercialized with recommended formulations
When should farmers expect this technology and what is the business case?	Primary aim of this project was to increase speed and efficiency of seed generation. Other opportunities have been identified and will be explored going forward. Some more work will have to be done before farmers can access the technology. Trails and analysis is being done to establish the technology's business case. Profitability model is being developed
Share experiences from Brazil on how you have managed to disseminate technologies from research. Uganda could pick best experiences	Embrapa has struggled with increasing efficiency of technology dissemination. Among others, using participatory R&D, CSEs, offering training. There was an extension system that was shut down which has curtailed technology dissemination. Loyalties for some of the technologies; Current Embrapa policy is that every technology produced should be protected. However, there are challenges with small holders.

Day II

Recap of Day I

Dominic shared a brief recap of Day I and thanked participants for being active and sharing very illuminating ideas. He took the workshop through the agenda for Day II. Guests were called upon to share ideas to advise next steps for the projects to help deliver intended impact to farmers and the entire cassava value chain.

Notable feedback from Day I revolved around how to scale processing technology, technology transfer, how to declare the product, product stewardship, involvement of stakeholders, and improving the narrative on product benefits and purpose. Below is some feedback from participants in brief.

Product Marketing Clarify the value proposition (Anton & Mike) Change perception of benefits to trigger demand (John) Need to emphasize protection and production benefits (Robert) Segment the market into two (or several) products (Robert) Develop farmer package (Charles)	**Technology Transfer** Build PPPs (Herminio) Technology/offer needs to be consolidated (Eder) (Pvt. Sector) partners needed for next phase (Eder) Target entreprenueurial larges-scale farmers at first phase (John) Need for more participatory evaluation (Anton)	**Product safety/stewardship** Residue analyses needed (Titus) Product stewardship guidelines (Jim) Resistance management, AI rotations (Jim) Combination with other means of P&D control (John)
Seed Systems Work Match seasonal supply and demand (seed tracker app, Mike) Location-specific recommendations based on soil properties (Charles) Define entry points (David)	**Regulation** Need to clarify regulatory frameworks/procedures (Eder) Product registration needs to be pushed (Mike)	**Market-pull** Market demand seems to be there (Mike, Charles) Engage with downstream VC partners to drive demand for product (Mike) Need to «work smarter» on VC partnerships Need for networking «along the value chain» Farmer interest in improved planting material (Charles)

Focus areas for current and future R&D Activities-Eder Jorge de Oliviera | Embrapa

Planting, agronomy, storage, alternative active ingredients, synthetic seeds, entry points of the MandiPlus in the CSS and strategies for scaling the technology were discussed by Eder. He spoke of the need to develop a propagation protocol for cassava seed to optimize seed pieces produced. Some work is going on at Embrapa in this regard and a protocol is being developed.

Aspects examined include vertical versus horizontal planting, spacing, cutting size and treatment (with MandiPlus) versus untreated stakes. No significant difference was observed on vigor and germination between horizontal and vertical planting. Spacing too didn't produce any significant difference in stems for plant, vigor and germination. These results assert cassava's good compensation effect as a crop. Studies have validated the effect of MandiPlus treatment on vigor and germination.

Small cassava cuttings (8cm) can improve the multiplication rate and can be used in CSS. Irrigation and good agronomic practices can improve the system. Planting vertically or horizontally has no effect in irrigated systems. In rain fed systems planting vertically can improve plant height and vigor. Spacing of 0.6m between plants can provide better soil coverage and keep the stand per area especially when using small cutting pieces. In future, tests ought to be done if this kind of system and technology can be useful in Uganda. Further, there is need to investigate how to improve the shelf life of the small cutting pieces especially preventing dehydration, and storability of uncut seed pieces.

With regards to storage, Benzalkonium chloride (BZK), Maxim Advanced and sodium hypochlorite can guarantee high germination rates 30-35 days after storage. However, sufficient knowledge is yet to be obtained on improving shelf life of small cutting pieces and storability of uncut seed pieces.

On alternative active ingredients, development and testing of new, adapted MandiPlus seed piece treatment formulations considering such factors as reducing costs is underway. Newer MandiPlus treatments have become increasingly cheaper to produce. Assessments so far have considered effects on vigor, germination, stem number per plant, plant height, stand, gall midge files. Significant differences have been identified between different MandiPlus formulations for the different test interest areas considered.

