RESEARCH PROGRAM ON
Roots, Tubers and Bananas

CGIAR

Report of the End of Project Workshop

Expanding Utilization of Roots, Tubers and Bananas and Reducing Their Postharvest Losses

RTB ENDURE

December 2016

LED BY

CIP INTERNATIONAL POTATO CENTER
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Expanding Utilization of Roots, Tubers and Bananas and Reducing Their Postharvest Losses (RTB-ENDURE) is a 3 year project (2014-2016) implemented by the CGIAR Research Program on Roots, Tubers and Bananas (RTB) with funding by the European Union and technical support of IFAD. http://www.rtb.cgiar.org/endure

The CGIAR Research Program on Roots, Tubers and Bananas (RTB) is a broad alliance led by the International Potato Center (CIP) jointly with Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Institute for Tropical Agriculture (IITA), and CIRAD in collaboration with research and development partners. Our shared purpose is to tap the underutilized potential of root, tuber and banana crops for improving nutrition and food security, increasing incomes and fostering greater gender equity, especially among the world's poorest and most vulnerable populations.

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List of Acronyms

ADB	African Development Bank
BTG	Bavubuka Twekembe Group
CGIAR	Consultative Group on International Agricultural Research
CHAIN	Coalition for Health Agriculture and Income Networks
CIAT	International Center for Tropical Agriculture
CIP	International Potato Centre
DAP	Days After Planting
DDG	Deputy Dırector General
EU	European Union
FARA	Forum for Agricultural Research in Africa
FCR	Fresh Cassava Root
FGD	Focus Group Discussion
GAP	Gender Action Plan
HCN	Hydrogen Cyanide
IFAD	International Fund for Agricultural Development
IFH	Interval between Flowering and Harvesting
IIRR	International Institute of Rural Reconstruction
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries
NaCRRI	National Crops Resources Research Institute
NARL	National Agricultural Research Laboratories
NARO	National Agricultural Research Organization
NPV	Net Present Value
PHL	Postharvest Losses
PHM	Postharvest Management
PIM	CGIAR Research Program on Policies, Institutions and Markets
PMCA	Participatory Market Chain Approach
PPD	Postharvest Physiological Deterioration
PPM	Pig Production and Marketing Ltd
RH	High Relative Humidity
RTB	CGIAR Research Program on Roots, Tubers and Bananas
SME	Small-Medium Enterprises
SP	Sweet Potato
SPV	Sweet Potato Vines
TSS	Total Soluble Solids
UGX	Uganda Shillings
UFVEPA	Uganda Fruits and Vegetable Exporters and Producers Association
VC	Value Chain
VEDCO	Volunteer Efforts for Development Concerns
WPS	Weight-based Pricing System
WTP	Willingness to Pay
ZARDI	Zonal Agricultural Research Institute

1.0 Workshop Background

The 'Expanding Utilization of RTB and Reducing Their Postharvest Losses' (RTB-ENDURE) project has been implemented in Uganda for the last three years (2014-2016). The goal of the project was to contribute to improved food security and incomes for RTB-producing communities in East Africa; and the interventions embraced various market chain actors and stakeholders along the RTB value chains. Towards project closure, it was considered necessary to share project results with stakeholders; build a consensus on project achievements and chart a way forward. An end of project workshop was thus conducted on the 7th and 8th of December 2016, at the Imperial Golf Course Hotel, Entebbe, Uganda. The workshop was attended by 101 participants (38 F, 63 M) representing various stakeholders including officials from donor/funding agencies, national and international research organizations and universities; implementing partners, private sector players and farmers (Annex 1). This report provides a synthesis of the workshop proceedings.

2.0 Workshop Objectives

The workshop objectives were as follows:

1. To share research findings among stakeholders
2. To obtain feedback from stakeholders to inform future research
3. To identify potential collaborations among actors to carry forward the innovations
4. To network with private sector
5. To exhibit innovations to the public.

3.0 Workshop Process

The specific context for the workshop was set in a plenary introduction session that consisted of welcome remarks, an overview of the workshop program, overviews of the RTB-ENDURE Project and the CGIAR Research Program on Roots, Tubers and Bananas (RTB) and how the two relate to each other. The general context for the workshop was set in the workshop official opening address. Subsequently, the workshop was organized in modules each one dedicated to a sub-project team (banana, potato, sweet potato and cassava) to present and discuss achievements and key-findings through a facilitated[1] panel discussion. These sessions were conducted during the mornings of the workshop days. The sharing and feedback from the morning sessions was complemented by an exhibition held in the afternoons during which the all sub-projects displayed their innovations and practical demonstrations of some of the innovations was done[2]. The general public was invited to the exhibition. A poster session was also organized as part of the exhibition, and the posters were entered into a competition and assessed by a team of experts using previously agreed upon criteria. At the end of the

[1] The Workshop was facilitated by Dr. Dan Kisauzi of Nkoola Institutional Development Associates Ltd.
[2] The innovations that were demonstrated were: (i) Chopping and ensiling of sweet potato vines for animal feed, and (ii) High relative humidity and waxing technologies for cassava shelf-life extension.

workshop the four best posters were awarded prizes. The Workshop Program is presented as Annex 2. All PowerPoint presentations can be accessed here.

3.1 Overview of the RTB-ENDURE Project

Dr. Diego Naziri, CIP/RTB, Project Leader

The RTB-ENDURE project is a three-year project funded by the European Union through the International Fund for Agricultural Development (IFAD). The project objective was to improve food availability and income generation through better postharvest management and expanded use of RTB. The project comprised of four sub-projects, namely:

- Reducing postharvest loses and promoting product differentiation in the cooking banana
- Postharvest innovations for better access to potato markets
- Improving the utilization of sweetpotato and other root and tuber crop residues as pig feeds
- Extending the shelf life of fresh cassava roots for increasing incomes and postharvest loss reduction.

Partners included the National Agricultural Research Organization (NARO) three universities, NGO's, extension workers, various value chain actors and research partners.

The Participatory Market Chain Approach (PMCA) was used to assist smallholder farmers link up with profitable markets through generating three types of innovation, namely: commercial, technological and institutional innovations.

Special attention was paid to engaging private sector actors and strengthening innovation brokerage by connecting researchers, users, extension workers, service providers, and other value chain (VC) players to work together from both the production and consumption ends of the VC to manage the high perishability of RTB crops.

Ten **graduate students were supported** - one had graduated, two had dropped out and the rest were finalizing their studies

3.2 Overview of the CGIAR Research Program on Roots, Tubers and Bananas (RTB)

Dr. Graham Thiele, RTB Director

The RTB Program primarily embraces bananas, cassava, potato, sweet potato and yam research. These crops are important because they are depended on by some 300 million farmers and value chain actors across the world and they play a buffering role in food systems. RTB original focus on production and productivity has progressively shifted towards the repositioning of RTB crops as value added crops by looking into other challenges such as the high perishability, bulkiness and limited postharvest and value chain options. This shift has necessitated the Program to address wider issues including:

i. Expanding use for processing and sales of preferred varieties to satisfy emerging markets in small and large cities

ii. Addressing issues of storage, transportation, and gaining market share through processing into diverse products

iii. Increasing shelf life and reducing postharvest losses

iv. Supporting value chain actors to work closely so as to create a demand pull to enable uptake and adoption of innovations

v. Enhancing use of gender sensitive approaches - recognizing that women play a critical role in postharvest stages as guardians of harvest, small-scale processors, and market agents but that they tend to lose out as profitability of RTB crops increases.

The above considerations fall under Flagship 4 of RTB's new program structure. This Flagship primarily focuses on nutritious food and value addition through postharvest innovation. Under this component, the RTB program supports greater equitable, and sustainable utilization of RTB crops, taking into consideration the consumer needs (changing nutrition needs, diet preferences, gender) and the changing market demands (processing technologies, urbanization, environment, gender). Activities under the component are organized into four clusters namely:

- Demand-led approaches to drive postharvest innovation and nutritious RTB products
- Raising incomes and improving the health & safety at small & medium cassava processing centers
- Bio-fortified cassava varieties for improved nutrition and livelihoods
- Nutritious sweet potato for expanding markets and healthier diets.

3.3. Official Opening of Workshop

Dr. Yona Baguma, DDG Research, NARO

In recognition of the diversity of participants at the workshop, the official opening speech acknowledged the project as having illustrated the principles of multi-stakeholder collaboration in research. Most notable was the presence of farmers, members of the business community, donors and senior members of the research and development community in Uganda who provide the anchorage of current and past efforts. The project also exemplified the current research design ethos of linking research with value chains. Furthermore, it addressed a topical theme of reducing postharvest losses - an area that particularly affects cassava and sweet potato due to limited technological capacity of farmers to address the problem. The presence of global experts at the workshop signified hope that these issues would be tackled at an international scale and in a holistic way which, for example, also appreciated that postharvest losses relate to the entire value chain. The market orientation of the project not only highlighted the need for strengthening linkages of farmers to markets but also the need to nurture entrepreneurship along all stages of the value chains. This again highlighted the centrality of entrenching the value chain approaches in research processes. A closing workshop of this nature was expected to be the starting point for scaling up and out of the innovations generated with a view to having impacts at sub-regional, continental and global levels. Overall the RTB project teams were thanked and congratulated for a well-designed and implemented project.

3.4. The Banana Sub-Project

Lead Institution: *Bioversity*
Sub-Project leader: *Dr. Enoch Kikulwe*

3.4.1. Research findings and lessons learnt

The banana sub-project research team delivered eight presentations relating to reducing losses and promoting product differentiation in the cooking banana value chain. The presentations are summarized below:

3.4.2. Assessment of postharvest losses in the cooking banana value chain

Lead Institution: *Bioversity International*
Activity Leader: *Dr. Enoch Kikulwe*

Bananas have a short shelf life, which renders them highly vulnerable to postharvest deterioration. For instance, large proportions of the crop get bruised, ripen and rot before they reach the final consumer. Reliable information on the extent of Postharvest Losses (PHL) at each VC node is important for identifying hotspots along the chain and subsequent targeting loss reduction strategies. Therefore, a study was undertaken to determine:

- Level of PHL at each node of the chain in Uganda
- Extent of PHL along the entire value chain
- Factors influencing PHL at various nodes of the chain

Using the value-chain approach, the study was conducted in the districts of Kampala, Isingiro, and Rakai and data were obtained from farmers, wholesalers and retailers. Results showed that up to 42.7% of traded bananas incur physical or economic PHL which represents significant food losses to consumers and significant income losses to producers, wholesalers and retailers. Factors affecting PHL at farm level included sex of household head, secondary school education, distance to tarmac road and farming orientation (subsistence vs commercial), while factors affecting PHL at retail level included sex of trader and group membership among others.

It was recommended that:

- Interventions at production should focus on:
    - Increasing farmer mobility (particularly for female-headed households which incurred more damage)
    - Access to bulk markets
    - Specialization through infrastructural improvements and collective action.
- At trader level, efforts should seek to promote proper handling, better storage of bananas and to strengthen information flow between traders and their suppliers
- Along the value chain, there is a need to sensitize all actors on PHL to enable them appreciate the economic implications of PHL and help them identify and adopt strategies for their reduction.

