



RESEARCH
PROGRAM ON
Roots, Tubers
and Bananas



Investing in rural people

RTB-ENDURE: ExpaNding Utilization through Research

Final Technical Report

Potato Sub-project

Reporting period:

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I. DESCRIPTION OF THE SUB-PROJECT (HALF A PAGE)

In eastern Uganda, potatoes are produced/harvested biannually. Limited access to storage facilities and other shelf-life extension technologies to store tubers without sprouting, rotting and loss of moisture leads to physical and economic losses. In order to limit these postharvest losses, producers tend to sell the potatoes immediately after harvest. Current practices result in a two marketing windows over the year, approximately 2 to 3 months each. Storage technologies can extend the marketing period to 8 to 9 months, depending on the storability of potato.

The potato subproject aims to improve access to potato markets through validating and promoting postharvest storage technologies and practices. The project is led by CIP partnering with BUGIZARDI, SelfHelp Africa and Makerere University. The project aims to improve integration in potato value chains by i) increasing the marketing period from five to 8 - 9 months, mainly through postharvest storage, ii) understanding potato markets in east Uganda, iii) enhancing entrepreneurial skills of actors involved in postharvest storage, iv) identifying varieties of potato balancing farmer- and market-preferred traits, and v) improving harvesting and handling practices. Through addressing the constraints and building on the opportunities along the potato value chain, the goal is to develop strategies to improve income of potato farmers through enabling them to integrate into markets by better control of potato sales and rational marketing during harvest gluts, thus increasing market opportunities by providing consistent year-long supply of potatoes.

The project entails validating off the grid, low-cost postharvest technologies, assessing the socio-economic feasibility of promoting adoption of postharvest technologies, and identifying the market constraints and opportunities at each node along the value chain. Specifically, the project works with farmer and trader associations to test and validate improved traditional and collective ambient storage technologies, with capacities of approximately 10 and 50 tonnes, respectively, gathering data on biological aspects of storage along with socio-economics of storage management at the household and association levels. Additionally, the project is developing entrepreneurial skills to enable postharvest storage users to better integrate into potato markets to promote investments in storage.

ACRONYMS AND ABBREVIATIONS

BUGIZARDI	Buginyanya Zonal Agricultural Research and Development Institute
KACOFA	Kapchorwa Commercial Farmers Association
MIFA	Mengya Integrated Farmers Association
MPODA	Mbale Potato Dealers Association
SHA	Self Help Africa
WASWAPPA	Wanale Seed and Ware Potato Producers Association

II. EXECUTIVE SUMMARY (1 PAGE)

The potato subproject aims to improve access to potato markets through improving access to postharvest storage, and improving entrepreneurial skills of farmers and associations. Through building on the opportunities along the potato value chain, the goal is to develop strategies to improve income of potato farmers through enabling them to integrate into markets by better control of potato sales through improved varieties and appropriate storage.

Potato production in the region is constrained by the poor marketing of the available varieties. The project sought to evaluate CIP clones and the introduced varieties for production in Mt. Elgon region. Specifically we wanted to determine agronomic performance of 18 new potato genotypes in Mt Elgon region and to assess the effect of staggered planting on potato tuber yield and occurrence of late blight and bacterial wilt diseases. Lower disease incidences were recorded on the improved genotypes 392797.22 and 393079.4 compared to local varieties. Improved genotypes like 398208.704, 398208.29, 393385.39 and 392797.22 had higher tuber yield of 31.3 to 46.3t/ha compared to only 30 t/ha for the commercial variety Victoria.

There are significant losses along the potato value chain most especially at post-harvest to consumption. These are attributed to the lack of proper storage facilities that would extend the ware potato shelf life. The project has piloted ambient and traditional/wooden potato stores in eastern Uganda in the areas of Kween, Kapchorwa and Mbale Districts. The value from potato storage is largely dependent on the quality of the stored product. This study was hence carried out to investigate the effectiveness of the ambient stores in maintaining potato quality and the storability of the newly introduced varieties. Eleven potato varieties including 392797.22, 398208.704, 393079.4, and 393385.39, Kinigi, Victoria, Rwangume, Rwanshaka, Cruza, Bumbamagara and Shangi were stored in ambient stores in Kapchorwa Town council (1,800 m), Bennet (2,300 m), and Mbale Town Council (1,200 m). These varieties were studied for their storage behavior, physical and chemical properties with special reference to their potential in chip processing and consumer acceptability. Farmer potatoes/ association potatoes were also stored in traditional stores. The relative humidity in Benet and Kapchorwa (85%) was higher than that in Mbale town (75%) while the average temperatures were lower in Benet (15.4⁰C) than Mbale at 22⁰C. The ambient store in Kapchorwa maintained better physio-chemical properties like a higher dry matter content, lower reducing sugars and a higher pH in comparison and also better processing quality properties like better chip colour, higher texture, lower oil uptake and lower chip moisture content in comparison to other ambient stores. CIP clone 393079.4 had the highest dry matter, high PH and a longer dormancy while CIP clone 398208.704 also has a long dormancy, high dry matter, low pH, high reducing sugar, high chip texture but with lowest chip moisture content.

