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CGIAR

Technical report

Market and Value Chain Analysis of Ware Potato from Eastern Uganda with a focus on postharvest management practices and losses

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

RTB ENDURE

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Enabling poor rural people to overcome poverty

A broad alliance of research-for-development stakeholders & partners

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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 ABBREVIATIONS AND ACRONYMS

CIP	International Potato Center
DSIP	Development Strategy and Investment Plan
FGD	Focus Group Discussion
IFDC	International Fertilizer Development Center
MT	Metric Tonnes
NAADS	National Agricultural Advisory Service
NARO	National Agriculture Research Organization
NGOs	Non-Government Organizations
PH	Postharvest
PHL	Postharvest Losses
PHM	Postharvest Management
PIM	CGIAR Research Programme on Policy, Institution and Markets
RTB	Roots, Tubers and Bananas
RTB	CGIAR Research Programme on Roots, Tubers and Bananas
SSA	Sub Saharan Africa
UCA	Uganda Census of Agriculture
UGX	Ugandan Shillings

DEFINITION OF TERMS

A market	People with needs, with money to spend, and willingness to spend it. Markets and prices play vital roles in any economic system and they determine the standard of living of society.
Marketing	The buying and selling of a commodity using a price mechanism that works out the interests of all individual producers, other value chain actors, and consumers, and thus leading to a socially optimal outcome. • The economic incentive structure and the goods handling system for agricultural and other type of products, from the point of production through processing and distribution to the final sale to consumers. • A total system of business activities designed to plan, price, promote, and distribute want-satisfying goods and services to the present and potential customers.
Supply chain	The links that connect inputs to farm and then on to storage, processing, transport and distribution to consumers for a given product through a single chain. • A supply chain consists of all parties/actors involved, directly or indirectly in fulfilling a customer request or bringing a product from "farm to fork".
Value-chain	A combination of several supply chains for a particular product. It includes the supporting services that allow the supply chains to operate and also the factors in the economic environment. • A value chain is a supply chain in which value addition occurs at each stage and actors work together as partners to maximize (and share) the total value added.
Market performance	How well the commodity marketing system performs what society and the market participants expects of it in terms of gross margins, market margins, prices, and volume sold. • Regardless of the economic system, a marketing system must meet the needs of the people.
Marketing margin	The difference between prices at different levels in the value chain, and in this case between the farm gate and retail prices of potatoes (the difference between what the consumer pays and the amount each value chain actors receive).
Value added	The difference between the value of output (y) and the value of inputs (x) used by the agent or value chain actor. The ratio of value added to total marketing costs represents marketing efficiency.
Gross margin	The difference between gross revenue (total revenue) from potato sales and operating costs (or variable costs) of production and marketing. • It's an indicator of the value chain actors' ability to produce enough returns to reimburse off the cost of resources used in production and marketing of ware potato products.
Net margin	The difference between gross revenue and the sum of variable costs and fixed costs incurred during production and marketing.
Agricultural supply	The amount of the commodity offered for sale in a particular market during a specific time interval at the prevailing values of prices and any other relevant conditioning variables. • The actual output on farms derived from use of agricultural inputs
Postharvest food loss (PHL)	Any loss in food quantity (such as physical weight losses) and quality (loss in edibility, nutritional quality, caloric value, and consumer acceptability) that occurs between the time of harvest and the time the product reaches the consumer. • Ware potato losses may be experienced in the pre-harvest, harvest, and postharvest stages. • Pre-harvest losses occur before the process of harvesting begins and may be due to damage by pests and diseases. • Harvest losses occur between the beginning and completion of harvesting, and are primarily caused by losses due to shattering, cuts, and bruises.

DETAILED EXECUTIVE SUMMARY

This study assesses the current status of the ware potato marketing, including the underlying nature of the ware potato value chains, the postharvest management practices, market performance, and the level of pre-and postharvest losses along the value chains in Eastern Uganda. The study analysis is based on a wide-ranging review of literature, the analysis of relevant secondary data and four unique primary data-sets collected along potato value chains in Eastern Uganda.

A number of interesting and important findings emerge from the analysis of quantitative and qualitative data. The study findings highlight the current status of potato marketing, existing priorities, and workable recommendations that enhance market performance in Eastern Uganda. Specifically, the study findings emphasize: (i) the current status and value chain of ware potato marketing system that also includes CIP's sub-project pilot farmers and traders in Eastern Uganda; (ii) the available ware potato storage practices and priorities for improving postharvest management, ware potato quality, and shelf-life in Eastern Uganda; (iii) the underlying gender based market constraints and opportunities along the ware potato value chain in Eastern Uganda; (iv) the existing postharvest losses and margins along ware potato value chains in Eastern Uganda; (v) potential avenues through which project interventions on ware potato storage create meaningful impacts along potato value chains in Eastern Uganda, and; (v) key baseline information for M&E indicators such as current storage losses, ware potato shelf-life, marketing period, and income.

Postharvest management (PHM) practices represent processes and activities undertaken when handling ware potato produce physically, right from the time of harvesting up to the final market destination. Proper PHM practices are crucial to minimize postharvest losses and deterioration. Key PHM practices in the study include sorting potato tubers, washing and cleaning, grading, weighing, storing, transporting, and packing. This report is valuable to all interested actors, including: farmers, traders, processors, researchers, policy makers, and other practitioners, who would like to gain a clear understanding of the current status of ware potato marketing, the underlying effect of potato price fluctuations, postharvest losses, market performance, and the use of postharvest management practices and technologies in the study area.

This study was conducted in four purposively selected districts of Kapchorwa, Kween-Benet, and Mbale located in Eastern region of Uganda, and Kampala district (Kalerwe, Owino and Nakawa markets) selected as one of the main final destination of ware potato from the Eastern region. Using a multi-stage sampling procedure and pretested semi-structured questionnaires, four unique quantitative and qualitative datasets were collected between July and September 2015. Respondents were randomly selected and include: 116 ware potato farmers, 72 ware potato traders (including 34 wholesalers and 38 retailers), 34 processors, and 85 consumers. A guided structured check-list was adopted to collect qualitative information from a number of focus group discussions (FGDs). A summary of key study findings and recommendations on how CIP, farmers, local leaders, all value chain actors, and stakeholders can work together to extend the marketable period, maintain a steady supply of good quality potatoes, even-out unstable potato market price, and therefore improve market performance and income distribution along potato value chains in Eastern Uganda are hereby presented.

Ware potato production and consumption in in Eastern Uganda

Irish potato is both a subsistence and cash crop of critical importance to smallholder farmers in Uganda. Production of potato tubers in Uganda has been increasing steadily since 1961, and this increase is attributed to slight growth in acreage and potato yield. According to the 2008 UCA statistics, Uganda

produces about 154,436 MT of Irish potatoes, on a total area of 32,758 Ha of land, and with average yield of 4.7 MT/Ha. Estimates from the latest 2017 FAO statistics are somehow different from Uganda government statistics. They indicate potato production in Uganda to have increased from 368,000 MT in 1994 to 770,000 MT in 2014, and with an on-farm yield of approximately 19.7t/Ha. Demand for ware potato is on the increase in both Uganda's rural and urban markets. Ware potato is the third most consumed root and tuber crop in Uganda after cassava and sweetpotato. The per capita consumption of ware potato in the country has been increasing steadily at a low rate since 1961 up to 2007, but started to decline in recent years.

Potato production is mainly rain-fed with a highly seasonal market supply. There are clear months in a year characterised by gluts in potato supply, low market prices, and high postharvest losses. The period of potato scarcity is associated with high market prices and relatively low levels of postharvest losses. Inadequate use of recommended PHM practices and high postharvest losses (PHL) along ware potato value chains limit food availability, reduce incomes, and negatively affect market performance.

Potato growing in Eastern Uganda is rapidly transiting from subsistence oriented production to mainly commercial production. The increase in area cultivated, yield, and improved access to agricultural extension service are making a significant contribution to overall potato production in the study area. Potato productivity across farm households though found to be growing, it is still low. A large number of potato producers, especially men are growing the crop on commercial scale. Most potato farmers recycle the own produced seed at least twice or three times before buying new planting material. Improving the availability and use of clean and better performing seed potato can help value chain actors tap into the existing huge potential to increase potato production, marketing outcomes, and value addition on fresh ware potato in Eastern Uganda.

The current status and map of ware potato marketing system in Eastern Uganda

The level of potato marketing and domestic demand of ware potato products is on the increase. However market supply of ware potato is inconsistent throughout the year. Potato prices are mainly set by traders depending on tuber availability and distance to target markets. Key players along the ware potato value chains include: farmers, agents (or brokers), local traders, urban wholesalers, urban retailers, processors, and consumers. Various institutions such as schools, hotels, and hospitals also procure and consume ware potatoes in large quantities. There exist strong linkages between ware potato farmers and each of the local traders, wholesalers and retailers. Market linkages between each of the farmers and traders and cooperatives and processors are still weak.

Potato marketing is primarily characterized by: largely informal market exchanges, informal marketing channels, limited value addition, dominance of local traders, fluctuating potato price due to gluts and scarce market supplies, minimal participation of women actors at crucial value chain nodes, and, limited upgrading of key functions along potato value chains. Value addition on fresh ware potato is limited to few potato products that include boiled potato, chips, and crisps. Farmers and traders mainly engage in low cost value adding activities of sorting, grading, washing, scrubbing, and packaging.

Existing level of market performance in Eastern Uganda

Market performance along the ware potato value chains is measured by profit levels, gross margins, market prices, value added levels attained by value chain actors. Long marketing channels are mostly used by men and especially during periods of peak potato supply. Potato is sold mainly on per bag basis, with each bag weighing between 80kg and 120kg. The standard bag of potatoes weighs 100kg after leaving

the main bulking point. Ware potato marketing is often at the peak during the months of December, August, July, September, and October in that order. Whilst the months of June and July are characterized by excess ware potato production in Eastern Uganda, the months of September, February, March, and April are typified by scarce ware potato production.

Potato price is often set by traders. Yet the final consensus is reached through a negotiation process due to the widespread lack of exchange standards. Transport and packaging costs dominate all the marketing costs incurred by farmers and other value chain actors. The highest variable marketing costs per kg of potato sold is incurred by ware potato processors, followed by wholesalers, retailers, and lastly farmers.

The magnitude of value addition on fresh ware potato tubers are highest for potato processors, followed by wholesalers, retailers, and lastly potato farmers. The average selling price per kg of potatoes at farm gate and other destination market varies across value chain actors, and it is highest for processors, followed by retailers, wholesalers, and lastly farmers. Processors incur the highest variable marketing costs per kg of potato, followed by wholesalers, retailers, and lastly farmers. The capacity of processors is very low and this is reflected by the average low volume of potato tubers they handle.

Ware potato marketing is a profitable business for all value chain actors. Processors enjoy the highest gross margins (UGX 1,427,258 or 69%) per week of operations, followed by farmers at UGX 1,046,021 (46%) per acre of land and selling at farm gate, retailers at UGX 215,396 (22%) per round of purchase stock in destination market, and lastly wholesalers at UGX 1,180,826 (20%) per route at destination market. Potato marketing is therefore more profitable for processors, followed by farmers, retailers, and lastly wholesalers. Although potato wholesalers and retailers incur the highest marketing costs as indicated by the ratio of marketing costs to gross margins, they are able to handle large volumes of ware potato in a season, and therefore more likely to make more money from potato business largely due to their high turnover.

The available different ware potato storage and other postharvest handling practices

The main PHM practices utilized by chain actors to minimize PHL and deterioration range from: sorting, washing (or cleaning), grading, weighing, storage, transporting, and packing. The most utilized storage techniques are rudimental, these are to some extent ineffective. They are able to keep potato tubers in good quality for a short period of only 2-5 weeks depending on the potato variety. Improved ambient stores have just been introduced in pilot sub-project sites by CIP covering target value chain actors.

Value chain actors who effectively use recommended postharvest management practices and cost-effective storage technologies can extend marketable period in a year, fetch better price, reduce PHLs, and enhance income from potato sales. The adoption of improved storage facilities for ware potato is very low in the study area. Few farmers and other value chain actors engage in effective storage of ware potato. Consequently, the supply of ware potato is largely inconsistent throughout the year. The cost of storage and postharvest loss is not yet well internalized and valued by value chain actors to warrant a genuine response. The price per bag of ware potato normally increases by 121 percent on average during off-peak season when compared to potato price in the peak-season.

Ware potato farmers and other actors along the value chains are yet to appreciate the importance of storage and other related handling practices that are all vital in maintaining quality of tubers, minimizing losses, and increasing market performance. A substantial proportion of potato tubers supplied along the value chains is of low quality. Good quality potatoes in the supply chain is attributed to better handling of

mature potato tubers that are selected through right procedures of grading and sorting and transacted in a timely manner between responsible actors who trust each other as a result of repeated transactions

Value chain actors mainly store potatoes using the floor of houses (especially mud floor houses), cribs made from local materials, wooden purlins, in the corners of their houses, covering potato tubers deep in the soil, stacking tubers in sacks covered with tarpaulin, and heaping potato tubers under the tree shades. Other common storage techniques include keeping potato tubers in a dark area (or corner in the house), using dark stores, stores that allow light to pass through, heaping potato tubers on a mud floor and concrete floor either covered or uncovered. The level of market exchange of stored potato in the study area is currently very low. Consumers are however very willing to buy and consume potato tubers stored in good conditions for a period of up to 4 months.

Gender dynamics along the ware potato value chain

Value addition on fresh potato tubers is driven by actors who tend to be: males compared to females, more trusted by other actors, relatively younger and more educated, and with fewer dependents (have smaller household sizes) in their homesteads.

Female ware potato producers are more active in potato planting, weeding, and harvesting. Male ware potato producers on the other hand engage more in strategic activities that directly contribute to tuber quality and income enhancement such as: seed selection; various practices of agronomic management of the crop; dehaulming; potato transport from the field; potato packaging; potato storage; potato transport to the market, and; potato selling in the market. Male ware potato value chain actors appear to benefit more from the current marketing system than their female counterparts, especially in terms of easier access to market information and sale of potato tubers at better price.

The underlying market constraints

Key constraints faced by farmers include: the declining soil fertility; limited access to credit for procurement of farm inputs; long distances from homes to gardens; pests and diseases; low and unstable farm-gate and market prices of potato tubers; inadequate supply and high cost of certified clean seed; lack of stores and limited use of storage facilities; inadequate use and access to farm inputs (fertilizers, pesticides); high seasonality in potato supply and negative effects of extreme weather conditions; loss of tuber weight due to moisture loss under poor storage facilities; high economic and physical losses largely due to the rotting of tubers; potato damage due to exposure to rains and other bad weather conditions, and; cheating and theft of tubers by hired laborers.

Traders (wholesalers and retailers) and processors mainly face constraints of: poor road network; poor market infrastructures; unfavorable market environment and conditions; poor linkages and weak coordination between value chain actors (producers, traders, processors, and consumers); low and unstable market prices of potatoes, and; limited processing and value addition on fresh tubers.

The underlying market opportunities

Major opportunities for ware potato value chain actors range from: the recently introduced improved ambient stores currently being promoted in the area to extend marketable period and even out market price fluctuations; reliable training so far received on storage and other postharvest handling practices; increased awareness on the need to invest time and resources in supervising workers during harvesting to reduce tuber cuts and damage; potato crop now turning into a reliable source of food and income for many households; the quality of potato tubers being supplied is slowly but steadily increasing and therefore more

likely to generate good income as a result of a significant number of value chain actors undertaking good practices of sorting and grading before selling; increasing availability of affordable technologies that are helping actors manage well potato production and physical handling, and; improved access to market information through use of mobile phones and mushrooming radio stations.

There are other general market opportunities identified by value chain actors, and these include: ability to sell potato tubers in a short time due to short distances to the main market; increased awareness and competence among ware potato actors to control potato quality through good practices of culling, grading, careful handling, pest management, and dehaulming; the increasing direct linkage between value chain actors and potato buyers; improved seed potato now available in the study area; increasing potato demand (as a result of direct linkages to emerging supermarkets, schools, kiosks, hotels, local markets, fast food restaurants, frozen chip processors, and regional markets); the increasing access to lending and saving institutions willing to finance potato agribusiness activities; growing potato demand in South Sudan, and; growing local demand for processed potato chips and crisps.

The current postharvest losses along ware potato value chains in Eastern Uganda

Potato loss is mostly in the forms of cuts, bruises, rot, greening, sprouting, thefts, and softening of tubers when mishandled or kept for a long time under unfavorable conditions. Rotten tubers dominate all forms of potato damage faced by value chain actors, followed by cuts on tubers, bruised tubers, greening tubers, and lastly other types of damage on tubers. Use of different harvesting tools is strongly associated with significant levels of potato damage and this damage is highest when hand hoes are used to harvest. Farmers appear to be the most affected by PHLs, followed by potato consumers, traders, and lastly processors. The amount of potato damage is highest on the farm, followed processing stage, consumption stage, transport and handling stage, and is least under the wholesale market conditions.

Potato tubers affected by economic losses have a residual value, while tubers vexed with the physical loss are often too damaged to be suitable to human consumption. The estimated level of physical and economic losses is high in Eastern Uganda. Ware potato processors face the highest physical losses (4-31 percent), followed by farmers (9-16 percent), traders (11 percent), and lastly consumers (5-9 percent). The proportion of economic loss representing the quantity of poor quality potatoes sold at discounted price in last 2 years is highest among farmers (6-17 percent), followed by traders (9-12 percent) and it is least (6-8 percent) for processors.

Noteworthy is that potato damage and related loss is mainly caused by the rotting of tubers, and to some extent others causes, including: the effect of crop diseases, insect damage, floods and wetting, sprouting, extreme dry condition, rain shortage, and animal damage. It is therefore imperative to devise ways that reduce PHLs, if value chain actors are to increase their tuber sales and income.

Project interventions on ware potato storage and their impacts along potato value chains

Project interventions on ware potato storage are vital in helping to increase potato sales and income. They help improve quality of potato tubers in the market, extend marketable period, ensure marketing efficiency along the value chains, encourage agricultural intensification through use of yield enhancing inputs and mechanization, and promote value addition through better postharvest handling and agro-processing. The adoption and use of improved locally adapted storage facilities reduce the challenges of seasonality, unstable market price, and low incomes of value chain actors.

Interventions along the ware potato value chains can among others: promote the adoption of improved postharvest handling practices; facilitate the dissemination of market information; strengthen the capacities of actors to properly handle ware potato tubers to avoid damage (cutting, crushing, and bruising); promote use of recommended PHM practices of sorting and culling damaged tubers and other items; increase shelf-life of potato tubers through use of better varieties and handling, and; promote practices and technologies that keep ware potato quality after harvest while awaiting a selling opportunity at a good price.

Some of the key areas complementary to storage interventions include introduction of marketing models with incentives to: improve the adoption of yield and labor enhancing technologies; promote use of organized market channels with clear aspects of bulking, check-off payments, and quality control; encourage better targeting and inclusive participation of value chain actors, especially women and those who are disadvantaged; ensure continuous improvement of existing value adding practices to take care of changes in climate and market demand; reduce postharvest losses; and harness value addition and agro-processing potential in the region.

Recommendations

Consistent and profitable supply of good quality potato tubers throughout the year can be achieved if policy makers, researchers (including CIP), private sector service providers, and development practitioners work together to address the following short-term and long-term recommendations. There is need to improve the availability, access, and use of clean and better performing potato planting material with longer dormancy period; improve the content and speed at which market information is disseminated to value chain actors; improve access to the services of commercial and agricultural banks willing to finance production and market operations of ware potato value chain actors; build capacity and sensitize value chain actors to further appreciate the value, effective use, and management aspects of improved ambient storage facilities, and; promote the construction and adoption of low cost improved ware potato stores made from locally available materials to ensure profitable trade.

Other interventions should among others: promote efficient marketing models with embedded arrangements to minimize postharvest losses and promote exchange of good quality of tubers; advocate for an increase in public investment in the development of road and market infrastructure to reduce transport and marketing costs incurred by value chain actors; embrace strategies that increase investment in potato value addition and upgrading of marketing operations of different actors along the potato value chains; support growth of incubation centers and entrepreneurial training of potato value chain actors; enhance the transformation and coordination of actors along entire potato value chain; champion women empowerment in agricultural and potato marketing activities; encourage better organization and active membership of different value chain actors to a local and national potato multi-stakeholders' platform, and; finally reach out to policy makers and technical people in ministry of agriculture (MAAIF) to appreciate the importance of potato crop in increasing food security and income and persuade them to urgently reconsider reinstating the crop on the list of key priority crops in the country.

1. INTRODUCTION

This study examines the current status of the ware potato marketing, assesses the importance of adopting recommended Pre-and Postharvest Management (PHM) practices, and further validates priorities for improving ware potato marketing along the value chain in Eastern Uganda. Irish potato is both a subsistence and cash crop of critical importance to low-income producers and consumers in Uganda.

Ware potato market and price generally play a very important role in rural livelihoods. The effect of seasonality in production however leads to inconsistency in potato supply and high fluctuations in market price, which may negatively affect market performance and income of value chain actors (Bonabana-Wabbi et al., 2013). The issue of enhanced postharvest management and improved marketing as a means of increasing food availability and income of value chain actors also continue to pose an interesting research question for many development practitioners (Foresight, 2011, Minten et al., 2016, Naziri et al., 2014, World Bank, 2011).

Potatoes have a short maturity period, and provide great opportunity for value chain (VC) actors, especially women to engage heavily in its production and supply to the market. The demand for ware potato and related potato products is on the increase in Uganda's rural and urban markets. The growing demand of potato products is attributed to the rapid increase in Uganda's population in the last two decades, the relatively high level of urbanization, and the adoption of economic liberalization policy framework.

Potato farmers and other VC actors face a number of challenges, including: the bulkiness and high perishability of the crop; inadequate use of recommended postharvest handling practices; limited storage and processing facilities; lack of bulking; high postharvest losses (PHL); limited value adding; high transport costs and; poor connectivity between the production areas and final markets. According to the Government of Uganda (2015), these constraints reduce profit margins, hinder innovation, undermine value addition along the supply chain, and limit the realization of the potential of ware potato enterprise to fully make a contribution towards food and income security.

There exist real opportunities for agro-processing and value addition to increase the benefits from ware potato production and marketing in the country Government of Uganda (Government of Uganda, 2015). Widespread adoption of improved PHM practices, including storage can help to minimize losses and reposition ware potato as an added value cash crop. Appropriate use of PHM practices can also boost the ability of small-scale farmers and other ware-potato value chain actors to increase the supply of good quality ware potato products to higher end markets, including supermarket chains and fast-food restaurants. The question is whether value chain actors are well linked and organized enough to equitably take advantage of the growing demand of ware potato in Uganda and neighboring countries.

Use of improved PHM practices help value chain actors to handle ware-potato produce with care and to avoid potato damage in form of cuttings, crushing, and bruises. Value chain actors who use these recommended PHM practices are more likely to maintain potato quality. They can also discard damaged potatoes before they reach a potential buyer, thus satisfying changing needs of emerging urban markets.

In this study, an in-depth analysis of ware-potato value chains in Eastern Uganda is undertaken, with the aim of understanding the nature of existing PHM practices, the extent to which VC actors participate in

each or a combination of these PHM practices, and how the decision translates into a differential reduction in postharvest losses and impact on market performance along the ware potato value chain.

The International Potato Center (CIP) is leading the subproject "*Postharvest Innovations for Better Access to Specialized Ware Potato Markets*" under the larger "*Expanding Utilization of RTBs and Reducing their Postharvest Losses*" (RTB-ENDURE) project. The potato subproject aims at improving access to potato markets through investigating and validating postharvest technologies and management practices. The project also applies an adapted version of the Participatory Market Chain Approach (PMCA) and is grounded firmly within a multi-stakeholder approach, where Research and Development (R&D) organizations and value chain actors work together, to jointly identify, assess, select, and test best-bet options for expanding utilization and reducing postharvest losses of selected RTB crops, including ware potatoes.

This report presents the findings of a quantitative market study conducted between July and September 2015. It highlights existing market status and profitability of the ware potato business in Eastern Uganda; varying levels of VC actors' engagement and adoption of postharvest management practices, and; market constraints and opportunities that characterize ware-potato value chains in Eastern Uganda. Through addressing the underlying ware-potato market constraints and building on the opportunities, the CIP subproject aims at improving income of potato farmers by enabling them integrate into markets and adopt better control of potato sales and marketing, especially during harvest gluts, thus increasing market opportunities by providing consistent year-long supply of potatoes.