3.4.3. Banana presentation forms less susceptible to damage: Storage temperatures for cooking banana

Lead Institution: *NARO-NARL*
Activity Leader: *Dr. Kephas Nowankunda*
Activity Partners: *Ssemwanga Group*

Current forms of banana on the market are susceptible to damage and are not compatible with emerging banana markets trends, including the need for smaller units for sale, peeled bananas, and sale by weight. Consequently, the study was set out to answer various questions from stakeholders including:

1. At what temperatures do we store cooking bananas to extend the shelf-life?
2. How can we extend shelf-life of peeled bananas?

The various experiments were conducted at the Ssemwanga Group and NARL facilities at Kawanda. Results indicated that the best temperature range for preserving bananas is 12-18^{0}C which increases shelf-life to over 12 days compared to five days at room temperature. Temperatures below 12^{0}C cause skin injury (chilling injury). Peeled and untreated banana at 18^{0}C keeps for four days compared to a few hours at room temperatures. There was no difference in shelf-life between clusters and fingers but bunches keep slightly longer (by about four days). The recommended temperature range of 12-18^{0}C is achievable with charcoal coolers at a temperature of about 17^{0}C. With support from the project, the chilled banana forms were made available on retail basis by a female entrepreneur who uses a charcoal cooler in Bugolobi market, Kampala.

Consideration for future research includes preservation of peeled and unpeeled cooking banana using organic extracts, while value chain development through creation of banana platforms was still ongoing.

3.4.4. Optimal harvest age for cooking bananas

Lead Institution: *NARO-NARL/CIRAD*
Activity Leader: *Dr. Kephas Nowankunda & Dr. Olivier Gibert*

Feedback from retailers showed that consumers complain about low quality of the highly demanded cultivars such as *Kibuzi.* This is often due to premature harvesting. The young bananas also dehydrate quickly and lose sale value. As such farmers need information on the right age for harvesting and how it can be determined. Various harvest age indicators commonly used include: size and shape of fingers, drying of leaves, color of pulp, and reduction in size/drying of the male bud. The study sought to establish scientifically defined indicators for determining the harvest age of bananas to reduce losses due to early harvesting. Physical (finger and bunch attributes), chemical (TSS and pH) and sensory attributes were all explored against 'Interval between Flowering and Harvesting' (IFH). The experiments were conducted at the Ssemwanga Group facility and NARL labs at Kawanda. The optimum harvest age for bananas was estimated between 133 and 150 days. Further computations were in process for more precise predictions of the optimum harvest age of banana using the thermal-sum concept.

3.4.5. Food and income security of banana farmers through sucker staggering

Lead Institution: *NARO-NARL*
Activity Leader: *Vincent Mugabi/Dr. Kephas Nowankunda*

Large seasonal fluctuation in banana production result in various problems, such as, price fluctuations, postharvest losses, income instabilities affecting household ability to consistently

meet financial need, and food shortages in some months. Sucker selection during de-suckering among other things is a contributing factor. The principle underlying the experiment was that during de-suckering, suckers of different ages are left on the stamp. Identifying suckers that are likely to mature in months of low production is crucial since the time from sucker emergence to harvest is known. The advantages of this would include:

1. Age structure control allowing the prediction of when the bunches can be harvested
2. Even out production throughout the year (though bunches may be sometimes smaller)
3. Control/regulate volumes available for sale.

Work was still on-going and a total of 56 on-farm sucker staggering demonstrations were set up and in-field explanation of the concept to host farmers was done, in addition to proper record keeping. The first successfully staggered plants had already flowered and the host farmers would share their experiences in the future.

3.4.6. Sell by weight or visual? Insights from the cooking banana value chain in Uganda

Lead Institution: *NARO-NARL*
Activity Leader: *Asha Nalunga*
Activity Partners: *Ssemwanga Group, Kaika Investco Ltd, UFVEPA*

Selling unweighted green cooking bananas is a common practice in East and Central Africa. Attempts to introduce weighing at farm level have proved to be futile. Thus, the study assessed the perceptions towards willingness to adopt a weight-based pricing system (WPS) in the cooking banana value chain in Uganda. A market study was conducted among different VC actors in eight markets in Rakai and Isingiro districts in south-western Uganda. The WPS for cooking bananas is perceived as a key innovation for more transparent, trustworthy and efficient price setting along the value chain. It is also perceived as a tool for reducing economic postharvest losses, thus improving income across the value chain. The banana VC actors are willing to adopt the WPS. For effective standardization of the cooking banana pricing system, all VC actors need to be considered and provided with information to understand how the WPS works and what benefits it would bring.

3.4.7. Increasing access to planting materials of market demanded banana varieties

Lead Institution: *NARO-NARL*
Activity Leader: *Asha Nalunga*
Activity Partners: *Ssemwanga Group, Kaika Investco Ltd, UFVEPA*

Farmers normally use planting material from own or neighbors' plantations. However, this could: be infected/infested, be limited in amounts, not of the most sought after cultivars, result in spoiling the root system of source plantations and reduced plantation life. A community based seed system was used to set up ten macro-propagation chambers associated to mother gardens (hosted by farmers groups), with five at each research site. The host groups were trained in three

multiplication techniques namely, corm (in macro-propagation chambers), decapitation, and enhanced nutrition. Revolving systems and group/individual business models for seed multiplication were promoted as options to enable adoption of the multiplication methods as well as increased access to clean planting materials of most demanded varieties. On evaluation at three months, corms/plants (100) in a space of 12x4ft (corm method), and 0.5 acre for decapitation and enhanced nutrition produced 2,000, 600 and 400 plantlets, respectively. The cost-benefit analysis based on net present value (NPV) showed that the decapitation method was the most profitable model.

3.4.8. Cooking banana trade: Can smallholder farmers access organised markets?

Lead Institution: *UFVEPA*
Activity Leader: *Eliot/Hasifa Tushabe*
Activity Partners: *Faisal and Katongole groups*

Small-scale farmers face various challenges in accessing markets including: limited supply of most demanded cultivars (mismatch between supply and demand); mixed cultivars in same plantation, low quality; limited quantities and bargaining power due to individual marketing; poor pre-and post-harvest handling methods and information gaps.

Applying the PMCA methodology, the project carried out market research to establish specific customer requirements; developed stakeholders' platforms for information exchange (at sub-county level), provided tailor made capacity building (e.g. strengthening groups' governance by establishing production and marketing committees) and facilitated exchange visits for participants. Through these efforts, farmers' participation along the value chain was enhanced. For instance, collective marketing by some farmer groups, product differentiation through venturing into the export market and supplying peeled banana, and starting up businesses to supply planting materials as a response to the demand.

The enablers for small-scale cooking banana farmers to access organized markets included collective marketing, adoption of Good Agricultural Practices (GAP), trust building, consistency in supply (quality and quantities of market demanded varieties), improved food safety for the consumers and proper record keeping and management.

3.4.9. The banana value chain, gender and enabling environment: Lessons learned

Lead Institution: *Bioversity*
Activity Leader: *Susan Ajambo*
Activity Partners: *NARO, Ssemwanga group, IITA, Kaika Investco Ltd, UFVEPA*

A gender analysis of the banana value chain in Isingiro and Rakai highlighted the following:

- There are generally fewer women banana producers due to limited ownership and access to land
- Generally, men (79%) control banana sales and use of income even for sales from plots allocated to their wives which limits the benefits that women (especially married women) obtain
- Women are mostly concentrated at the retail stage because:
    - High capital investment in other nodes ($303 retail compared to $2,000 per truck of 400 bunches capacity).

- Limited ability to access credit from financial institutions due to lack of collateral – mostly depend on farmers' groups for credit which is minimal
- Gender norms: it is considered inappropriate for women to move a lot, more so at night

- Limited access to inputs (mulch and cow dung) by men and women but women are more constrained, compromising production quality (small bunch) and yields
- Limited access to market information and extension services by men and women
- Workloads across the value chain for men and women
- Long chain of middlemen and poor handling practices that compromise quality resulting into low margins at the retail node.

To address the above, the project adopted gender mainstreaming approaches by working with both men and women to promote equity; promote improved handling; and to strengthen collective action. The specific activities jointly undertaken by men and women included macro-propagation, piloting of low-cost charcoal cooler to extend banana shelf-life, promoting women in wholesale trade with support from men, and promotion of group marketing and product differentiation as well as good handling practices.

Key lessons and results include the following:

- Gender mainstreaming should be integrated into capacity building activities to ensure sustainability of interventions
- Working with men and women to promote equity is important even when it is women who are being targeted
- Economic appeal is important for uptake of innovations by men and women. For instance, two women (one in Rakai and one in Isingiro) had taken on banana wholesale, with one supplying the export market. These were also acting as role models for other women and households in their communities
- Some participants in the trainings had started dealing in differentiated products, for instance, supplying peeled banana and accessing better markets (exports) for their produce and for other community members.

3.4.10. Feedback from stakeholders

Moderator: Dr. Eldad Karamura, Regional Director, Bioversity

The panel discussion and question-and-answer (Q&A) session highlighted the still outstanding challenge of how the information shared would be used to improve the efficiency of the banana value chain. This was intended to engage the minds of the banana sub-project team at this stage when the project is ending. In particular, the way forward should focus on impact on the ordinary people with a view to scaling the findings in entrepreneurial endeavors that would enable to break out of poverty. The following were singled out by stakeholders for taking forward:

i. Replicating/promoting the charcoal cooling technology. This would require more information and sensitization on, among other things, the cost of the charcoal coolers, the costs of operating them, the benefits, hygiene and an indication of the operational costs involved in case of promoting the technology to other chain actors

ii. More work on extending the shelf life of banana - beyond the twelve (12) days that has been achieved by the project - to better position the product in the export markets

iii. Innovative processes of handling the banana peels to improve their utilization

iv. Developing business models based on the findings to facilitate movement from innovation to viable businesses

v. Providing holistic information to convince policy makers to support initiatives for scaling out and up of the results

vi. Institutional innovations that would further empower smallholder banana farmers to be major beneficiaries of enhanced market access

vii. Further advocacy for adopting the PMCA as one of the approaches for coordination of actors in the banana value chain

viii. Advocacy to donors to fund projects of this nature for longer implementation periods that would enable initiating activities for going to scale.

3.5. The Potato Sub-Project

Lead Institution: *CIP*
Sub-Project leader: *Dr. Monica Parker*

3.5.1. Research findings and lessons learnt

The potato sub-project research team made a total of seven presentations in relation to postharvest innovations for better access to specialized ware potato markets. The results and recommendations are summarized below:

3.5.2. Construction of on-farm ware potato storage facilities (collective stores and improved traditional stores)

Lead Institution: *NARO-Buginyanya ZARDI*
Activity Leader: *Arthur Wasukira*
Activity Partners: *CIP, Farmer and Trader Potato Associations*

There are two major harvest seasons of ware potato in eastern Uganda. Prices are at the lowest during peak harvest periods, a condition worsened by high imports from Kenya. Rushed sales due to lack of storage is also a common practice. In addition to lack of collective marketing practices there are also high losses during transportation given that marketing points are far off in urban centers. The purpose of the project activity was therefore to extend availability of quality ware potato on the market and to stimulate better marketing. As such, the project was intended to identify ways of keeping potato tubers in optimal conditions with minimum deteriorative changes for later use (fresh or processed). Common deteriorative changes/problems in potato storage include rotting, weight loss / shrinkage, sprouting, greening, and sweetening.