The development of the potato value chain is dependent on the involvement of several stakeholders/actors along the value chain. The eastern regional potato innovation platform has become stronger through various interactions facilitated by Buginyanya ZARDI. The platform was able to hold five sessions through the project life. In these an executive committee of 9 was elected, a general work plan developed and a possible business linkage created. The executive pledged to remain together and grow stronger despite the looming end to the project. BugiZARDI also offered to continue supporting growth of the platform and together seek for further support to develop potato value chain in Eastern Uganda.

The potato season in 2016 was characterized by long drought which affected yields and cropping cycle. Several association members were not able to establish potato fields in time thus affecting the planned store evaluations. The four ambient stores were available for full research but stocking was hampered by the high market prices offered at the farm gate. This resulted into most of the potato being sold out from the association members and thus delayed association potato for research purposes. There was also some challenges in the structures supporting the ambient stores in Mbale and Wanale which necessitated a re-enforcement using steel frames for all the stores to ensure both safety and extended lifetime of the stores. A new design was developed and established for the Mbale Town store under Mbale potato dealers Association (MPODA). This new design will be adopted in future for any establishment of new stores in the region.

Affordable options of storage using the improved traditional wooden stores was also introduced and piloted with 12 host members. The twelve stores were finally constructed at an average cost of \$1,084. There was good reception from the hosts with many offering supportive services such as labor, meals and storage for the materials. The construction of these stores met several setbacks in regard to logistical arrangements and procurement systems delays and accessibility hindrances'. Research with farmer potatoes was also conducted for one season in four of the traditional stores close to the ambient stores except in Mbale Town. It was observed that potato in Benet and Wanale locations stayed good for longer. Conclusive results from the research student are yet to be completed.

Table 1: Key Sub-project Outputs and Current Status

Output	Deliverable	Due Date		Current Status ¹	If delayed, indicate revised Date		Comments regarding progress ²
		Mon	Year		Mon	Year	
1. Current status and ware potato marketing system in Eastern Uganda mapped and gender based market constraints and opportunities identified, analyzed along the potato value chain ³		June	2015		Aug	2015	
	a) 1 Potato production, post-harvest & storage status report	June	2015		Aug	2015	
	b) Potato market structure report	June	2015		Aug	2015	
	c) Report on gender based constraints & opportunities in ware potato along the VC	June	2015				
2. Testing and validation of pre-harvest and storage methods by potato variety under different ambient conditions developed taking into account technical, economic and social aspects as well as consumer acceptability ⁴		Oct.	2016				
	a) 1 report on postharvest quality of potato by variety and storage conditions	June	2016	Achieved	Nov	2016	3 seasons of work in ambient stores completed and 1 season in traditional stores, complete data to be prepared for publication

¹ Indicate either achieved, on-track, or delayed for each (output and deliverable)

² Comment on the progress in a short narrative format for both the output and the deliverable

³ Sam Namanda (CIP)

⁴ Arthur Wasukira (NARO)

Output	Deliverable	Due Date		Current Status ¹	If delayed, indicate revised Date		Comments regarding progress ²
		Mon	Year		Mon	Year	
	b) Report on socio-economic and consumer acceptability aspects of different storage practices.	Dec.	2015		Oct	2016	
	c) 1 report assessing store designs for different stakeholders	June	2016		Oct	2016	
	d) 1 report on potential impact of the technology on women and households	Oct.	2016				
	e) Three MSc theses	Oct.	2016				
3.	Capacity in ware potato pre harvest and storage methods for producers, traders, researchers and extension agents strengthened ⁵	June	2016				
	a) Guidelines on ware potato postharvest and storage techniques	June	2016	Achieved	Oct	2016	Draft guidelines were developed and used at trainings, final guidelines submitted March 2017
	b) Report on the trainings on better pre-harvest and appropriate storage management techniques	June	2016	Achieved	Nov	2016	Final consolidated report developed and submitted as a deliverable in March 2017
4.	Skills in entrepreneurship, agribusiness and collective action developed for selected actors in specialized ware potato market ⁶	Jun.	2016				

Commented [MP1]: 2A, 2C, 3A and 3b need to be delayed until Sept to enable another postharvest season to complete thus better observations and analysis of the technologies

⁵ Arthur Wasukira (NARO)

⁶ Misaki Okotel (Self Help)