Efforts to promote value addition and reduce PHL of ware potatoes complement existing initiatives under various R&D organizations that range from plant breeding and seed systems. There are efforts to develop, multiply and disseminate potato varieties with higher, more stable yield, and potential to respond to end-users' preferences. Improved potato varieties are helping to address constraints to food security and income generation. This notwithstanding, participation in appropriate PHM practices has a potential of prolonging ware potato shelf-life, evening out the supply, stabilizing prices, and incomes, hence improving market performance. Findings of this study therefore highlight priorities for improved PHM practices to enhance market performance. The study also offers a number of practical recommendations on how to improve ware potato marketing, reduce postharvest losses, and increase gender equity along the potato value chain in Eastern Uganda.

1.1 OBJECTIVES OF THE STUDY

The purpose of this study is to assess the current status of the ware potato marketing and its relationship with existing postharvest management practices and losses along the potato value chain in Eastern Uganda. Specifically, the study involves a wide-ranging review of existing literature and conducts the analysis of relevant primary and secondary data on ware potato supply, postharvest handling practices, and marketing along ware-potato value chains with the aim of understanding:

1) the current status and map of ware potato marketing system of which RTB-ENDURE pilot farmers and traders are part of in Eastern Uganda;
2) the different ware potato storage practices and priorities for improving postharvest management, ware potato quality, and shelf-life in Eastern Uganda;
3) existing level of postharvest losses
4) the current gross margins along the value chain in Eastern Uganda;

5) the underlying gender based market constraints and opportunities of storing potato along the ware potato value chain in Eastern Uganda;
6) potential avenues through which project interventions on ware potato storage can create meaningful impacts along potato value chains in Eastern Uganda, and;
7) key baseline information for M&E indicators such as: current storage losses, ware potato shelf-life, marketing period, and income.

The study analysis answers three main questions, namely: (i) what is the current status of the ware potato marketing system in Eastern Uganda?; (ii) What are the pre and post-harvest practices currently adopted by value chain actors that help maintain ware potato quality and extend shelf-life?, and; (iii) what are the underlying gender-based marketing constraints and opportunities along the ware potato value chain in Eastern Uganda?

Relevant information was collected on each node of the ware potato value chains in Eastern Uganda. Semi-structured questionnaires and interview schedules were utilized to collect quantitative and qualitative market data, including information on: quantities of potato marketed, market price, storage and other PHM practices adopted destination markets, postharvest losses, and end uses. The study further identifies key market performance indicators, the underlying opportunities and constraints faced by VC actors, and the differential participation of women, men and youth actors at each node of the value chain.

The findings of this study are expected to help the International Potato Center (CIP), its R&D partners, potato farmers, and other stakeholders interested in improving the performance of ware potato value chains and ensuring equitable distribution of income generated along the value chain. The report identifies priorities for: (i) reducing PHLs through improved storage, (ii) improving the marketing of good quality ware potato harvested in glut periods and supplied to the market during the period of scarcity, and (iii) enhancing gender equity along potato value chain in Eastern Uganda.

This report is organized as follows: following this introduction, are the reviews of the importance of ware potato in Uganda, access to potato markets and market supply, ware potato marketing, postharvest management practices and market performance, the role of market imperfections and transaction costs, and relevant evidence on market performance along the value chain in section 2 to 2.6. Section three describes the survey areas, field sampling and methodology. Section four presents descriptive statistics on household identification and demographic characteristics. Section five presents an assessment of ware potato production in Uganda; section six discusses the consumption of ware potato in the country; section seven provides a description of ware potato value chains; section eight discusses the marketing of ware potato and costs incurred; section nine presents the marketing margins, while section ten presents the policies and enabling environment for ware potato value chains. The analysis of postharvest losses is summarized in section 11. Section 12 summarizes conclusions and key policy recommendation for improving the marketing of ware potato in Uganda and neighboring countries.

2. LITERATURE REVIEW

This section reviews past studies on marketing and value chains of ware potato and related roots and tuber crops. The section further highlights the importance of potato, characteristics of the potato value chains, the role of storage and other recommended postharvest practices, postharvest losses incurred, gross margins attained, level of market performance, marketing constraints and opportunities faced along the value chains.

2.1 The importance of ware potato

Ware potato *(Solanum tuberosum)* has a number of characteristics common to other root and tuber crops. These characteristics range from: the bulkiness and perishability of the harvested product; the nature of vegetative propagation conducive to the spread of diseases; the intensive labor demands for production and marketing; limited market access and integration; seasonal production leading to market variation in quality and quantity; and minimal value addition through processing (Thiele et al., 2009).

Potato is the world's fifth most important food crop in Low Developed Countries (LDC) by total production (159 MT), and the third most important food crop by food consumption (118 MT) after rice and wheat (CIP, 2010). The crop provides food, employment, cash income, and raw material for some agro-processing firms, which produce French fries, chips, crisps/snacks, and other miscellaneous products like flour and starch. Potato crop is an excellent source of protein, low fat carbohydrates, vitamins C, B6, and B1, folate, potassium, phosphorus, calcium, iron, zinc, and valuable supplies of essential trace elements such as manganese, chromium, selenium and molybdenum (CIP, 2010). Potato crop is also reported to provide high dietary fiber and antioxidants such as polyphenols and tocopherols.

Potato is grown in diverse environments in Africa, Asia, and Latin American Countries (LAC). While the potato is considered a high latitude crop originating in the Andes, it is now grown in a wide range of environmental conditions, from traditional ranges to warmer, drier areas, including irrigated areas (MacKenzie et al., 1997). More than a billion people worldwide consume ware potato. The global total crop production currently exceeds 300 million metric tons. Arguably, more than half of global potato production comes from developing countries, where a one hectare of potato yields two to four times the food quantity of grain crops (CIP, 2010). Potatoes therefore produce more food per unit of water than any other major crop and are up to seven times more efficient in using water than cereals.

In Uganda, Irish potato is an important crop for food and income generation in Uganda. The crop is considered one of the strategic commodities with potential to remarkably contribute to increasing rural incomes and livelihoods, and improving food and nutrition security (Mbowa and Mwesigye, 2015, UBOS and MAAIF, 2011). There is need therefore to enhance the level of potato productivity, post-harvest handling, storage, marketing, and value addition to the satisfaction of the final consumer. Interventions that promote the adoption of improved and affordable technologies help to minimize PHLs due to the sheer bulk of harvested ware potato and short shelf-life at any one time. Currently, in sub-Saharan Africa (SSA) much of the ware potato crop production is consumed on-the-farm or areas nearby the production site.

2.2 Access to potato markets and market supply

The Eastern region of Uganda is characterized by two potato cropping seasons and highly seasonal market supply of potatoes. The prevalence of clear period of potato gluts and scarcity in turn creates the challenge of high price fluctuations throughout the year. Introducing improved storage technologies and related PHM practices can help value chain actors to expand the cropping period and further take advantage of the higher price during the off-season. This postharvest innovation ultimately guarantees higher and more stable income for small-scale farmers who can now maintain consistent market supplies through better storage.

Ware potato farmers and other value chain agents work very hard. They use unskilled family and hired labor to increase their earnings, income, and living standards. Women are in particular heavily involved in the production and supply of potatoes and other root crops in many SSA countries (Thiele et al., 2009). Nonetheless, over the last three decades, value chain actors have not registered impressive welfare outcomes. This phenomenon can be attributed to the high production costs as well as the pre-harvest and postharvest losses incurred. Different factors, including high fuel prices, increasing labor wages, the high cost of fertilizers, and the lack of access to postharvest storage facilities raise the cost of producing quality ware-potato. Ultimately, the high cost of production reduces profit margins made by each category of actors along potato value chain.

To the extent that the cost of production and marketing is very high, value chain actors will register low returns, and will further be deprived of meaningful profits. It is therefore important to understand the level of PHLs, marketing costs, and profit margins of each actor along the ware potato value chains.

2.3 Ware potato marketing in Uganda

Policies to influence and motivate an increase in the production and marketing of agricultural crops, including potatoes, to a large extent emphasize the role of higher and more stable producer prices. The role of price signal and other inputs in agricultural crop production is normally examined based on the analyses of own and cross price elasticity. In Uganda, empirical evidence on the dynamics of price elasticity in the roots and tuber crops is still scanty and flimsy. This undermines the ability of policy makers and other stakeholders to identify possible drivers of output growth and to identify the right policy interventions to increase the supply of these crops.

In a market-based economy, it is the competition between and among buyers and sellers that leads to the equilibrium price. Buyers competing with one another for goods in short supply rise price to try to capture some of the good. As price increases, demand falls and supply rises. This process continues until the price equates with the equilibrium price and quantity supplied equals quantity demanded, which is the equilibrating role of prices in a free market economy. Higher prices raise farm income which enables farmers to buy other items and farm inputs (Campenhout et al., 2012). Price therefore plays an important role in ensuring efficient distribution of resources and signaling of shortages and surpluses. Information on market price helps farmers and other value chain actors to respond to changing market conditions.

In Eastern Uganda, potato is produced twice a year during rainy seasons resulting into excess supply in harvest periods (January, June, July, August and December) and shortage in supply on the market (March, April, May, September, October and November) when the crop is in field (Wasukira et al., 2014b, Wasukira et al., 2014a). High levels of postharvest losses, the lack of value addition technologies, little bargaining

power of VC actors, and failure to access timely market information increase transaction costs, reduce the quality and volume of marketed production, and further limits market performance along the ware potato value chains (Birachi et al., 2013).

Market performance along potato VC is undermined when ware potato price is low and volatile. According to the findings of the CIP scoping study in Eastern Uganda, farm-gate price for ware potato can drop to as low as $ 0.08 per kg which hardly covers production costs, while in periods of scarcity, farm-gate prices rise to about $0.44 per kg (Wasukira et al., 2014a). Besides, about 95 percent of potatoes produced in Uganda are marketed in fresh form with limited value addition. The inability to store potato long after harvest and the inconsistency in potato supply causes high levels of PHL. High seasonal price fluctuations also negatively affect VC actors' level of marketing outcomes throughout the year.

Engaging in effective PHM practices, especially better storage technology can help VC actors to upgrade their operations in terms of: reducing PHL; stocking-up potatoes in seasons of plenty and releasing them back into the market in seasons of scarcity; maintaining a steady supply of good quality potatoes throughout the year, and; conducting their work based on clear business management (Kaganzi et al., 2009, Wasukira et al., 2014a). Furthermore, participation in simple value adding activities such as sorting, storage, packaging, and branding are likely to have a positive effect on farmer incomes and marketing outcomes. The ability to adopt technologies that extend potato shelf-life, improve the quality of the potato product through recommended practices of storage, sorting, packaging, and branding may create opportunities to sell into distant high end markets that attract better prices and consumer appeal.

According to Birachi et al. (2013), VC actors have the potential to benefit from better markets when they choose to among others: operate within organized groups that encourage collective marketing in a timely manner, adopt some value-adding activities, and engage in processing of potato products to prevent postharvest losses.

The underlying poor linkages (e.g., arrangements that foster commodity purchases based on pre-agreed terms) and coordination among VC actors may also significantly reduce market performance and profit margins attained by each of the actors in ware potato value chains. This calls for the deliberate effort to embrace collective marketing, appropriate postharvest handling practices, strong leadership within organized groups of VC actors, and continuous learning of new skills and innovations, all of which help to increase and maintain supply of high quality ware potato throughout the year.

2.4 Participation in PHM practices and marketing performance

There is little reliable or no information that reveals robust linkages between participation in PHM practices, the extent of PH losses, and how these two affect marketing performance of ware potato value chains. Several studies have been conducted in Uganda to study the performance of ware potato value chains such as Kyomugisha et al. (2012); Sebatta et al. (2014); Birachi et al. (2013); Bonabana-Wabbi et al. (2013), but they focused on such aspects as: contractual relationships with buyers; market efficiency in terms of value added at each node, factors that influence the decision of value chain actors to participate in the ware-potato market, and determinants of how much to participate in the potato market. Not much is known regarding ware-potato value chain actors' participation in selected postharvest management practices, including storage, and how this creates differential impacts on reduction of PHLs and enhancement of market performance in terms of margins and gross profit.

Kyomugisha et al. (2012) reveals that potato market chain in Uganda is characterized by a large number of small uncoordinated farmers and buyers who face high marketing costs resulting into lack of mutually beneficial linkages between the various actors in the chain. The study observes that engaging in collective marketing, negotiating contracts, and selling good quality potatoes under some form of a contract improves market efficiency and profits attained by values chain actors. Sebatta et al. (2014) did not control for the effects of postharvest management practices on market participation. The authors reveal that proximity or access to a village market, the average level of potato price, number of extension visits, and education level have a positive and significant effect on farmers' decision to participate in the market. Distinctively, non-farm income earned is shown to have a negative and significant effect on potato farmer's market participation.

In a study conducted in South-Western Uganda, Bonabana-Wabbi et al. (2013) identifies marketing channels of potatoes from the farm to consumption, identifies marketing constraints faced by farmers and traders in the potato marketing chain, and assesses the marketing performance of potato markets, and different potato varieties using gross margin analysis. The findings of this study underscore the need to carefully respond to institutional and product-related constraints that appear to inhibit the development of the potato value chains. In particular, the low prices at the time of sell, high perishability of the product, and poor market access as a result of bad road conditions and high transport costs are some of the factors that were found to inhibit market performance. Ultimately, these findings justify the need to promote the adoption of effective and affordable postharvest handling practices and storage techniques if VC actors are to succeed in curbing price fluctuations due to seasonal production.

Elsewhere and contrary to usual expectations about traditional supply chains for staples being mired with high rates of wastage, Minten et al. (2016) reports much lower total quantities of potatoes wasted at 5.2 percent in the harvest period and 6.4 percent during the off-season of all quantities that enter the value chain for Bangladesh. Their analysis further found that similar quantities of wastages are much lower in India at 3.2 percent and 3.3 percent, respectively, but much higher in China, a factor that is attributed to long distance potatoes often get to be shipped.

2.5 Market imperfections and transaction costs

Agricultural production in SSA is characterized by various market imperfections that include: **s**patial dispersion, high transportation and travel costs, seasonality, problems of synchronic timing, heterogeneity of factors of production, high costs of information acquisition, and risk (Binswanger and Rosenzweig, 1986). The combination of market imperfections and uninsured risk create inefficiencies and fluctuations in household production and income. These in turn limit the ability of households to take on profitable activities that otherwise would have been useful in reducing income poverty (Dercon, 2002, Dercon, 2005). These market imperfections also impose constraints on input demand, output supply and investment in asset building.

Various *material conditions* and *production relations* (the nature of different output markets) in tropical agriculture also have serious implications on the performance of the output market and other institutions in rural areas (Binswanger and Rosenzweig, 1986). Material features of agriculture may include the spatial nature of agriculture (*dispersed, with low or high population density*), the existence or absence of technical economies of scale (*level of technology*), the resulting covariance of risks (*seasonal rainfall and price*), and

the distinct attributes of each factor or output (Binswanger and McIntire 1987, Binswanger and Rosenzweig 1986). Conversely, production relations are determined by the joint combination of rural economic factors such as: the consequences of risk, information costs, seasonality, changes in material and technological features of agricultural production, and biophysical attributes of agricultural output.

The joint effect of transaction costs, covariate risk, and asymmetric information (*moral hazard and adverse selection problems*) lead to market imperfections that may range from: missing markets, thin markets (imperfect competition), partly missing markets (rationing, seasonality), limited access to credit, access to informal credit at high interest rates, constrained access to off-farm employment, price bands on output and labor, interlinked (input, credit and output) markets, and constrained access to rental markets of assets such as land (Holden et al., 2005, Holden and Binswanger, 1998, Holden et al., 1998). In communities where these market imperfections are pervasive, development of strong institutions helps to reduce transaction costs of market exchanges between actors in the value chain.

High transaction costs create heterogeneity in resource use (compels farmers to use resources differently) and discourage market transactions (Sadoulet and de Janvry, 1995). This is the case when the producers' subjective equilibrium for the production of commodities they also consume or for the use of factors they also own falls within their own price band. Farmers also face different types of risks that range from yield risk, market price risk, timing uncertainties, breakdown and lifecycle risks, and covariate risk (Binswanger and Rosenzweig, 1986). Covariate risk in particular, causes even risk neutral producers to be affected by risk. Covariate risk creates strong negative correlation between production and price, especially in relatively isolated areas with poor market integration. In such areas, any price stabilization may result in a clear outward shift in the supply curve and a lower average price. Thus, a higher market price may reflect an increase in production cost that indirectly discourages domestic supply. This justifies the need to for more research on how to unlock existing complexities that limit steady production and supply of agricultural crops, including roots and tubers in SSA.

In Uganda, food markets are characterized by information asymmetry, inadequate storage, poor transport infrastructure, and weak physical and institutional market organization. Most of ware potato VC actors face significant challenges that limit their capacity to effectively participate in the marketing of their stock (Bonabana-Wabbi et al., 2013). For example, value chain actors face high market price risks, high levels of postharvest losses, limited access to market information, lack of capital, lack of appropriate technologies for value addition and poor physical handling system of agricultural commodities.

All the above mentioned critical value chain constraints need immediate interventions from policy makers and stakeholders if on-going efforts to alleviate poverty in the country are to succeed. The proposed potential interventions include: strategies that facilitate and up-scale market information sharing among value chain actors; investment in physical infrastructure (including improved storage and better roads) to facilitate trade; and provision of incentives to encourage public-private partnerships in storage, distribution, and marketing. From a policy perspective, efforts should be made to facilitate arbitrage through the improvement of storage and physical market infrastructure.

2.6 Evidence on market performance along the value chain

There are number of supply response studies focusing on smallholder producers in Africa, including Farayola et al. (2013); Yu et al. (2010); Olwande et al. (2009); Vitale et al. (2009); Muchapondwa (2008);

Olubode-Awosola et al. (2008), and; Olubode-Awosola (2006). These studies analyze crop supply response to changes in price and quantity of inputs and outputs. The approach of many other past studies is to analyze crop supply responses from the standpoint of prevailing institutions, price, technology, and investment (Yu et al., 2010). They provide empirical evidence on the role of price signal and other inputs in agricultural crop production based on the analyses of own price elasticities, which help to underpin possible causes of output growth and marketed production in specific agricultural crops. To the extent therefore that there is stronger response to market price of inputs and output, this implies that the market plays a big role in the decision making process of agricultural production at the household level.

In his comprehensive review of literature, Olubode-Awosola (2006) established several factors that affect agricultural supply response. These include among others: risk, farmers' attitude to risk, technology, farm industry structure and cost of production. The author emphasizes the need to incorporate key information in the analysis of output supply such as changes in prices and changes in factors that shift the supply curve. Arguably, changes in prices, though not always, are shown in economic literature to account for a small proportion of total changes in supply that occur over a period of several years. This implies that short-run changes in supply can be caused by other factors such as weather. Distinctively, long run changes in supply can be attributed to improvements in technology, and programmes that reduce risk in agriculture.

In a recent study in Nigeria, Farayola et al. (2013) investigates the role of transaction costs in determining sweetpotato supply response of farmers in Kwara State. The study utilized cross sectional data of about 120 sweetpotato producers to determine the magnitude and direction to which the level of transaction costs influence changes in sweetpotato supply in the area; and to estimate the elasticity of sweetpotato supply in the study area. Ordinary least squares model was employed to estimate the linearized log transformed estimable equation of quantity of sweetpotato supplied. Results of the study show that transaction costs, market price, area of land cultivated, and marketing agents and service have a significant effect on the supply response of sweetpotato producers.

In a related study conducted in Kenya, Nyagaka et al. (2010) used data from a field survey using a random sample of 127 smallholder potato producers from Nyandarua North District to assess technical efficiency in resource use and to identify the underlying determinants of variations in production efficiency. A dual stochastic parametric decomposition technique was used to derive technical efficiency indices while a two-limit Tobit model was used to examine the effects of socio-economic characteristics and institutional factors on the derived technical efficiency indices. Results show that resource use is subject to decreasing returns to scale, while the mean technical efficiency is estimated at 67 percent. Education, access to extension, access to credit, membership in farmers' association and innovations positively and significantly were found to influence technical efficiency. Technical efficiency and access to credit are shown to be positively and significantly related, which suggests that farmers with greater access to formal credit are able to obtain higher technical efficiency.

3. FIELD SAMPLING AND METHODOLOGY

This study is mainly focused on size of ware potato business at various nodes of the value chain. It covers ware potato value chains, including marketing activities of ware potato farmers, traders (wholesalers and retailers), processors, and consumers in major potato producing districts of Eastern Uganda and high end markets in the region and Kampala city. Primary data was collected from all potato value chain actors and selected key informants representing district authorities and local leaders in each of the selected districts.

The study is based on a number of quantitative and qualitative cross sectional data on marketing and the level of competition between locally produced and ware potato supplies from neighboring Kenya. Data was collected using a pretested structured questionnaires administered to selected respondents. Additional secondary data was collected on ware potato supply, postharvest handling, and marketing along ware-potatoes value chains. Secondary data sources included relevant journal papers, books, FAO data bases and results from an earlier scoping study on ware potato postharvest handling in Eastern Uganda by Wasukira et al., (2014a). Noteworthy is that a substantial quantity of ware potato sold in Eastern Uganda originates from Eastern Kenya and other distant areas. Key information was collected on the characteristics of the demand of ware potatoes from other parts of the country such as Mbale and distant markets, including South Sudan.

The sample consisted of the selected pilot farmers, non-pilot farmers, and also other downstream value chain actors. Small-scale farmers are the ultimate beneficiaries of the on-going CIP's project and form the main target. By the time of field work, some of the pilot farmers had not been selected. Decision was made to select target-type farmers, in situations where there were no pilot farmers. For the analysis of the demand of ware potato, the target was the local and urban consumers currently or potentially purchasing ware potatoes originating in the pilot sites.

3.1 Survey areas

This study was conducted in Eastern Uganda in areas where the International Potato Center (CIP) is implementing the RTB-ENDURE potato subproject. The aim of this subproject is to improve access to potato markets through investigating and validating postharvest technologies and enhanced postharvest handling practices. In wider context, the project aims at improving income of potato farmers through enabling them to integrate into markets in ways that among others: encourage better control of potato sales, limit marketing during harvest gluts, and help take advantage of PHM practices that not only increase market opportunities, but also ensure consistent year-long supply of potatoes. The study therefore analyses the available market opportunities and market performance of value chains originating from Eastern region of Uganda, where CIP has project sites and potential beneficiaries of its agribusiness development and storage construction intervention.

The study focused on four districts which were purposively selected based on their highest rank in potato production in the Eastern region (Kapchorwa, Kween-Benet and Mbale-Wanale) or being main destination markets (Mbale town and Kampala city). In Uganda, districts prominent in potato production include: (i) Kabale, Kisoro, Kanungu in Southwest part of the country; (ii) Manafwa, Mbale, Kapchorwa, Kween, Sironko in Eastern, and (iii) Nebbi in Northwestern.

3.2 Sampling and data collection method

Using a multi-stage sampling procedure and semi-structured questionnaires, four unique quantitative cross-sectional data-sets were collected between July and September 2015 from randomly selected 116 farmers, 72 traders (including 34 wholesalers and 38 retailers), 34 processors, and 85 consumers as summarized in Table 1. Qualitative data was also collected using field guides, key-informant interviews and focus group discussions.

Table 1: Sampling frame for study respondents in Eastern Uganda

Study areas	Farmers (pilot)			Traders		Consumers	Processors	Totals
	Accessing IS	Not-accessing IS (Control)	Accessing CS	WS	RT			
Kween/Benet	0	7	15	6	3	15	0	46
Kapchorwa	10	8	15	4	10	15	5	67
Wanale/ WASWAPA	10	16	32	.	.	16	3	77
Mbale/ MPODA -traders	0	3	0	11	11	20	6	51
Kampala	0	0	0	13	14	19	20	66
Total no. of respondents	20	34	62	34	38	85	34	307
Total number of respondents	116			72		85	34	307

Note: (i) "WS" denote wholesalers; "RT" denotes retailers; "IS"-individual stores; "CS"- collective stores; (iii) where actors were very few, almost all of them were selected; (iv) Almost all farmers in Mbale district were selected from nearby Wanale/WASWAPA because Mpoda is located in a commercial area with very limited farming activity.