New MandiPlus formulations are being tested for prevention of cassava root rot establishment. The new formulations have shown promise to reduce cost by up to 30% while reducing pathogen infestation and colonization. The three MandiPlus versions (1,2 and 3) seem to be promising for cassava seed treatment to reduce damage caused by root rot pathogens.

The audience was challenged to think through whether there are similar effects for other insects e.g. white flies in the early stages of crop development.

For synthetic seed production, Embrapa is testing the leaf buds method. Leaf buds can be used for both root and stem production. Immature and mature single buds are being explored as another technique for synthetic seed production. Experiments are at the proof of concept stage. These technologies have potential to ease transport, long term storage and will be useful for rapid release of improved varieties with high agronomic value.

A model for future cassava propagation

including different entry points of the MandiPlus technology to improve multiplication rates have been developed.

A cassava seed cutter at NaCRRI. New prototypes have been developed for more efficient cutting & processing equipment

Innovations from Syngenta and partners, technological development agreements (with DeRossi, Antonoisi, John Deere) and improved varieties (from Embrapa, NaCRRI) have been identified as key strategies to scale up the MandiPlus technology.

DeRossi Mechanica Agricola and John Deere are developing new prototype to enable full mechanization for cutting and treatment. Considerations have been made for a MandiPlus planting machine.

Assessment of the cost and business models of MandiPlus-David Eagle | MEDA

David presented an overview of BEST Cassava, purpose of the MandiPlus project, use of generated data, benefits, outcomes and assumptions of Mandiplus project. He also discussed the cost model of MandiPlus experiments, potential business models and offered conclusions for discussion.

The BEST (Building an Economically Sustainable Seed System in Tanzania for Cassava) Cassava project aims to build an economically sustainable seed system for cassava. It is a collaboration (MEDA, IITA, TARI, TOSCI) led by IITA. The project hopes to enable the scale up of the commercial cassava seed system through private sector and government institutions.

Achievement of project objectives is being pursued through; pilots for testing and validating business models for a commercial cassava seed supply chain; identifying and testing cassava varieties through a regional exchange to determine suitability, disease-resistance and –tolerance, to be officially released at country-level; community phytosanitation; implementing and testing community phytosanitation protocols for maintaining clean cassava fields at the community level.

The project deliverable is to establish business cases for seed multipliers and input providers. It is also exploring business models for current and future multipliers by examining costs related to MandiPlus to build viable business models considering cost structures.

While experimental data was captured

Workshop participants tour an exhibition at NaCRRI

throughout, the cost data was gathered based on recall in the last few months of the experiments. Care and consideration needs to be taken when extrapolating experiment cost data (which has research purpose) to commercial CSE operations (which have business purpose). "These results presented here are preliminary, illustrative and meant to facilitate discussion," David said.

Improved early plant establishment and smaller length cassava stakes were pointed as benefits. Increased multiplication rate and less bulkiness of materials were identified as desired outcome. Assumptions made were equal yield (no reduction in stem yield for all scenarios), no significant change in field labor costs and no change in disease indexing protocols and costs.

He explained the Cost Model for the MandiPlus Project. Field costs included labor, land preparation, planting and management costs. Planting material was purchased at 30,000 Uganda shillings per bag. Transport of stakes included movement to and from source to treatment facility. Field costs took up 63% of all production costs followed by MandiPlus costs at 16%.

Transport costs from Kigumba to NaCRRI took up 15% of production costs. Costs were divided into variable costs (treatment labor, treatment solution, and capital costs), building and equipment costs. Capital costs were 63% of total costs.

David pointed out areas that needed optimization like transportation of stakes, labor efficiencies and savings based on learnings. He reported that Transportation of stakes that was more similar to the experience of CSS project—63% less cost. Labor efficiencies and savings based on learnings led to 50% less cost resulting in 15% less cost overall.

A 30-acre hypothesis with commercialized cost was presented for illustrative purposes. It demonstrated how impact of incremental MandiPlus costs become more reasonable when acreages increase. "Small acreage may over estimate cost," he told participants. In the 30-acre model, optimizations would lead to field costs being the biggest expense. Planting material costs remain constant and MandiPlus costs decrease to less than 10% of the cost.