Output	Deliverable	Due Date		Current Status ¹	If delayed, indicate revised Date		Comments regarding progress ²
		Mon	Year		Mon	Year	
	a) 1 guideline on association/ group development for ware potato agri-business	Jun.	2015		June	2016	
	b) Report on the training on entrepreneur skills and ware potato (marketing	Jun.	2016				
5. Recommendation for extending shelf life, increased utilization and reduction of post-harvest losses along ware potato value chain disseminated ⁷		Oct.	2016				
	a) Protocol on best bet business model for reducing post-harvest losses along ware potato value chain	Oct.	2016	Delayed	May	2017	This will be a consolidation of all the research work done in the project which is yet to be fully written up for each section, team need facilitation for joint development of the deliverable

⁷ Arthur Wasukira (NARO)

III. PROGRESS NARRATIVE BY SUB-PROJECT OUTPUT

1. Current status and ware potato marketing system in Eastern Uganda mapped and gender based market constraints and opportunities identified, analyzed along the potato value chain (Sam Namanda -CIP) I have already drafted the report on market tracking and will share with you late tomorrow) The I will draft presentation for the workshop on Sunday.
2. Testing and validation of pre-harvest and storage methods by potato variety under different ambient conditions developed taking into account technical, economic and social aspects as well as consumer acceptability (Arthur Wasukira - NARO)

2.1 Evaluating adaptability of new potato clones in Mt. Elgon (MSc. Student: Ms. Lorna Winnie Kwaka, Crop Science, College of Agriculture and Environment Sciences of Makerere University)

Introduction

The Mt. Elgon zone is the second largest producer of potato in Uganda after South western Highlands. However there is limited access to diversity of improved potato varieties. Common varieties include Nakpot5 and Victoria which were previously sourced from south western region. Their yield and quality especially low dry matter gives them poor processing attributes. The low yield is attributed to several cycles of re-planting (Gildemacher et al., 2007). More recently they are less competitive in urban markets especially Kampala and Juba. The variety evaluation thus, aimed at identifying suitable varieties that could be adapted in eastern Uganda.

Buginyanya potato project received initial minitubers from KaZARDI in south western Uganda and CIP in Kenya. These were first planted in the screen house for multiplication at Buginyanya station before planting on-station in the field and later on-farm. Agronomic and yield performance were conducted in 2015B, 2016A and 2016B seasons. A total of 18 variety treatments including 7 CIP clones, 6 varieties from western Uganda, 4 commercially released varieties in Uganda and Shangi variety from Kenya were evaluated each season. Each treatment was planted on 3m long x 2.1m wide plots in CRBD replicated 3 times. Soil amendment using NPK compound fertilizer (17:17:17) at a rate of 10g/hill each 0.6m² was applied during planting. The research years 2016A and 2016B were characterized with low rainfall and extended drought which affected both bulking and field experimentation. In each case supplemental irrigation was availed through sprinkler irrigation every two weeks for 10 weeks thus affecting the number of marketable tubers.

The observations per genotype are summarized in Table 1. Genotypes Shangi, Victoria and Rwangume are observed to have profuse flowering compared to 392797.22 with low flowering. It was observed that 392797.22, 398208.29 and Rwangume had medium sized tubers while Shangi were small. Tuber appearance is key to marketing, CIP clone 392797.22 had the highest average score of 8 classified as good compared to 396036.201, Cruza, Katchpot1 and Nakpot5 with a score of 4.0-4.5 thus poor tubers. 393077.159, Rwangume, Shangi and Victoria have early senescence while the CIP clones 392797.22 and 398208.704 are both late in senescence. These two genotypes also gave the highest yields over two seasons compared to Victoria a commercial variety (Figure 1). In season 2016B, the genotypes 398208.704, kinigi and Victoria had a zero Area under Disease Progress Curve (AUDPC) for late-blight

while 398208.29, 396036.201 and Rwanshaki recorded the highest AUDPC. In regard to AUDPC for bacterial wilt, 398208.704, Kinigi and Rwanshaki recorded the lowest score while 393079.4 and Katchpot1 were highest. In summary it is proposed that we advance clones 392797.22 and 398208.704 for field evaluations while continuing to popularize Rwangume and Kinigi for their characteristics.

Table1: Summary characteristics of Genotypes evaluated at Buginyanya ZARDI

	VARIETY	FLOWERING DEGREE	TUBER SIZE	TUBER APPEARANCE	SENESCENCE	LATEBLIGHT AUDPC	BACTERIAL WILT AUDPC	TUBER YIELD (t/ha)
1	Shangi	Profuse	Small	Regular	Early	1379.7	609.4	24.17
2	Victoria	Profuse	Medium	Regular	Early	1460.95	168.75	38.93
3	Rwangume	Profuse	Medium	Regular	Early	220.3	418.75	42.02
4	392797.22	Low	Medium	Good	Late	417.15	164.05	62.5
5	398208.29	Moderate	Medium	Regular	Very Late	1126.55	687.5	41.31
6	Cruza	Moderate	Small	Poor	Medium	1285.9	950.05	38.33
7	Katchpot1	Moderate	Medium	Poor	Medium	476.6	800	13.21
8	Nakpot5	Moderate	Small	Poor	Very Late	634.35	46.9	34.52
9	396036.201	Low	Medium	Poor	Very Late	1464.1	98.45	29.52
10	398208.704	Moderate	Medium	Regular	Late	46.85	42.2	44.03
11	393077.159	Profuse	Medium	Regular	Early	310.95	107.85	31.19
12	Kinigi	Moderate	Medium	Regular	Late	218.75	42.2	51.9
13	Rwanshaki	Moderate	Medium	Regular	Medium	1095.3	142.2	29.64
14	393079.4	Moderate	Small	Regular	Late	295.3	745.35	36.55