The study covers several potato markets from: (i) Bugwere, Chemonges square, Chepkwasta, Dagorate, Kamunakrut, Kapchesombe Central, Kapchorwa market, Kipilat market that are located in the districts of Benet and Kapchorwa; (ii) Mulyom, Mutyoru, Muzana zone, Mbale Central, Mengya, Badama lane in Mbale district, and; (iii) Kalerwe, Nakawa, and Owino in Kampala city. Major Farmer groups in the study area, whose members were selected for interviews include: WASWAPPA, Mengya Integrated Farmers Association (MIFA), Bushuiyo Womens Group, Wanale Highland Farmers Association, and Kepchesombe farmers group and Bonio womens group among others as indicated in Table A3, Annex A.

3.4 Data analysis

A combination of different techniques was adopted to analyze the data with an aim of assessing marketing performance of value chain actors. They include constructing a value chain map, generating descriptive statistics, quantifying marketing margin for different value chain actors, and utilizing a number of selected bivariate and multivariate approaches to data analysis.

4. HOUSEHOLD DEMOGRAPHIC CHARACTERISTICS

This section presents a description of inherent characteristics and capabilities of the different respondents interviewed in the study. These characteristics range from age of household head, education level, marital status, gender and family size. Notice that the majority of this study's respondents are from rural areas. They exhibit particular demographic characteristics, which can also have implications on the extent of their participation in PHM practices and their performance in the ware potato market.

Results in Table 2 show that 2.6 percent of selected farmers only, 73.61 percent of traders, all processors, and 43.53 percent of selected consumers are located in peri-urban and urban areas. The biggest proportion of selected farmers (52.59 percent) resides in Mbale district (Wanale sub-county), followed by 28.45 percent in Kapchorwa district (Kapuchesombe sub-county), and Kween district (Benet sub-county) at 18.97 percent (also see results in Table A1, Annex A). The study was conducted in five counties of Bungokho, Kween, Tingey, and Mbale Municipality. In Kampala, selected respondents were from Kyaddondo County and specifically in divisions of Kampala Central, Kawempe, Nakawa, Makindye and Kiira Town council.

Table 2: Household identification in the study area

Particulars	Farmers			Traders			Processors			Consumers	
	Obs.	Pct.		Obs.	Pct.		Obs.	Pct.		Obs.	Pct.
Location											
Rural areas	113	97.41		19	26.39					48	56.47
Peri-urban & urban areas	3	2.59		53	73.61		34	100		37	43.53
District name											
Mbale	61	52.59		22	30.56		9	26.47		36	42.35
Kapchorwa	33	28.45		14	19.44		5	14.71		15	17.65
Kween	22	18.97		9	12.5					15	17.65
Kampala				27	37.5		20	58.82		19	22.35
County name											
Bungokho	61	52.59		2	2.78					23	27.06
Kween	24	20.69		10	13.89					15	17.65
Tingey	31	26.72		13	18.06		5	14.71		15	17.65
Kyaddondo				27	37.5		20	58.82		19	22.35
Mbale Municipality				20	27.78		9	26.47		13	15.29

Results in Table 3 further reveal that the proportion of male respondents is lowest (25.88 percent) for consumers, low (26.72 percent) for ware potato farmers, and high at 48.61 percent for traders, and it is highest at 61.76 percent for processors. It is therefore evident that men are more active at the ware potato value chain nodes of processing and trading, while females dominate activities of potato production and consumption.

Most of the respondents, whether farmers (65.52 percent), traders (58.33 percent), processors (47.06 percent), and consumers (60 percent) are in a monogamous marriage (*see results in Table 3*). Being married instills discipline and obligations according to the societal standard and compels respondents to work hard due to family responsibilities. The category of processors has the largest proportion (52.94 percent) of respondents not married. Unlike older people already married that dominate ware potato production, trade, and consumption, unmarried young people are more active in ware potato processing into different products, including chips and crisps.

Table 3: Household identification along the ware potato value chain analysis in Eastern Uganda

	Farmers			**Traders**			**Processors**			**Consumers**	
Particulars	Obs.	Pct.		Obs.	Pct.		Obs.	Pct.		Obs.	Pct.
Sex of the respondent is male	31	26.72		35	48.61		21	61.76		22	25.88
Sex of the respondent is female	85	73.28		37	51.39		13	38.24		63	74.12
Marital status of the respondent											
Single (never married)	4	3.45		19	26.39		14	41.18		16	18.82
Monogamous marriage	76	65.52		42	58.33		16	47.06		51	60
Polygamous marriage	31	26.72		9	12.5					17	20
Separated/Divorced				2	2.78		3	8.82			
Widowed	5	4.31					1	2.94		1	1.18
Marriage status of respondent											
Household head is not married	9	7.76		21	29.17		18	52.94		17	20
Household head is married	107	92.24		51	70.83		16	47.06		68	80

It is clear from results in Table 4 that the majority of value chain actors at the nodes of production, processing, and consumption are Christians (Protestant, Catholics, and other Christians). To some extent, Muslim value chain actors are more common (at 26.98 percent) at the lucrative node of ware potato trade.

Table 4: Religion of household head in the study area

	Farmers			**Traders**			**Processors**			**Consumers**	
Particulars	Freq.	Percent		Freq.	Percent		Freq.	Percent		Freq.	Percent
No religion	1	0.96		1	1.59					15	22.39
Catholic	14	13.46		13	20.63		4	25		30	44.78
Protestant	49	47.12		15	23.81		5	31.25		8	11.94
Other Christian	21	20.19		17	26.98		4	25		13	19.4
Hindu	1	0.96					1	6.25			
Muslim	18	17.31		17	26.98		2	12.5		1	1.49
Other											
Total	104	100		63	100		16	100		67	100

The dominant tribes of selected ware potato farmers are Bamasaba (55.24 percent) and the Tepeth at 42.86 percent (*Table A2, Annex A*). The largest proportion of the other ware potato value chain actors (traders, processors, and consumers) is constituted by tribes of Bamasaba, Baganda, and Tepeth in that order.

Ware potato farmers were asked whether they are active member of any farmer group in their area. Responses to this question and names of specific farm groups they belong to are summarized in *Table A3, Annex A*, and they show that the majority of farmers (71.55 percent) are members of a group. In particular, some of the dominant farm groups of selected producers include: WASWAPPA (26.51 percent), Mengya Integrated Farmers Association (15.66 percent), Bushuiyo Women's Group (8.43 percent), Wanale Highland Farmers Association (4.82 percent), and Kepchesombe farmers group (3.61 percent).

4.1 Demographics and household composition

The characteristics of value chain actors are summarized in Table 5. The average age of household head and their spouse is highest (42.66 years) among farmers, and least (33.54 years) among processors. Household heads are relatively older than their spouses with an average difference of between 2 and 4 years. Average education level is highest among consumers, followed by processors, farmers and it is lowest among traders. Education level of household heads is highest at 12.89 years across processors, followed by consumers at 10.42 years, farmers at 9.45 years and is least among traders at 8.70 years.

Table 5: Demographic characteristics and household composition status

Variable	**Farmers**		**Traders**		**Processors**		**Consumers**	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Age of household head (years)	116	44.94 (10.91)	72	35.25 (9.01)	34	35.03 (7.72)	85	35.90 (9.74)
Age of household head's spouse (years)	116	40.75 (8.40)	72	33.41 (6.50)	34	33.95 (8.34)	85	33.00 (8.02)
Average age of household head and spouse (years)	116	42.66 (10.31)	72	33.75 (9.08)	34	34.47 (8.04)	85	33.88 (9.59)
Education level of Household head (in years)	116	9.45 (4.41)	72	8.70 (3.71)	34	12.89 (2.20)	85	10.42 (10.41)
Education level of Household head's spouse (in years)	116	8.33 (4.23)	72	7.10 (3.80)	34	10.05 (4.64)	85	11.89 (14.46)
Average level of education (in years)	116	8.90 (4.08)	72	8.52 (3.96)	34	11.44 (4.44)	85	11.64 (14.99)
Family size	116	8.32 (3.29)	72	6.03 (3.58)	34	5.15 (3.67)	85	5.74 (2.39)

Notes: (i) Standard deviations are in parentheses

Almost similar trends exist with regards to education level of the household head's spouse. There is a strong correlation between the average family size and education level of actors. Family size is lowest among ware potato processors at 5.15, followed by consumers at 5.74, traders at 6.03, and it is highest at 8.32 among ware potato farmers**.** Unlike traders and farmers, ware potato consumers and processors appear to be younger, more educated, and less burdened with many dependents in their homesteads. Farmers are the most burdened by large family sizes, while traders are the least educated among all value chain actors.

Results in Table 6 also reveal that the number of adult females and adult males in a household are highest among ware potato farmers, followed by traders, processors, and its least among consumers. With exception of the number of children less than 2 years which is highest (0.46) among consumers, the number of all other children under age categories 2 - 5 years, 5.1 - 10, and 10.1 - 15.9 follow the same pattern of being highest among farm households and least among consumers.

Table 6: Household size and number of household members in different categories

	Farmers		**Traders**		**Processors**		**Consumers**	
Variable	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Number of adult females>=16 year in a household	116	2.34 (1.58)	72	1.58 (1.26)	34	1.69 (1.20)	85	1.55 (0.93)
Number of adult males >=16 years in a household	116	2.26 (1.58)	72	1.61 (1.27)	34	1.35 (1.30)	85	1.44 (0.85)
Number of children <2 years in a household	116	0.37 (0.61)	72	0.38 (0.52)	34	0.08 (0.24)	85	0.46 (0.59)
Number of children 2-5 years in a household	116	0.82 (0.91)	72	0.75 (1.02)	34	0.54 (0.56)	85	0.68 (0.71)
Number of children 5.1-10 years in a household	116	1.34 (1.14)	72	1.01 (1.09)	34	0.85 (0.91)	85	1.04 (0.94)
Number of children 10.1 -15.9 years in a household	116	1.18 (1.15)	72	0.69 (1.12)	34	0.65 (0.92)	85	0.57 (0.99)

Notes: (i) Standard deviations are in parentheses

Summary

Some of the basic demographic characteristics of value chain actors were examined. Differences in household characteristics may have implications on how much they participate in PHM practices and ware potato market performance. Development of ware potato value chains would require different actors to: operate in suitable locations that are well linked to markets, better exploit existing gender roles, participate with high level of responsibility grounded within existing cultural norms, be organized in produce marketing groups, and have necessary experience, education, and ability to utilize market information. In the case of farmers, a large proportion (71.55 percent) is organized in farmers group. Experience in marketing and being responsible is vital in helping actors to minimize market risk and increase trust.

Male actors are more active on ware potato value chain nodes of trading and processing than their female counterparts. The value chain nodes of production and consumption are on the other hand dominated by female actors. A large proportion of value chain actors involved in the value chain nodes of production, trade, and consumption are relatively older and already married. Young actors, who are not married, possess unique skills of creativity that gives them an advantage over their relatively older peers on matters of ware potato processing into different products, including chips and crisps. Ware potato processors are on average younger, more educated, and least burdened with dependents in their homesteads. Ware potato farmers are the most burdened by demands of large families. Traders are the least educated among all value chain actors.

5. PRODUCTION OF WARE POTATO IN UGANDA

This section focuses on ware potato production in Uganda and, particularly, in the specific districts in Eastern region where the RTB-ENDURE project is being implemented. Detailed information is presented regarding the ware potato volume of production, acreage, yield, land size, land allocated to potato production, the preferred varieties, farming system, seasonality, and the role of men and female in farming.

5.1 Trends in potato production and productivity in Uganda

Potato is a crop produced primarily by smallholders with limited use of improved inputs. Potato production in Uganda was estimated at 770,000 in 2014 up from 368,000 MT in 1994 with production area of 33,000 Ha of land and on-farm yield of approximately 19.7t/Ha (FAOSTAT, 2017). These statistics are different what the 2008 UCA statistics indicate. Uganda is shown to produce about 154,436 MT of Irish potatoes, on the total area of 32,758 Ha of land, and with the yield of 4.7t/Ha (UBOS & MAAIF, 2010).

National statistics indicate that Western region has the highest production of Irish Potatoes with the total output of 135,000 Mt (87.6%) followed by the Central region with 13,000 Mt (8.6%), the Eastern region with 4,624 MT (2.9%), and the least is the Northern region with 1,000 Mt (0.8%) (UBOS & MAAIF, 2010). In terms of Irish potato yield, Western region has the highest at 5.2 Mt/Ha, followed by the Eastern region at 3.6 Mt/Ha, Central region at 2.8 Mt/Ha, and lastly Northern region at 2.2 Mt /Ha.

In addition, farm households growing potatoes in Eastern region in the 1st season of the year constitute about 1.1 percent of all potato farmers in the country and the proportion is lowest compared to 2.1% in the Northern, 9.8% in the Central, and 87% in Western region (UBOS and MAAIF, 2011). These proportions change slightly in the 2nd season to 3.5% in Eastern region compared to 1.4 % in Northern, 10.5% in Central, and 84.6% in Western Uganda. According to UBOS & MAAIF (2010), potato farmers in Uganda sell about 40 percent of their harvest; consume 39.1 percent; store 6.8 percent; and use the remaining 13.6 percent for other purposes. Potato is currently being utilized to provide food and cash to many households in the rural and urban areas (MAAIF, 2010).

The 2014 potato production in MT was equivalent to 27 percent of cassava production and 41 percent of sweetpotato production in the same year. This implies that potato production in the country is still much lower compared to that of cassava and sweetpotatoes. That said, Uganda has experienced a general positive trend in production of potato since 1961 and this is attributed to slight growth in acreage and yield. Figure 1 reveals that Uganda produces more cassava than any other root and tuber crop, followed by sweetpotato whose production has grown overtime, while potato is the least produced. We see a decline in production of potatoes, cassava and sweetpotatoes between 2012 and 2014, a phenomenon that is most likely attributed to estimation error by FAOSTAT.

Figure 2 further reveal that potato production in Uganda has increased from 8 percent of all major roots and tuber crops in 1994 to 14 percent in 2014, thus registering a gain of 6 percent in the last two decades. While the production levels of potatoes and cassava are increasing in the country, sweetpotato production is on the steady decline.

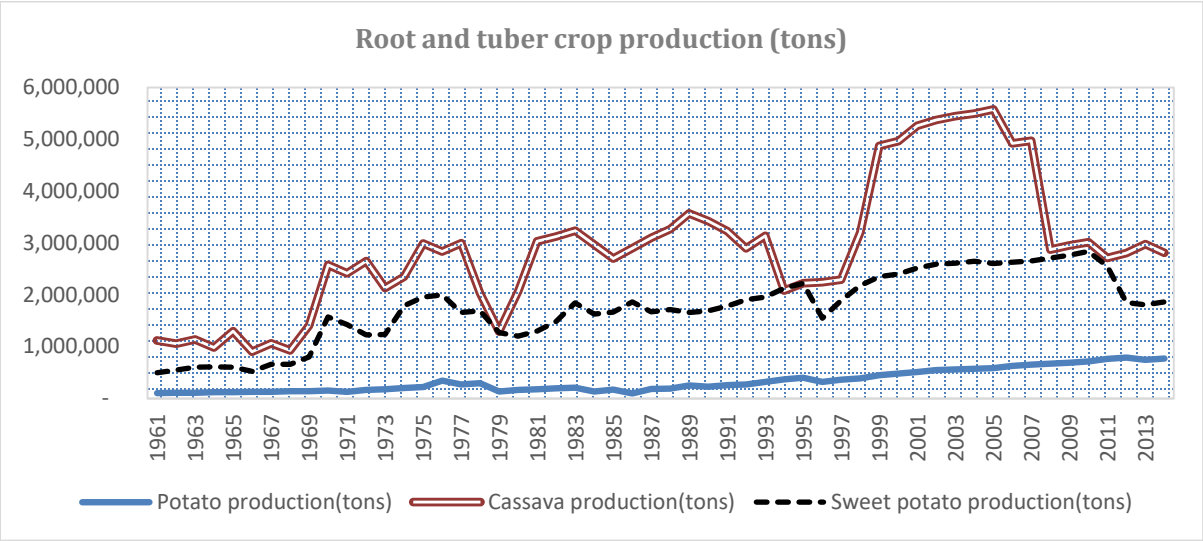

Figure 1: Root and tuber crop production (tons) in Uganda
Source: Author's computation using FAO data (FAOSTAT, 2017)

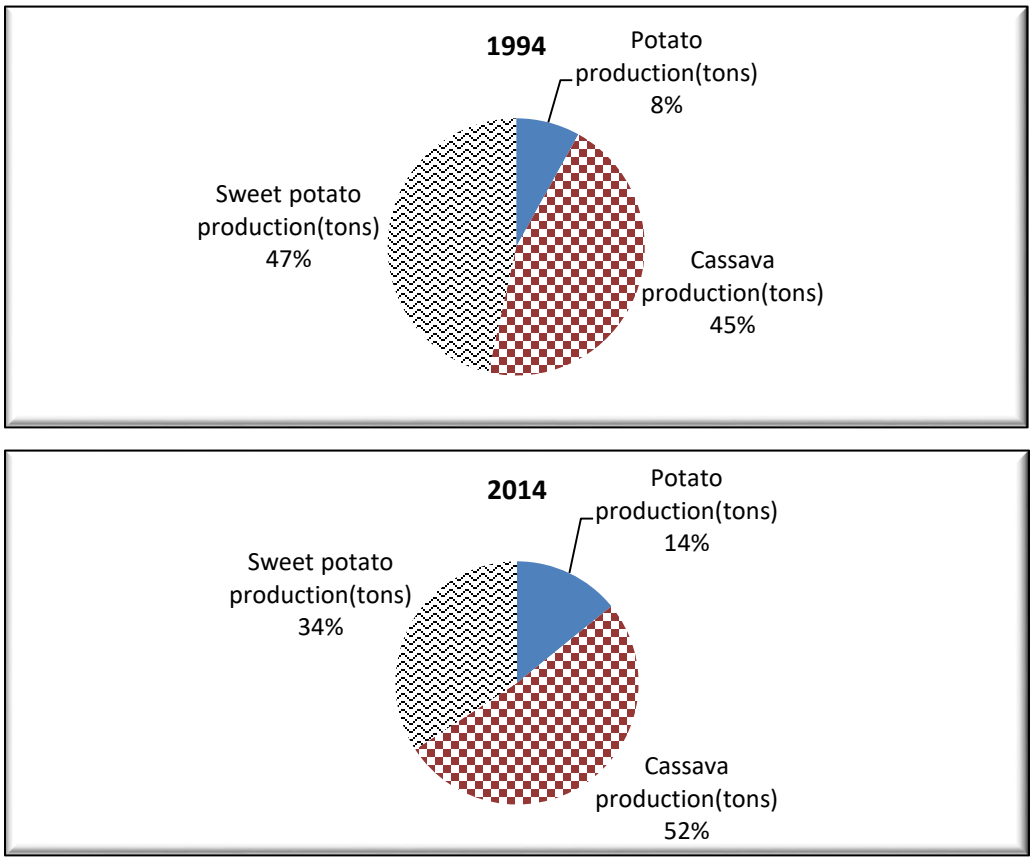

Figure 2: Root and tuber crop production (tons) in Uganda
Source: Author's computation using FAO data (FAOSTAT, 2017)

It is clear from Figure 3 that the productivity of Irish potato in Uganda declined consistently between 1961 and 1999, later stabilized up to 2009, before increasing drastically up to 2011, and later suffered a slight decline up to 2014. Productivity of cassava has been growing consistently more than any other root and tuber crop until 2005 but experienced a severe decline in recent years. There was drastic improvement in cassava yields in 1997, a year when the Plan for Modernization of Agriculture (PMA) was first introduced in the country. Distinctively, yield in sweetpotato sub-sector has only increased slightly over the last 5 decades.

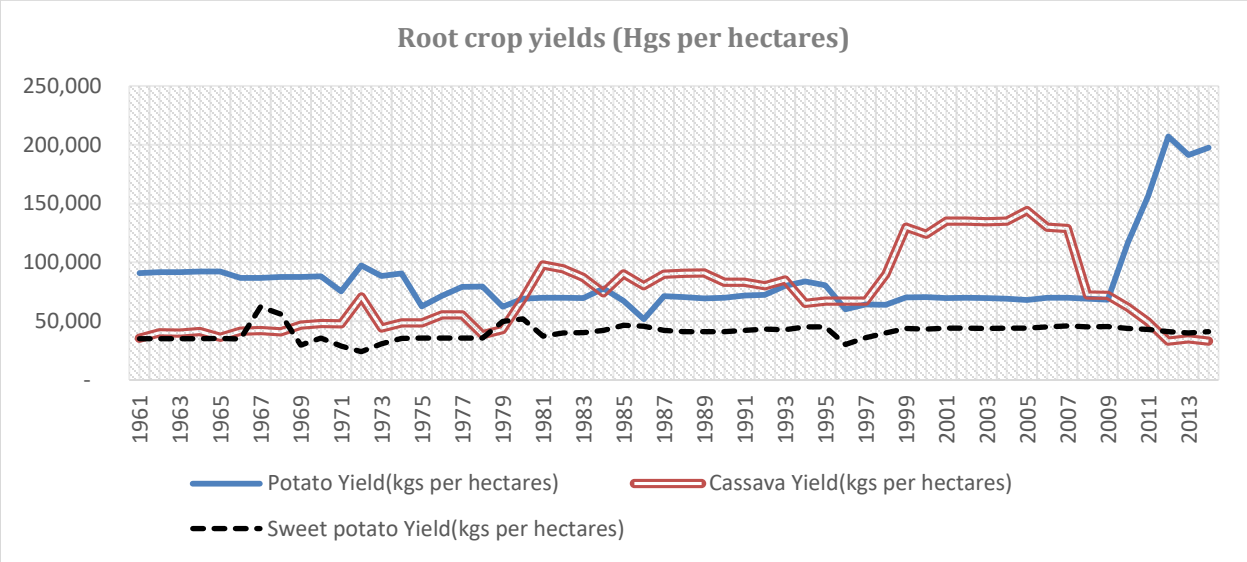

Figure 3: Root and tuber crop yield (hectograms per hectare) in Uganda
Source: Author's computation using FAO data (FAOSTAT)

The increase in volume of potato production has been achieved by to a large extent an increase in the area cultivated (see Figure 4).

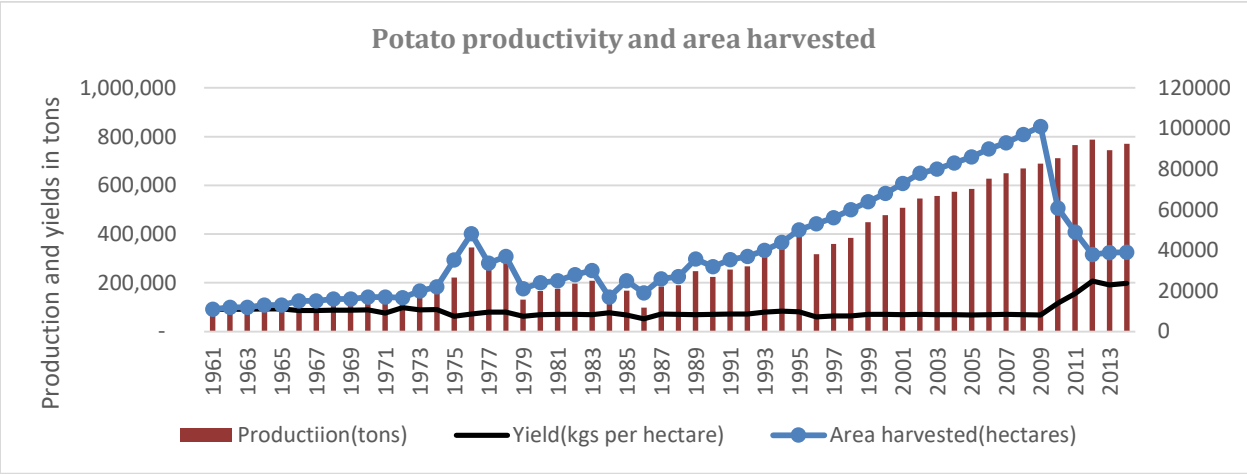

Figure 4: Potato productivity (tons per hectares) in Uganda
Source: Author's computation using FAO data (FAOSTAT)

Potato production in Uganda is on the increase, and this is particularly attributed to the increase in area cultivated and just recently an increase in yield. There is a huge potential to boost potato production and productivity through intensification and investment in value addition. A recent study in Uganda by Mbowa and Mwesigye (2015) reveals a still untapped huge potato production potential. Optimal exploitation of the underlying potato production potential in the country can fully be achieved when value chain actors are supported to quickly adopt various recommended technologies and practice, but also creating efficiencies through upgrading the entire potato value chain. The use of quality seed with fertilizer was also found to increase potato yield in some areas in South-western Uganda from 6.4 MT to 16.5 MT per hectare, which could translate to a boost in potato production in the country.