The project worked with four associations in Mt. Elgon region including Mengya Integrated Farmers Association (MIFA), KACOFA-Irish Potato Association, Wanale Seed and Ware Potato Producers Association (WASWAPPA), and Mbale Potato Dealers Association (MPODA). The associations provided land for construction of the potato stores and also identified local artisans to support construction. As such, the ambient and improved traditional wooden store models for

ware potato storage were successfully piloted in Mt. Elgon region. The two models have a capacity of 60tonnes and 8tonnes, respectively.

The lessons learnt were: successful piloting of the models was attributed to (i) good understanding of local conditions so as to adapt the designs, and (ii) integration of indigenous information which helps to save resources. Group cohesion is key to maximum utilization of postharvest facilities. The institutional innovation from the project was a store management system to record the volumes of potato received/taken out and manage the entry/exit of the store to ensure the quality of the stored tubers.

3.5.3. Evaluation of potato (Solanum tuberosum, L.) genotypes for adaptability in Mt Elgon region

Lead Institution: *Makerere University*
Activity Leader: *Lorna Kwaka (MSc. Student)*
Activity Partners: *CIP, NARO-Buginyanya ZARDI*

Current potato yield in Uganda is about 4.6 t/ha while yields in Mt. Elgon region hardly exceed 2.9t/ha, both of which are far below the potential of 30 t/ha. In Uganda *Victoria* is the most widely adopted commercial variety. Unfortunately, it is extremely susceptible to late blight disease and bacterial wilt. Therefore; varieties that are resistant to late blight diseases are sought after. Accordingly, the purpose of the study was to identify new disease resistant high yielding potato genotypes adapted for Mt. Elgon region. To achieve this, adaptability of 18 potato genotypes to Mt. Elgon region was determined. Parameters included tuber size, tuber uniformity, flowering degree, senescence, tuber yield, marketable tuber yield, late blight incidence and bacterial blight incidence. Overall, ware potato genotypes 392797.22 and 398208.704 were found to be most adapted to the Elgon region because they are high yielding and more resistant to late blight.

3.5.4. Effect of storage conditions on the processing quality of different potato varieties

Lead Institution: *Makerere University*
Activity Leader: *John Senkumba (Msc. Student)*
Activity Partners: *CIP, NARO-Buginyanya ZARDI*

The general objective of the study was to evaluate the effectiveness of the improved storage structures in maintaining quality of the potatoes. The specific objectives were:

- To determine the effect of storage conditions on the physiochemical and sprouting properties of the potatoes
- To evaluate the effect of storage conditions on processing quality of potatoes
- To determine the sensory qualities and consumer acceptability of potatoes stored under different conditions

The study was conducted in Eastern Uganda in Kapchorwa town council (1,800m), Benet (2,300m) and Mbale Town council (1,200m) and tested the effect of two storage technologies (ambient and traditional storage) on ten potato varieties, namely 392797.22, 398208.704, 393079.4, 393385.39, Cruza, Kinigi, Victoria, Bumbamagara, Rwangume and Rwanshaki.

Findings showed that potato can easily been store for up to 6 weeks. However, tubers and storage temperature and relative humidity play a major role in maintaining potato quality as they influence weight loss and dormancy period. Accordingly, tubers in stores located in places with lower temperatures and higher relative humidity such as Benet exhibited longer dormancy period and

less weight loss than those in places with high temperatures and low humidity. On the other hand, varieties with low reducing sugars and good chip color such as 39279.22, Kinigi and Rwangume are generally more acceptable by consumers.

3.5.5. Current ware potato postharvest management practices in eastern Uganda

Lead Institution: *Makerere University*
Activity Leader: *Caroline Nabukeera (MSc. Student)*
Activity Partners: *CIP*

High PHL due to poor postharvest management (PHM) practices along the value chain limit food availability, reduce incomes and negatively affect market performance. This study aimed to: 1) investigate the storage practices and other PHM practices in eastern Uganda; and 2) assess the level of PHL and major causes of PHL incurred by VC actors.

The study was conducted in four districts, namely, Kapchorwa, Kween-Benet, Mbale, & Kampala using questionnaires and focus group discussions (FGDs) to collect data from farmers, farmers, wholesalers, retailers, processors and consumers.

Results indicated that potatoes were mainly planted from March-April (1st season) and August-October (2nd season) and that the months of gluts (high production) with low prices were June to August and December to January. On the other hand, months of scarcity with high prices were February to May and September to October. Farm gate prices averaged 315 UGX/kg during peak season and 697 UGX/kg during off season. The various actors along the value chain store ware potato for short periods of time as follows:

- **Farmers (56%)** store tubers after harvesting for an average of 4 weeks for home consumption, waiting for buyers or better prices;
- **Traders (37%)** store potato for an average of 6 days to wait for buyers or better prices, and to fill trucks before transport
- **Processors (41%)** store potato for an average of 4 days to ensure consistent availability of raw materials

Short-term storage was mainly due to: limited access improved storage facilities; poor varieties with short dormancy period; fear of storage PHL; tubers produced from uncertified seed that are attacked by pests and diseases; high family demands for quick cash and ready market.

Common ware potato storage practices include storing tubers on floors of houses, cribs made from local materials, wooden purlins, in the corners of houses, deep in the soil, stacked sacks covered with tarpaulins and under tree shades. The poor storage conditions consequently lead to high PHL, for instance, most farmers (96%) experience PHL during harvesting, storage and marketing of potatoes. Traders incur PHL mainly during peak harvesting months, most of the losses being caused by bruises and cuts while harvesting, resulting in rotting. Traders and processors who store potatoes incur more PHL (85%) compared to farmers (78%). Most of these PHL are due to poor on farm practices, including varieties with short dormancy, pests and diseases, cuts and bruises; and poor sorting practices.

Improved PHM practices and adoption of suitable and cost-effective storage technologies can help even out supplies to the market, fetch better prices and reduce PHL along the chain. Recommendations for enhancing adoption of improved PHM practices and adoption of suitable and cost-effective storage technologies included:

- Sensitization of VC actors on good management practices during production, harvest and postharvest
- Collective action to pool resources to implement collective storage and marketing
- Adopt varieties with a longer dormancy period
- Empower women to undertake in PH activities, including storage and marketing.

3.5.6. Implications of immature harvesting and regional potato trade

Lead Institution: *CIP*
Activity Leader: *Sam Namanda*
Activity Partners: *Farmers and traders*

Premature harvesting of potatoes is quite a common practice in order to respond to urgent family needs and take advantage of high prices due to market shortage during the off-season. However, harvesting premature tubers (50 to 80 days after planting) is thought to negatively affect yield and quality of tubers. On the other hand, several key hubs for potato trading do exist in Uganda. These include eastern Uganda highlands which are the second largest production area of potato after south-western region; Mbale town - the main hub through which eastern potato is sold and re-distributed to other destinations including across borders; and the MPODA association based in Mbale town which is the main trading potato association that buys, re-packages and re-distributes to different destinations. However, the indicative figures on volumes traded at these different points are not documented. Thus, the study looked at both the implications of premature harvesting on tuber yield and quality and the volumes that are traded through the key link towns and market players in the region.

It was found that immature harvesting of potato in eastern Uganda is a threat to profitable regional potato trade because it greatly reduces the yield, tuber quality, shelf life, food security and incomes. For instance, pre-harvesting at both 70 and 90 days after planting (DAP) resulted into negative changes in gross income per hectare. The benefits of harvesting a premature crop include arresting losses due to late blight epidemics and addressing immediate cash needs. However, margins from sale of immature tubers could further be increased by storing them for some time since the prices again rise shortly after peak of harvesting. It was also observed that there is growing inland and cross border trade for potato. The study recommended concerted efforts to address pre-harvest practices and strengthening trade links.

3.5.7. Evaluation of ware potato harvesting techniques and pre & post-harvest management options

Lead Institution: *NARO-Buginyanya ZARDI*
Activity Leader: *Arthur Wasukira*
Activity Partners: *Potato farmers*

The study highlighted several pre- and postharvest management options and went ahead to evaluate ware potato harvesting techniques. Among the recommended pre-harvest technologies/practices were: variety selection based on market demand and season (Victoria, Rwangume, Kinigi); planting certified seed potato sources or own field sanitation which can be achieved by zoning out seed producers in an association; timing of planting; proper land preparation, ridging (30cm), fertilization (NPK50kg/ha + manure) and spacing (60x30cm). Other techniques included planting in straight lines; timely weeding and earthing up to enhance

vegetative cover to increase tuber yield; pest and disease surveillance for judicious use of agro-chemicals (aphids, tuber moth, late blight, bacterial wilt); dehaulming 10 – 15days before harvest to ensure skin thickening and wound healing; rouging out off-types and general field sanitation including boundaries to prevent cross infestation.

On the other hand, recommended postharvest technologies included harvesting 10 – 15 days after dehaulming with appropriate tools in good weather; sorting and grading of tubers for marketable, small and damaged tubers. Other practices include management of storage pests especially potato tuber moth using pesticides like actelic dust; regular sorting of potato in store for diseased tubers especially soft and dry rots; and using proper packaging material and storage methods (jute bags, crates, chambers, heaps).

The four-ware potato harvesting techniques evaluated included 1) Hand hoe, 2) Ox-drawn potato lifter (NARO); 3) Ox-drawn potato lifter- Farmer (redesigned with farmers' input) and 4) Tractor drawn potato lifter technologies. The purpose of the study was to evaluate different harvesting technique according to recovery of marketable tubers and extent of mechanical damages in order provide recommendations for techniques to be used for potatoes meant to be stored. Hand digging was found to cause damage to 40% of harvested potatoes and leave up to 20% of the mature tubers underground. It is estimated that 100% crop can be harvested if appropriate tools are used.

The key lessons learned were:

i. The ox-drawn potato lifter redesigned with farmers' input is more efficient than the one imported;

ii. The ox-drawn potato lifter helps minimize potato damage;

However, it was noted that for this technology to work efficiently, potato planting needs to be done in lines with 60cm ridges and ox-handlers should be trained in potato harvesting. For larger producers, tractor lifters may be a better option if fields on which the technology is to be applied are cleared of stones, stumps and boulders. For small-scale farmers, this would require working collectively or have access to leased equipment.

3.5.8. Transforming potato associations into businesses

Lead Institution: *Self Help Africa*
Activity Leader: *David Okot*
Activity Partners: *Farmer and Trader Associations*

The project aimed at building capacities of four potato associations (3 producer, 1 Trader) to become viable potato businesses through training and mentoring. Capacity building of the associations was provided in four core areas including 1) technical competence, 2) strategic networks, 3) business orientation, and 4) institutional capacity. The critical path included capacity assessment, development & validation of curriculum, curriculum based training and monitoring & mentoring. Modules provided included leadership & governance, enterprise analysis, business planning, markets and marketing, business records, savings and resource mobilization, financial literacy, elected executive and functional committees, customer specific products, business plans, marketing plans, financial strategy, and individual spending plans.