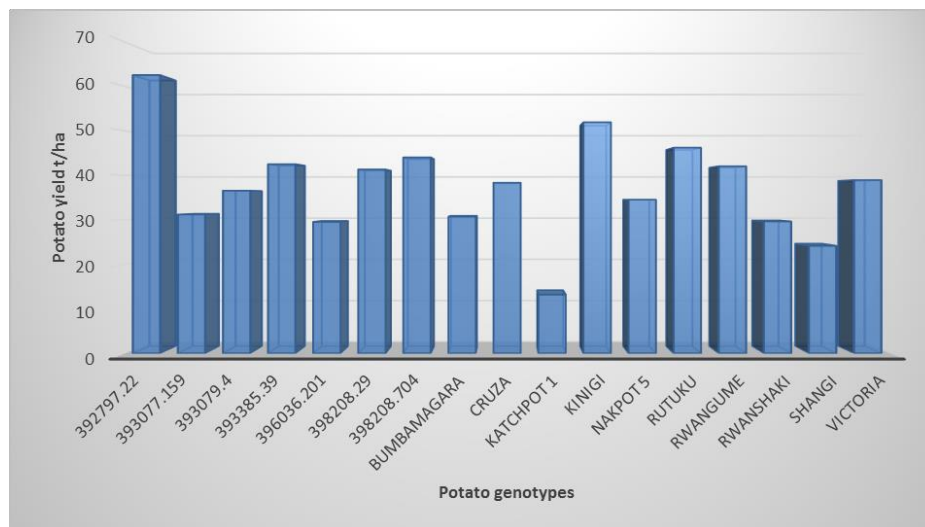


Figure 1: Average potato genotype yields for 2016B

2.1.2 Effect of staggered planting on potato tuber yield and occurrence of late blight and bacterial wilt diseases

Staggered cropping systems increase efficient use of natural and socio-economic resources to maximize production and productivity in a sustained manner. Timely planting is important in achieving high yield and hence full potential of potato based cropping system. Staggered planting in potato is the planting at different times in the same season, it could be early, normal or late planting. Staggered planting of potato results in better tuber prices by avoiding gluts on the market. Two types of stagger were applied with stagger 1 taken as early planting and stagger 2 2 weeks/14days after stagger 1. Ten genotypes were used in the experiment setup in 2016A and 2016B in Kapchesombe, Kapchorwa District and Buginyanya, Bulambuli District. In 2016A stagger 2 in Buginyanya had higher marketable yield than other sites. In 2016B stagger 2 did not yield any marketable tubers for both sites. This is attributed to the normal rains in 2016A and rather extended drought in 2016B.

Late blight is a significant threat to potato production and greatly depends on prevailing weather conditions and thus time of planting. Season 2016B when rains were low and extended drought had lowest late blight AUDPC compared to 2016A. Genotypes 398208.704 and 393079.4 had the lowest late blight AUDPC across sites, seasons and stagger types. Genotypes 392797.22, Bumbamagara and Victoria recorded the highest late blight AUDPC across the sites and seasons.

Bacterial wilt was significantly different in genotypes and seasons but not location. Rwangume and Kinigi genotype were the most affected across locations and stagger types. 393385.39 recorded the lowest AUDPC for bacterial wilt across seasons, locations and stagger types.

2.2 Effect of storage conditions on the processing quality of different potato varieties grown in eastern Uganda (Msc. Student Mr. John T. Senkumba, Food Science and Technology, College of Agricultural and Environmental Sciences of Makerere University)

In this study 11 different potato varieties which included 4 CIP clones, Shangi and 6 Ugandan varieties were evaluated in ambient stores for their quality and processing characteristics. The eleven potato varieties included 392797.22, 398208.704, 393079.4, and 393385.39 (CIP clones), Shangi, Kingi, Victoria, Rwangume, Rwanshaka, Cruza and Bumbamagara were assessed for storability under ambient store conditions at Kapchorwa Town council (1,800 masl), Benet (2,300 masl), Wanale Sub county (2092 masl) and Mbale Town Council (1,200 masl). Fresh tubers harvested from the adaptability evaluation trials were immediately placed in field potato bags for storage in the different ambient stores. Samples from the stores were randomly collected every three weeks for 4 months. These tubers were evaluated for weight loss, storage behavior, physical and chemical properties with special reference to their potential in chip processing and consumer acceptability at Food Biosciences Department of Makerere University.