5.2 Potato production system in Eastern Uganda

Potato is mainly produced twice a year during the rainy seasons resulting into two supply seasons, namely: (i) excess supply period during harvest periods (January, June, July, August and December), and (ii) shortage period in supply on the market (March, April, May, September, October and November) when crop is in field. Market supply is highly seasonal, with period of gluts and scarcity and, therefore, high price fluctuations. Almost all farmers (99.13 percent) grow potato in a pure stand, whereas only 0.87 percent grows potato intercropped.

Farmers' choice of crop production

Potato farmers were asked to indicate their five most important crops grown. Results in Table 7 show that ware potato is one of the major crops grown for food and cash in Eastern Uganda. Other important crops grown in the study area are maize, beans, onions, and cowpeas. Potato (for ware production, seed or both) is the most important grown crop for over 65% of sampled farmers.

Table 7: Most important crops grown by households in the last 12 months (July 2014 to July 2015)

Particulars	1st crop		2nd crop		3rd crop		4th crop		5th crop	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
Irish Potato (for seed & ware)	48	41.38	17	14.78	2	1.82	7	7.45	1	1.61
Irish Potato only for ware	23	19.83	2	1.74	1	0.91				
Irish Potato only for seed	7	6.03	2	1.74	1	0.91	1	1.06		
Onions	10	8.62	11	9.57	12	10.91	6	6.38	4	6.45
Bean	9	7.76	13	11.3	19	17.27	24	25.53	7	11.29
Maize	7	6.03	31	26.96	14	12.73	11	11.7	10	16.13
Coffee	4	3.45	3	2.61	1	0.91	1	1.06	4	6.45
Cassava	2	1.72	2	1.74	1	0.91				
Carrot	2	1.72	8	6.96	8	7.27	5	5.32	3	4.84
Cowpea/Gobbe/ Mpind	1	0.86	9	7.83	12	10.91	8	8.51	5	8.06
Cabbage	1	0.86	8	6.96	10	9.09	11	11.7	5	8.06
Banana (desert)	1	0.86			1	0.91	2	2.13		
Barley	1	0.86			5	4.55			3	4.84
Field pea			1	0.87						
Groundnut									1	1.61
Millet			1	0.87						
Wheat			3	2.61	16	14.55	7	7.45	3	4.84
White flesh sweet potato			1	0.87					1	1.61
Yams							4	4.26	2	3.23
Bitter Solanum/ berries					1	0.91				
Local vegetables							1	1.06		
Egg plant					1	0.91			1	1.61
Passion fruit					1	0.91			1	1.61
Banana(cooking)			3	2.61	4	3.64	6	6.38	11	17.74
Total	**116**	**100**	**115**	**100**	**110**	**100**	**94**	**100**	**62**	**100**

There are three seasons of potato growing in Eastern Uganda. The first season in a year is the most dominant with over 99 percent of potato farmers engaging in potato growing. In the second season, the proportion of farmers growing potatoes slightly reduces to about 93.97 percent. Only 3.45 percent of farmers engage in potato growing in the third season that is often conducted on irrigated areas. While all farmers practice crop rotation, only 29.31 percent of farmers currently use irrigation on potatoes.

According to results presented in Table 8, farmers plant potatoes mainly during the months of March and April in the first season; months of August and September in the second season, and; in the month of December in the case of the third season.

Table 8: Months of planting and harvesting potatoes in the three seasons of the year

Particular months	Planting season of the year						Harvesting season of the year					
	I		II		III		I		II		III	
	Obs.	Pct.	Obs.	Pct.	Obs.	Pct.	Obs.	Pct.	Obs.	Pct.	Obs.	Pct.
January	1	0.88					2	1.74	10	9.17	1	25
February	14	12.28							6	5.5		
March	60	52.63	1	0.92					3	2.75	2	50
April	21	18.42	1	0.92							1	25
May	15	13.16	1	0.92			9	7.83				
June			2	1.83			26	22.61				
July			5	4.59			51	44.35	3	2.75		
August			33	30.28			22	19.13				
September	2	1.75	58	53.21	1	25	3	2.61	3	2.75		
October	1	0.88	7	6.42			1	0.87	5	4.59		
November			1	0.92					7	6.42		
December					3	75	1	0.87	72	66.06		
Total	114	100	109	100	4	100	115	100	109	100	4	100

The first season potato crop is mainly harvested in June, July and August; the second season potato crop is mainly harvested in December and January, while the third season crop is mainly harvested in March. In terms of gender differences in potato growing, men appear to participate in potato growing more than is the case with women and youth. Results in Table 9 indicate that an estimated larger proportion (72.5 percent) of men engage in potato production, compared to 56.4 percent of women, and 36.6 percent of the youth. The difference in potato growing across men, women, and the youth can be attributed to the differential access to land.

The reasons why farm household choose to grow potato vary. According to results in Table B1, Annex B farmers grow potatoes mainly due to: the reliable cash income the crop provides (63.79 percent), early maturity (17.24 percent), its importance as food crop (9.48 percent), has a ready market in the area (4.31 percent), and for its high yields (3.45 percent). No doubt, potato crop is important for cash mobilization, food in the house, and for maintaining land through crop rotation.

5.3 Land access in the study area

Respondents were asked to assess the status of land access in the study area. The majority (76.72 percent) of household heads agree that land access in the area is not enough (See Table B2, Annex B). About 19.83 percent of household believe that land access is sufficient, while its only 3.54 percent who feel that land access is more than enough. The limited access to land justifies the need to promote use of technologies and practices for intensifying potato production.

Major constraints to land access in the area are also summarized in Table B2. About 24.77 percent of farm households attribute existing limited land endowment in the study area to the increasing demand for farm land to grow more crops for sale and consumption; the increasing population density and larger family sizes (13.76 percent); the availability of different modes of land access and opportunity to make flexible adjustments of land endowment for farming (13.76 percent); the need to reserve land for children inheritance (10.08 percent), and the emerging need to engage in commercial farming (10.09 percent).

Farm households in the study area own 5.75 acres of land on average, while total land accessed or operated by households is 6.92 acres (see Table 9). In this study, land owned is a combination of land that is purchased, inherited, borrowed-out, rented-out and occupied or squatted on for a period of more than 12 years without being evicted. Conversely, land operated or access constitutes land that is owned (exclusive of land bequeathed and sold) plus land borrowed-in and land rented-in minus land rented-out and land borrowed-out.

Furthermore results indicate that households inherit 2.51 acres; purchase 4.28 acres; rent-in 2.30 acres; allocate a total of 4.39 acres to general crop cultivation; maintain 1.97 acres under fallow; use about 2.25 acres for livestock keeping; utilize 1.20 acres for other land uses, and use on average 1.54 acres to grow potato in the last season.

Table 9: Land access by farmers through different modes in the study area

Particulars	Farmers			
	Obs	Mean	Min	Max
Inherited land in acres	87	2.51 (2.42)	0.25	13
Purchased land in acres	102	4.28 (4.43)	0.25	20
Rented-in land by the household in acres	64	2.30 (1.79)	0.25	10
Total owned land in acres including rented-out & borrowed-out	116	5.75 (5.19)	0.5	25
Total land accessed by household in acres	116	6.92 (5.95)	0.75	31
Land in acres under cultivation/farm size	116	4.39 (3.26)	0.5	17
Land in acres in fallow	37	1.97 (2.27)	0.25	9
Land in acres under livestock grazing	39	2.25 (2.46)	0.25	10
Land in acres under other uses	36	1.20 (1.30)	0.25	7
Total potato acreage/farm size in acres last season	116	1.54 (1.38)	0.25	7

Out of 10 men in the study area, how many engage in potato production?	116	7.25 (2.12)	2	10
Out of 10 women in the study area, how many engage in potato production?	116	5.64 (2.63)	1	10
Out of 10 youth in the study area, how many engage in potato production?	116	3.66 (2.04)	1	10

Note: (i) Standard deviations are in parentheses

Overall, we see in Table 10 that the size of land allocated to potato production varies to some extent between growing seasons, namely: 1.71 acres in the first season (January to June) and 1.66 acres in the second season (July to December). Only 20 percent of potato farmers engage in irrigation practice where they allocate the average farm size of between 0.60 and 0.93 acres. Growing potatoes under irrigation production system is more predominant in the second season of each year (July to December).

The figures for quantitative variables for the overall two seasons in Table 10 are slightly lower than is the case of each of the first and second seasons. This is attributed to the attempt to control for extreme outliers during the cleaning process in order to arrive at insights that are representative to the population. There was a cleaning effort to manage extreme outliers which ensures that the quantitative variables are normally distributed and not skewed to the left or right.

5.4 Potato production and supply in the peak and off-peak seasons

The average total annual production of potatoes across farm households is estimated at 9,033 kg, of which 4,933 kg of potatoes is produced in the first cropping season of January to June, and 5,458 kg in the second cropping season of July to December (see Table 10). In the case of potato produced on irrigated land, the average quantity produced is larger at 5,689 kg in the second season than 4,459 kg of potatoes produced under rain-fed production system in the same season. Besides, potato productivity is highest (6,689 kilograms per acre for the second season and 6,678 kilograms per acre for the two seasons combined) on irrigated land than on any production system. This confirms that there is potential to boost potato production through use of irrigation technology.

Table 10: Ware Potato farm size, quantity harvested, and productivity in the two seasons of the year

	Farmers' ware potato harvest in the last 12 months					
	First crop season A, 2015 (January to June)		Second season B, 2014 (July to December)		Overall (June 2014 to June (2015)	
Particulars	Obs	Mean	Obs	Mean	Obs	Mean
Area in acres under potatoes under overall	116	1.71 (1.69)	116	1.66 (1.22)	116	1.45 (1.40)
Area in acres under potatoes under rain-fed	116	1.69 (1.64)	116	1.52 (1.06)	116	1.35 (1.30)
Area in acres under potatoes under irrigation	3	0.60 (0.36)	23	0.93 (0.46)	24	0.48 (0.21)
Potato quantity (Kg) harvested under overall	116	4933.31 (4441.75)	116	5457.78 (5512.03)	116	9033.36 (9262.74)

Potato quantity (Kg) harvested under rain-fed	116	4860.87 (4326.91)	116	4459.10 (3719.51)	116	7845.00 (7503.37)
Potato quantity (Kg) harvested under irrigation	3	2333.33 (3177.00)	23	5689.13 (3355.46)	24	5743.75 (3218.74)
Potato quantity (Kg) harvested per acre of land under overall	116	3387.29 (2484.65)	116	3333.48 (2563.74)	116	2752.32 (2380.75)
Potato quantity (Kg) harvested per acre of land under rain-fed	116	3383.39 (2485.05)	116	3172.07 (2394.44)	116	2599.11 (2259.04)
Potato quantity (Kg) harvested per acre of land under irrigation	3	2844.44 (2733.60)	23	6689.13 (3889.26)	23	6678.26 (3901.48)

Notes: (i) Standard deviations are in parentheses

Potato production and supply appear to vary significantly across peak and off-peak seasons. According to results in Table 11, the months of June and July are characterized by excess ware potato production, while the months of September, January, February, March, and April are characterized by scarce ware potato production. During the peak season, the proportion of farm households that supply ware potato to the market in a given month: once, twice, three times, and four times is 46.49%, 22.81%, 14.91 %, and 8.77% respectively (see results in Table 11). These proportions during the off-peak season are 71.43%, 17.14%, 7.14%, and 2.86%, respectively. Most farmers therefore supply potatoes to market either once or twice a month.

Table 11: Months in a year and number of times in a month household supplies potatoes to clients

Particulars	Farmers (n=116)		
	Freq.	Percent	Cum.
Months in a year that are characterized by excess ware potato production			
June	80	68.97	73.28
July	30	25.86	99.14
May	4	3.45	4.31
Feb	1	0.86	0.86
Dec	1	0.86	100
Total	**116**	**100**	
Number of times in a month household supplies or sells ware potato to clients during peak season			
1	53	46.49	46.49
2	26	22.81	69.30
3	17	14.91	84.21
4	10	8.77	92.98
5	3	2.63	95.61
10	3	2.63	98.24
6	2	1.75	100
Total	**116**	**100**	

Particulars	Farmers (n=116)		
	Freq.	Percent	Cum.
Months in a year that are characterized by scarce ware potato production			
Sep	29	27.1	91.59
Mar	19	17.76	42.06
Jan	16	14.95	14.95
Apr	13	12.15	54.21
Feb	10	9.35	24.3
Aug	6	5.61	64.49
May	4	3.74	57.94
Oct	4	3.74	95.33
Dec	4	3.74	100
June	1	0.93	58.88
Nov	1	0.93	96.26
Total	**107**	**100**	
Number of times in a month household supplies or sells ware potato to client in off-peak season			
1	50	71.43	71.43
2	12	17.14	88.57
3	5	7.14	95.71
4	2	2.86	98.57
5	1	1.43	100
Total	**70**	**100**	

Results in Table 12 reveals that the average number of times farmers supply potatoes to market is 2.2 times in a month during the peak season, but this reduces by 35 percent to 1.43 times per month during off-peak season. Results in Table 12 further show that the average number of potato bags sold each time is 38.94 during peak season, slightly more than the 36.71 bags in the off-peak season. The price farmers receive for each bag of potato is UGX 31,578 in the peak season compared to UGX 69,971 per bag during the off-peak season (implying a 121 percent price increase).

Table 12: Variation in frequency and quantity potato supply during the peak and off-peak seasons

	Obs	Mean	Min	Max
Peak Season				
Number of times in a month a household supplies or sells ware potato to clients	116	2.22 (1.76)	1	10
Number of ware potato bags (each of 100 kg) sold by a household on every round of potato supply during the peak season	116	38.94 (43.27)	1	300
Average potato price per bag (each of 100kgs) during the period of excess production/supply over the last 2 years	116	31577.59 (9333.58)	20000	70000
Off-peak Season				

Number of times in a month a household supplies or sells ware potato to clients	69	1.43 (0.85)	1	5
Number of ware potato bags (each of 100 kgs) sold by a household on every round of potato supply during the off-peak season	69	36.71 (36.39)	2	200
Average potato price per bag (each of 100kgs) during the period of scarce production/supply over the last 2 years	69	69971.01 (28996.44)	14000	200000

Note: (i) Standard deviations are in parentheses

Results in Table 13 presents average market prices that farmers receive in the two seasons of the year. Price of potatoes varies across the two seasons, with a higher price (UGX 53,465.74 per bag) received in the second season compared to UGX 34,661.91 per bag in the first season. The cost of potato transport also follows the same pattern of market price. This trend in market prices highlights relative scarcity of potatoes and high demand in the second season of the year than is the case for the first season. It is also possible that consumers have plenty of substitutes to potatoes in the first season than is the case in second season.

Table 13: Price and transportation cost of potato harvest during the two seasons of the year

	Farmers' ware potato harvest and utilization in the last 12 months					
	First crop season A 2015 (Jan – Jun)		Second season B 2014 (June to Dec)		Overall (June 2014 to June 2015)	
Particulars	Obs	Mean	Obs	Mean	Obs	Mean
Potato average price (UGX per kg)	116	343.90 (122.29)	116	536.42 (185.61)	116	426.81 (147.83)
Transportation cost (UGX per kg of potatoes sold)	116	23.49 (13.03)	116	33.79 (17.59)	116	25.93 (14.77)

Notes: (i) Standard deviations are in parentheses

The supply of ware potatoes is largely affected by the following constraints: (i) production constraints in form of pests and diseases, expensive inputs, seed quality, unreliable climate conditions, infertile soils; (ii) challenges of seasonality, and; (iii) high postharvest losses (Kaganzi et al., 2009). Results in Table E2, Annex E further confirm that demand for potato is relatively lower during the peak season than is the case with off-peak season. Accordingly, the average price fetched per kg of good quality potatoes during peak season is UGX 354, UGX 444, UGX 940, and UGX 537 for farmers, traders, processors, and consumers respectively. In the off-peak season, this increases to UGX 784, UGX 1651, and UGX 1206 for traders, processors and consumers, respectively.

Variation ware potato wholesale and retail prices across source and destination markets

Results in Figure 5 show that retail potato prices have been increasing steadily within the range of UGX 1000 to UGX 1950. Retail prices are highest in Nakawa market located in Kampala and its least in Kapchorwa and Mbale markets. Similalry, potato wholesale prices are also higher in Kampala markets and lowest in the markets of Kapchorwa and Mbale (Figure 6). Potato wholesale prices appear to be most volatile in Kabale district. Wholesale prices are relatively higher in Nakawa market among Kampala markets.

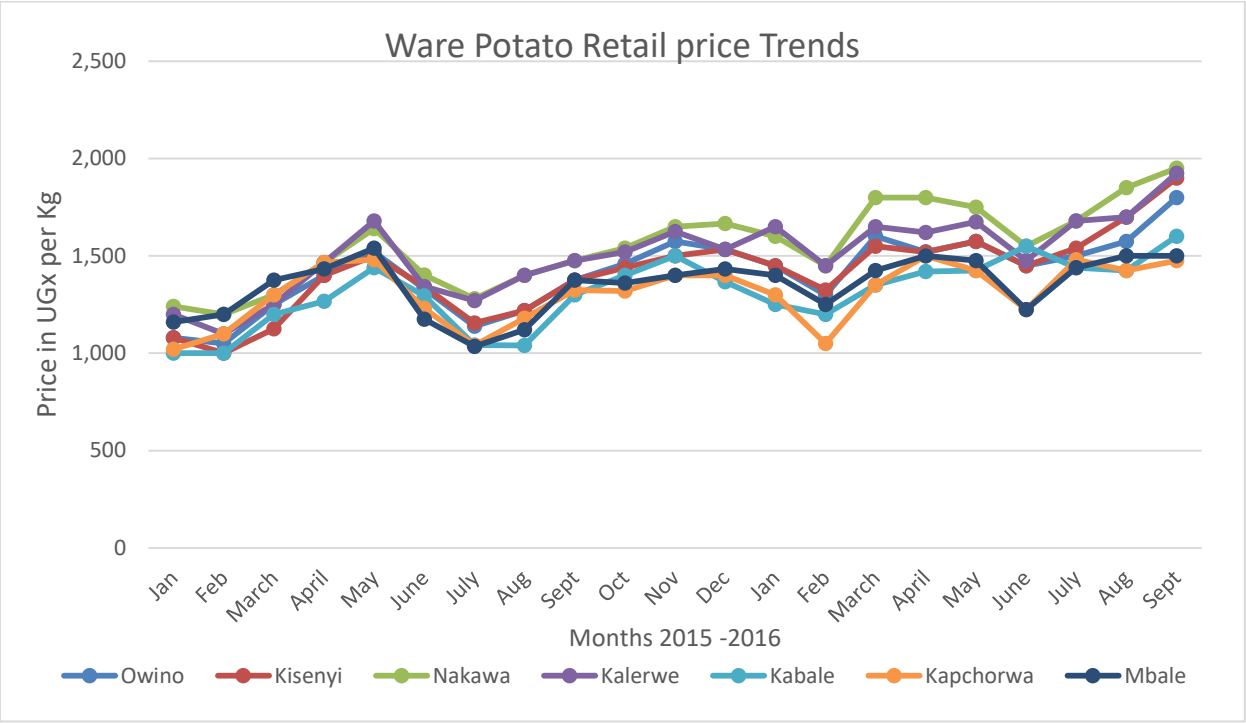

Figure 5: Retail potato prices per month, 2015 - 2016 at different destination markets in Kampala and source markets (Kapchorwa and Mbale)
Price data source: Farm gain

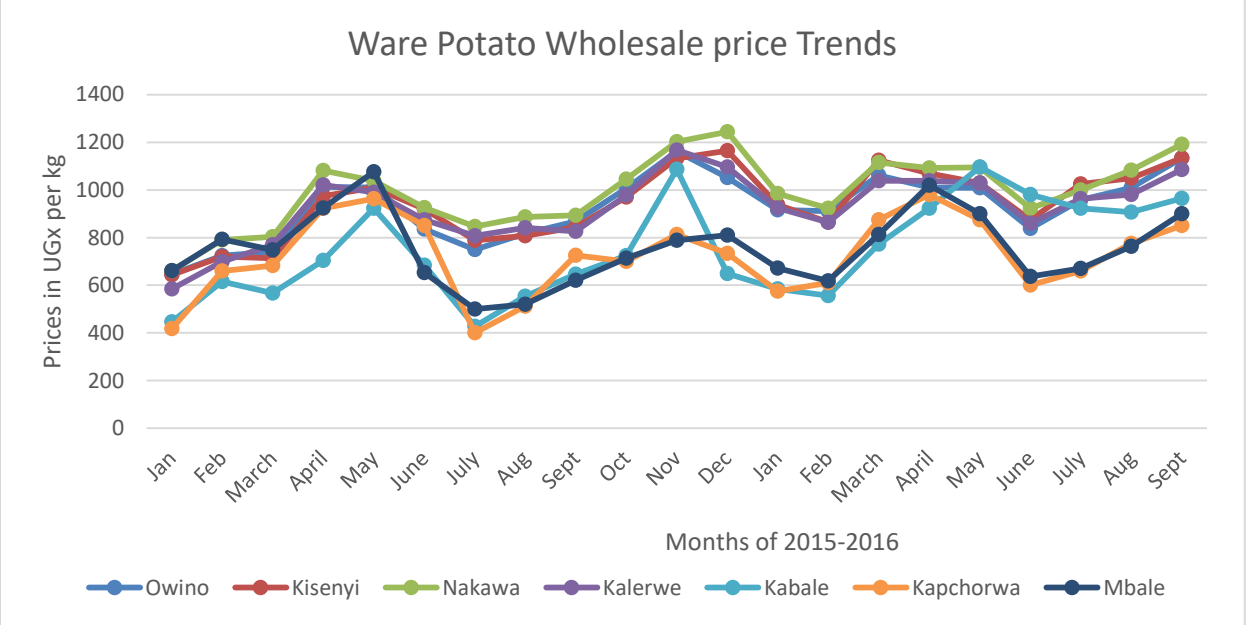

Figure 6: Wholesale potato prices per month, 2015 - 2016 at different destination markets in Kampala and source markets (Kapchorwa and Mbale)
Price data source: Farm gain

The relative difference between the national level potato wholesale and retail prices has remained the same on average (Figure A1). The average wholesale prices range between UGX 700 - 1,200, while retail potato prices falls in a range of UGX 1,260 – 1,600.

5.6 Access to seed potato

Certified seed potato is considered expensive. The high cost of good planting material compels most smallholder farmers to recycle their own seed. Responses from the FGDs indicate that about 90 percent of potato farmers recycle their own seed potato at least twice or three times before buying new seed. Results in Table B5, Annex B, shows that only 7.96 percent of potato farmers have never engaged in buying new seed potato; the majority (78.76 percent) of farmers buy new seed after 1-3 planting seasons, while a significant proportion of about 11.5 percent purchase new seed after 4-6 seasons.

To the extent that only a small proportion of potato farmers buy good seed potato from other farmers (at an average price of UGX 500 per kg), a significant proportion of seed in Eastern Uganda is not clean enough and easily gets affected by pests and diseases. Nonetheless, seed producers continue to play a significant role in promoting good quality seed in the study area. It is important to note that some farmers have specialized in growing, multiplying, and selling improved seed to fellow farmers. These seed producers select, grade, and store good quality seed potato for selling at the onset of the planting season. Conversely, some actors, including large farmers and local traders bring in new seed potato every season from Kabale district and other distant places.

Participants in the FGDs also revealed that clean seed is normally bought from research stations, including NARO BugiZardi at an average price of UGX 100,000 per bag of 100kgs. In this case, seed purchases are often made during the planting months of March and April. The price of seed can sometimes reduce to UGX 50,000 depending on the source and quality.