Results showed that the capacity building efforts enabled the associations to achieve various benefits including: improved access to finances because of increased internal savings (45-60%); increased gender responsiveness; reduced investment risk, bulk marketing & economies of scale, strategic linkages among the associations, and operational & transactional efficiency &

effectiveness. Challenges to transforming associations into businesses include the following: drought, storage pests/rats, delayed responsiveness in developing business & store management plans by associations, sale by weight as opposed to sacks in some market segments, and standardization of market prices.

3.5.9. Feedback from stakeholders

Moderator: Elmar Schulte-Geldermann, CIP Seed Potato for Africa Program Leader

Farmers' testimonials of benefits from the project:

A female farmer reported that she had earned an extra UGX 400,000 as a result of storing her potatoes for a period before selling. Another female farmer gave testimony that she harvested in July and sold only two bags at UGX 70,000 per bag and stored the rest which she sold in November at a higher price (UGX 100,000 per bag). Yet another female farmer reported that she harvested 60 bags of potato from one acre, sold some at 50,000 per bag and had stored the rest in anticipation of a better price. She noted that from September the stored potatoes were still good though a few had sprouted but the market had not complained. Another practice that farmers found beneficial was dehaulming because it resulted in minimal weight loss between harvesting and selling. There was consensus among farmers that using tractors during harvesting reduced losses. Traders attested that they could store and sell later and also to attract better markets. Training in record keeping was also reported as having been beneficial.

Areas that need more work

Strategies and innovations for coping with climate change/unpredictability of weather were needed. An area that was singled out in this regard was innovations for irrigation because in some areas irrigation of potatoes had started and had showed potential for increased production.

Contrasting experiences from Kenya and Uganda on the effect of packaging on the quality of potatoes on the market pointed to a need for context specific innovations for packaging. Currently in Uganda big bags are specifically used as the unit for packaging of potatoes for the Rwanda market while the preferred unit of measure in the eastern region of Uganda is kilograms. In Kenya traders prefer using 100kg bags but it leads to poor quality of potatoes on the market. Hence technological and institutional innovations are needed for ensuring quality, reliability and consistency of potatoes along the value chain.

Recommendations on the way forward

The multi-disciplinary approach where both farming and reduction of postharvest losses are addressed with a business mindset to change livelihoods should be continued. The thinking should however be undertaken within framework that ensures resilience of systems for both food security and income generation.

The linkages between farmers on the one hand and researchers and government ZARDI on the other hand should be maintained and used as leverage for tapping into funding for agricultural development.

The current work was evidently undertaken without detailed baselines with the consequence that it is difficult to quantify the adoption of innovations and benefits attributable to the project. If scaling up of the results is envisaged it will be necessary to establish the baselines. Farmers' testimonies

will not be sufficient as a basis for claiming impact. Similarly, it will be necessary to clearly show the cost-benefit analysis of adopting the technologies.

More work is needed on innovations that enable farmers to access good quality seed of the different varieties.

Institutional innovations to enable farmers to deal with market fluctuations are needed. Inspiration can be obtained from the mechanisms used in the coffee industry.

3.6. The Sweet Potato Sub-Project

Lead Institution: *CIP*
Sub-Project leader: *Dr. Gerald Kyalo*

3.6.1. Research findings and lessons learnt

The sweet potato sub-project research team made a total of seven presentations relating to improving the utilization of sweet potato and other roots and tuber crop residues for pig feeds in Uganda. The results, lessons and recommendations are summarized below:

3.6.2. Current on-farm pig feeding practices

Lead Institution: *ILRI*
Activity Leader: *Ben Lukuyu/Peter Lule*
Activity Partners: *VEDCO, CHAIN, CIP*

The major constraints of pig production include: feed availability (quantity), poor feed quality, high cost of feeds, and extreme seasonal variations. There are abundant and diverse local feeds available which farmers resort to mitigate feed shortages. However, such locally available feed resources are not well documented for use. Thus, the study aimed to: 1) Document current pig feeding practices in Masaka and Kamuli districts; 2) Determine the nutritive content of the current feeding rations used by farmers; and 3) Assess performance of pigs on current farmer feed rations.

A longitudinal study was done in the study districts, and data were collected every two (2) weeks. Generally, pigs are mostly fed by women, with high participation of children in some areas. Feed resources include: maize bran, sweet potato vines, swill, spurge and weeds. There was a higher use of mixed rations amongst farmers in Masaka compared to Kamuli district and sweet potato vines and weeds were a major feed resource on farms especially in Kamuli district. Generally, farmers fed pigs on whatever is available at that time (opportunistic feeding). The practice of mixing local feeds to improve on quality was not common among farmers but the cost of home feed rations was still high. The wet season diets were more forage based while the dry season diets were more cereal based, with sweet potato vines were mostly utilized in the wet season. It was noted that farmers generally achieved poor pig growth rates (average daily gains).

3.6.3. Sweet potato vines silage based diets for growing pigs: Findings from on-station and on-farm trials

Lead Institution: *Makerere University*
Activity Leader: *Prof. David Mutetika*

Activity Partners: *MUZARDI, ILRI*

Optimum use of affordable rations based on local ingredients can go a long way in assisting pig farmers deal with feed shortages. Sweet potato is a good alternative pig feed resource. Uganda is the highest producer of sweet potato in Africa (about 2.2 million tons/annum), with an estimated yield of 5.0 tons of vines per hectare. Sweet potato vines (SPV) also have a high crude protein content (19-22%). However, the fresh form can only be used as feed for a short period after harvest. Therefore, preservation of vines through ensiling helps to mitigate seasonal feed shortages.

The purpose of this study was to 1) determine the best combination for silage making; 2) determine the effect of silage based diet on pig performance; and 3) validated the results on-farm. On-station trials were carried out at MUZARDI - Kamenyamigo in Masaka district and data were collected over a period of 12 weeks. Findings showed that although the vines are a protein-rich feed ingredient in the diets, sweet potato silage alone does not support optimum levels of weight gain in pigs. Thus, supplementing sweet potato silage with 40% maize and soybean improved quality and performance of growing pigs. Using sweet potato vines silage can even out the supply of feed on smallholder pig farms.

3.6.4. Effect of periodic vine harvesting for feed on biomass yield of selected sweet potato varieties in Uganda

Lead Institution: *Uganda Martyrs University*
Activity Leader: *Akiror Elizabeth (MSc. Student)*
Activity Partners: *CIP, sweetpotato farmers*

Sweet potato vines and non-marketable roots can be used to make silage for livestock. Dual purpose varieties produce adequate quantities of vines and roots. However, timing of vine harvesting is very important to achieve optimum root and fodder yield. There was a need to classify varieties according to root/vine ratio as well as determining appropriate vine harvesting times. Accordingly, the specific objectives of the study were to: 1) Assess the effects of vine harvesting on the root yield of the four selected sweet potato varieties; and 2) Determine effect of vine harvesting on chemical composition of sweet potato roots. The farm trials were carried out on Uganda Martyrs University (UMU) farm in Nkozi, Masaka (central region) and Kamuli (eastern Uganda). The varieties tested included: NASPOT 11, 12 O, 13 O and the local variety. The root/vine ratio was computed using root and vine dry matter.

It was established that when sweet potato vines are harvested periodically (detopping), NASPOT 11 performed best in terms of vine/root yield in all locations, making it a suitable dual purpose sweet potato variety. Periodic harvesting of vines from the local variety reduced yield by over 60%. Generally, detopping sweet potato increased contributed to increased sweetness and the energy levels of sweet potato roots. Therefore, it is recommended that farmers detop their sweetpotato crop if they wish to increase these parameters while NASPOT 11 should be recommended to farmers intending to harvest vines for silage making.

3.6.5. Sweet potato vine and root wastages, willingness to pay for silage and economic viability of silage making

Lead Institution: *Makerere University*
Activity Leader: *Marsy Asindu (MSc. Student)*

Activity Partners: *CIP, ILRI*

High sweet potato root and vine wastage presents a missed opportunity for farmers to overcome seasonal pig feed shortages. This however presents an excellent opportunity for SMEs to invest in sweet potato silage business for pig feeding. To capitalize on this, there is need to estimate the extent of wastages as well as to ascertain the demand and farmers' willingness-to-pay for silage. The study thus set out to assess the demand and farmers' willingness-to-pay for sweet potato silage as pig feed. Semi-structured questionnaires were used to obtain data from farmers at a radius of 3 and 16 kms around pilot farmers in Kamuli and Masaka districts respectively. A binary logit model was used to analyze the data.

The assessment revealed that the mean willingness to pay price was UGX 668 per kg. There is a huge market potential for silage-based diets in both Kamuli and Masaka districts that could be exploited by SMEs. The main driver of willingness to pay was the income from pig sales.

3.6.6. Capacity building in sweet potato silage making and marketing

Lead Institution: *VEDCO*
Activity Leader: *Grace Babirye*
Activity Partners: *CHAIN, CIP*

Silage making being a new technology for farming communities in Masaka and Kamuli, training of farmers and staff was paramount for silage uptake. Trainings to staff covered silage production, gender mainstreaming, data collection, and bio-security measures. Technical training in silage making to farmers/entrepreneurs targeted 16 pilot farmers (F= 10, M= 6) and 771 non-pilot farmers. Furthermore, the business capacities of 14 potential silage business entrepreneurs (7 individual entrepreneurs, 5 farmer groups, 2 business centers) were strengthened. Thus, the following were achieved:

i. Fourteen business plans developed by silage business entrepreneurs that can be used to access funding
ii. Entrepreneurs expressed willingness to champion silage making and marketing and to continue promoting the technology after the end of the project
iii. Silage entrepreneurs produced and sold sweetpotato silage to the tune of 77 tons
iv. Farmers (adopters + pilot farmers) were making and feeding their pigs on silage
v. Two business centers for VEDCO and CHAIN were established and these will continue to offer silage services to farmers.

3.6.7. Pig marketing in Masaka and Kamuli districts

Lead Institution: *Pig Production and Marketing (PPM)*
Activity Leader: *Christopher Mulindwa*
Activity Partners: *Pig farmers in Masaka and Kamuli*

It is envisaged that promotion of sweet potato silage to reduce the shortage of pig feed in Masaka and Kamuli districts would result in increased pig production. On the other hand, strengthening market linkages was deemed important to create a market pull to pig production and therefore demand of sweet potato silage. As such PPM was contracted to strengthen the marketing capacities of pig farmers in Kamuli and Masaka districts for enhanced market access. The specific objectives were: 1) To enable farmers demand for better pig prices from traders; 2) To enable

farmers enjoy economies of scale through collective marketing; 3) To enable farmers understand pig products distribution channels; and 4) To build farmer's capacities to meet market demand for pig products.

The training covered various modules including: overview of pig meat production; trade and consumption in Uganda; emerging market opportunities for pig meat production & marketing; opportunities and constraints of different marketing channels; strategies for identifying best-bet marketing opportunities & channels for individual and collective marketing; how to search for and use market information; and pricing strategies for pig farm products. Up to 113 farmers (33 females and 80 males) were trained on pig marketing in the sub-counties where the silage intervention had been tested. A training guide "Pig and pig-meat marketing" was developed to be used by farmers during and after the training and linkages were made for farmers to supply their pigs to PPM.