In summary the observations indicated that the average relative humidity was highest in stores in Benet and Kapchorwa at 85% while Mbale was 80%. Average temperatures were highest at Mbale store (22.8°C) while Benet had the lowest 15.4°C. CIP clone 393079.4 lost the least weight while 393385.39 and variety Rwangume lost more weight. Rwangume and Victoria had the shortest dormancy period while 398208.704, Kinigi and 393079.4 had a longer dormancy period. The highest dry matter content was recorded in CIP clone 393079.4 and 398208.704 while Rwanshaka and Victoria had the lowest dry matter content. Varieties 393079.4 and Kinigi had the highest pH levels while 398208.704 and Victoria had the lowest Ph. Varieties 398208.704 and Victoria had the highest level of reducing sugars while Rwangume and Rwanshaka had the lowest level of reducing sugars. Clones 398208.704 and 393385.39 had very good chip texture while 392797.22 and Rwangume had the best chip color.

The CIP clone 392797.22, Kinigi and Rwangume were the most accepted by consumers based on overall chip quality. In terms of store suitability it is proposed that stores located in Benet and Kapchorwa have a suitable storage period of 9 weeks owing to the high RH and low indoor temperatures while 6 weeks is a maximum for Mbale. Due consideration however should be made on decision to sale based on the quality of the potato by variety in store. It is also best to store potatoes with a longer dormancy than those of short dormancy.

3. Capacity in ware potato pre harvest and storage methods for producers, traders, researchers and extension agents strengthened (Arthur Wasukira - NARO)

3.1 Improved skills in potato pre and post-harvest management and storage techniques

The growing of market demanded potato varieties is key to ensuring improved household incomes. The potato enterprise in Eastern Uganda is constrained by the variety grown which does not attract premium price in urban markets. The production of market preferred potato varieties has to be supported with good agronomic practices that are efficient and ensure good ware quality. Ware potato

production in Uganda is characterized by inconsistent supply which is dependent on seasonal harvests, poor handling, high moisture content, bruised skins, poor packaging and transportation. More importantly from scoping studies, it was shown that there are no attempts to store the surplus appropriately. This has resulted into low prices during times of surplus and peaks when supplies drop. The project therefore provided trainings to the participating associations in modules of 1: Pre harvest procedures to improve ware potato quality and 2: Post harvest operations and storage techniques for ware potato.

The trainings were arranged, coordinated and implemented through consultations with association leaders and Buginyanya ZARDI technical staff. These trainings were held in premises in close proximity to majority of the association members (Table 2).

Table 2: Association participation and specific training workshop dates

ASSOCIATION	WORKSHOP DATE	LOCATION	NUMBER OF PARTICIPANTS	
			FEMALE	MALES
KACOFA	12th January 2016 (Pre-harvest training)	Kapchesombe	6	8
	1st March 2016 (Post-harvest training)	Kapchesombe	10	5
MIFA	13th January 2016 (Pre-harvest training)	Mengya centre	5	8
	2nd March 2016 (Post-harvest training)	Mengya, FHI	7	10
WASWAPA	14th January 2016 (Pre-harvest training)	Wanale centre	4	10
	3rd March 2016 (Post-harvest training)	Wanale Baptist church	15	10
MPODA	4th March 2016 (Post-harvest training)	Bugwere Market	4	11

Total			51	62
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Best practices in improved potato pre-harvest management included potato Variety and quality seed selection which emphasizes that producers should select varieties that are suitable for the targeted market and utilization. The popular marketable varieties in Uganda include Victoria, Rwangume, Rutuku and Kinigi which are suitable for dual purpose (fresh consumption and processing). Field preparation and management focused on site selection, good land preparation (use of ridges 25 -30cm high), application of organic manure and fertilizer (NPK 17:17:17@ 50Kg/acre) at planting, spacing (30 by 70cm) and good first weeding and earthing up including rouging out of off types. In pest and disease management, participants were reminded about the importance of regular pest monitoring and disease symptom surveillance before application of cost effective control options.