Three potential business models were presented. In the first model—in which the farmer treats own seed with MandiPlus—without reduction in stake size, profitability goes down. There was a break-even point at which MandiPlus becomes more profitable than untreated stakes. In the second model—in which the multiplier treats both own planting material and product sold with MandiPlus—the breakeven point was at a higher stem length and profits increased at a much more rapid rate. In the third model involving a centralized treatment wholesaler, transportation logistics was a significant factor. He noted the need to consider distances which add costs and perishability of stems. The third model also depends on willingness of CSEs to pay for seed in a new wholesale model.

David painted a picture of the Ugandan potential. "We are only scratching the surface on the demand currently," he said. 2016 data suggests over 850,000 hectares of cassava (tuber) under production in Uganda. 1,592 acres for seed production (commercial and basic) per harvest cycle. Current seed production satisfies less than 0.5% of demand for planting material.

Current seed production satisfies less than 0.5% of demand for planting material.

However, there is potential to significantly address it through greater multiplication rates and modelling out farmer purchase behavior.

In conclusion, David discussed key factors that impact the profitability of business models which included field size, yield, stake length, MandiPlus treatment mix and location—which affects transport costs.

African Cassava Whitefly Project (ACWP) - John Colvin | NRI

John quickly shared the current global distribution of cryptic whitefly species. Different species exist in different areas of the world, and are extremely adapted to transmitting several viral species. About the impact of the pest, he discussed the devastation that arises from whitefly damage in various parts of the world. A recent devastating whitefly attack on the cotton crop in Punjab that has led to at least 15 farmer suicides was brought to guests' attention.

Whiteflies are vectors for over 200 plant virus species. The Cassava Mosaic pandemic of the 1990s was highlighted. This pandemic brought with it a huge whitefly infestation. A subsequent CBSD pandemic followed exacting huge yield losses in cassava. He then

Whiteflies on a cassava leaf

talked about the inception of the ACWP and its charitable purpose—prevention of food insecurity and famine. BMGF funded the project which aimed to understand the pest and end the cycles of whitefly pandemics.

The need for clean planting material with multiple whitefly resistances was underscored. In the past, a lot of research focus was on plant viruses ignoring the whitefly. The ACWP is looking to eliminate the devastating whitefly vector from the equation to support effective disease control.

Participants learned that 9 PhD studies have been supported by the project. He added that the project's next phase (given funds availability) will look to get whitefly resistance genes into cassava. Quite a few promising genotypes—some already growing in Africa—have been identified.

John talked about progress and challenges in the whitefly resistance phenotyping in cassava. This work was done at CIAT under the Cassava whitefly project. Efforts are ongoing to achieve accurate, quantitative whitefly-resistance data. For 24 years, CIAT has led pest monitoring efforts to help unravel candidates for sources of whitefly resistance in cassava.

Whitefly resistance trials are under assessment in Malawi. "The MandiPlus technology can support this kind of breeding work especially given the rapid multiplication advantage of MandiPlus," he asserted. Whitefly resistant Latin America and African genotypes have been raised in Malawi. Insecticide trials for clean cassava seed production are also ongoing in Uganda and Tanzania. Whitefly nymph parasitism rates in different regions were presented. John mentioned the need to conserve whitefly populations despite ongoing efforts to control their effects on cassava.

Key achievements and discoveries for ACWP discussed were; a clear understanding of why whitefly populations in East Africa have increased; screening of improved cassava genotypes from E. Africa and confirmed that many are highly whitefly susceptible; cassava genotypes with both virus and whitefly resistances identified; whitefly resistance in Latin American (LA) cassava genotypes identified; LA material established in three E. African countries in preparation for pre-breeding crossing activities; proof-of-concept for a method for protecting clean-seed material; numerous potential RNAi targets in cassava whitefly identified; and capacity building (two MSc and nine PhD ACWP students)

Areas of common interest between ACWP and MandiPlus: Rapid multiplication of clean cassava with multiple disease and whitefly resistances, rapid multiplication of material for pre-breeding crosses particularly for Latin American genotypes, and on-farm protection from whitefly and diseases with existing technology.