Three institutional innovations for pig marketing were tested with the PPM abattoir, namely: group bulking and delivering live pigs to the abattoir by selected representatives; farmer groups bulking pigs at one central point for the abattoir to collect; and the abattoir sourcing pigs from farmers through an agent selected by farmers within their groups. The farmers preferred the third option. PPM has started to effectively adopt this innovation. However; the emerging challenge was that collecting pigs from individual farms increases transaction costs thereby reducing the profits for all the actors. In addition, many farmers still sell underweight pigs that do not attract premium prices.

3.6.8. Sweet potato silage making and marketing: A case of Twekembe Youth Group

Lead Institution: *Bavukuba Twekembe Group*
Activity Leader: *Vincent Lutwama*
Activity Partners: *CIP, NARO*

The Bavubuka Twekembe Group (BTG) is a success story of youth who have embraced the silage technology as an investment opportunity. The business involves sweet potato silage making and marketing. From experience the group estimated the cost of production for 1,500 kg silage using plastic tube silage technology at UGX 265/= per Kg, which they sold at UGX 400-500/=. In a space of one year (Nov 2015-Nov 2016) the group made a total of 15,128kg of silage and sold up to 14,652kg. In 2016 alone the group trained up to 2,140 people across nine districts in the country comprising 280 youth, 402 men and 1458 women.

Successful project's engagement with BTG demonstrated the feasibility of a process for engaging the youth in sweet potato silage making as a profitable income generating activity which enables the youth to diversify their livelihood options. Furthermore, using youth groups for capacity building of interested entrepreneurs is an effective way of scaling out the silage technology. It is recommended that in order to fortify capacity development a range of context-specific business models or options need to be developed and promoted alongside the capacity development package. In the case of BTG, for example, a business model that would mitigate the challenge of accessing operational funding, dependence on hired forage chopper, unreliable supply of sweet potato residues, high cost of inputs would be helpful.

3.6.9. Feedback from stakeholders

Moderator: Robert Mwanga, CIP-Uganda Country Manager

Further research

Further research was recommended in the following areas:

- Testing and validating more dual-purpose sweet potato varieties for different agro-ecologies
- Formulating and evaluating diets based on locally available feed stuffs in terms of pig performance and economic benefits
- Furthering research to identify most economical feed combinations with silage to achieve higher daily weight gain
- Gender dimensions in the implementation of the business models.

3.6.10. The way forward

The project results should be scaled out and this should include commercialization of the innovations. This process would necessitate accompanying information on aspects that might be of concern to the adopters and the clients of the products. Among the concerns highlighted were the scalability (i.e. whether the innovations tested in only two districts can be taken to other districts), economic considerations for all the processes, sustainability of the enterprises based on the innovations, and assurances that the products would meet the consumers' requirements such as meat quality (especially fat and taste) and nutritional value.

Youth should be supported to take advantage of the technology and commercialize silage on the market. However, the support should be to enable their businesses to become self-sustaining not to make them donor-dependent. The same goes for other business models that have been supported by the sub-project.

3.7. The Cassava Sub-Project

Lead Institution: *IITA*
Sub-Project leader: *Dr. Adebayo Abass*

3.7.1. Research findings and lessons learnt

The research findings from the nine presentations relating to extending the shelf-life of fresh cassava roots for increased incomes and postharvest loss reduction are outlined below.

3.7.2. Effect of waxing technology on Postharvest Physiological Deterioration (PPD) and biochemical composition of selected cassava varieties in Uganda

Lead Institution: *NARO*
Activity Leader: *Dr. Ephraim Nuwamanya*
Activity Partners: *IITA*

Cassava undergoes rapid Postharvest Physiological Deterioration (PPD) that occurs within two days after harvesting. This research aimed to establish the effectiveness of waxing technology in increasing the range over which fresh roots can be marketed while retaining the desired quality traits. Reduction in PPD both in laboratory and market conditions was determined. Finding showed that waxing increases the shelf-life of cassava from just a few days to more than four weeks and thus allows for extended utilization. It also improves palatability and nutritive value of

cassava. However, for waxing to be used for cyanogenic varieties, other processing techniques are required.

3.7.3. Effect of defoliation on PPD and biochemical composition of roots in different cassava varieties;

Lead Institution: *NARO*
Activity Leader: *Dr. Moses Matovu*
Activity Partners: *IITA*

Visible signs of PPD appear in cassava roots from 24-48 hours after harvesting. The deterioration starts rapidly in wounded roots during harvest, usually in the root's distal and proximal extremes. This research aimed to 1) Investigate the effect of cassava leaf defoliation (pruning) on level of PPD in Ugandan cassava varieties; and 2) Evaluate the effect of defoliation on bio-chemical properties of fresh cassava roots with storage time. The bio-chemical properties included dry matter content, % starch yield, % reducing sugars, and hydrogen cyanide (HCN) content (cyanogenic potential). Eight cassava varieties were investigated including Bufumbo, Njule, Kirimumpale, Hoima, Kigita, TME14, Nyaraboke and NASE14.

Defoliation extended the shelf-life of fresh cassava roots for four to seven days and had no effect on dry matter content, starch yield, HCN, but increased reducing sugars. The effect of defoliation on PPD varied among the different cassava varieties. The effect of the treatment was most pronounced in Bufumbriro and Nyaraboke varieties and least effective in TME14.

3.7.4. Effectiveness of pruning and High Relative Humidity (RH) storage in extending the shelf-life of fresh roots

Lead Institution: *Kyambogo University*
Activity Leader: *Elizabeth Nyakaisiki (MSc Student)*
Activity Partners: *NARO, IITA*

Traditional methods of storing cassava including soaking, burying and leaving roots un-harvested only extend shelf-life of cassava for a few days. This study aimed at extending shelf-life of cassava roots for a longer time using a combination of defoliation/pruning and high relative humidity (RH) storage.

Results showed that pruning extends shelf-life to 4-7 days while pruning followed by RH storage extends the shelf-life of most fresh cassava roots up to 28 days. The combination also had no effect on physical and chemical properties of cassava roots. Moreover, sensory characteristics of cassava roots that undergo pruning and RH storage were maintained over a longer period of time (up to 21 days). This combination of technologies can be promoted for shelf-life extension of cassava roots at household level and for market vendors.

3.7.5. Acceptability of different cassava varieties after waxing and relative humidity treatments

Lead Institution: *NARO*
Activity Leader: *Dr. Harriet Muyinza*
Activity Partners: *IITA, Farmers of Masindi and Kyenjojo*

To promote waxing and RH technologies on the market, it was necessary to determine the sensory attributes and acceptability of the treated cassava over storage time. Thus, this study

evaluated the sensory attributes and overall acceptability of waxed and RH treated roots of different varieties and how these varied with storage time. Four popular varieties were tested including NASE 14, NAROCAS 1, Tim Tim and Nyaraboke.

Findings showed that the different cassava varieties maintained their quality attributes up to 14 days with both waxing and RH treatments when compared with freshly harvested roots. Thus, the technologies can be recommended for storing roots over this duration.

3.7.6. Consumer acceptability and willingness to pay for shelf-life extended cassava roots

Lead Institution: *Makerere University*
Activity Leader: *Innocent Kwagala (MSc Student)*
Activity Partners: *NARO, IITA*

Prior to promoting waxing and RH as successful technologies for extending cassava shelf-life it is necessary to assess consumer acceptability and willingness to pay (WTP) for such differentiated products. The study thus aimed to determine factors that influence consumers' WTP for fresh cassava with shelf life extended by waxing and RH. It specific objectives were: 1) To identify consumer perceptions about attributes of shelf-life extended cassava; 2) To estimate the WTP for shelf-life extended cassava; and 3) To determine the factors that influence consumers' WTP for shelf-life extended cassava. A survey was conducted with respondents from open markets and supermarkets.

Consumer acceptability and WTP for the various forms of cassava, namely, waxed cassava, RH treated cassava and conventional cassava were assessed. Supermarket respondents showed more appreciation of waxed cassava for all parameters (color, aroma, taste, flavor, appearance and mouth feel), and minimal difference with respect to RH cassava in comparison to conventional cassava. According to open market respondents waxed cassava and conventional cassava were very similar, except for better taste, but the respondents were less satisfied with the RH cassava regarding aroma, flavor and mouth feel. Thus, waxed cassava was generally more preferred than conventional and RH cassava.

3.7.7. Multi-stakeholder partnerships for effective action and impact of shelf-life enhanced fresh cassava: Lessons learned and results from south-south collaboration

Lead Institution: *IIRR*
Activity Leader: *Robert Kaliisa*
Activity Partners: *NARO, IITA*

Collaboration at various levels were necessary for the successful implementation of the project. Collaboration at the international level facilitated knowledge and skills transfer where the Ugandan researchers visited different sites for instance the CIAT campus and the private sector actors for fresh cassava storage and marketing in Bogota, Colombia. Partnerships were established with various actors according to three project output areas as follows: 1) Capacity building of project team: CIP, CIAT, CIRAD, Agrollanos Limited (Private sector) and CLAYUCA; 2) Strengthening research and training on extended shelf-life technologies in Latin America/Africa: IITA, NARO, NaCRRI, IIRR, Kyambogo University, and Makerere University; and 3) Development of market models and partnerships with Kyenjojo and Kabarole District Local Government, Private sector (John Balinda), Rwibaare farmers marketing cooperative society limited and a number of chain of restaurants.

Among the lessons learnt from the multi-stakeholder engagements was that inter-institutional collaboration within the team was critical for attaining success. Different market segments for extended shelf-life cassava exist in Uganda but developing integrated and multiple fresh cassava root (FCR) products is critical for quick adoption and marketing. Key areas for capacity building include knowledge in the innovative fresh cassava storage technologies, practical skills for applying the knowledge and attitude change to accept the shelf-life extended cassava roots by consumers.

To further enhance effective action and impact of shelf-life enhanced cassava, there is need for continuous agronomic and pre-harvest best practice capacity building for effective application of waxing and HR treatment; further support to two waxing and RH storage pilot pack-houses is required in order to ensure their business plans are sustained. Linkages and partnerships with the private sector and encouraging entrepreneurs to invest in the technologies is critical for extended shelf-life of FCR to take root in Uganda; continuous mentoring of farmers and traders is critical; and continuous promotion through media such as radio is needed.

3.7.8. Best practices for marketing shelf-life extended cassava roots: Perspectives for farmer and trader led models

Lead Institution: *IITA*
Activity Leader: *Kelly Wanda*
Activity Partners: *NARO, IIRR*

The liberalization and privatization policies imply that markets are competitive. However, if unprepared for this competition, smallholders receive low value for their efforts. This study tested two (2) models, namely, a farmers- and a trader-led operations to market the differentiated cassava products.

In the farmer-led model, members of the cooperative run the pack-house operations and cassava roots are supplied by other members. In the trader-led model the operations at the pack-house are carried by employers and the roots are sourced from a variety of nearby producers. In the farmer-led model pack-house operations tend to have more control on their raw materials. At the time the workshop was conducted, emerging market channels pointed mainly to urban markets. Through efforts to market shelf-life extended cassava roots using the farmer- and trader-led models about 120 outlets had been contacted and negotiation for supply of waxed roots with 2 supermarkets, 3 hotels, 2 restaurants, and 2 food vendors were on-going. Further outcomes of the models would be shared at a later date.