In module 2 the potato post-harvest handling methods were shared with the participating associations including the Mbale Potato Traders association. Participants were reminded to conduct proper field based assessment for potato maturity before dehauling. The discussion on harvesting methods and storage management in ware potato introduced them to improved harvesting using equipment and methods that limit damage to the tubers. This can be done using animal drawn lifter/digger or tractor lifter as practically evaluated and demonstrated in Kween. This evaluation showed that the tractor lifter was able to harvest all the tubers in a given area with very limited damage as compared to the animal drawn lifter or hand hoe. The animal drawn lifter however was preferred to the tractor lifter due to the use of animal drawn implements like the mouldboard plough which they are already familiar with in farm operations. A leader of the Mengya integrated farmers association was able to use the implement for harvesting his own fields and reported that it took him half the expected harvest period. Harvested potato is then subjected to field sorting, grading and curing prior to appropriate storage depending on variety, prevailing market prices and intended purpose. The marketable tubers should be packaged in well aerated materials such as crates, chambers or jute/sisal bags prior to placing into storage. Members were informed that ware potato storage is aimed at obtaining the maximum quantity of tubers, of acceptable quality to the consumers, at a rate to meet consumer demand. This requires the lowest possible quantitative and qualitative losses, with no or little sprouting, kept in the dark to prevent greening and firm tubers, all at an economical cost. Record keeping was emphasized and records such as Date of harvesting, Names of owner, Price at harvest, quantity stored, price at storage, variety, source of stock, quantity damaged, quantity sold and price at time of sale.

3.2 Ware potato storage options (Ambient and Improved wooden ware potato stores)

Ware potatoes can be stored up to six months in tropical highlands without significant losses if the variety of potato is one with a long dormancy, the potatoes are free from diseases and damage or insect infestation. Internal conditions include storage temperatures are kept to levels that do not induce high rates of respiration and the relative humidity within the store is kept at sufficiently high levels to reduce water loss from the tubers and the potatoes are not wet as a result of rain or condensation. The project piloted two types of storage methods aimed at the individual household and at association storage. Twelve improved wooden ware potato stores with a capacity of 4-6 tonnes of ware potato were constructed with the participation of individual hosts in Benet (4), Kapchesombe (4) and Wanale (4).

The design was based on the traditional cereals store made of wooden planks with an iron sheet roof. The dimension of the store are 5 by 4 by 3.5m using strong poles, tightly covered walls with planed timber to minimize light. The floor is made of strong timber frames with spacing of 5cm between the struts. Attach a rat proof netting such as expanded metal on the floor (Figure 2). A false ceiling can be placed before the corrugated iron roof with a layer of straw for the warmer areas. A ventilation window facing the common direction of wind is placed at the top corner of the roof (Figure 3). This window is only opened at night to let out warmer air from the store. The walls should be lined with papyrus mats to further minimize light in the store.



Figure 2: Framework of an improved wooden ware potato store



Figure 3: External outlook of a completed Improved wooden ware potato store

Ambient stores: The associations willing provided legal plots of land for construction of ambient stores. The design and supervision were provided by international potato center through contracted trained engineer with experience of constructing similar stores in Kenya. The ambient stores were located at different altitudes in Benet, Kapchorwa, Wanale and Mbale. The Ambient ware potato store is a large-scale modern facility for long-term storage (around 3 months or more) designed to regulate air temperature and relative humidity using natural weather. It is made of compressed straw bales (25-30Kg), strong timber strut frames on a metal super structure and sits on a re-enforced gabion foundation (Figure 4). This store has a capacity of 600 bags or 60tonnes of ware potato measuring 13 by 6 by 5m. A wind vent is fitted at the corner opposite the door to enhance ventilation control. The floors are made of strong timber struts covered with expanded metal to reduce rat damage while allowing floor ventilation. All walls are plastered with cement to protect the straw from rodent and weather damage. A corrugated iron roof on a timber pole frame is placed to cover the ambient store (Figure 5).



Figure 4: Framework of an ambient store before installing metallic re-enforcement bars



Figure 5: Front Exterior of a completed ambient ware potato store

3.3 Development of a Regional Potato platform:

A regional potato platform to foster development of the potato value chain in Eastern Uganda was muted by member associations and adopted by the project coordination at CIP, Kampala. This Multi Stakeholder Innovation Platform (MSIP) was formed based on the different partners involved in the project and also any supporting agencies within the zone that had previously worked with Buginyanya ZARDI. Initial meetings to develop a roadmap for its initiation was guided by technical persons from the Districts, BugiZARDI and CIP (Table 3). It was agreed that Buginyanya ZARDI plays a facilitation role as MSIP is already being partially initiated by NARO. In the early stages CIP through the ENDURE project agreed to meet costs of the meetings in the formative stages with a view of having the MSIP self-sustaining after project closure. This platform was built on existing structures and initiatives such as the National Potato steering committee under IFDC. It aimed at identifying those who were interested, who else can be engaged and their roles and responsibilities for development of the potato enterprise.

The regional potato multi-stakeholder innovation platform first identified a 9 man executive committee to steer its planned activities in the region. The executive committee is composed of members from producer groups, input dealers, research, international agencies and trade (Table 5).