Joint aims, according to John, should be to set up necessary infrastructure to produce and distribute treated planting material, build human resource capacity and establish technology validation and demonstration trials, trials for pest and disease control, and participatory trials with seed multipliers and farmers.

Discussion

Question/Concern	Response
Has anyone done any genetic population studies on whiteflies in Africa?	Yes. No evidence of whitefly invasion in Africa from other regions of the world has been established. Whiteflies have also been found to be very good at evolving extremely rapidly to adopt to pesticides and other pest management measures.
Is there a place for biological control of whiteflies?	Current focus is on technologies that would make quantitative change given present logistical challenges. Skepticism is high that biological control would be very feasible based on current knowledge.

Beyond Seed Multiplication-Saulo Alves Santos de Oliviera | Embrapa

In a presentation dubbed "Beyond Seed Multiplication" Saulo discussed additional benefits of seed treatment in the context of Pest and Disease Control.

Clearing cuttings from pathogen and saprophyte attack and deterioration was emphasized as the major reason for seed treatment. He shed light on the 'CRRD Complex' in Brazil that includes Fusarium, Phytophthora and Botryosphaereacea species. Saulo further shared results from MandiPlus seed treatment experiments comparing effects on germination, internal colonization and weed management.

Experiments validated the positive effect of MandiPlus treatment on germination rates, root density and vigor of cassava seed. MandiPlus treatment also prevented internal pathogen colonization of the seed. An additional advantage of seed treatment was enhanced growth and disease control which resulted in less competition from weeds.

Benefits of seed treatment for Pest and Disease Control and enhanced shelf life of cassava planting material Uganda-Phillip Abidrabo | NaCRRI

Information on prevalence, incidence and distribution of cassava root rot and its causal pathogens is limited. Phillip presented cassava stem and root rot symptoms observed in farmers' fields in Uganda. Work on isolation of fungal pathogens causing cassava root rot in Uganda was discussed. Three fungal species—*Fusarium Solani, Fusarium Oxysporum and Sclerotium spp*—were isolated.

MandiPlus technology enhanced percentage germination of cassava planting material in the presence of fungal pathogens. Scholorotium fungi is still proving stubborn despite MandiPlus treatment. Over 84 % of MandiPlus treated stems attained maximum sprout rate scale in the presence of fungal inoculum.

Conclusions from the studies in Uganda and Brazil; significant reduction of fungal deterioration, early control of stem/root rot pathogens, significant control if leaf gall midge and termites.

Future research will address sucking insects, Vector borne diseases, weed management, test new MandiPlus formulations (MandiPlus v3) and/or develop new more effective formulations for long term storage, and root rot control.

Discussion

Question/Concern	Response
Need to establish optimal/lethal dose of the MandiPlus formulation especially with the idea of controlling pathogen resistance.	This considered during MandiPlus treatment formulations. Baseline tests are conducted to establish minimum effective doses.

Breakout session

Participants were divided into groups to discuss specific questions. Each group then presented results from their discussion to all workshop participants.

Guiding questions to respond to group tasks were: What should a solution look like? What needs to be done to get there? How do we get it done? Who does what (ownership)? Whom do we need to engage? How can we move forward? What can/should be done now/later?

Feedback from Groups

Group I:

Question:

What are the most efficient ways to embed the MandiPlus technology into the current seed multiplication systems? How can we push this forward?

Response:

Seed Multiplication

What?

(a)Inclusion in certification schemes for QDPM

(b) Link to interested partners(private)-participatory approach.

(c) Clarify benefits to the seed multipliers

Breakout session; Group I

(d) Clarify product registration status

(e) Embed from early seed generation

(f) Distribution and logistics

How?

(1) Policy brief (NaCRRI, govt, NSCS)

(2) Participatory trials, demos, field days (CSES); Assess willingness to invest

(3) Seed tracker – Ministry of Agriculture

(4) Trials/data for label extension, engage with manufacturers, dealers.

(5) Engage with TC labs NaCRRI

(6) Move treatment closer to CSEs

When?

(1) Approximately one month based on existing data

(2) Next season march 2019

(3) November, already started

(4) Application now, field trials early 2019; dealer, NARO to support data collection – Twiga, Crop care

(5) Already started, screen house needed for minicuttings

(6) 2019

Group II

Question:

What additional R&D work should be considered to improve the product offer(s)?