3.7.9 Profitability of waxing and relative humidity storage for cassava roots' shelf-life extension

Lead Institution: *IITA*
Activity Leader: *Kelly Wanda*
Activity Partners: *NARO, IIRR*

The profitability analysis considered the costs involved in the waxing and RH technologies for extension of cassava shelf-life. Data on the cost items of each technology was collected right from harvesting to packaging. The costs of waxing and RH technologies were estimated at UGX 248 and 237 per kg, respectively. The price per kg of extended shelf-life cassava ranged from UGX 1,500-2,000.

3.7.10. Way forward

Lead Institution: *IITA*
Activity Leader: *Dr. Adebayo Abass*

The research initiatives need to be taken to scale and this will entail capacity building on the pre-harvest best practices for effective application of waxing and relative humidity treatment of FCR and supporting the two waxing and HR storage pilot pack-houses to ensure their business plans take off. Linkages and partnerships with the private sector and encouraging entrepreneurs to invest in the technologies will also be critical. This should go hand-in-hand with continuous mentoring of farmers and traders. A consumer sensitization strategy will be needed.

The partnership should now shift its focus to providing leadership - individually or collectively - for identifying sources of funding for scaling out. There may be a need to expand the partnership to bring on board agencies/donors who support technological innovation for cassava value chains in Africa. The ones that are already inclined in this direction include the Rockefeller Foundation and the African Development Bank (ADB). The latter is initiating a large program that will invest in different technologies for eight focus crops, including cassava. Indeed the Uganda government has already submitted a letter of intent to ADB to participate in this program and cassava was one of the priority commodities highlighted in the letter. In addition, research questions relating to cassava technologies have been submitted to form part of the Africa research agenda which is being formulated by FARA in collaboration with international research agencies and national research organizations.

Further research

There is an array of questions that additional research address. These include:

- How great is the development opportunity through increased income and gender-equitable benefit distribution from expanded market for RH-stored and waxed roots?
- What are the strengths and limitations of the use of waxing and modified atmosphere (RH) storage?
- What is the estimated economic loss reduction to the cassava industry due to PPD delay through the proposed technologies and what are their potential impacts on traditional roles of men and women?
- How can women be assisted to benefit from increased sales of preserved fresh roots to the different markets?
- What is the best age at which a particular variety is most suitable for waxing?
- Does season affect PPD?
- Does the rainy season, for instance, affect the PPD of fresh roots and softness of boiled roots?
- What factors influence the bitterness/sweetness in cassava roots harvested from the same plot and at the same time?
- Why is the same variety pruned & waxed soft when boiled at one time and then hard at other times?
- What are the varietal differences in the optimum days after pruning for reducing PPD?
- Does ridging affect the shape and size of the roots?

- Does ridging produce roots of similar shape and size?
- To what extent does ridging influence the length of the peduncle?
- What is the influence of soil type and nutrients on bitterness of both waxed and relative humidity stored cassava roots?
- What is the cultural acceptability of waxed and relative humidity stored cassava roots in open markets?
- What is the best scaling model for the promotion of shelf-life extending technologies?
- What are the effects of RH storage and pruning on enzymatic activities in cassava roots (e.g. linamarase activity)?
- What is the effect of maturity of cassava on the sensory attributes of waxed and RH stored cassava?
- What are the genetic factors that make indigenous varieties better in quality than improved varieties under different treatments?

3.7.11. Feedback from stakeholders

Moderator: Dr. Dominique Dufour, CIRAD/CIAT

A female farmer who has been involved in the process for one year testified that farmers were very interested in the technologies and even already saw a potential opportunity for penetrating the export market. However, they were still at the phase of mastering the use of the technologies and their concern was on how traction would be sustained after the project ends.

The testimony from a private sector entrepreneur confirmed the enthusiasm of the farmers in adopting the technologies but from his perspective the problem was that farmers were producing cassava that was inconsistent in quality - especially with regards to bitterness. This was not good for the market. The farmers therefore needed more support from research and extension. This includes availing them with clean planting materials of the right varieties and increasing their awareness of the factors that lower quality - especially when cassava stays in the ground for a long time. Adoption of the technologies will entail transforming farmers into a new generation capable of applying new production, harvesting and postharvest practices. In addition, there is a need for institutional innovations such as the Kabarole cassava forum in Western Uganda and for networking through these fora.

In considerations of scaling out the waxing and RH, it would be prudent to recognize that waxing gives higher quality roots than RH and that the two technologies can be promoted to target diverse market segments. For example, waxing which also includes sorting involves high costs and would be ideal for supermarkets whereas RH would be more suitable for restaurants.

Investment for scaling out should come from the private sector as has happened in South America - most notably Colombia. However, it is important to think about how the private sector will be engaged and how consumers might migrate from the informal markets to buying from supermarkets. However, this process should not lose sight of the fact that it is important to reach all the markets with quality products to ensure success in all the segments. Indeed the experience from Latin America was that adoption of waxing by farmers was between 20-30% because of high costs but adoption of pruning was 100%. Nobody was selling unpruned cassava but waxed and RH treated roots form just part of the market with the largest share taken by pruned conventional

roots sold through direct sales. Therefore, pruning has the potential to be largely adopted in Africa in the short term.

Additional research on the economics and safety of waxing and RH technologies should be part of the scaling out agenda. Highlighted areas for which information is needed include the cost of applying the technologies, the safety of using wax, the types of wax that are safe and economical. Other issues include the safety of the fungicides used in the waxing process, the palatability of the waxed cassava, and the length of time the cassava can stay - for example during transportation to markets. In addition, consumers need to be made aware that what is termed as "sweetness" of cassava means low cyanogenic potential but not sweet in terms of sugar. Related to this, consumers need to be made aware of the factors that affect cyanogenic content of cassava.

The margins at each chain node should be estimated as well as the effects of PPD at these nodes. It was recommended that going forward engagement with the private sector such as supermarkets would be critical but the precondition for this is consistency in quality. To achieve consistency, different models of production may have to be considered e.g. the plantation system of growing cassava just like in the case of sugarcane. To this end it was suggested that pilot centers demonstrating different systems of production should be established.

3.8. Gender Mainstreaming in Project Implementation

Lead Institution: *CIP*
Activity Leader: *Netsayi Mudege/Sarah Mayanja*
Activity Partners: *All sub-projects implementing partners and beneficiaries*

3.8.1. Gender research and strategy development

The gender mainstreaming approach/model used in the project comprised of four components, namely, gender landscape studies and strategy development, capacity building, gender mainstreaming in value chain & business development, and technical backstopping to the four sub-project teams. The landscape studies explored constraints that could hinder technology and innovation uptake by both men and women in relation to the proposed technologies. The studies also sought to establish the existing empowerment levels for women and men in five dimensions: agricultural production, access to resources, access to services, leadership and time.

Across the crops, findings indicated that though both men and women were resource constrained, women were more affected given their limited access to land, agricultural inputs and finance. Women also were not usually targeted for training yet they played major roles in agricultural production and would thus benefit from such training which would have a positive impact on increased productivity. Baseline values also indicated that women perceived that they were not very empowered to make decisions related to technology adoption, market engagement and innovation development.

Based on the constraints identified by men and women by category of VC actor e.g. farmers and traders under the different value chains (cassava, potato, banana and sweet potato), various context specific strategies were drawn to address such constraints. In line with the RTB/CIP gender strategy, two paradigms were considered in strategy development: (i) gender responsive and (ii) gender transformative. For instance, the strategy for addressing gender norms to facilitate women to take up leadership positions (working with Self Help Africa) in associations involved the following: working in teams so that husbands are not jealous of women's group activities,

developing timetables that are sensitive to women's needs; and sensitizing husbands about the roles and duties of female committee members. On the other hand, potato women traders advocated for rules to limit how much their fellow traders should store to avoid monopoly in using the collective store by larger male traders. The draft strategies were validated with sub-project target group(s) and implementers and finalized for operationalization.

3.8.2. Capacity building and technical backstopping to the teams

Capacity building and technical backstopping to sub-project teams centered on mainstreaming gender in PMCA and business plans. Accordingly, teams were offered gender awareness trainings and supported to integrate gender in all their activities e.g. in postharvest and marketing research and for M&E by analyzing gender issues and identifying solutions using various tools. The gender team also supported capacity development in gender-responsive business plan development which assisted the process of developing business plans in the various sub-projects.

3.8.3. Results, lessons learnt, recommendations

For successful integration of gender and meaningful capacity development, there is need for a committed gender person attached to each sub-project on the ground. This was possible for the banana and sweet potato sub-projects which edged the others in the gender aspect.

3.8.4. Gender mainstreaming in value chain & business development

The gender strategies were developed for the sub-projects providing options for integrating gender at all levels of the value chain. It was noted that there were some concerns that affected the different actors alike, for instance, among traders, both men and women prioritized market related constraints except in the potato case where men only mentioned marketing constraints; and both men and women prioritized access to credit and finance. Also, constraints such as lack of business development services and training seem to cut across men and women. However, this does not imply that men and women are affected in the same way even where they may be affected by similar challenges since women have less access to and control of key resources and limited decision making power. For instance, women unlike men prioritized production related issues e.g. limited access to equipment and manure, in addition to lack of quality seed and other inputs. Various needs/constraints were pointed out by both men and women also regarding safety and health related issues associated with the various VC activities and technologies.

3.8.5. Results, lessons learnt, recommendations

Gender mainstreaming in VC and business development is possible but challenging. Factors for consideration while pursuing gender mainstreaming across the VC include the following:

- There is need to go beyond technical aspects of technology and also consider how it is socialized
- There is need to develop technologies that reduce drudgery especially in production and processing where women are heavily involved
- There is need to involve men and women in extensive evaluation of technologies and develop easy to use guides that address health and safety concerns

- There is need to pay attention to health issues when developing hardware (encountered 4 cases of injuries from silage choppers)
- Training is important, especially business training in local languages
- Women's role models are key
- Engage female farmers in group and round table discussion to come up with their own solutions e.g. how to negotiate with husbands to be allowed to participate
- Improve targeting and recruitment making extra effort to recruit women into projects
- Engaging men is critical, for instance, they should be sensitized on gender issues at family level (whole family approach) so that they can appreciate that women can also be involved in planning and budgeting for the success of the different enterprises

3.8.6. Way forward

The next steps for the gender mainstreaming component included the following:

- Scaling up model for gender mainstreaming to other projects through providing training and technical support to partners on PMCA using experiences from RTB-ENDURE, for instance, this had been done with AGRODEP and FARA in the past and there is an opportunity to present and showcase at the Global Donor Platform for Rural Development
- Engaging with projects like VISTA Tanzania and AVCD Kenya, Irish Aid (CIP Ethiopia) on integrating some of the tools and processes that worked in RTB-ENDURE
- Exploring the possibility of continued collaboration with the CGIAR Research Program on Policies, Institutions and Markets (PIM)
- Documenting of process and lessons learnt, for instance integrating gender into RTB postharvest and value chain development projects and RTB seed systems in addition to a short brief on gender and health issues in RTB
- Utilizing RTB funds to follow-up on a study on commercializing sweet potato silage making with women in mind
- Though the gender strategies were not completely rolled out due to time and financial constraints, they have been widely shared and can be adapted by other projects and research interventions.