Table 3: Summary activities and outcomes of the Regional Potato MSIP meetings

	Dates of meeting	Objectives	Outcomes
1	22 nd October 2015	Setting the stage for initiating Regional Potato MSIP	Identified key institutions to be considered for the MSIP, facilitators understood the current ongoing initiatives such as Rice and Potato committees, element of sustainability was inbuilt through selection of BugiZARDI to facilitate
2	22 nd March 2016	Share lessons from other similar enterprise platforms	Members appreciated methods used by Rice platform facilitated by IFDC as a viable approach (Competitive Agribusiness System Enterprise (CASE) Members incorporated members of the National Potato steering committee from Eastern Uganda onto the executive
3	7 th July	To understand	Associations and business entities introduced to savings methods

	2016	the importance of finance and savings and develop target activities for the MSIP	and credit access opportunities from Centenary bank and the Uganda Cooperative Savings and Credit Union Limited (UCSCU) The following activities were planned:- Storage and stocking of potato stores, Tracking of marketing records in the region, associations capacity building in sorting and grading of potato, strengthening of the involvement of the municipal council to have the two markets (Central and Bugwere) in potato trade and build capacity of associations in seed potato production for marketable varieties
4	15 th September 2016	To link the potato value chain to an international partner	Regional potato MSIP, president's office through the science and technology desk and local governments agreed to participate in a business venture that introduces commercial warehousing approaches for improved collective marketing guided by Harvest Protection Network

A stakeholder mapping exercise was conducted in one of the meetings and potential roles of the actors identified as per table 4.

Table 4: Outline of MSIP stakeholders on Potato

No	Who	What	Where	Interest in MSIP
1.	Farmer Associations / Seed Producers: WASWAPA, MIFA, MABUGU, KABATEC, KIPA and Sosyo Potato FFS	- Seed & Ware potato production - Post harvest handling - Collective marketing Capacity building for farmers Ware potato storage & marketing	Bududa, Bukwo Bulambuli, Kapchorwa, Kween, Manafwa, Mbale, Sironko	Collective marketing & linkages - Collective production through farmer institutional development - Learning from other members of the value chain, - Link up with BugiZARDI for foundation seed - Technical information on pest & disease management - Soil fertility improvement with soil testing techniques - Intra/inter learning visits for capacity building - Post harvest handling with ambient storage of seed - Expand on ware potato production in the district
2.	Districts Local Governments: Bududa, Bukwo Bulambuli, Kapchorwa, Kween, Manafwa, Mbale, Sironko	- Capacity building of farmers & extension staff - Verification of seed & other inputs - Supervision of farmers & processors - Enhance field farm schools	Bududa, Bukwo Bulambuli, Kapchorwa, Kween, Manafwa, Mbale, Sironko	- Learning from other members in the value chain - Markets & market strategic linkages - Collective voice to change policy - Infrastructure development in storage / warehouse for potato farmers
3.	Agro input dealers: El- Shaddai International Limited, EPSEDEC and BDS	Selling inputs to potato farmers	Bududa, Bukwo Bulambuli, Kapchorwa, Kween, Manafwa, Mbale, Sironko	- Leading supplier of quality potato seed in the region - Strategic linkages with value chain partners e.g. Farmers, processors
4.	Non-Governmental Organizations: Self Help Africa, IFDC, AT Uganda, Child fund	- Improve Seed potato accessibility to farmers - Improve efficiency in the potato value chain for seed & ware potato	Kapchorwa, Kween & Mbale	- Develop the seed & ware potato value chain - Improve quality seed potato accessibility
5.	Financial institutions: Centenary, Micro finance Support Centre, Post, Opportunity, Housing Finance banks	Access to credit and finance	Kapchorwa, Mbale	Improve access to finance and credit to support the value chain
6.	Processors: Peak values Uganda Limited and Tom Crisp-Kampala	Cottage processing	Kampala	Capacity enhancement in primary potato processing
7.	Traders: MIFA, MPODA and KIPA	Buying of potato from farmers	Bududa, Bukwo, Mbale Bulambuli, Kapchorwa, Kween, Manafwa, Sironko	Market linkages
8.	Transporters: Imani Investments	Bulking and movement of ware to urban centers	All districts	Improve safety and efficiency in transportation of quality ware potato
9.	Input dealers: El- shaddai International Limited, Faith Agro and Super Export	Selling inputs to potato farmers	Mbale, Kapchorwa, Sironko	- Leading supplier of quality potato seed in the region - Strategic linkages with value chain partners e.g. Farmers, processors
10.	Researchers: BugiZARDI and CIP	Generating appropriate potato technologies for uptake pathways	Bududa, Bukwo Bulambuli, Kapchorwa, Kween, Manafwa, Mbale, Sironko	- Back stopping other service providers - Spearheading MSIP establishment - Avail foundation potato seeds to uptake pathways
11.	Media: Uganda Radio Network Eastern Region	Sensitizing stakeholders on access to information on availability of inputs, market prices, new available varieties	Bududa, Bukwo Bulambuli, Kapchorwa, Kween, Manafwa, Mbale, Sironko	- Sharing of market information - Get information on best practices for potato production - Strengthening access to public information