Response:

What would a possible solution look like?

- Different solutions and formulations regarding different conditions and locations
- "modular product" – in terms of adapting to the conditions and locations
- Changing the active ingredient according to the cassava species and across seasons/times, also according to the rotation in order to prevent building of resistance OR having various active ingredients in the formulation
- Develop effective formulation against whiteflies
- "profiling" for certain problems: if special incidences such as nematode

problems – use different formulation

- Included increased shelf life of both seed pieces and active ingredient
- A further optimized seed piece in order to scale up

What is needed to be done?

- Overview of disease prevalence according to locations – disease mapping
- Also, soil mapping
- Affordable price of product
- Field validation, approved by the farmers
- Field validation of current "best formulation" regarding shelf life regarding both stems and root establishment including research on formulation
- Further research of formulation on whitefly protection (different compounds, combinations and dosages)
- Further research on resistance management
- Checking the regulatory status regarding the formulation containing neonicotinoids -> continuing research on alternative non-neonicotinoid active ingredients
- Change from dipping to spraying: further research for alternative application methods (as spraying, adhesive characteristics of formulation might change)
- Reduction of field costs to ensure affordable prices for the farmers
- Exploring of alternative "seed solutions" – such as synthetic, minicuttings…

How do we get it done?

- Check local studies on pest and disease prevalence and species – mapping (incl. soil mapping)
- Further mapping of corresponding

Breakout session; Group II

formulations on the pest & disease map

- Creating "disease profiles" for different regions
- Informing about the diseases/ raising awareness how to identify and further fight them
- Publicity
- Trialing per region in to obtain validation
- Laboratory analysis including field validation of optimized formulations
- In general: good agronomic practices (soil analysis, herbicides, fertilisers) including informing about them
- Establishing crop systems devoted to stem production vs. root production

Who does what?

- NARO conducting research and mapping (pest and diseases, soil)
- NARO optimizing and validating spraying method including adaptation of formulation
- NARO to provide varieties (preferably with already increased resistance traits)
- Input providers supplying the products
- Regulatory agencies/department being informed and asked
- NARO, CSEs, farmers, cooperatives, extension services to plant trials
- NRI Greenwich/Research Institutes to perform research

Whom do we need to engage with?

- NARO, CSEs, farmer (cooperatives), extension services, processors, input providers, agricultural ministry, NRI Greenwich

When – how can we move forward?

What can and should be done now, what later?

NOW:

- Overview of disease prevalence according to locations – disease mapping; Creating "disease profiles" for different regions
- Informing about the diseases/ raising awareness how to identify and further fight them
- Publicity
- Field validation of current "best formulation" regarding shelf life regarding both stems and root establishment
- Trialing per region in to obtain validation
- Further research on resistance management
- Further research about formulation combination
- Checking the regulatory status regarding the formulation containing neonicotinoids -> continuing research on alternative non-neonicotinoid active ingredients
- Change from dipping to spraying: further research for alternative application methods (as spraying, adhesive characteristics of formulation might change) -> Scaling up technology to obtain an affordable price of product

LATER:

- Establishing crop systems devoted to stem production vs. root production
- Further research on resistance management

- Mini cuttings in the fields, synthetic seed

Group III

Question:

What further aspects need to be considered to take the product to the field/farmers?

Response:

1. Demonstrating the benefits
   - NARO - adaptative trials (farmer managed)
   - ZARDI
   - Farmer level (CSEs)
2. Training stakeholders (Farmers, CSEs, LGs)
   - NARO – creating awareness/
   - Government extension service
3. Business case (Prices, markets, finance, demand, profitability analysis)
   - Public Private Partnership
   - Informed CSEs
4. Regulatory issues/ MAAIF
   - Quality assurance and certification
   - Registration of CSEs
   - Actors - NGOs, CBOs, Private Sectors

Breakout session; Group III

Closing Remarks - Titus Alicai | NaCRRI, Mike Robinson | Syngenta Foundation

Titus thanked participants for honoring the invitation to take part in this meeting especially those who are not part of the project team. "You have greatly enriched this workshop with your ideas", he added. He implored guests not to lose sight of the bigger picture of the project—to deliver impact in the cassava value chain. A lot has been learnt since efforts were taken to adapt the MandiPlus technology from Sugarcane. He felt confident and happy about the stock of ideas collected at this workshop. He further challenged participants to think through next steps to put suggested ideas into action especially by identifying strategic synergies.