4.0 The Workshop Exhibition

4.1. Overview

The exhibition gave an opportunity for the researchers on the various sub-projects to further interact with participants and provide information concerning the various innovations to facilitate their adoption and use by the general public. During the exhibition, held at the Entebbe Botanical Gardens, research teams made poster presentations and conducted some technology demonstrations.

4.2. Official Opening of the Exhibition

Prof. Tushemereirwe, Director, National Agricultural Research Laboratories (NARL)

The official opening remarks for the exhibition were in the context of the persistent challenges rooted in low productivity that is not only due to biological and physical factors such as pests, diseases and declining soil fertility but that is now being increasingly being understood to be compounded by social and economic factors. Notable among the latter factors are the poor incentives for commercial orientation of farmers due to the low prices they receive for their produce. Overcoming constraints of this nature required a holistic approach to research and innovation that even brings on board the consumers and their interests. Such research would lead to innovations that for example contribute to price stabilization in a win-win situation between farmers and consumers.

The outcome of the exhibition was to trigger a process that would lead to some of the displayed products getting into and successfully competing in the market. The seeds for this outcome are in the way the research is structured. Researchers should begin to design projects so that the concerns are not only about the outputs that they can exhibit but also take on board concerns for the desired outcomes. The RTB-ENDURE project had taken a step in the right direction but more steps needed to be taken to provide more evidence on adoption to support initiatives for scaling out, and to brand the products in the process of commercializing them. These steps will require stronger and sustained engagement between researchers and entrepreneurs. The Exhibition should therefore be taken as the first of the steps that should be taken going forward after the conclusion of the project.

4.3. Results of the Poster Competition

The poster review teams assessed the posters presented during the exhibition on day one. The assessment was based on several criteria including logical flow, content, organization, clarity, relevance and completeness. In general, it was noted that the posters were good but there were gaps in relation to the original business cases implying the need for more pilots in the future. As a result of the assessment, four posters were shortlisted, namely: i) Reducing Postharvest Losses and Promoting Product Differentiation in the Cooking Banana Value Chain by Enoch Kikulwe; ii) An Evaluation of the Performance of Pigs Fed on Supplemented Sweetpotato Silage Diets by James Francis Ojakol; iii) Piloting Ware Potato Storage in Mt. Elgon by Arthur Wasukira; and iv) Acceptability of Different Cassava Varieties after Waxing and Relative Humidity Treatments by Harriet Muyinza. Each of the presenters made a pitch to the participants in the workshop. However, given the limitations in the projections of the posters which made it difficult for the

participants to have good view and make an informed decision about the preferred one, participants unanimously agreed that all the presenters equally shared the award.

4.4. Official Closure of Exhibition and Workshop

Dr. Diego Naziri, Leader, RTB-ENDURE Project
Graham Thiele, Director, RTB
Harriet Muyinza, Representing the Head of Extension, MAAIF.

From the perspective of the RTB-ENDURE Project Leader, the exhibition illustrated that although the project had made significant progress and achievements there was still a lot to be done. Sadly, because of some changes within the European Union, funding for a second phase of the project was unlikely. On a positive note, however, the project had engaged national researchers and private sector and pilots had been conducted, which provides a basis for the innovations to move forward. For instance, the silage youth group and the banana multiplication business where people had pooled own resources together to start business signaled a path to sustainability. The fact that there are many pending research questions and that new ones have emerged as a result of the project should be taken as a seed for future research initiatives. The development business plans is expected to facilitate future engagement with value chain stakeholders and other research and development initiatives.

From the vantage point of the RTB Program Director, it was interesting and satisfying to see the project come from an idea on paper to completion. Many things had been covered during the workshop, and the Project leader, workshop facilitator and all participants were to be thanked and congratulated for the success of the Exhibition – as well as the Workshop. The workshop proceedings would be complemented by a synthesis of the achievements and innovations for each of the research teams.

The representative of the Director of Extension, MAAIF, thanked the RTB Program for having initiated the research and for putting together multi-stakeholder teams that significantly included the private sector. The Ministry in general and NARO in particular, recognized the need to change the way research is being done. In this regard, there were many lessons to take from this project. The results and lessons from RTB-ENDURE therefore reinforce the foundation not only for more research but also for a multi-stakeholder approach. The end of the project should therefore be regarded as a new beginning for more research on reducing postharvest losses and adding value to roots, tubers and bananas

To view the workshop photos, please click here to visit our Flickr page.

5.0 Synthesis of Project Achievements and Next Steps

Following guidance from the Director RTB in his closing remarks, the four sub-projects met immediately after the workshop and drafted a brief write up detailing:

- Summary of the achievements
- Major scientific and value chain accomplishments
- Critical gaps in research and value chain development and
- Key steps for moving the innovations forward in 2017 and beyond

The briefs are embedded in this report and can be accessed through the links below.

5.1. The Banana Sub-Project

Banana sub-project _Summary_2017.doc

5.2. The Potato Sub-Project

Synthesis of project outputs_Potato.doc

5.3. The Sweetpotato Sub-Project

sweetpotato silage work summary CIP_F

5.4. The Cassava Sub-Project

Extending the shelf life of fresh cassava

ANNEXES

Annex 1. List of Participants

	First Name	Last Name	Title	Institution	City	Country
1	Susan	Ajambo	Research Assistant	Bioversity International	Kampala	Uganda
2	Beatrice	Akello	Director of Research	MuZARDI	Mukono	Uganda
3	Elizabeth	Akiror	Student	Uganda Martyrs University	Kampala	Uganda
4	Abel	Arinaitwe Byarugaba	Research Scientist	NARO	Kabale	Uganda
5	Marsy	Asindu	Student	Makerere University	Kampala	Uganda
6	Vivian	Atakos	Regional Communication Specialist	CIP-Nairobi	Nairobi	Kenya
7	Julius Peter	Ayo	District Agriculture Officer	Mbale District L.G.	Mbale	Uganda
8	Grace	Babirye	Program Manager	VEDCO	Kampala	Uganda
9	Yona	Baguma	DDG-Research	NARO	Entebbe	Uganda
10	Kaloli	Balikitenda	Farmer	-	Kamuli	Uganda
11	John Brian	Balinda	Entrepreneur	BRICA INVESTMENT	Fort Portal	Uganda
12	Joyce	Banan	Chairperson	KACOFA	Kapchorwa	Uganda
13	David	Chemusto	Chairperson	KACOFA	Kapchorwa	Uganda
14	Luwandagg a	David	Market Specialist	Farm Gain Africa	Kampala	Uganda
15	Simon	Heck	Sweetpotato Program Leader	CIP-Uganda	Kampala	Uganda
16	Brian	Isabirye	Theme Leader	ASARECA	Entebbe	Uganda
17	Archileo	Kaaya	Head of Department	Makerere University	Kampala	Uganda
18	Robinson	Kabanda	Officer Animal Production	KCCA	Kampala	Uganda
19	Veronica	Kabanyoro	Field Based Crop Inspector	MAAIF	Kabarole	Uganda
20	Jolly	Kabirizi	Principal Research Officer	NARO	Tororo	Uganda
21	Kato	Kalema	Field Officer	CHAIN-Uganda	Masaka	Uganda
22	Eldad	Karamura	Regional Representative	Bioversity International	Kampala	Uganda
23	Aloysious	Karugaba	District Production Officer	Isingiro District Local Govt.	Isingiro	Uganda
24	Anna	Kateregga	Farmer	-	Masaka	Uganda
25	Enoch	Kikulwe	Scientist	Bioversity International	Kampala	Uganda
26	Moses	Kiptala	Chairperson	MIFA	Mbale	Uganda
27	Dan	Kisauzi	Director	NIDA	Kampala	Uganda
28	Titus	Kisauzi	Director	AgroBasics(U) Ltd	Kampala	Uganda
29	Nuuru Kiiza	Kisembo	Chairperson	Rwibale Farmers' Marketing Cooperative	Isingiro	Uganda
30	Lorna Winnie	Kwaka	Student	Makerere University	Kampala	Uganda
31	Gerald	Kyalo	Agronomist	CIP-Uganda	Kampala	Uganda

32	Aloys	Lorkeers	Head of Section	EU	Kampala	Uganda
33	Yusufu	Lubega	District Agriculture Officer	Rakai District	Rakai	Uganda
34	David	Lukungu	National Agronomist	IFDC	Kampala	Uganda
35	Ben	Lukuyu	Country Representative	ILRI	Kampala	Uganda
36	Peter	Lule Mulindwa	Research Technician	ILRI	Kampala	Uganda
37	Vincent	Lutwama	Student	Bavubuka Twekembe	Kampala	Uganda
38	Enoch	Lwabulanga	Agricultural Officer	Bioversity International	Rakai	Uganda
39	Rose	Makumbi	Research Technician	CIP-Uganda	Kampala	Uganda
40	Patrick	Makweta	Managing Director	El-Shaddai International	Mbale	Uganda
41	Priscilla	Marimo	Post-doctoral Fellow	Bioversity International	Kampala	Uganda
42	Joseph	Masereka	Lecturer/Associate Dean	Uganda Martyrs University	Kampala	Uganda
43	Moses	Matovu	Research Scientist	NARO	Kampala	Uganda
44	Joseph	Matovu	Programme Officer	CHAIN-Uganda	Kampala	Uganda
45	Sarah	Mayanja	Research Associate	CIP-Uganda	Kampala	Uganda
46	Geoffrey	Menya	Research Assistant	NARO-NARL	Kampala	Uganda
47	Netsayi Noris	Mudege	Gender Scientist	CIP-Nairobi	Nairobi	Kenya
48	Hakimu	Mufumbiro	Head, Food and Agriculture Standard	Uganda National Bureau of Standards	Kampala	Uganda
49	Vicent	Mugabi	Extension Officer	-		Uganda
50	Edriisa	Mugampoza	Senior Lecturer	Kyambogo University	Kampala	Uganda
51	Christopher	Mulindwa	General Manager	PPMU	Kampala	Uganda
52	Yvonne	Munabi	Investment Executive	UIA	Kampala	Uganda
53	David	Mutetika	Lecturer	Makerere University	Kampala	Uganda
54	Kimani	Muturi	Managing Director	AFRIBANANA	Kyambogo	Uganda
55	Harriet	Muyinza	Senior Research Officer	NARO	Kampala	Uganda
56	Robert	Mwanga	Sweetpotato Breeder	CIP-Uganda	Kampala	Uganda
57	Ruth	Nabaggala	Programme Officer	PELUM	Kampala	Uganda
58	Sauda	Nabatanzi	Freelance Writer	New Vision Newspaper	Kampala	Uganda
59	Annet	Nabigaga	Trader	-	Rakai	Uganda
60	Caroline	Nabukeera	Student	Makerere University	Kampala	Uganda
61	Maria	Nabukenya	Farmer	-	Rakai	Uganda
62	Gideon	Nadiope	Team Leader & Livestock Expert	ISU-UP	Kamuli	Uganda
63	Ms	Nakamya	Store Manager	MPODA	Mbale	Uganda
64	Patricia	Nakatudde	Veterinary Officer	Masaka District	Masaka	Uganda
65	Esther	Nakkazi	Journalist	MEDIA	Kampala	Uganda
66	Adiah	Nakuti	News Reporter	UBC Television	Kampala	Uganda
67	Asha	Nalunga	Socio-Economist	NARO	Kampala	Uganda
68	Sam	Namanda	Senior Research Associate	CIP-Uganda	Kampala	Uganda
69	Ruth	Nanfuka	Freelance Journalist	New Vision Newspaper	Kampala	Uganda
70	Rose	Nanyondo Mugabe	Programme Officer	IIRR	Kampala	Uganda