The main sources of seed potato in the study area therefore range from: buying from local traders in nearby market; using own recycled potato stock; buying from local seed potato producers, and; buying from private sources in distant towns, including Kampala city in that order (Table B5, Annex B). Participants of FGD discussions further reiterated the need for government and stakeholders to improve local availability and access to better seed through interventions that: (i) strengthen capacities of all potato producers; (ii) promote the use of improved clean seed potato; (iii) establish a producers' collective fund to finance the purchase of clean seed, and; (iv) support widespread construction of seed stores for farmers across villages.

Preferred potato varieties in Eastern Uganda

Responses from this study's FGDs reveal four major potato varieties grown for commercial and consumption purposes in the study area, and these are: *Victoria, Kabale red, Kachpot1* (with white skin), and *Lwangume.* In particular, *Victoria* variety is highly preferred by traders and consumers because of its good characteristics, including: a unique red skin color, good cooking properties, and its longer shelf life. *Victoria* and *Kachpot1* varieties fetch higher price than other varieties largely because of their longer shelf life. Conversely, *Cruza* variety is preferred by producers in Eastern Uganda mainly for food consumption, but not for sale.

Evidence from the quantitative household survey data (Table 14) further confirm that major potato varieties grown by majority of the farmers in Eastern Uganda are *Kabale red* (at 43.97 percent); *Victoria* at 37.07 percent; *Wanale* at 7.76 percent; *Lwangume* at 2.59 percent, and: *Nakpot1* at 2.59 percent. Others important potato varieties in the study area are *Cruza* and *Civilian*.

Table 14: Main potato varieties grown by farmers

Particulars	1st major varieties grown		2nd major varieties grown		3rd major varieties grown		4th major varieties grown	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Kabale red	51	43.97	9	20.93	3	20	1	50
Victoria	43	37.07	7	16.28	2	13.33		
Wanale	9	7.76	8	18.6	4	26.67	1	50
Lwangume	3	2.59	5	11.63	1	6.67		
Nakpot 1- 4/5	3	2.59	1	2.33	1	6.67		
Sankena	2	1.72						
Kachpot	1	0.86	1	2.33				
Wanale red	1	0.86						
Makapon White	1	0.86	1	2.33				
Magabond	1	0.86	1	2.33				
Kakumi	1	0.86						
Sebei			2	4.65	1	6.67		
Cruza			3	6.98	2	13.33		
Civilian			3	6.98	1	6.67		
A.T			1	2.33				
Lutuku			1	2.33				
Total	**116**	**100**	**43**	**100**	**15**	**100**	**2**	**100**

These potato varieties are dominant regardless of the production system, whether rain-fed, irrigated, or a combination of both. Results in Table B3, Annex B confirm that potato varieties of *Kabale red, Victoria, Wanale, Megabond, Lwangume*, and *Civilian* are mostly grown in the two production systems. The same list of potato varieties are shown to be mostly grown in each cropping seasons and highly preferred at each value chain node. Specifically, *Kabale* and *Victoria* varieties appear to dominate the preference of potato farmers, traders, processors, and consumers according to results in Table B7; Annex B. Results in the Table B7 further indicate that almost all consumers (90.59 percent) have a clear preference of some potato variety to others. This potato variety preference of consumers appears to be dominated by: Kabale red at 51.28 percent, Wanale variety at 21.79 percent, and Victoria at 10.26 percent.

The reasons for this variety preference across the value chain are summarized in Table B8, Annex B. In the case of traders, these varieties are preferred because they are cheap and affordable; are heavy with the

ability to extend the size of bags which helps to attract higher price, and; are highly demanded due to good mashing and taste attributes.

Processors prefer the varieties characterized by producing good chips; easy to process, and; attracting good price due to the big size of tubers. The preference of consumers for potato varieties is related to: good taste; being good for chips; inability to mash during cooking; having good cooking attributes; longer shelf-life, and; their availability in the market throughout the year.

Efforts are underway to select potato varieties with desirable traits such as long dormancy for prolonged storage, short maturity for early marketing, disease resistance and high dry matter as well as acceptable oil absorption for better processing and quality products.

Figure 7: Potato garden in Mbale district

Figure 8: Harvesting and sorting potato in Kapchorwa

Figure 9: Packed potato ready for marketing

Figure 10: Ware potato tubers on display in the market

5.7 Access to fertilizers, extension services, and market information.

Ware potato farmers were asked to reveal whether they are getting enough yields from potato varieties currently grown. Interestingly, the majority (79.31 percent) of farmers agree that the yields currently realized are satisfactory. The others (20.69 percent) indicate that yields are still very poor due to: lack of fertile land; use of poor agronomic practices and timing; presence of pests and diseases; use of poor quality seed, and; inadequate use of yield enhancing inputs.

Participants of FGDs also revealed that they buy agro chemicals and fertilizers from local stock shops and farm input dealers. The local agro-input shops sell NPK fertilizer at a price between UGX 110,000 and 125,000 per 100kg bag. Potato farmers apply DAP and NPK fertilizer during planting and top dressing later when the crop is well established. Use of fertilizers is recommended for farmers to realize higher yield and farm output.

Constraints to better use of farm inputs

There are a number of constraints that limit adequate use of farm inputs and potato farm output as pointed out by responses from FGDs. These include: (i) high costs of disease-free and good quality seed potato; (ii) limited use of pesticides and fertilizers that are very expensive; (iii) widespread exposure to fake fertilizers, pesticides and chemicals traded on market; and (iv) limited number of farm input stockists who also operate a limited range of pesticides and fertilizers.

Access to extension services

A very large proportion (98 percent) of farmers receives extension services from fellow model farmers who also produce Irish potatoes, cabbages, barley, and wheat. Less than 2 percent of farmers acquire extension services from Kapchorwa Barley Technical Centre (*KABATEC)* and NARO, and this largely focuses on how to acquire good seed potatoes, access to reliable markets, and use of better potato varieties. Policy interventions to increase the production and productivity of ware potato producers should aim at enhancing smallholder farmers' access to market information and new technologies to improve the level of technical efficiency.

In terms of potato utilization in a year, we see from Table 15 that potato farmers consume on average 670 kilograms; set aside 1,339 kilograms for seed; lose about 382 kilograms, and; sell about 7,321 kilograms in a year, which implies a marketed surplus of over 76 percent.

Table 15: Ware Potato utilization during the two seasons of the year

	Farmers' ware potato harvest and utilization in the last 12 months					
	First crop season A, 2015 (January – June)		Second season B, 2014 (July-December)		Overall (June 2014 to June 2015)	
Particulars	Obs	Mean	Obs	Mean	Obs	Mean
Potato quantity (Kg) consumed under overall	116	394.92 (680.11)	116	397.06 (363.51)	116	670.01 (813.24)
Potato quantity (Kg) consumed under rain-fed	116	391.80 (679.81)	116	366.33 (335.93)	116	623.23 (802.81)

Potato quantity (Kg) consumed under irrigation	3	133.33 (57.74)	23	211.96 (103.32)	24	217.71 (94.55)
Potato quantity (Kg) used for seed under overall	116	791.21 (700.60)	116	956.86 (815.23)	116	1338.91 (1357.19)
Potato quantity (Kg) used for seed under rain-fed	116	781.32 (693.12)	116	868.84 (703.84)	116	1257.01 (1249.08)
Potato quantity (Kg) used for seed under irrigation	3	800.00 (0.00)	23	624.64 (286.62)	24	635.00 (283.17)
Potato quantity (Kg) lost at home under overall	116	215.63 (165.65)	116	261.55 (260.08)	116	382.05 (398.86)
Potato quantity (Kg) lost at home under rain-fed	116	215.08 (166.07)	116	222.97 (203.31)	116	349.60 (347.27)
Potato quantity (Kg) lost at home under irrigation	3	20.00 0.00	23	256.23 (137.01)	24	258.70 (129.50)
Potato quantity (Kg) sold under overall	116	4066.01 (3779.53)	116	4419.00 (4509.58)	116	7320.69 (7620.36)
Potato quantity (Kg) sold under rain-fed	116	4006.95 (3682.40)	116	3563.49 (2884.89)	116	6282.24 (6050.16)
Potato quantity (Kg) sold under irrigation	3	1960.00 (2633.40)	23	4981.74 (3229.02)	24	5019.17 (3106.90)

Notes: (i) Standard deviations are in parentheses

Access to market information service

Potato farmers receive market information from traders and fellow farmers. Traders provide farmers with market information on market prices and performance of different potato varieties on the market. Conversely, fellow farmers give information on farm level performance of new varieties, production technologies, and new markets in the area. However, the underlying trust issues between farmers and traders continue to undermine the extent to which this information is trusted and used across potato producers.

5.8 Gender roles and disparities in prices received

The term “gender” refers to non-biological differences between women and men. Roles in farming and decisions along ware potato value chain activities differ by gender (Norton et al., 2015). Women tend to have traditional responsibilities of taking care of children, household management affairs, and being in charge of household food crops. Women can also work as unpaid or paid workers in agriculture and off-farm work, and along agricultural commodity value chains. Current government policies aim at empowering women, and the youth in order to ensure equitable participation in value chains and distribution of benefits derived from different levels of value addition.

Results of data analysis indicate that compared to spouses (who tend to be women), household heads (who are largely men) dominate decision making with regards to quantity of seed potato purchased (at 53.45% of the time), and how much potato produce to sell at 72.41 percent (See results in Table B5). It is apparent that the on-going gender based emancipation in the country is taking root. According to the

majority (66.38 percent) of farmers, the decision on how to use income derived from potato sale is made by both household head and their spouse; while in 29.31 percent of cases this decision is made by the household head only, and in 2.59 percent of cases by the household head's spouse only.

An attempt was made to identify household members that are responsible of various ware potato activities. Results in Table B6 indicate that female members of the household dominate planting activity, weeding, and harvesting. In some cases these three activities are to a large extent handled equally between women and men within the households. Men dominate key activities related to: selecting planting seed; pre-harvest loss management practices such as spraying; dehaulming; transporting potatoes from the field; packing potatoes; storing potato; transporting potato to the market, and; selling potatoes in the market. All this information confirms that growing potato has now become commercial, a development that explain why the crop is slowly graduating to become a man's crop.

Male and female producers of ware potato receive different prices for their potato sales. According to responses from FGD discussions, women are more likely to receive lower prices per unit of ware potato sold compared to men. This discrepancy is attributed to selling potatoes during time of crisis and the fact that women tend to have inadequate market information and demonstrate lower bargaining power than men. Conversely, male value chain actors are able to invest time in securing market information and are more likely to succeed in securing better prices for their produce.

Months of potato import to Eastern Uganda

Findings from the FGDs in Eastern Uganda reveal that potato; especially the *Shangi* variety is imported from Kenya to Uganda to supplement low supply particularly in months of February, March and April every year. During this period of scarcity, traders purchase potatoes from Kenya at an average price of UGX 800 per kg and sell them at UGX 1000 per kg in Mbale. Potato farmers in Western Kenya enjoy access to Eastern Uganda markets because of close proximity and the fact they are able to supply the market during the period of scarcity. A substantial proportion of potato produced and bulked in Eastern Uganda is also exported to South Sudan. There is also limited importation of frozen chips from South Africa by fast food outlets.

5.9 Main challenges faced by farmers in potato production

Main challenges faced by farmers and how they are rated based on their importance are summarized in Table B4, Annex B. They indicate that the most important challenges faced by farmers are: limited access to storage facilities rated by 19.19 percent of farmers; drought and weather related factors by 17.17 percent; inadequate supply of certified seed by 16.16 percent; pests and diseases by 14.14 percent; limited access to inputs (fertilizers, pesticides, etc.) by 12.12 percent, declining soil fertility by 7.07 percent, and; shortage of land by 5.05 percent. Other key challenges considered important are the lack of credit to buy inputs, low and unstable prices, and high costs of transporting the produce.

Farmers were also asked to rank these challenges according to their importance. Results in Table 16 show that the most highly ranked challenges faced by farmers are: pests and diseases; low and unstable prices; inadequate supply of certified seed; limited access to storage facilities; limited access to inputs such as fertilizers, pesticides; drought and weather related factors, and; low market demand for ware potato. Declining soil fertility; limited access to credit for procurement of inputs, and; long distances from home to gardens are other important challenges to potato production.

Table 16: The ranking of most important challenges faced by farmers in potato production

Particular challenges	1st Ranked		2nd Ranked		3rd Ranked	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Pests and diseases	57	50.44	21	18.58	12	11.11
Low and unstable prices	17	15.04	29	25.66	36	33.33
Inadequate supply of certified seed	11	9.73	21	18.58	6	5.56
Limited access to storage facilities	10	8.85	18	15.93	12	11.11
Limited access to inputs such as fertilizers, pesticides	7	6.19	15	13.27	17	15.74
Drought and weather related factors	6	5.31	2	1.77	5	4.63
Low market demand for ware potato	2	1.77	1	0.88	5	4.63
High losses due to spoilage in handling	1	0.88	2	1.77	3	2.78
Declining soil fertility	1	0.88	2	1.77	7	6.48
Poor quality seeds	1	0.88			1	0.93
Extended bags			1	0.88		
Limited use of irrigation			1	0.88		
Shortage of land					2	1.85
Difficult to transport/bulkiness					1	0.93
Expensive seed potatoes					1	0.93
Total	113	100	113	100	108	100

It is also evident from results in Table 17 that some of these challenges have improved, remained the same or worsened in the last 5 years. Factors that are reported to have improved over the years include: pests and diseases; inadequate supply of certified seed; limited access to inputs such as fertilizers, pesticides, and; market demand for ware potato.

In comparison, the challenges of low and unstable prices; drought and weather related factors, and long distances from home to gardens have not changed much in the last 5 years. Those challenges shown to have worsened are limited access to storage facilities; declining soil fertility, and limited access to credit for procurement of inputs.

Table 17: Farm households rating of change in main challenges faced in the last 5 years (2010-15)

Particular challenges	Improved		Same/not changed		Worsened	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Pests and diseases	8	28.57	6	10.91	14	13.08
Inadequate supply of certified seed	5	17.86	7	12.73	16	14.95
Limited access to inputs such as fertilizers, pesticides	4	14.29	2	3.64	15	14.02
Low market demand for ware potato	2	7.14	1	1.82	1	0.93

Low and unstable prices	2	7.14	8	14.55	6	5.61
Limited access to storage facilities	2	7.14	12	21.82	24	22.43
Drought and weather related factors	2	7.14	9	16.36	8	7.48
Extended bags	1	3.57				
High losses due to spoilage in handling	1	3.57	3	5.45	3	2.8
Declining soil fertility	1	3.57			13	12.15
Limited use of irrigation			1	1.82		
Shortage of land			1	1.82	3	2.8
Long distances from home to gardens			2	3.64		
Limited access to credit to procure inputs					1	0.93
Difficult to transport/bulkiness			1	1.82		
Poor quality seeds			1	1.82	1	0.93
High input costs such as seed			1	1.82		
Expensive seed potatoes					1	0.93
Theft of inputs such as planted seeds					1	0.93
Total	28	100	55	100	107	100

Summary

Potato production in Uganda is on the rise as a result of the increase in area cultivated and productivity. This notwithstanding, potato productivity across farm households is still low mainly due to a combination of low soil fertility, use of poor agronomic practices; presence of pests and diseases; use of poor quality seed potato, and inadequate use of yield enhancing inputs such as fertilizers. Potato growing is conducted in two main growing seasons. The third growing season is utilized by a very small proportion of farmers that have access to irrigated farm lands. Despite of limited land access in Eastern Uganda, farmers allocate a substantial proportion of their land to potato growing. Land rental and sales enable farm households to easily access and adjust land operated for commercial farming.

Most (about 90 percent) potato farmers recycle the own produced seed at least twice or three times before buying new planting material. There is great need to improve the availability and use of clean and better performing seed potato in the study area. Potato varieties of *Kabale*, *Victoria, Wanale*; *Lwangume*, *Kachpot1*, *Megabond, Civilian, Mbale,* and *Cruza*, are highly preferred by all the value chain actors from potato farmers to consumers. The harvest months of January, June, July, August and December are characterized by excess supply of ware potato. The period of scarce ware potato supply normally occurs during the months of March, April, May, September, October and November, periods when the crop is in field. The price of potato varies across each of the two growing seasons, with a higher price received in the second season of the year compared to the first season. Ware potato price per bag is shown to increase by 121 percent on average between peak and off-peak seasons.

The underlying trust issues between farmers and traders undermine the smooth flow and equitable distribution of benefits derived from access to market information in the study area. Female members of

the farm household dominate male members in taking care of ware potato planting, weeding, and harvesting activities. Conversely, men dominate key activities of: selecting planting seed' engaging in pre-harvest management practices such as spraying, dehaulming, transporting potatoes from the field, packing potatoes, storing potato, transporting potato to the market, and selling potatoes to traders in the market. Women are more likely to receive lower prices per unit of ware potato sold compared to men. Male value chain actors are able to invest time in securing market information and are more likely to succeed in securing better prices for their produce.

Potato growing is rapidly transiting from subsistence oriented production to mainly commercial production. A substantial number of male value chain actors are entering potato production and marketing business to harness the cash benefits being offered by the crop currently. No doubt, there is huge potential to boost potato production, productivity, and marketing in Eastern Uganda. Some of the interventions that can help tap the existing potential include: promoting the adoption of recommended technologies for intensifying the cultivation, the adoption of enhanced postharvest practices (including storage) to reduce losses, promoting investments in potato value addition to facilitate timely upgrading along value chains, and establishing better linkages and coordination along the entire potato value chain.

6. CONSUMPTION OF WARE POTATO IN UGANDA

This section focuses on potato consumption in the wider Uganda. No doubt, Ugandans consume more of cassava and sweet potatoes than potatoes (see Figure 11). The per capita consumption of potato in Uganda has increased at low rate but steadily between 1961 up to 2007, after which per capita potato consumption appears to decline again. The FAO data indicates that potato supply in Uganda increased from 10 kg/capita/year in 1961 to 16.06 kg/capita/year in 2007, but has since reduced to 3.94 kg/capita/year in 2013 due to unclear reasons. The per capita potato supply or quantity of potato available for human consumption in 2013 is much less than the 75.77 kg/capita/year for cassava and 46.72 kg/capita/year for sweet potato.

It is therefore evident that demand for potato and its products is growing in Uganda. New emerging factors are also impacting negatively on quantity of potato consumed per capita in recent years. The decline in quantity of potatoes available for consumption in the country after 2007 can also be attributed to issues of data quality due to poor estimation.

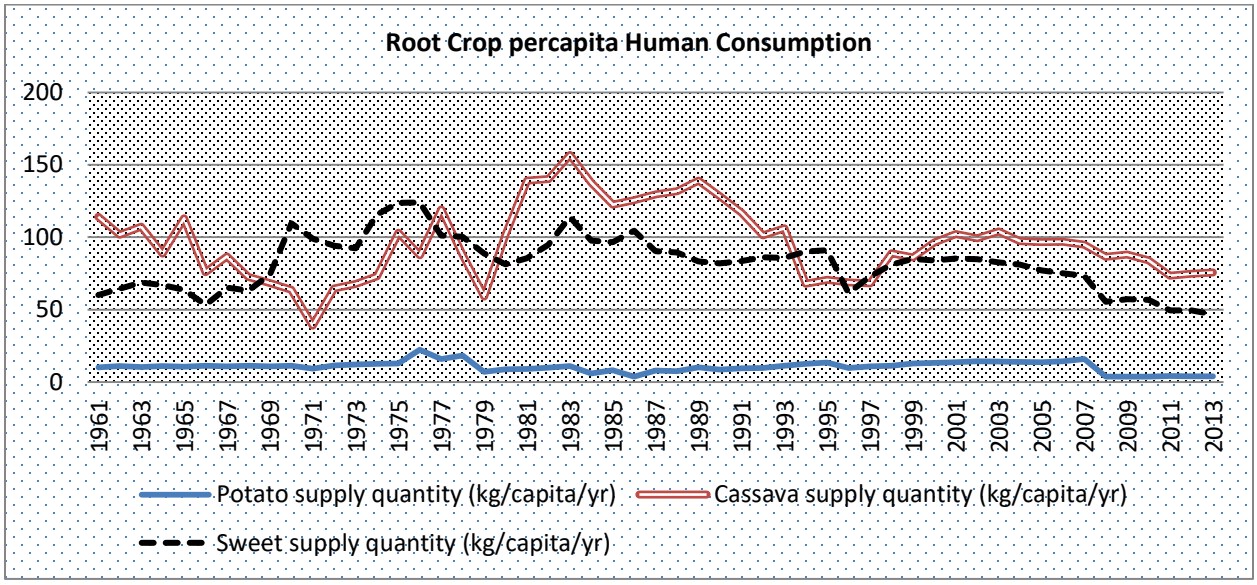

Figure 11: Root crop per capita human consumption (kg/capita/year) in Uganda
Source: author's computation using FAO data (FAOSTAT, 2017)

Notice that "*potato supply*" denotes the total quantity of potato produced in Uganda added to the total quantity imported and detracted of exports adjusted to any change in stocks that may have occurred since the beginning of the reference period. This measure gives the supply available during that period, and in this case a year. When this total quantity of potato supply is divided to the population actually partaking of it we then arrive at per capita potato supply.

Between 1961 and 1997 the growth rate in per capita consumption of potatoes has been higher than growth rate of potato production (Figure 12). After 1997, the year PMA was introduced in the country, potato production has been growing more than per capita consumption, an indication of potential exports of potatoes in the regional markets.

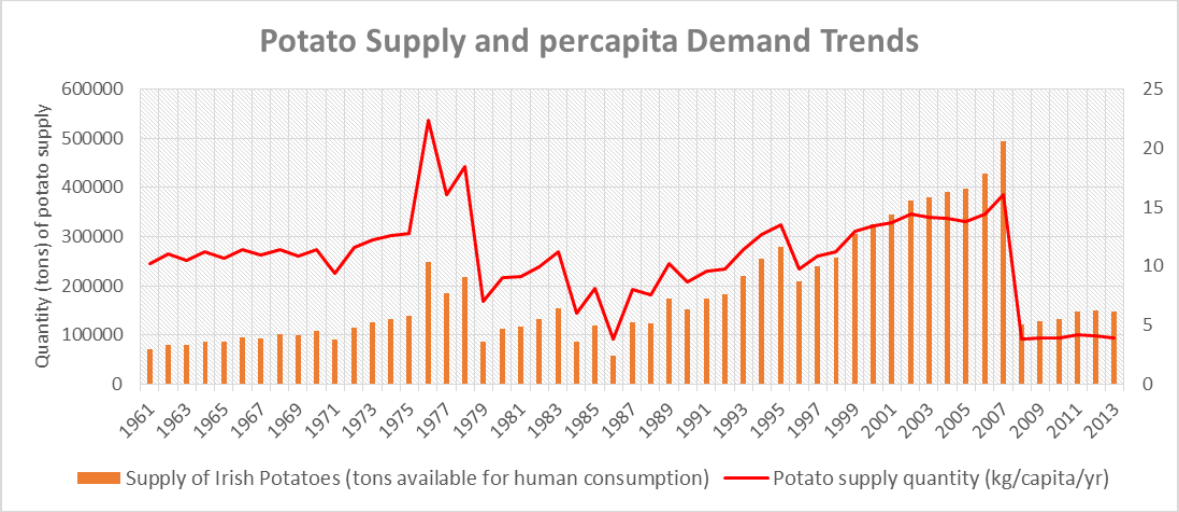

Figure 12: Potato supply and per capita demand trends (kg/capita/year) in Uganda
Source: author's computation using FAO data (FAOSTAT)

According to Figure 1, cassava and sweet potatoes are the most produced root and tuber crops in Uganda. However, potato supply is growing faster than any other root crop, and this indicates the country's potential to produce potatoes for export, beyond satisfying the domestic market. The increase in ware potato demand in the country is attributed to the rapid increase in population and level of urbanization. There are now real opportunities for smallholder farmers and other ware-potato value chain actors to earn higher incomes by supplying potato products to high end markets, including supermarket chains and fast-food restaurants.

Ware potato value chain actors need support and necessary technology to upgrade their operations in terms of reducing PHLs, supplying good quality potatoes throughout the year, and conducting their work based on clear business management (Kaganzi et al., 2009). It is now imperative that VC actors get the support to enable them to: get organized, increase their social capital endowment, enhance their linkages and trust with other actors along the ware potato value chain, and adopt improved postharvest practices and storage techniques. This calls for the deliberate effort to embrace collective marketing, strong leadership within organized groups of VC actors, and continuous learning of new skills and innovations that help to increase and stabilize supply and consumption of high quality ware potato throughout the year.