Table 5: Executive and profiles of Regional Potato MSIP

	Executive office	Names	Description
1	Chairperson	Mr. George Shiondo	George is the chairperson WASWAPA a farmers' association interested in commercial agriculture, he is also a member of the National Potato steering committee representing Eastern Uganda
2	Vice Chairperson	Mr. Peter Cherwaru	Peter is the executive director of Kapchorwa barley Technical Center an organization that fosters innovation and market linkages in highland cereals and potato production in the Sebei sub region of Mt. Elgon
3	Secretary	Ms.Doreen Khakusuma	Doreen is a trained marketing officer working with the District local government as a commercial officer at Manafwa District. She is also a produce dealer that includes potato and grain legumes
	Committee members		
4	Input Dealer	Mr. Patrick Makweta	Patrick is the owner of ELshadai International an input dealership located in Mbale and Kampala. He is also a member of the Eastern Region Private Sector Enterprise
5	Financial Institution	Centenary Bank-Agricultural Credit section	Centenary Bank-our Bank is the leading source of credit for agriculture based and small enterprise financing in the region
6	Business Development Services	Self Help Africa	SHA has long experience in providing capacity development and support in conducting agriculture as a business in the country along value chains
7	Commercial farming	KIPA and MIFA	The two associations have specialty in conducting agriculture at a commercial scale with special interest in Potato
8	Marketing	Mbale Potato Traders Association and Mable central market	The organizations conduct trade both at wholesale and retail with linkage to markets in urban centers and Juba, Southern Sudan
9	Research	NARO_BugiZARDI	Extensive experience in providing technologies suitable for commercial potato production and marketing

In summary this project was able to bring together several key actors in the potato value chain through the regional potato platform. The platform selected an executive of 9 members who were able to formulate a work plan for strengthening the potato value chain in the region. It was noted that the marketing aspect of the value chain needed significant improvement through collective action. The platform resolved to continue interacting even when the project closes and requested BugiZARDI to continue coordinating their activities.

4. Skills in entrepreneurship, agribusiness and collective action developed for selected actors in specialized ware potato market (Misaki Okotel - Self Help)

5. Recommendation for extending shelf life, increased utilization and reduction of post-harvest losses along ware potato value chain disseminated (Arthur Wasukira - NARO)

This activity is yet to be done because it should have been done in a workshop of all partners of the potato sub project. However several activities were yet to be finished completely by the time the final review took place in December 2016.

IV. COURSE DEVIATION AND IMPLEMENTATION CONSTRAINTS

The Bugizardi activities were constrained by lack of sufficient field staff to supervise and support the coordinator, procurement systems that delayed establishment of the traditional stores, long drought that affected quality of seed potato for planting and are potato for research in stores. On the other hand access to vehicles on time and funds for smooth running hindered completion of some activities. The high market prices of ware potato at farm gate also delayed the availability of association potato for research in both ambient and traditional ware potato stores.

V. COURSE CORRECTION

VI. SUMMARY ON CURRENT PROGRESS ON PROJECT INDICATORS⁸ (WHERE POSSIBLE)

Sub-project Research Outcomes	Baseline	Achievement during the reporting period	Remarks
1. 15% reduction in the amount of potato incurring quality deterioration, and therefore market price discount, after 3 months from harvest under current on-farm storage practice as a result of improved pre-harvest and harvest practices			
2. 3 months average extension of the shelf life of ware potato			
3. 20% higher profit margin obtained by male and female pilot farmers and traders because of deferred sales of stored ware potato			

⁸ Confirm the indicator definition, baseline value and target in the Performance Monitoring Matrix (PMM)

Sub-project Research Outcomes	Baseline	Achievement during the reporting period	Remarks
4. 30% of male and female pilot farmers adopting at least one pre-storage technique in their own field (not pilot fields)			
5. At least 10 additional farmers/traders (among those not involved in the trial and supported by the project) constructing ambient stores or paying a fee for storage services			
6. At least 20% of women involved in the pilots are involved in more profitable nodes of the RTB chain			
7. At least 30% of women involved in the pilots perceive greater control over RTB crop income			

Contribution of the Sub-project towards Project Wide's Outputs			
1.3 No. of RTB varieties with improved postharvest characteristics identified			
1.4 No. of RTB on-farm storage and processing systems tested and validated			
1.5 No. of other RTB technologies to reduce PHL and expand utilization tested and validated			
2.3 No. of RTB producers, traders and processors strengthened for equitable participation and innovation in value chains			
2.4 No. of sustainable multi-stakeholder platforms for further RTB value chain innovation created or strengthened			
3.2 Capacity built in key national partners for reducing PHL and increasing use of RTB			
3.3 No. of outputs of research disseminated throughout agricultural knowledge and information systems			

VII. APPENDICES (PHOTOS, LIST OF PARTICIPANTS, CASE STORIES..)