71	Losira	Nasirumbi-Sanya	Research Officer/PM	MuZARDI	Mukono	Uganda
72	Diego	Naziri	RTB-ENDURE Project Leader	CIP-Uganda	Kampala	Uganda
73	Kephas	Nowankunda	Head of Programme	NARO	Kampala	Uganda
74	Henry	Nsereko	Executive Director	VEDCO	Kampala	Uganda
75	Patricia	Nsiime	Project Manager	FAO	Kampala	Uganda
76	Ephraim	Nuwamanya	Research Officer	NARO	Kampala	Uganda
77	Elizabeth	Nyakaisiki	Student	Kyambogo University	Kampala	Uganda
78	Pamela	Nyamutoka	Country Director	IIRR	Kampala	Uganda
79	Sospeter	Nyamwaro	Project Coordination	CIAT	Kampala	Uganda
80	James Francis	Ojakol	Student	Makerere University	Kampala	Uganda
81	David	Ojara Okot	Programme Coordinator - Agricluture and Livelihoods	Self Help Africa		Uganda
82	Julius	Okello	Impact Assessment Specialist	CIP-Uganda	Kampala	Uganda
83	Gibert	Olivier	Researcher	CIRAD		Indonesia
84	Monica	Parker	Scientist	CIP-Nairobi	Nairobi	Kenya
85	Gordon	Prain	Senior Advisor	CIP-Lima	Lima 12	Peru
86	David	Rupiny	Senior Business Reporter	Uganda Radio Network	Kampala	Uganda
87	Patrick	Seruyange	Operations Advisor	EU	Kampala	Uganda
88	George	Shiondo	Chairman	WASWAPA	Mbale	Uganda
89	Kirimi	Sindi	Country Manager	CIP-Rwanda	Kigali	Rwanda
90	Nicholas	Ssekabunga	Farm Manager	NARO-MuZARDI	Masaka	Uganda
91	Gorrettie	Ssemakula	Principal Research Officer	NARO	Kampala	Uganda
92	James	Ssemwanga	Managing Director	The Ssemwanga Centre	Kampala	Uganda
93	Godfrey	Taulya	Post Doc (Modeler)	IITA/Bioversity	Kampala	Uganda
94	Consuer	Tenente	Partnership Manager	AKF	Kampala	Uganda
95	Graham	Thiele	Team Leader, RTB	CIP-Lima	Lima 12	Peru
96	John	Tibesigwa Senkumba	Student	Makerere University	Kampala	Uganda
97	William	Tinzaara	Research Scientist	Bioversity International	Kampala	Uganda
98	Kelly	Wanda	Consultant	IITA	Kampala	Uganda
99	Arthur	Wasukira	Research Officer	NARO-BuGIZARDI	Mbale	Uganda
100	Deborah	Wendiro	Head of Department	Uganda Industrial Research Institute	Kampala	Uganda
101	Edith		Farmer	-	Kampala	Uganda

Annex 2. Workshop Program

Program: 6th December 2016

Time	Activity	Responsible
8.00-8.20 am	Registration	Martha Ameru (CIP)
8.20-8.30 am	Welcome and workshop program	Diego Naziri (Project Leader)
8.30-8.40 am	Overview of the ENDURE Project	Diego Naziri (Project Leader)
8.40-8.50 am	Overview of the RTB Program	Graham Thiele (RTB Director)
8.50-9.00 am	Official opening of workshop	Yona Baguma (NARO DDG Research)
The Banana sub-project: research findings, achievements and way forward		
9.00-9.05 am	Reducing losses and promoting product differentiation in the coking banana value chain: Overview	Enoch Kikulwe (Bioversity)
9.05-9.15 am	Assessment of postharvest losses in the cooking banana chain	Enoch Kikulwe (Bioversity)
9.15-9.30 am	Banana presentation forms less susceptible to damage: Storage temperatures for cooking banana	Kephas Nowankunda (NARO)
9.30-9.40 am	Optimal harvest age for cooking bananas	Kephas Nowankunda (NARO)/ Olivier Gibert (CIRAD)
9.40-9.50 am	Food and income security of banana farmers through sucker staggering	Vincent Mugabi/ Kephas Nowankunda (NARO)
9.50-10.00 am	Sell by weight or visual? Insights from the cooking banana value chain in Uganda	Asha Nalunga (NARO)
10.00-10.10 am	Increasing access to planting materials of market demanded banana varieties and lessons learned	Asha Nalunga (NARO)
10.10-10.20 am	Cooking banana trade: Can smallholder farmers access organised markets?	Eliot/Hasifa (UFVEPA)
10.20-10.30 am	The banana value chain, gender and enabling environment: Lessons learned	Susan Ajambo (Bioversity)
10.30-11.00 am	HEALTH BREAK	Hotel
11.00-11.30 am	Discussion	Eldad Karamura (Bioversity Reg. Director)
The Potato sub-project: research findings, achievements and way forward		
11.30-11.35 am	Presentation of project partners	Monica Parker (CIP)
11.35-11.45 am	Construction of on-farm ware potato storage facilities (Collective stores and improved traditional stores)	Arthur Wasukira (NARO)

11.45-11.55 am	Evaluation of potato (*Solanum tuberosum*, L.) genotypes for adaptability in Mt Elgon region	Lorna Kwaka (Makerere University)
11.55-12.05 pm	Postharvest potato variety testing and results	John Senkumba (Makerere University)
12.05-12.20 pm	Current ware potato postharvest management practices in eastern Uganda	Caroline Nabukeera (Makerere University)
12.20-12.30 pm	Implications of immature harvesting and regional potato trade	Sam Namanda (CIP)
12.30-12.40 pm	Evaluation of ware potato harvesting techniques and pre & post-harvest management options	Arthur Wasukira (NARO)
12.40-12.50 pm	Transforming potato associations into businesses	David Okot (Self Help Africa)
12.50-1.00 pm	Summary and way forward	Monica Parker (CIP)
1.00-1.30 pm	Discussion	Elmar Schulte-Geldermann (CIP Seed Potato Africa Leader)
1.30-2.30 pm	LUNCH	Hotel
2.30-2.40 pm	Travel to Botanical Gardens	Martha Ameru (CIP)
2.40-2.50 pm	Official opening of the Exhibition	Prof. Tushemereirwe (NARL Director)
2.50-4.00 pm	Exhibition	Exhibitors
4.00-4.30 pm	Refreshments for invited participants	Hotel
4.30-5.00 pm	Interactive poster session	PI, posters' authors and Review Teams
5.00-5.15 pm	Travel back to hotel	Martha Ameru (CIP)
7.00 pm	COCKTAIL	Hotel

Program: 7th December 2016

Time	**Activity**	**Responsible**
8.00-8.20 am	Registration	Martha Ameru (CIP)
8.20-8.30 am	Introduction to day 2	Diego Naziri (Project Leader)
The Sweetpotato sub-project: research findings, achievements and way forward		
8.30-8.45 am	Current on-farm feeding practices	Ben Lukuyu/Peter Lule (ILRI)

8.45-8.55 am	Sweetpotato vines silage based diets for growing pigs: Findings from on-station and on-farm trials	David Mutetika (Makerere University)
8.55-9.05 am	Suitable dual purpose sweetpotato varieties and their cutting management	Akiror Elizabeth (Uganda Martyrs University)
9.05-9.15 am	Sweetpotato vine and root wastages, willingness to pay for silage and economic viability of silage making	Marsy Asindu (Makerere University)
9.15-9.25 am	Capacity building in sweetpotato silage making and marketing	Grace Babirye (VEDCO)
9.25-9.35 am	Pig marketing in Masaka and Kamuli districts	Christopher Mulindwa (Pig Production and Marketing)
9.35-9.45 am	Sweetpotato silage making and marketing: A case of Twekembe Youth Group	Vicent Lutwama (Bavukuba Twekembe)
9.45-9.55 am	Outputs to date and future perspectives	Gerald Kyalo (CIP)
9.55-10.25 am	Discussion	Robert Mwanga (CIP Country Manager)
10.25-10.45 am	HEALTH BREAK	Hotel
The Cassava sub-project: research findings, achievements and way forward		
10.45-10.55 am	Effect of defoliation on PPD and biochemical composition of roots in different cassava varieties	Moses Matovu (NARO)
10.55-11.05 am	Effectiveness of pruning and high relative humidity storage in extending the shelf-life of fresh roots	E. Nyakaisiki (Kyambogo University)
11.05-11.15 am	Effect of waxing technology on PPD and biochemical composition of selected cassava varieties in Uganda	Ephraim Nuwamanya (NARO)
11.15-11.25 am	Acceptability of different cassava varieties after waxing and relative humidity treatments	Harriet Muyinza (NARO)
11.25-11.35 am	Consumer acceptability and willingness to pay for shelf-life extended cassava roots	Innocent Kwagala (Makerere University)
11.35 11.45 am	Multi-stakeholder partnerships for effective action and impact of shelf-life enhanced fresh cassava: Lessons learned and results from south-south collaboration	Robert Kaliisa (IIRR)
11.45-11.55 am	Best practices for marketing shelf-life extended cassava roots: Perspectives for farmer and trader led models	Kelly Wanda (IITA)
11.55-12.05 pm	Profitability of waxing and relative humidity storage for cassava roots' shelf-life extension	Kelly Wanda (IITA)
12.05-12.10 pm	Extending the shelf-life of fresh cassava roots: Progress and prospects for technology uptake in Africa	Abass Adebayo (IITA
12.10-12.40 pm	Discussion	Gordon Prain (CIP Social Sciences Leader)
12.40 – 1.00 pm	Gender mainstreaming in RTB postharvest and marketing research	Netsayi Mudege/Sarah Mayanja (CIP)

1.00-1.30 pm	Feedback from the poster session, posters' speed presentations and awards. Closure of Science sessions	Review Teams, posters' presenters and Diego Naziri
1.30-2.30 pm	LUNCH	Hotel
2.30-2.40 pm	Travel to Botanical Gardens	Martha Ameru (CIP)
2.40-4.00 pm	Exhibition	Exhibitors
4.00-4.30 pm	Refreshments for invited participants	Hotel
4.30-5.00 pm	Official closure of Exhibition and Workshop	Beatrice Byarugaba (MAAIF Head Extension)
5.00 pm	Travel home	Participants (Martha for upcountry participants only)