Results of the this study's survey data analysis (See Table 15) show that on average potato growing farm households consume 394.92 kg in the first season and 397.06 kg in the second season, which translates to 8.0 percent and 7.3 percent of total production in respective seasons. As earlier mentioned farm households consume 670.01 kg (7.4 percent) of total potato production in a year; utilize 1338.9 kg (14.8 percent) for seed; lose 382.05 kg (4.23 percent), and sell 7320.69 kg (81.04 percent). These results indicate that the target farmers are highly commercial oriented and need support to make the most out of each transaction.

Summary

Ware potato is the third most consumed root and tuber crop in Uganda after cassava and sweetpotato. The supply and demand for potato in Uganda is growing faster than any other root crop. The per capita consumption of ware potato in the country has increased at a low rate but steadily since 1961, although it's beginning to decline in recent years after 2007. On average, farm households consume about 7.4 percent of total potato production in a year; utilize 14.8 percent of the annual production for seed; experience postharvest losses of 4.23 percent, and market most of their potatoes estimated at 81.04 percent.

Potato farmers in Uganda are highly commercial oriented. It is imperative that ware potato value chain actors get the necessary support to: enhance their organization, increase their social capital endowment, improve their linkages and trust with each other along the ware potato value chain. They urgently need support to make investment in improved storage facilities and adopt recommended ware potato postharvest handling practices and techniques that reduce postharvest losses and maintain quality of tubers.

7. VALUE CHAIN ANALYSIS

This section presents the status of various marketing aspects of ware potato in the study area right from the farm up to final consumers. An in-depth assessment is conducted on quantity of potatoes traded, frequency of engaging in the purchase and sale of potatoes, the distribution of potato products, and how potato is physically handled (transported, sorted, graded, and stored) by different value chain actors. Varying levels of interaction and coordination between ware potato value chain actors are also examined. The aim is to understand who along the potato value chain is storing, how they are storing, who is transporting, and how all these physical handling activities influence market performance.

Value chain refers to a full range of activities and exchanges that are required to bring ware potato products from a stage of conception through different phases of production up to the final consumer. A value chain map of ware potato provides key information on who is doing what based on the key elements of input supply, ware potato production, assembly, processing, wholesale, and export. Different nodes of operation, major actors, and their specific roles are presented in the value chain map. With good coordination and flow of relevant information, value chain actors become more efficient in: boosting production, minimizing losses, and enhancing the distribution of quality ware potato up to consumers.

Value chains can be analyzed independently using different approaches, namely: at different geographical levels, focusing on gender effects, climate change impacts, and poverty mapping. Various tools are used to analyze the performance of value chains and these include: (i) crop budgets; (ii) value chain map; (iii) gross margins (simple); (iv) gross marketing margins or total marketing margins; (v) farm-retail spread; (vi) proportion of final price captured by producer, and (vii) proportion of consumer income spent on product or food.

Using preliminary data collected on different actors, their functions, and product flow involved in the chain, the initial basic ware potato value chain map was constructed. The initial map was later adjusted based on additional information collected through field interviews, especially on costs and margins at different nodes of operation. Figure 13 illustrates a ware potato value chain map constructed based on unique secondary data and primary data collected during field interviews.

The map provides vital information on core processes in the value chain; key players that are engaged in specific functions; modes of transporting ware potato products to end markets, the average quantities of ware potato handled, volume of potato products reaching end markets, and different market channels that are functional and available to value chain actors at the nodes of input supply, production, assembly, processing, wholesale, and export. Noteworthy is that the largest proportion of ware potato goes through wholesalers to urban retailers and up to household consumers.

7.1 Key players along the potato value chain

Key players along the ware potato value chains range from farmers, agents or brokers, local traders, urban wholesalers, urban retailers, processors, and consumers. Some institutions (schools, hotels, and hospitals) procure and consume ware potatoes in large quantities. Government agencies (including NAADS, NARO, and MAAIF), NGOs, and research organizations also engage in different activities of breeding, multiplying, and distributing improved varieties of seed potato to farmers.

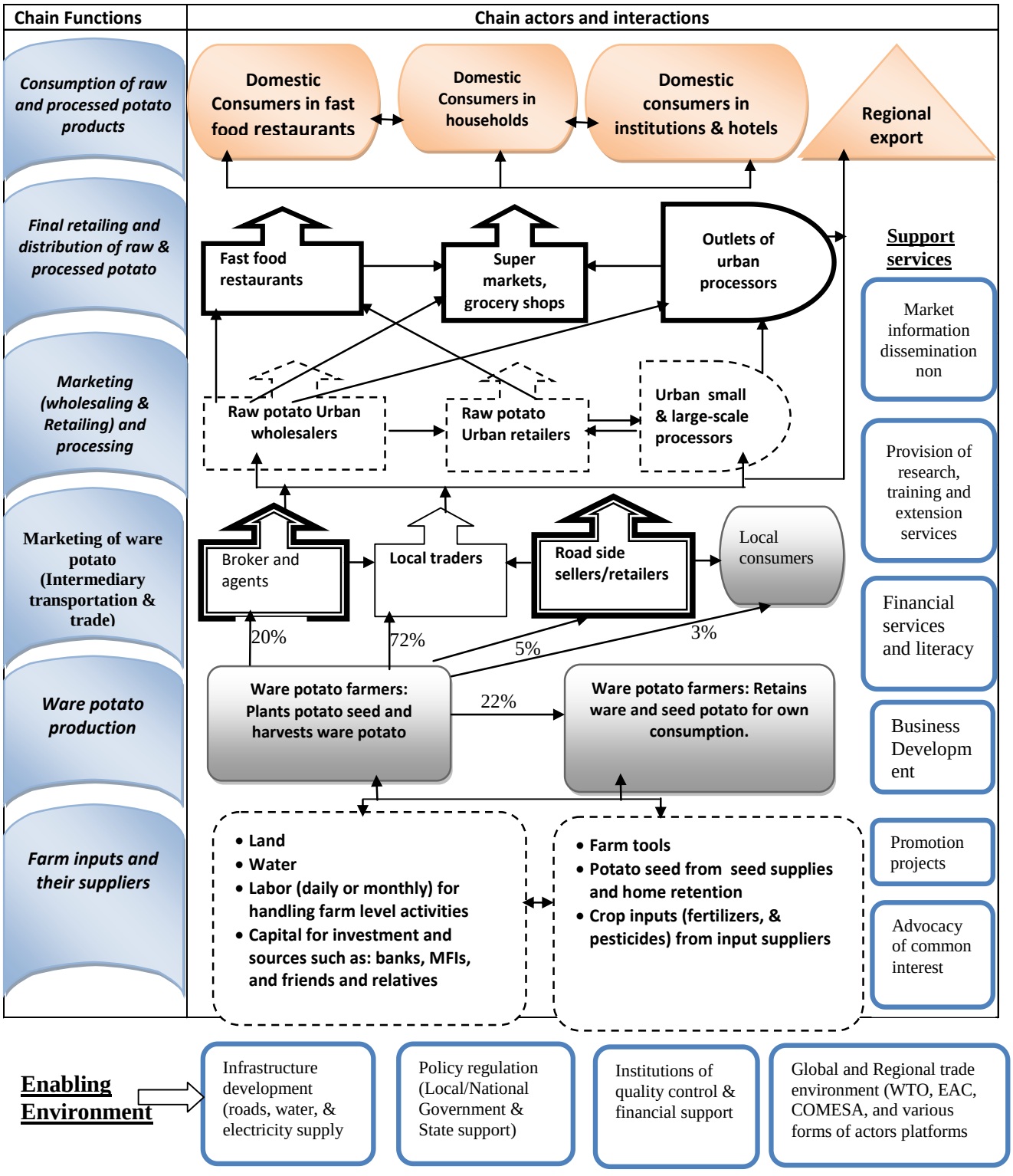

Figure 13: Ware potato value chain map in Eastern Uganda
Note: ⟶ Implies "sells to"

7.2 Activities being done in the value chain

Figure 13 indicates that different value chain actors play different roles along the ware potato value chains in Eastern Uganda, and they include:

a) Farmers produce seed potato and ware potatoes, which they sell in fresh and stored forms to the market. After harvesting, farmers keep some proportion of the harvest for seed (15%) and home consumption (7%). The proportion (78%) of marketed potato production is either sold on farm gate (62%) or transported (38%) for sell at various destination markets. The largest (72%) quantity of ware potato marketed production is purchased by local traders, followed by brokers (17%), retailers (5%), commission agents (3%), and local consumers (3%).
b) Brokers act as intermediary agents between farmers and different types of urban traders. They earn a commission from traders (wholesalers and retailers) for collecting and bulking potatoes.
c) Ware potato sold by farmers is bought by local traders and urban wholesalers mainly from Mbale and Kampala districts. Mbale town is the current potato hub in Eastern Uganda where traders from different places meet to re-weigh, sort, and package potatoes before shipping them to different higher end markets such as Kampala, Lira, and South Sudan.
d) Some of the urban traders from Mbale and Kampala also trade in seed potato that are especially bought from South-Western markets of Kabale and Kisoro.
e) A substantial proportion of local traders also sell agro-inputs such as fertilizers to farmers during the production seasons. They purchase these farm inputs from shops in Mbale town and sell them deep in rural areas at a higher price to compensate transaction costs.
f) Wholesalers buy fresh potatoes from farmers, brokers/agents, and local traders. They transport their purchased potatoes for sell in urban markets to retailers, processors, and various institutions, including schools and hospitals.
g) Retailers after buying potatoes from wholesalers, brokers, and farmers, they sell them to consumers, institutions, and processors who also include fast food restaurants.
h) Processors buy potatoes from retailers, wholesalers, and brokers. They add value on the ware potatoes before selling different potato products to consumers, retail shops, supermarkets, and institutions like schools.
i) There are some government agencies (MAAIF, NARO, NAADS, UNBS etc.), Non-Governmental Organizations (IFDC, UNSPA, CIP, World Vision, etc.), and private sector organizations that make a significant contribution in sensitizing farmers on very important aspects of potato production. The aspects range from: adoption of recommended potato production technologies that are yield enhancing, training on various thematic areas, supporting the supply and uptake of high yielding potato varieties, access to affordable credit, participation in marketing, and disease control. Some of these organizations provide farm inputs, including seed potato, fertilizers, and farm equipment to farmers in organized groups.

7.3 Movement of potato products up to the end markets

Ware potato end markets in Eastern Uganda range from selling at farm gate; nearest local market in the village; roadside/spot markets; urban markets at the district towns including the regional hub market in Mbale town; high end destination urban market in Kampala city, and export markets in South Sudan and other neighboring countries.

7.4 Ware potato market channels available up to the end markets

Marketing channels represent a set of activities necessary to transfer ownership and move a commodity produce from point of production to the point of consumption. In Eastern Uganda, a significant number of farmers who produce ware potatoes sell them either directly to local consumers or to a range of intermediary traders. Traders include middlemen or brokers, local traders, urban wholesalers and retailers. The intermediary traders in turn sell ware potato to consumers in rural, peri-urban, and urban markets.

In Eastern Uganda, the following marketing channels (Figure 14) stand out regarding the sale of fresh or stored ware potato. They are utilized by value chain actors to deliver ware potato produce to the final consumer in Eastern Uganda:

1. Farmer >> Local consumer (in Wanale, Benet and Kapchorwa rural setting)
2. Farmer >> Local trader >> local consumer
3. Farmer >> Local trader >> Urban trader (Mbale, Soroti, Iganga, Jinja, and Kampala) >> Urban consumers
4. Farmer >> Agent/broker >> Urban trader >> Urban consumer
5. Farmer >> Local trader >> Local processor (restaurants) >> Local consumer
6. Farmer >> Local trader >> Urban retailer >> Processors >> Urban consumers
7. Farmer >> Local trader >> Urban trader >> Export markets (retailers in South Sudan)
8. Farmer >> Local trader >> Urban trader >> Urban retailer in Kampala >> Urban processors >> Urban consumers
9. Farmer >> Agent >> Local trader >> Urban trader >> Urban retailer >> Urban consumer
10. Farmer >> Urban trader >> Institutions (schools, hotels, hospitals)
11. Farmer >> Urban trader >> Processors >> Supermarkets >> Urban consumers
12. Farmer >> Broker >> Urban trader >> Urban retailer >> Processors >> Urban customer

Figure 14: Marketing channels of ware potato in Eastern Uganda

Unlike men, most women sell small quantities of potatoes in short market channels. Channel 1 is mostly used by women, especially during peak season to sell small quantities. Results of the FGDs reveal that about 80 percent of women farmers sell ware potato at farm gate to local traders. Income generated in this channel is used to take care of immediate household needs. Furthermore, 20 percent of the women producers sell ware potato using the 3rd marketing channel indicated above.

Longer channels are mostly used during periods of high (peak) supply of potato. Mbale town provides a central hub of potato trade in Eastern region of Uganda. The town of Mbale is centrally located and provides easy access to all potato traders from various source markets, including Kween, Kapchorwa, and rural areas in Mbale district. Mbale town is also strategically positioned to supply potatoes to key destination markets, including Kampala, Soroti, Jinja, Iganga, Lira and South Sudan. All potato transactions in Uganda are currently based on weight based system as opposed to eye ball estimation.

7.5 Value chain analysis

The study uses value chain approach to identify high-potential opportunities for better inclusion of men, women and households in the various segments of the ware potato value chains. The analysis also explores future scenarios in relation to uncertainties and risks in the value chains and its actors. The analysis examines the underlying value chain activities, actors, relationships, governance structure, constraints and opportunities for upgrading in the marketing of ware potato.

Value chain analysis provides a framework to improve rural livelihoods by identifying constraints and possible upgrading options to increase efficiency and gains enjoyed by each value chain actor. The marketing of the agricultural products faces various challenges that include: limited market access, lack of appropriate technology, limited capacity of smallholders in production and marketing, high transaction costs coupled with the perishability of the agricultural products (Holloway and Ehui, 2002). It is important to identify the most pressing challenges and how they can be mitigated.

Value chain approach (VCA) enables researchers and practitioners to not only view activities and processes performed with the aim of adding value to products, but also takes into account the characteristics of the actors involved in the chain. Value chain analysis framework in developing countries can have three basic components as noted by Trienekens, (2011), namely identifying: (i) value addition, horizontal and vertical networks, and governance; (ii) major constraints for value chain upgrading; and (iii) best-bet upgrading options in the value chain.

The VCA also helps to identify constraints and opportunities for further upgrading the value chain to include (more) actors in the chain (Kula et al., 2006); can analyze the degree of relationships among the actors and the coordination mechanism within the value chain (Kaplinsky and Morris, 2002), and it is also useful in identifying the missing links and activities in the chain, including suggesting intervention areas to upgrade the chain and to further benefit the poor. Furthermore, VCA can identify and promote employment opportunities especially in rural areas where unemployment is widespread.

Findings from value chain analysis should therefore unveil the constraints in potato production. The findings can also provide guidance in relation to formulating interventions that: (i) upgrade processes or value added activities to increase the supply of processed products such as frozen chips and crisps, instead of fresh potatoes, thus increasing income; (ii) upgrade ware potato products which involves creations of variety of products and further identify buyers for these varieties of products; (iii) upgrade functions which involves the production, sorting, grading, packaging, storage, processing functions, etc.; and (iv) upgrade marketing channel such as by introducing new channels of distribution such as direct distribution, cooperative channel, emerging intermediaries to collect and supply buyers.

7.6 Current status of ware potato value addition in Eastern region

Ware potato value addition in Uganda is still limited (Mbowa and Mwesigye, 2015). There is inconsistent ware potato supply and little value addition taking place in the study area. About 95 percent of ware potato is traded as fresh tubers in local markets, while 5 percent is consumed in fresh form, processed chips, and crisps. The potential for value addition on fresh ware potato is however vast in the country. Currently, farmers and traders engage in value adding activities of sorting, grading, washing, scrubbing, and packaging.

Hotels, restaurants, and fast-food take-away outlets process ware potatoes into chips. Findings from the survey data reveals that 24 (70.59 percent) processors process ware potato into chips that are usually consumed in fast food restaurants. Conversely, the proportion of potato processors producing crisps is smaller at 32.35 percent.

A substantial proportion of potatoes are of low quality due to inconsistency in varieties and tuber sizes, deep eyes, thick skin, immature tubers, and cuts and bruises caused by poor harvesting and postharvest

practices. The problem of low potato quality and losses is exacerbated by the underlying limited access to improved postharvest management techniques especially storage. According to Wasukira et al., (2014b), potato that is stored for long after harvest may lead to up 30 percent loss in quantity. Producers are therefore forced to sell potatoes at very low prices during peak periods.

There is a general lack of organization in the marketing value chain. The level of productivity, processing, and upgrading of actors along the chain is still very low in terms of production technology that is used, access to market information, and linkages (structure and organization of purchases based on pre-agreed terms) between various stakeholders, especially those that provide a supportive service to producers and up-coming processors (Tatwangire, 2014). The lack of organization of farmers, traders, processors, and other actors in the value chain creates inefficiencies that pave the way to exploitation and poor quality products.

Results of the ware potato value chain analysis

Details of the current ware potato value chains are summarized in Annex C, Tables C2-C5. As expected, results in Table C2 show that ware potato farmers are well linked with wholesalers at 95.58 percent, followed by retailers (69.09 percent), cooperatives (42.99 percent) and are least linked to processors (23.23) percent. The finding justifies the need to support cooperatives in order to promote farmers' bargaining power.

Results in Table C2 further show that traders have strong linkages with fellow traders (97.22 percent), retailers (95.71 percent) and farmers (70.42 percent) than is the case with processors (56.52 percent) and cooperatives (34.78 percent). Ware potato processors appear to be poorly linked with cooperatives (9.09 percent) and farmers (24.24 percent) than is the case with fellow processors (53.13 percent), wholesale traders (72.73 percent), and retailers (76.47 percent). Interventions along the value chain should be directed towards supporting cooperatives, processors, and farmers to be better linked with other actors in the chain.

The nature of linkages between ware potato value chain actors is mainly verbal and informal (Table C3). Its only cooperatives that appear to have significant proportion (30-33 percent) of its linkages reported as written in nature. In the same line, the study reveals that farmers, cooperatives, wholesalers, and retailers to a large extent enjoy some trust. A small proportion (3.54 - 22.52 percent) of all actors, with exception of processors, agrees that there is trust among other actors in the chain. About 66.7 percent of processors appear to experience a significant lack of trust when dealing with other actors. Distrust is to a large extent minimal, since those who reported it constituted 0.88 - 16.67 percent of respondents and this appears to be particularly a problem between cooperatives and other value chain actors.

It is also evident from Table C5 that ware potato value chain actors (farmers, cooperatives, and wholesale traders) often meet "*irregularly*" in a year, followed by meeting "*many times*" in a year and meeting "*at least once*" in a year. Retailers and processors also report meeting other actors at least "*three times*" and "*once*" respectively in a year.

7.7 Pricing and payment mechanism

Ware potato, like any other typical agricultural commodity has an inelastic demand and supply that shifts from season to season, thus making its equilibrium price highly variable from year to year. Potato prices

are mainly set by traders depending on availability and distance to markets of interest. During peak season, traders do not have to travel deep in rural areas to mobilize enough purchases. Instead, farmers are compelled to incur transport costs from their gardens to road side markets to seek the attention of traders. Responses from FGD discussion revealed that farmers sometimes sell at low average price of UGX 250 per kg of potatoes during peak season, compared to up to UGX 1600 - 1800/kg price during periods of scarcity. FGD participants further revealed that actors along potato value chains face seasonal fluctuating prices of ware potato, and yet prices of processed potato products remain stable. It is also widely agreed that an elevated price during scarcity is a disadvantage to farmers and other stakeholders; it is often a sign of market imperfections and inflation that affects also other commodities purchased by farmers.

The average cost of casual labor for transporting potatoes from farm to roadsides is estimated at UGX 8,000/km/100kg of potato bag. Normally, each bag is split into two pieces of 50 Kg each that can easily be carried to the roadside. Farmers usually sell their produce from gardens during scarcity, an arrangement that reduces quantity of potato bought by local consumers. Local traders also sell potatoes to retailers in Mbale town at an average price of UGX 2,200/kg. Retailers in turn sell potatoes to consumers at an average price of UGX 2500/kg. Distinctively, retailers in Kampala buy ware potato from traders at UGX 2500/kg and sell at UGX 3,000/kg. Farmers normally desist from engaging in harvesting potatoes before getting a reliable buyer.

Noteworthy, is that demand for potato is relatively low during the peak supply season compared to off-peak season. Results in Table E2 show that during peak periods when there are potato gluts in the market, farmers produce 1kg of good quality potato at a cost of UGX 354 on average and sell it at UGX 362; traders (both wholesalers and retailers combined) purchase 1 kilogram of good quality potato at UGX 444 and sell it at UGX 612; processors purchase at UGX 940 a kilogram and sell potato products from 1 kilogram at UGX 4,319, while consumers purchase ware potato at an average price of UGX 537.

Results in Table E2 further indicate that during off-peak season, potato farmers sell 1 kilogram of potatoes at UGX 697; traders purchase potatoes at UGX 784 and sell at UGX 1,061; processors purchase potatoes at UGX 1,651 and sell the derived products at UGX 5,960, whereas consumers purchase 1 kilogram of potatoes at UGX 1,206. It is therefore evident that potato purchase and sale prices are higher during off-peak season than peak season.

Payment mechanism

During peak seasons, local traders pay for their potato purchase using cash. In some cases, traders buy potatoes on credit and pay back one week after selling the consignment in destination markets. Payments are normally effected in at least three installments, although, this depends on trust and meeting frequency between the trader and the farmer. The credit mode of payment is arguably risky and can lead to a loss and break down of trust when a trader fails to pay a farmer. When the urban traders buy potatoes a few times in a season and are not well known to the farmers, the cash mode of payment tends to be adopted. During the period of scarcity, all traders pay cash and also meet transport costs from the garden. Some even deposit money in advance or buy potato while still in gardens before they are ready for harvesting.

7.8 Value chain marketing constraints

There are marketing constraints that continue to affect potato farmers such as:

(i) Poor structure of ware potato industry reflected by: high transaction costs, lack of capital, lack of improved transport, and limited access to information which leave the majority of potato farmers out of higher end markets of potato products. This justifies the need to enforce standards on the handling of fresh potatoes and quality of potato products;

(ii) Potato farmers are poorly organized, and are therefore unable to utilize the advantages of collective marketing and high bargaining power. This limits farmers' efforts to upgrade into various potato related market exchanges at different nodes of the value chain;

(iii) Potato farmers also face many technical problems that limit productivity, while increasing the cost of production. This also limits their ability to adopt better potato varieties and reduce postharvest losses. An improvement in potato demand has contributed to enhanced production, but the market price is still not good enough to encourage and reward high quality fresh potato and potato products.

Summary

Ware potato value chains in Eastern Uganda are poorly developed. They are characterized by limited value addition on fresh ware potato. Market supply of ware potato is inconsistent throughout the year. Key players along the ware potato value chains are: farmers, agents (or brokers), local traders, urban wholesalers, urban retailers, processors, and consumers. Various institutions such as schools, hotels, and hospitals procure and consume ware potatoes in large quantities. Some of the government agencies and research organizations are also active in spearheading breeding, multiplication and distribution of improved seed potato to farmers.

Value chain actors (farmers, wholesalers, retailers, and processors) are not well organized, and this hinders the level of market efficiency and the quality of ware potato tubers marketed. There is need to promote better coordination and smooth flow of relevant market information across all the value chain actors, if market performance along the ware potato value chain is to improve.

A significant number of ware potato farmers sell their tubers either directly to local consumers or to a range of intermediary traders who include: middlemen or brokers, local traders, urban wholesalers and retailers. The intermediary traders in turn, sell ware potato to consumers in rural, peri-urban, and urban market centers. A substantial proportion (78 percent) of potato production is marketed by farmers, who sell most (62percent) of their produce at the farm gate. Local traders buy the largest proportion (72 percent) of potato marketed by farmers, followed by brokers (17percent), retailers (5 percent), commission agents (3 percent), and lastly local consumers (3 percent).

Urban wholesalers mainly come from Mbale town and Kampala districts. Mbale town is the current potato hub in Eastern Uganda where traders from different places meet to re-weigh, sort, and package potatoes before shipping them to different higher end markets such as Kampala city Lira, and export markets South Sudan and other neighboring countries. Some of the urban traders also trade in fertilizers and seed

potatoes, especially bought from South-Western markets of Kabale and Kisoro. All potato transactions in Uganda are currently based on weight based system as opposed to eye ball estimation.