Mike thanked all teams that have been involved in developing a superior cassava seed piece. He reiterated the call to keep an eye on the three Ps; priorities, people, policies. All guests were challenged to leverage whatever resources they could to keep the vision of the project alive. "It's been a great effort so far and we hope we can move forward together", he concluded.

Field Tour at NaCRRI

Next Steps

The following were identified as the most urgent next steps for project management and partners going forward:

- Mapping of private sector demand for cassava
- Identification of lead farmers and cassava seed entrepeneurs to evaluate the interest, motivation and willingness for the MandiPlus technology uptake
- Large scale pest (Whiteflies) and disease (CBSD) trials
- Compiling a policy paper for seed certification
- Registration of the product used in MandiPlus for cassava
- Scale the production and develop commercial models

Appendices

List of Participants

Name	Institution
Kiddo Mtunda	TARI, Tanzania
Caroline Otto	Syngenta Foundation
Dominik Klauser	Syngenta Foundation
Mike Robinson	Syngenta Foundation
Mamadou Cissé	Syngenta Foundation
Jim Lorenzen	Gates Foundation
David Eagle	MEDA, Canada
John Colvin	NRI, UK
Sharon van Brunschot	NRI, UK
Eder Oliveira	Embrapa, Brazil
Mbowa Anorld	AATF
Saulo Oliveira	Embrapa, Brazil
Helton Fleck	Embrapa, Brazil
Herminio Souza Rocha	Embrapa, Brazil
Ephrance Tumuboine	MAIIF, Uganda
Erongu Moses	MAIIF, Uganda
Godfrey Asea	NARO, NaCRRI
Christopher Omongo	NARO, NaCRRI
Anton Bua	NARO, NaCRRI
Robert Kawuki	NARO, NaCRRI
Benard Yada	NARO, NaCRRI
Williams Esuma	NARO, NaCRRI
Titus Alicai	NARO, NaCRRI
Charles Liri	NARO, NaCRRI
Gerald Adiga	NARO, NaCRRI
Julius Baguma	NARO, NaCRRI
Phillip Abidrabo	NARO, NaCRRI
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Laban Turyagyenda	NARO, NgeZARDI
Augustine Akutu	Amuria District
Labanya Alfred	Kiryandongo District
Abdallah Drasiku	Arua District
Peter Garido	Nakasongola District
Stephen Sekamate	Kiryandongo District
Felix Wani	Kiryandongo District
Dick Ayiko	Arua District
Noela Ojara	Lira District
Sosimu Twesiga	Kiryandongo District
Pravin Kekal	Nwoya District
Kabonesa Bashima	Kyenjojo District
Issa Hassan Byenkya	Kiryandongo District
Henry Kaweesi	Nakasongola District
Gertrude Badaru	Arua District
James Peter Odenyi	Soroti District
Moses Onika	Lira District
Mabira Stephen M	Mukono District
Apollo Kasharu	CHAIN Uganda
Francis Alacho	AFRII, Uganda
Narcis Tumushabe	FICA, Uganda
Sunil Tada	Crop Care, Uganda
Kintu Michael	IDEA Index


NaCRRI
EVALUATION OF CASSA
TECHNOLOGIES FOR
SUPERIOR CASSA
PROJECT:
LEAD TRAITS
DESIGN:
TREATMENT:
VARIETIES:
STEM LENGTH:
REPLICATIONS:
FUNDERS:
LOCATION / DATE:
MANDIPL
% GERMI
SPLIT - S
4 TREATM
3
3
4
SYNGEN
NaCRRI -


/NARO
VA SEED TREATMENT
R DEVELOPMENT OF
AVA SEED PIEACE
US PROJECT
NATION VIGOUR, SEED YIELD
PLIT PLOT DESIGN
MENT
TA FOUNDATION
25/08/2017

MandiPlus

Developing a superior cassava seed piece

NARO

NaCRRI
NATIONAL CROPS RESOURCES RESEARCH INSTITUTE

Embrapa

syngenta foundation for sustainable agriculture