Most women farmers (80 percent) mainly sell their ware potato produce at the farm gate to local traders. During peak season, women farmers sell small quantities of potato through very short market channels: "*Farmer >> Local consumer*". About 20 percent of the women ware potato producers participate in one of the most utilized and relatively longer marketing channels in the study area defined as: "*Farmer >> Local trader>> Urban trader (Mbale, Soroti, Iganga, Jinja, and Kampala) >> Urban consumers*". Long marketing channels are used mostly during periods of peak potato supply.

There is vast potential for value addition on fresh ware potato in Eastern Uganda. Farmers and traders engage in value adding activities of sorting, grading, washing, scrubbing, and packaging. Hotels, restaurants, and fast-food take-away outlets process ware potatoes into chips. About 70 percent of processors produce chips that are sold in the fast food restaurants, while crisps are produced by less than 32 percent of ware potato processors.

A substantial proportion of potatoes along the value chain are of low quality. Value chain actors tend to mix good quality tubers with less desired tubers of different varieties, sizes, with deep eyes, with thick skin, immature, and with cuts and bruises caused by poor harvesting tools and postharvest practices. While ware potato farmers are well linked with wholesalers and to some extent retailers, linkages between farmers and each of the cooperatives and processors are still very weak. Traders have strong linkages with fellow traders, retailers, and farmers, unlike the case with processors and cooperatives. Ware potato processors are poorly linked with cooperatives and farmers, but well linked with fellow processors, wholesale traders, and retailers.

Value chain actors face seasonal fluctuations in market price of ware potato and yet price of processed potato products is relatively stable. Potato prices are mainly set by traders depending on tuber availability and distance to target markets. Farmers normally desist from harvesting potatoes before getting a reliable buyer. Farmers sell potatoes at an average price UGX 426/kg in peak periods of the year, but this can go as low as UGX 216 per kg in case of poor quality potatoes; UGX 276 per kg for medium quality potatoes, and; UGX 354 - 390 per kg of good quality potato tubers. During periods of scarcity farmers receive up to UGX 700 - 800/kg of potatoes at farm level. It is during periods of scarcity that farmers sell their potato produce while still in gardens.

Farmers produce 1kg of good quality potato at UGX 354 on average. When there are gluts in potato market, traders (wholesalers and retailers), processors, and consumers purchase potatoes at UGX 444, UGX 940, and UGX 537 per 1 kilogram respectively. The average selling price for farmers, traders, and processors is slightly higher at: UGX 426, UGX 612, and UGX 4,319 respectively.

During off-peak season, 1 kilogram of potatoes is: sold at UGX 697 by farmers; purchased at UGX 784 and sold at UGX 1,061 by traders; purchase at UGX 1,651 and the derived products sold at UGX 5,960 by processors, whilst consumers purchase 1 kilogram of potatoes at UGX 1,206. Potato purchase and selling prices are much higher during off-peak season than peak season.

Responses from FGDs revealed that local traders sell their potato tubers to retailers in Mbale town at a much higher average price of UGX 2,200/kg. Retailers in turn sell potatoes to Mbale consumers at an average price of UGX 2500/kg. Distinctively, retailers in Kampala buy ware potato from wholesale traders at UGX 2500/kg and sell at UGX 3,000/kg to Kampala city consumers. Traders and processor fetch the highest price per kilogram of potatoes which is much higher during off-peak period than during peak period.

Ware potato farmers, cooperatives, wholesalers, and retailers along ware potato value chain enjoy substantial levels of trust. Ware potato processors on the other hand trust to a less extent each of the other value chain actors. Interventions to promote quantity and quality of potato along the value chain should be therefore be directed towards enhancing linkages between value chain actors, supporting cooperatives, promoting cooperative marketing channels, and contract farming between processors and farmers.

8. MARKETING OF POTATOES AND COSTS INCURRED

Marketing is defined as the transfer of ownership of products through buying and selling of a commodity using a price mechanism that works out the interests of all individual producers, all other value chain actors, and consumers. The ultimate goal of marketing is to lead to a socially optimal outcome, depending on the nature of the underlying market structure, conduct, and performance that facilitate the flow of goods from the point of initial production to the ultimate consumer. Marketing includes all the exchange activities of buying and selling; all the physical activities performed to give the commodity increased utility through the transportation, handling, storage, processing and packaging, as well as all the auxiliary activities such as financing, risk bearing, and dissemination of information to participants in the marketing process.

Market structure denotes a set of market features that determine the economic environment in which a trader operates (Thomas and Maurice, 2011). *Market structure* is characterized by the conditions of entry and exit, degree of product differentiation, number and size of distribution of buyers and sellers, and amount and cost of information about product price and quality. *Market conduct* refers to patterns of behaviors that traders follow in adopting or adjusting to the changing market conditions in which they operate. The conduct dimensions include among others price setting methods and sales promotion policy, barriers to entry and exit (Bain, 1968).

Marketing performance generally refers to how well the marketing system works; how competitive or efficient VC actors are, or more broadly how successful VC actors are at delivering benefits to consumers in terms of value addition. The level of *market performance* attained by VC actors is represented by the magnitude of the profits and it is a reflection of the extent to which VC actors are succeeding in achieving their objectives. Other market performance outcomes may include affordable prices paid by consumers that are not excessively above the marketing cost, processing cost, transaction costs and prices that a producer gets to cover the costs of production.

Market performance therefore measures: (i) outcomes and impacts of existing market structure (how well the system is organized) and market conduct (how decisions are made in the system); (ii) a composition of end results in the dimensions of price, output, production cost, selling cost, product design and so forth; (iii) the extent to which markets result in outcomes that are deemed good or preferred by society; other desirable outcomes, including whether or not traders are able to obtain excessive profits, and; whether commodities meet certain quality standards.

Economic literature indicates that market outcome or equilibrium can be assessed based on allocative efficiency as defined by profitability level and price-cost margin. Any marketing system is measured with two criteria or yardstick: (i) efficiency in terms of how well goods and services flow from business to consumers, and; (ii) fairness reflected by how the marketing system meets the needs of the consumers. Other indicators of market performance include: price levels and stability (long-run, short-run, and through space), profits, margins and costs, volumes, product quality, variety and distributions within the market. The dimensions of market performance therefore embrace the pricing efficiency, profit distribution and consumer preference.

Agricultural marketing and sales of food items

Economic literature show that sales of food item, including potatoes, depend largely on the nature of socio-economic characteristics of actors in the value chain, demographic factors, food safety issues and preferred quality cues. Ware potato sales in particular are determined by various factors that range from: seasonal variations that affect the supply and demand of the product, geographical concentration of the food items, quality of the product, access to storage facilities, product bulkiness, costs of transport/shipments, distance to market, level of postharvest losses due to lack of or improper storage (Anderson and Hanselka, 2009; Kohs and Uhl, 2002).

Agricultural marketing therefore includes all business activities involved in the flow of goods and services from the point of initial agricultural production to the ultimate consumer (Kohls and Uhl, 1990). In the same spirit, Dixie (1989) defines agricultural marketing as series of services involved in moving a product from the point of production to the point of consumption. The level of consumer happiness and the level of business profits largely depend on how well the marketing system meets the needs of the people. The main focus of agricultural marketing is on competition, and its connection to the profitability of actors. Competitiveness can be captured by the degree of actor's ability to set price above the cost of producing a single additional unit of output.

8.1 Marketing performance and postharvest management practices

Potato is sold mainly in bags, each ranging from 80kg to 120kg. The lack of exchange standards means that negotiation processes determine the price and terms of exchange between VC actors. The price received depends largely on the trust built on different aspects, including the extent of repeated transactions between actors, experience in marketing, negotiation skills, and access to information.

Ware potato VC actors seek to maximize profits from the sale or purchase of their potato produce by exploiting the margin. Marketing margins denote performance of marketing systems in terms of the difference between what the consumer pays and the amount each of the VC actors receive; provides a clear measure of the portion of the consumer's food expenditure that goes to ware potato marketing, and; represent the price charged for one or several marketing services. Margins therefore reflect the value added or the price of all utility adding activities at each node of the market chain (Bonabana-Wabbi et al., 2013; Kraybill and Kidoido, 2009). Arguably, the concept of margin analysis offers a chance to understand power relationships of different actors along the value chain.

Market performance for ware potato farmers and other value chain actors can be improved when better pre- and postharvest management (PHM) practices are adopted. Use of PHM practices and technologies help to reduce transaction costs and market intermediaries who tend to extract larger margins at the expense of the producers, and this justifies the need to transform freshly harvested potatoes to prevent postharvest losses along the value chain (Birachi et al., 2013). Noteworthy is that high levels of PHL and limited access to profitable market price may restrict the expansion and further investment in postharvest technologies that increase efficiency and value addition to primary potato produce.

Market performance along the ware potato value chains can be measured by gross margins, market prices, value added, and profit levels attained by VC actors. Generally, the markets for most agricultural products in developing countries are relatively poorly organized, less competitive, and in some cases

missing. This can be attributed to their low initial value per unit weight (bulkiness), the crucial requirement to transport and process the product, and few processing facilities for a large geographic areas.

In particular, ware potato prices tend to be more volatile than is the case with prices of most non-farm goods. This price instability is mostly accredited to the biological nature of the product that is characterized by seasonal variation in production, short shelf-life, and significant on-farm and postharvest losses due to infestations and poor handling practices. There are also substantial time lags between a decision to produce and the realization of the final output, and this limits the ability of farmers to respond promptly to a change in price signals. No doubt, marketing of ware potato products plays an important role in increasing income level of VC actors, promoting food security, improving the welfare of people, and stimulating growth of the roots and tubers' subsector. The cost of transportation of ware potato also affects market price and varies with distance to the destination markets.

Low market performance across all value chain actors can partly be attributed to unstable potato farm-gate and market prices that often become too low to cover production and marketing costs especially during the glut seasons. This notwithstanding, high postharvest losses and the underlying limited skills in proper postharvest handling and the lack of effective means to prolong shelf-life of ware potatoes remain major concerns of government and policy makers.

8.2 Results from analysis of survey data

Results in Table 18 show that a larger proportion (93.97 percent) of potato farmers sells potatoes produced under rain-fed production system. The proportion of farm households selling potatoes in the dry season is 78.45 percent, compared to 69.83 percent of farmers who sell potatoes during the rainy season.

Table 18: Status of market participation across farm households

Particulars	First season A (Jan - June), 2015		Second season B (July -Dec), 2014		Overall in a year (last 12 months)	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Whether household sold potato, overall						
Yes	103	99.04	87	93.55	109	93.97
No	1	0.96	6	6.45	7	6.03
Whether household sold potato produced under rain-fed production						
Yes	103	99.04	83	93.26	109	93.97
No	1	0.96	6	6.74	7	6.03
Whether household sold potato produced under irrigated production						
Yes	3	100	23	100	24	100
Whether sold potatoes in the dry season						
Yes	31	29.52	79	84.95	91	78.45
No	74	70.48	14	15.05	25	21.55
Whether sold potatoes in the rainy season						
Yes	75	71.43	20	21.51	81	69.83
No	30	28.57	73	78.49	35	30.17

In addition, results in Table 19 indicate that most of the farm households (60.34 percent) sell potatoes at the farm gate, followed by selling at local market (15.52 percent), other city markets (12.07 percent), and; nearby trading centers also at 12.07 percent. Furthermore, about 73.28 percent of potato farmers sell their produce directly to the trader, followed by brokers (15.52 percent), retail shops (6.03 percent), commission agents (2.59 percent), and individual customers (2.59 percent).

Table 19: Where farm households sell potatoes and to whom

Particulars	First season A (Jan - June), 2015		Second season B (July -Dec), 2014		Overall in a year (last 12 months)	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Where farm households sell potatoes						
Farm gate	64	62.14	52	59.09	70	60.34
Nearby trading centre	12	11.65	8	9.09	14	12.07
Local market	14	13.59	17	19.32	18	15.52
Other city	13	12.62	11	12.5	14	12.07
Total	103	100	88	100	116	100
To whom a farm household sells ware potatoes						
Broker	18	17.48	11	12.36	18	15.52
Commission agents	3	2.91	2	2.25	3	2.59
Trader	74	71.84	67	75.28	85	73.28
Retail shop	5	4.85	7	7.87	7	6.03
Individual customer	3	2.91	2	2.25	3	2.59
Total	103	100	89	100	116	100
How farm households make contact with sales outlets						
Phone	37	35.92	35	39.33	37	31.9
Friends	11	10.68	4	4.49	8	6.9
Relative	4	3.88	4	4.49	5	4.31
Neighbor	18	17.48	21	23.6	26	22.41
By chance	31	30.1	22	24.72	35	30.17
Others	2	1.94	3	3.37	5	4.31
Total	103	100	89	100	116	100

Potato trading is often at the peak effectively during the months of December, August, July, September, and October in descending order. The quantity of potatoes traded and costs incurred by traders and processors are presented in Table 20. Unlike potato processors whose business is relatively younger (at 4.76 years), potato traders tend to have more experience (9.12 years on average). Processors handle an average of 1,818 kg of potato in a month, which constitutes only 4.5 percent of the potato quantity

(40,367 kg/month) handled by traders in the same period. Traders and processors are characterized by different purchase volumes, sale price, transportation costs, distance between source markets and each of the main road and selling point.

Ware potato purchase and selling prices are relatively lower for traders compared to processors. Traders incur higher monthly costs of transportation, loading and unloading, packaging, and all other costs than processors. Traders also travel longer distances between main roads and potato source markets, and between main buying points and main selling points in comparison with processors.

Table 20: Quantity of potato traded and costs that are incurred by traders and processors

Particulars	Traders		Processors	
	Obs	Mean	Obs	Mean
Years trading in ware potato	72	9.12 (7.03)	34	4.76 (5.48)
Quantity of potato purchase (kg/month)	72	40366.91 (69556.73)	34	1818.08 (3100.76)
Potato purchase price (UGX/kg) in a year	72	459.73 (178.87)	34	827.70 (386.83)
Potato sells price (UGX/kg)in a year	72	651.73 (255.97)	34	6775.00 (4851.35)
Transportation cost (UGX/kg)	72	45.66 (50.86)	34	16.74 (27.01)
Loading /unloading cost (UGX/kg)	72	9.64 (9.79)	34	2.27 (8.45)
Cost of sacks for packing potatoes (UGX)	72	656.69 (470.47)	34	566.15 (1110.23)
Other costs incurred per month irrespective of the marketing channel (UGX)	72	109900.10 (176781.50)	34	603800.70 (786585.40)
Distance from main potatoes buying point to main road (Km)	72	15.80 (49.72)	34	1.54 (3.68)
Distance from main potatoes buying point to main selling point (Km)	72	74.74 (119.58)	34	1.48 (3.33)

Notes: (i) Standard deviations are in parentheses

Additional information in relation to how quantity purchased per month by VC actors varies across periods of minor and major consumption in terms of market demand is summarized in Table 21. Traders and processors purchase less potato (26,714 kg and 437 kg respectively) in periods of low consumption than is the case (61,113 kg and 680 kg respectively) during periods of major consumption. It was also found that traders store potatoes for an average of 0.48 weeks (3.5 days) before selling; processors store for 0.71 weeks (5 days), while consumers store for 2.05 weeks (14.35 days). According to consumers, purchased ware potato can be stored at home for up to 30 days before they spoil.

Figure 15: Ware potato wholesale trading in Mbale district

Figure 16: Local traders buying ware potato in Mbale district

Figure 17: Ware potato stock for retailers in Kalerwe market in Kampala

Table 21: Potato purchases and market price during periods of minor and major consumption

Variable	Traders		Processors		Consumers	
	Obs	Mean	Obs	Mean	Obs	Mean
Quantity of potato purchase per month during the period of minor supply/sale/consumption	72	26713.90 (46565.05)	34	437.34 (779.40)	85	107.58 (151.50)
Quantity of potato purchase per month during the period of major supply/sale/consumption	72	61113.06 (109137.30)	34	679.72 (1228.02)	85	56.11 (47.63)
Quantity of potato purchase per month during the last 12 months					85	93.65 (133.32)
Average price (UGX/Kg) of potatoes in during the period of minor consumption					85	828.63 (476.01)
Average price (UGX/Kg) of potatoes in during the period of major consumption					85	1076.99 (430.02)
Average price UGX/Kg) of potatoes in the last 12 months					85	813.99 (397.16)
How long (in weeks) do you store potato before selling on average?	72	0.48 (0.79)	34	0.71 (0.89)	85	2.05 (2.09)
No. of days potatoes stay in good condition at home when stored					85	30.11 (31.03)

Notes: (i) Standard deviations are in parentheses

The total cost and corresponding cost per kg of each ware potato production activity was computed, and results presented in Table 22. The highest cost incurred by farmers is for the purchase of planting seed (UGX 100 per kg of harvested tubers), followed by land rent (UGX 30.63 per kg), land ploughing/heaping (UGX 24.45 per kg), land preparation (UGX 21.07 per kg), pesticides (20.01 per kg), harvesting labor (14.57 per kg), weeding (13.43 per kg), planting labor (11.93 per kg), other costs (9.56 per kg), and is least (UGX 7.76 per kg) for transporting the potato produce.

Table 22: Production cost (UGX) per each production activity for a farmer selling at farm gate

Average cost for a farmer selling at farm gate	Farmers (n=116)	
	Obs	Mean
Cost of land rent per kg potato production	116	30.63 (25.53)
Cost of land preparation per kg potato production	116	21.07 (19.99)
Cost of heaping per kg potato production	116	24.45 (21.50)
Cost of seed per kg potato production	116	100.65 (81.74)
Cost of planting per kg potato production	116	11.93 (11.68)
Cost of weeding per kg potato production	116	13.43 (12.86)
Cost of pesticides per kg potato production	116	20.01 (18.87)

Cost of harvesting per kg potato production	116	14.57 (10.18)
Cost of transporting to the store per kg potato production	116	7.76 (7.59)
Other production costs per kg potato production	116	9.56 (6.69)
Average total production cost (UGX) per kg of potato for	**116**	**204.23 (111.69)**

Notes: (i) Standard deviations are in parentheses

Similarly, costs per kg of each marketing activity undertaken by potato producers are presented in Table 23. When a farmer is selling at farm gate, she/he incurs the highest cost per kg (UGX 3.24) for packaging, while the least cost (UGX 0.05) is incurred on transporting potatoes to the selling point. Conversely, the cost of transporting potatoes to nearby market is the highest (UGX 21.2) when selling at the destination market, while the cost of taxes appears to be the least at UGX 1.86. Farmers could not indicate the amount of money they spend on storing their potato produce, whether selling on farm or at some destination market. Transport and packaging appear to dominate all the marketing costs incurred by farmers. Farmers incur lower marketing cost per kg (UGX 1.8) when they sell potatoes at farm gate market compared to selling at nearby market (UGX 11).

Table 23: Marketing cost per each activity when selling at farm gate or nearby destination market

Variable	Farmers		
	Obs	Mean	Std. Dev.
Marketing cost per each marketing cost activity when selling at farm gate			
Cost of transporting to the market per kg potato production	36	0.05	0.16
Cost of postharvest storage per kg potato production	19	0.00	0.00
Cost of sorting per kg potato production	29	1.59	5.87
Cost of packaging/sack per kg potato production	39	3.24	6.76
Cost of loading/unloading per kg potato production	31	0.97	2.87
Cost of tax and other related costs per kg potato production	25	0.80	2.77
Other marketing costs per kg potato production	9	0.56	1.67
Average total marketing cost (UGX) per kg of potato	**116**	**1.77**	**6.61**
Marketing cost per each marketing cost activity when selling at nearby destination potato market			
Cost of transporting to the market per kg potato production	36	21.20	23.19
Cost of postharvest storage per kg potato production and selling	19	0.00	0.00
Cost of sorting per kg potato production	29	2.97	7.07
Cost of packaging/sacks per kg potato production	39	5.64	5.65
Cost of loading/unloading per kg potato production	31	4.12	5.18
Cost of tax & other related costs per kg potato production	25	1.86	2.15
Other marketing costs per kg potato production	9	3.57	2.96
Average total marketing cost (UGX) per kg of potato market	**116**	**10.95**	**23.08**

Notes: (i) Standard deviations are parentheses

In the case of traders and processors, their production and intermediate marketing costs per each ware potato activity are shown in Table 24. The highest marketing cost of traders relates to the transportation of potatoes to destination markets at UGX 41 per kg, while the least cost is for storage at UGX 2.5 per kg. The cost of travelling upcountry in search of potatoes is the highest (UGX 161) for processor, and is least at UGX 0.1 per kg for the loss incurred as a result of poor transportation. Value chain actors therefore are highly constrained by the cost of transport. Storage and loss due to postharvest handling are not yet well appreciated or factored in as important costs that really need immediate attention.

Table 24: Production and intermediate marketing cost (UGX) per each activity

	Traders		**Processors**	
Variable	Obs	Mean	Obs	Mean
Cost of labor (loading/unloading) per kg potato purchased/sold	72	11.96 (8.69)	34	27.05 (59.50)
Cost of transport going upcountry per kg of ware potato	72	16.97 (22.69)	34	160.79 (258.66)
Cost of rental and of technology per kg of ware potato			34	79.12 (195.62)
Cost of transport within villages per kg of ware potato	72	5.60 (9.03)	34	0.00 0.00
Cost of transport to destination markets per kg of ware potato	72	41.01 (31.08)	34	23.20 (26.42)
Cost of storage/warehousing per month per kg of ware potato	72	2.49 (3.80)	34	0.00 0.00
Cost of weighing bridge per kg of ware potato	72	3.76 (5.10)	34	0.00 0.00
Cost of sacks/packaging material per kg of ware potato	72	8.05 (3.45)	34	79.10 (130.90)
Cost of marketing fees per kg of ware potato	72	8.40 (11.16)	34	58.83 (105.25)
Cost of sales tax (empoza) per kg of ware potato	72	3.87 (4.91)	34	27.66 (41.02)
Cost of overhead costs-lodging and food per kg of ware potato	72	20.00 (32.08)	34	0.84 (2.28)
Cost of potential loss due to poor transport per kg of ware potato	72	8.57 (16.19)	34	0.09 (0.34)
Cost of utility bills (firewood, charcoal etc.) per kg of ware potato			34	247.15 (199.38)

Notes: (i) Standard deviations are parentheses

Farm households were asked whether ware potato of different quality fetches different prices in the study area. Results in Table 25 show that 39 percent of farmers agree that ware potato of different quality attributes fetch different prices. Good quality potato, medium quality potato, and poor quality potato on average fetch UGX 390, UGX 276, and UGX 216 respectively. Farmers who sell good quality potato are more likely to earn higher income.

Table 25: Farm-gate price due to different quality

Particulars	Farmers	
	Obs	Mean
Distance in km from homestead to where potato is transported for selling	63	8.77 (10.02)
Whether different quality potatoes fetch different prices in the area: 1=yes; 0 =otherwise	116	0.39 (0.49)
The quality specific differential price in the main harvest season		0.00
Differential price of good quality potatoes UGX/kg	116	389.85 (77.80)
Differential price medium quality potatoes UGX/kg	116	275.82 (45.69)
Differential price poor quality potatoes UGX/kg	116	216.34 (47.29)

Notes: (i) Standard deviations are in parentheses

Summary

Market performance along the ware potato value chains is measured by gross margins, market prices, value added, and profit levels attained by value chain actors. Ware potato producers aspire to receive a good price that covers at least the costs of production. All other value chain actors also desire to sell ware potato at prices that are not only affordable by consumers, but also reasonably above the marketing cost. In Eastern Uganda, potato is sold mainly on per bag basis, with each bag weighing between 80kg and 120kg. The standard bag of potatoes weighs 100kg after leaving the main bulking point in Mbale town. The lack of exchange standards in the study area means that value chain actors rely more on a negotiation processes to determine the terms of exchange, including price of ware potato.

Some of the key determinants of market price received by value chain actors include the level of trust built among actors (which is largely based on the extent of repeated transactions), experience in marketing, negotiation skills, and access to information. Over 93.97 percent of farmers sell ware potato produced under rain-fed production system. A large proportion (78.45 percent) of farm households sells potatoes in the dry season, compared to farmers (69.83 percent) who sell potatoes during the rainy season. The months of June and July are characterized by excess ware potato production; months of September, January, February, March, and April are characterized by scarce ware potato production, while months of December, August, July, September, and October are characterized by peak potato trade in Eastern Uganda. About 60.34 percent of ware potato farmers prefer selling their produce at farm gate, compared to 15.52 percent that prefer selling at the local market, 12.07 percent at other city markets, and lastly 12.07 percent at nearby trading centers. An estimated 73.28 percent of potato farmers sell their produce directly to the traders, 15.52 percent sell to brokers, 6.03 percent sell to retail outlets, 2.59 percent sell to commission agents, and 2.59 percent sell to individual consumers.

Potato processors are relatively young (4.76 years) in business, unlike potato traders who appear to have the longest (9.12 years) experience in business. The capacity of processors is very low, since they on average operate a small quantity (1,818 kg) of ware potato. This average capacity of processors is

equivalent to 4.5 percent of all the potato quantity (40,367 kg/month) handled by traders in the same period. Traders and processors are characterized by different purchase volume, sale price, transportation costs, and distance between source markets and selling points. Ware potato purchase and selling price are relatively lower for traders compared to processors. Traders also incur higher monthly costs of transportation, loading and unloading, packaging, and all other costs than processors. Besides, traders travel longer distances between: (i) main roads and potato source markets in villages and (ii) in between main buying points and main selling points when compared with processors.

Traders and processors purchase relatively less quantity of ware potato (26,714 kg and 437 kg, respectively) in periods of low consumption than in periods of major consumption (61,113 kg and 680 kg, respectively). The duration of storage of potatoes varies inversely with quantity of potato handled at a time by value chain actors. For instance, traders who handle a large quantity of potatoes store the tubers for a period of 0.48 weeks (3.5 days) before selling; processors store for 0.71 weeks (5 days), while consumers store for 2.05 weeks (14.35 days). It is important to note that consumers store purchased ware potato at home for up to 30 days before they spoil.

The highest cost incurred by farmers is for the purchase of planting seed (UGX 100 per kg), followed by land rent (UGX 30.63 per kg), land ploughing/heaping (UGX 24.45 per kg), land preparation (UGX 21.07 per kg), pesticides (20.01 per kg), harvesting labor (14.57 per kg), weeding (13.43 per kg), planting labor (11.93 per kg), other costs (9.56 per kg), and is least (UGX 7.76 per kg) for transporting the potato produce. Transport and packaging appear to dominate all the marketing costs incurred by farmers. When a selling at farm gate, farmers incur the highest marketing cost per kg (UGX 3.24) on packaging material, and transporting potatoes to the selling point is their least cost at UGX 0.05 per kg of potato sold. Farmers who sell potatoes to nearby destination points face the highest (UGX 21.2) marketing cost for potato transporting, as opposed to the least cost marketing activity of taxes that is at UGX 1.86 per kg of potato sold. Farmers could not indicate the amount of money they spend on storing their potato produce, whether selling on farm or at some destination market.

In the case of traders the highest marketing cost is for the transportation of potatoes to destination markets at UGX 41 per kg, while the least cost is related to storage at UGX 2.5 per kg. The cost of travelling upcountry in search of potatoes is the highest (UGX 161) for processor, and is least at UGX 0.1 per kg for the loss incurred as a result of poor transportation. Value chain actors therefore are highly constrained by the cost of transport. Storage and postharvest loss are not yet well appreciated or valued as important costs that really need immediate attention and as a result most of them cannot attach the value on storage costs. Interventions to improve market performance for ware potato farmers and all other value chain actors should focus on: promoting the adoption of better pre and postharvest management (PHM) practices and technologies that reduce postharvest losses; dissemination of market information that enables actors to access to profitable market price; improve access to affordable good quality seed through farmer based seed multiplication, promote labor enhancing technologies to reduce drudgery and cost of hiring labor, promoting practices that improve the quality of potato tubers, and; reduce the cost of transport.

9. MARGINS

The study adopts the commodity approach to market performance analysis, which combines institutional and functional analysis of the marketing of ware potato. The approach mainly helps to identify how physical differences in quantity and quality of ware potato contribute to different marketing costs. It also helps to expound geographical sources, different stages in marketing, and conditions of commodity supply, storage, transportation, standardization, and demand of ware potato.

In particular, the institutional approach to market analysis is vital in studying the various agencies and business structures that perform different marketing processes. These agencies may include: (i) merchant middlemen (retailers and wholesalers); (ii) agent middlemen (brokers and commission men); (iii) speculative middlemen (who buy and sell on their own account while expecting to make profit from price movements); (iv) processors; and (v) facilitators of value chain operations.

The functional approach is also one of the methods used to classify activities that occur in the marketing processes of ware potato. The functional approach breaks down the marketing processes into various functions that must be done by value chain actors. These functions include: exchange function (mainly composed of selling and buying), physical functions (comprised of storage, transportation and processing), and facilitating functions (composed of standardization, financing, risk-bearing, and market intelligence).

Physical functions therefore denote activities that are useful in assessing differences in marketing costs as a result of differential engagements in the postharvest handling, movement, and physical change of ware potato. The question is whether or not the necessary number of postharvest physical functions is being performed, and whether these functions are being performed in the most efficient manner to enhance market performance. These marketing functions ultimately add value, but also some costs to ware potato products. Simply minimizing the functions is therefore not an acceptable goal. Here, the rule is that additional functions and services should be performed in the context of marketing until costs exceed the values of functions. Functional approach generally examines factors that affect postharvest practices (including storage) such as price, speculation, government policy, and availability of credit facilities.

In a purely competitive market, it is assumed that every producer-seller seeks to maximize profits by selling at as high price as possible, and at the same time every buyer seeks to maximize utility by obtaining the product at as low a price as possible. It is this collective action of buyers and sellers that in turn determine market price. The concept of perfectly competitive market assumes: perfect knowledge by buyers and sellers, complete divisibility of the product, and perfect mobility of the product within the market. Nonetheless, these crucial aspects of competitive marketing are often missing in Ugandan market, thus resulting into market frictions.

9.1 Margins and other measures of profitability

The assessment of profitability can adopt various techniques that help to compares the magnitudes and timing of cash flow returns to cash flow costs. These techniques range from: a measure of income; a ratio of income to some asset measure; gross margin analysis (GMA); net income measure (NI); the internal rate of return (IRR); returns on investments (ROI); net-present value (NPV), and; enterprise budgeting. Net-income is the difference between total revenue and total production and marketing costs. Net-

income is what remains after deducting all costs namely depreciation, interest, and taxes from business revenues or gross income[3].

Margins are based on the assumption that each of the value chain actors seeks to maximize profit or operate their businesses at the minimum cost. Margin analysis is based on the widely used supply function approach that is useful in explaining the rational behavior of farmers and other value chain actors in any given environment The first-order profit maximizing conditions equates marginal rates of substitution between inputs and their inverse price ratios. They also equate the marginal cost (MC) to the given marginal revenue (MR), thus revealing efficiency levels. Marginal revenue is the increase in total revenue resulting from a one-unit increase in output.

The internal rate of return (IRR) is also known as yield on an investment, and is defined as the rate at which an investment project promises to generate a return during its useful life. In other words, IRR denotes a discount rate at which the present value of a project's net cash inflows becomes equal to the present value of its net cash outflows. Internal rate of return, which helps to compare the internal rate of return to the minimum required rate of return of the project, is the discount rate at which a project's net present value becomes equal to zero.

The net present value (NPV) or net present worth (NPW) is a measurement of profit calculated by subtracting the present values (PV) of cash outflows (including initial cost) from the present values of cash inflows over a period of time. The NPV is therefore the sum of present net values of annual cash flows generated over a lifetime of an investment minus its initial cost.

Returns on investments (ROI) is a performance measure based on profit ration that is used to evaluate the efficiency of an investment or to compare the efficiency of a number of alternative investments. A ROI measure compares investment revenue and investment cost and helps to reveal how efficiently each dollar invested in a project is at producing a profit.

9.2 Gross margin analysis (GMA) as an indicator of market performance

Here we adopt a much simpler concept of gross margin (profitability) analysis for each value chain actor as an indicator of market performance. Arguably, ware potato production is annual by nature and is characterized by short-run planning decisions when compared to perennial crops. The GMA has the advantage of revealing relative profitability of various actors in the ware potato value chain, who include mainly ware potato farmers, traders (wholesalers and retailers), and processors. The size of land operated is assumed fixed, given the short time of the two seasons of potato production in year. Value chain actors are also assumed to receive interest free loans during this short production period. They do not own fixed assets such as tractors apart from use of hired labor. Fixed costs in farming may include the cost of buying land, depreciation of investments, and annual subscription that are key to assessing net-profit. Data on these fixed costs were however not collected.

Ware potato VC actors seek to maximize profits from the sale of their potato produce by exploiting the margin. Marketing costs and profit margins make up marketing margins, and are both indicators of

[3] Gross farm income represents the sum of cash receipts from farm marketing, the amount of government payment and any income from farm sources.

efficiency or inefficiency of marketing systems. Marketing margins act as incentives or disincentives in maintaining potato business sustainability.

In this study, the level of VC actors' profitability was computed from their respective gross revenue, less operating (variable) costs of production. The average total revenue (gross value of output) was computed by adding up principal sources of revenue in ware potato production and marketing that signify sales of ware potatoes. Profitability was computed using gross margin analysis technique from gross value of output $(y_i * p_i)$ less total variable costs (TVC) as defined below:

$GM = TR - TVC$ ..... (1)

Where GM = Gross margin

TR = Total Revenue (a product of output and average price)

TVC = Total Variable Costs

Variable costs vary with the level of output, and include variable production costs and marketing costs. In the case of farmers, production costs range from expenses on: land rent, land preparation (ploughing), soil heaping, seed potato, labor for planting, labor for wedding, pesticides and spraying, harvesting, transporting to homesteads and stores, and other costs. Conversely, marketing costs include costs of transporting to the market, postharvest storage, sorting, packaging and packing material, loading and unloading, relevant taxes and other related costs, and other marketing costs.

Therefore $GM_i = [P_i * Y_i] - \sum_{i=j}^{J} W_j X_j$ ..... (2)

where P_i = Price of ware potato output

Y_i = Total ware potato output for the i^{th} farmer, $i = 1,2,3 \ldots . n$

W_j = Price of variable inputs used in production of ware-potato, $j = 1,2,3 \ldots . n$

X_j = Quantity of inputs, j

Estimated results about total variable costs incurred, selling price, and gross margins derived from selling 1 kg of ware potato at farm gate and nearby destination market are shown in Table 26. Notice that retailers engage in highest number (4.29) of weekly transactions (purchases) compared to other actors, namely processors (3.76) and wholesalers (3.05). Earlier in Table 12, farmers are reported to sell potato for average 1.43 - 2.22 times (off-peak and peak season, respectively) in a month.

Table 26 further reveals that wholesalers transact the highest quantity (9,932 kg) of ware potato per route, while processors operate business with the least quantity (307.3 kg) of potato per week. The average selling price per kg of potatoes at farm gate and other destination market varies across farmers, retailers, wholesalers, and processors at UGX 376, UGX 670.8, UGX 626.1, and UGX 5,829.2 respectively. Detailed information regarding the value chain actors' production costs, value of quantity of potato transacted at source and destination markets, and variable marketing costs are also summarized in Table 26. We see that processors incur the highest variable marketing costs per kg (UGX 570.3), followed by wholesalers (UGX 103.3), retailers (UGX 34.3), and lastly farmers (UGX 10.95).

Figure 18: Displaying ware potato in Mbale market

Figure 19: Ware potato retail marketing in Mbale town

Figure 20: Local traders of ware potato in Kapchorwa district

Table 26: Potato purchase, sales, variable costs, and selling price at different markets

Particulars	Farmers		Retailers		Wholesalers		All traders		Processors	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Number of times in a week a value chain actor engages in purchase and sale of ware potato			38	4.29 (2.04)	34	3.05 (1.51)	72	3.71 (1.90)	34	3.76 (2.55)
Quantity (kg) of ware potato sold per acre or route at destination market	116	5649.14 (4532.24)	38	2177.02 (2590.69)	34	9932.43 (8620.58)	72	5839.30 (7296.54)		
Quantity(kg) of ware potato sold per week at destination market			38	9796.63 (13145.62)	34	25865.18 (20564.33)	72	17384.56 (18758.10)	34	307.30 (248.19)
Selling price per kg of potatoes selling at farm gate/ selling in a week at destination market	116	376.00 (83.11)	38	670.80 (270.55)	34	626.07 (199.44)	72	649.67 (239.03)	34	5829.19 (3564.56)
Potato production cost /purchase price per kg by the VC actor in source market	116	204.23 (111.69)	38	490.50 (184.96)	34	379.35 (121.63)	72	438.01 (166.82)	34	829.82 (387.03)
Value of potato quantity (UGX) sold by the VC actor per acre/ route/week in destination market	116	1967275.00 (1542923.00)	38	1449029.00 (1828476.00)	34	6640482.00 (6694813.00)	72	3900548.00 (5420883.00)	34	1857752.00 (1710064.00)
Variable marketing cost (UGX) per kg of potato sold by a farmer at farm gate	116	1.77 (6.61)								
Variable marketing cost (UGX) per kg of potato sold at nearby market	116	10.95 (23.08)		34.32 (32.49)		103.31 (50.99)		66.90 (54.42)		570.28 (353.75)
Total variable marketing cost (UGX) incurred per acre, selling at farm gate	116	5380.95 (24714.68)								
Total variable marketing cost (UGX) incurred by farmer per acre, selling at destination market	116	80717.16 (196697.70)								
Value of quantity of potato (UGX) sold per acre/ purchased per route/week at source market	116	896821.40 (703055.50)	38	1086102.00 (1313027.00)	34	4257069.00 (4571089.00)	72	2583503.00 (3626490.00)	34	267215.10 (248221.20)
Total variable marketing cost(UGX) incurred per route/week up to destination market			38	50689.41 (52776.22)	34	997790.80 (937936.10)	72	497931.70 (798150.50)	34	160044.20 (144822.30)
Total variable cost (UGX) incurred per acre selling at farm gate/ route/week up to destination market	116	902202.40 (700782.60)	38	1133633.00 (1337965.00)	34	5320948.00 (5498075.00)	72	3110976.00 (4406170.00)	34	431965.10 (391538.20)
Total variable production/marketing cost (UGX) incurred per acre, selling at destination market	116	977538.60 (803568.90)								

Notes: (i) Standard deviations are in parentheses; (ii) Farmers selling potatoes per acre of land; (iii) Retailers selling potatoes per route in the destination market; (iv) Rural/Urban wholesalers selling potatoes per route to destination market; (v) All traders (retailers and wholesalers) selling per route to/in the market; (vi) Processors purchasing and selling processed potato products per week in destination market.

The estimated indicators of market performance across actors along ware potato value chains are summarized in Table 27. Processors appear to be adding the highest value (UGX 4,999.36) based on the average price per kg of processed potato products; wholesalers add the equivalent value of UGX 246.72 followed by; retailers at UGX 180.3, and lastly farmers who add the least value at UGX 168.47. In the same line, the ratio of variable marketing costs to value added is least for processors at 0.21, compared to farmers at 1.58, wholesalers at 1.84, and retailers at 3.33. That market engagements is different, these results indicate that market performance in terms of value addition is much better with processors, followed by wholesalers, retailers, and is the lowest for ware potato farmers.

Similar pattern of market performance is demonstrated by the estimated absolute measures of gross margins per acre of land for farmers, single route for traders, and per week's operation in case of processors. Processors are shown to enjoy the highest gross margins (UGX 1,427,258 which is equivalent to 69.35% of economic significance), followed by wholesalers at UGX 1, 180,826 (19.81%), farmers at UGX 1,046,021 (46% when selling at farm gate and 44% when selling at destination market), and is least at UGX 215,395.5 (22.18 %) among potato retailers. Wholesalers and retailers appear to be incurring the highest marketing costs as indicated by the ratio of marketing costs to gross margins. Potato marketing appears to be more profitable among processors, followed by farmers, retailers, and lastly among wholesalers, although these actors handle different volumes of potato produce.

9.3. Opportunities to market performance of traders and processors

The extent to which market performance of traders (wholesalers and retailers) and processors is significantly affected by major opportunities in the study area is evaluated using descriptive statistics based on responses provided by value chain actors. Results show that market performance of traders is influenced positively by: (i) interventions that increase demand of ware potato through fast food restaurants and frozen chip processors (77.78 percent); improved access to market information through mobile phones and radio (66.67 percent); encouraging active membership to a potato traders/multi-stakeholder platform (47.22 percent); more banks in the area willing to support and finance actors in ware potato value chain (38.89 percent); women and men getting more or less equally engaged in production, wholesale, and retail of potatoes (27.78 percent); easy access and availability of improved seed potato that require less agro-chemicals and fungicides (16.67 percent); engaging in improved ware potato storage for extended shelf-life and PHL reduction (15.28 percent).

Table 27: Value added and gross margins derived from selling potato produce at different markets

Particulars	Farmers		Retailers		Wholesalers		All traders		Processors	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Value added based on average price per kg for good and medium quality potatoes	**116**	**168.47 (90.22)**	**38**	**180.30 (115.03)**	**34**	**246.72 (114.97)**	**72**	**211.66 (118.97)**	**34**	**4999.36 (3419.56)**
Costs to value added based on average price per kg for good and medium quality potatoes	116	1.58 (1.55)	38	3.33 (1.78)	34	1.84 (0.99)	72	2.63 (1.63)	34	0.21 (0.13)
Value added based on average potato price (UGX) per kg in a year	116	221.44 (141.71)								
Costs to value added based on average potato price (UGX) per kg in a year	116	1.36 (1.56)								
Gross margins (UGX) derived per acre selling at farm gate/route/week to destination market	**116**	**1046021.00 (1051903.00)**	**38**	**215395.50 (194295.40)**	**34**	**1180826.00 (1128303.00)**	**72**	**671293.00 (920297.10)**	**34**	**1427258.00 (1407823.00)**
Gross margins as a percentage derived per acre selling at farm gate/route/week to market		**46.33 (23.38)**		**22.18 (10.34)**		**19.81 (11.66)**		**21.06 (10.97)**		**69.35 (18.97)**
Total variable cost (production/marketing costs) to gross margins per acre at farm gate/route/week	116	1.53 (1.40)	38	5.20 (4.20)	34	5.86 (4.14)	72	5.51 (4.16)	34	0.42 (0.26)
Gross margins (UGX) derived by potato farmer per acre/week selling at destination market	116	969822.60 (1004569.00)	38	904760.90 (1038397.00)	34	3033714.00 (2809121.00)	72	1910100.00 (2318439.00)		
Total variable cost(production/marketing) to gross margins per acre/week selling at destination market	116	1.56 (1.41)								

Notes: (i) Standard deviations are in parentheses; (ii) Farmers selling potatoes per acre of land; (iii) Retailers selling potatoes per route in the destination market; (iv) Rural/Urban wholesalers selling potatoes per route to destination market; (v) All traders (retailers and wholesalers) selling per route to/in the market; (vi) Processors purchasing and selling processed potato products per week in destination market; Gross margins (UGX) derived by potato farmer per acre and selling potato tubers at destination market is equivalent to 43.74 percent.

Figure 21: Processed chips from ware potato in Mbale town

Figure 23: Crisps made with a low cost technology in Mbale district

Figure 22: Crisps made with a relatively high cost technology in

In the case of processors, similar factors affect their market performance in the following descending order: improved access to market information through mobile phones and radio (44.12 percent); increase in the demand of ware potato by fast food restaurants and frozen chip processors (38.24 percent); more banks in the area willing to support and finance actors in ware potato value chain (15.15 percent); women and men getting more or less equally engaged in production, wholesale, and retail of potatoes (14.71 percent); easy access and availability of improved seed potato that require less agro-chemicals and fungicides (8.82 percent); engaging in improved ware potato storage for extended shelf-life and PHL reduction (5.88 percent).

These findings clearly indicate that traders and processors have not yet internalized the importance of storage and other related physical handling of ware potato produce in enhancing quality product, minimizing losses and increasing market performance.

9.4 Barriers to market performance of traders and processors

Market performance of traders in the last 12 months is significantly affected by the following key barriers, namely: poor road network (66.67 percent); poor market infrastructure (59.72 percent); unfavorable environment conditions (58.33 percent); high potato demand from other districts and countries (54.17 percent); poor linkages and coordination between ware potato producers, traders, processors, and consumers (30.56 percent), and; the lack of or limited processing and value addition of ware potatoes (27.78 percent).

In the same line, barriers that significantly affect market performance of processors range from: unfavorable environment conditions (35.29 percent); high potato demand from other districts and countries (29.41 percent); poor market infrastructure (29.41 percent); poor road network (20.59 percent); the lack of or limited processing and value addition of ware potatoes (14.71 percent), and; poor linkages and coordination of ware potato producers, traders, processors, and consumers (14.71 percent).

The findings on key barriers to market performance point to the challenges faced by value chain actors as a result of the market infrastructure and the environment that is less supportive to their operations. To the extent that the environment is less enabling to market operations, actor continue to face high transaction costs and small gross margins.

Summary

A gross margin analysis is adopted for each value chain actor as an indicator of market performance. Margins represent the price charged for one or a collection of marketing services along the potato market chain, and reflect the value added or the price of all utility adding activities at each value chain node. Wholesalers transact the highest quantity (9,932 kg) of ware potato per route, while processors operate the least quantity (307.3 kg) of potato per week. The number of times in a week different value chain actors engage in the buying and selling ware potato is highest (4.29) for retailers, followed by processors (3.76) and wholesalers (3.05). Farmers engage in the sale of potato for 1.43 - 2.22 times in a month.

The average selling price per kg of potatoes at farm gate and other destination market varies across value chain actors, and ranges from UGX 376/kg for farmers, UGX 670.8/kg for retailers, UGX 626.1/kg for wholesalers, and UGX 5,829.2/kg for processors. Processors incur the highest (UGX 570.3) variable marketing costs per kg of potato, followed by wholesalers at UGX 103.3, retailers at UGX 34.3, and lastly farmers at UGX 10.95. Conversely, processors add the highest value (UGX 4,999.36/kg) based on the average price per kg of processed good and medium quality potato products. Wholesalers add the

equivalent value of UGX 246.72, followed by retailers at UGX 180.3, while farmers add the least value of UGX 168.47. The ratio of variable marketing costs to value added is least for processors at 0.21, compared to farmers at 1.58, wholesalers at 1.84, and retailers at 3.33. These results indicate that although there is an inverse relationship between quantities of potatoes handled, market performance in terms of value addition appear to be much better for processors, followed by wholesalers, retailers, and is least across ware potato farmers.

Gross margins of farmers were derived from quantity of potatoes produced from each acre of land and sold at farm gate. Processors are shown to enjoy the highest gross margins (UGX 1,427,258) at 69.35%, followed by wholesalers at UGX 1,180,826 (19.81%), farmers at UGX 1,046,021 (44%-46%*)*, and gross margin is least at UGX 215,395.5 (22.18%) among potato retailers. Wholesalers and retailers incur the highest marketing costs as indicated by the ratio marketing costs to gross margins. Wholesalers and retailers are more likely to make more money from potato marketing in a given period. That said, the business of potato trade is more profitable among processors, followed by farmers, retailers, and lastly among wholesalers.

Market performance of traders is positively associated to each of the interventions that: increase demand of ware potato through fast food restaurants and processing of frozen chips (77.78 percent); improve access to market information through mobile phones and radio (66.67 percent); encourage active membership to a potato traders/multi-stakeholder platform (47.22 percent); improves access to more banks in the area that are willing to support and finance actors in ware potato value chain (38.89 percent); improves equal participation of women and men actors in the production, wholesale, and retail aspects of potatoes (27.78 percent); enhances easy access and use of improved seed potato that also require less agro-chemicals and fungicides (16.67 percent), and; improve ware potato for extended shelf-life and PHL reduction (15.28 percent). That said, traders and processors have not yet appreciated the importance of storage and other related physical handling of ware potato produce that enhance quality, minimize losses, and increase market performance.

Market performance of traders in particular is significantly affected by the following key barriers: poor road network (66.67 percent); poor market infrastructure (59.72 percent); unfavorable environment conditions (58.33 percent); high potato demand from other districts and regional countries (54.17 percent); poor linkages and coordination of ware potato producers, traders, processors, and consumers (30.56 percent), and; the lack of or limited processing and value addition of ware potatoes (27.78 percent).

In the same line, barriers that significantly affect market performance of processors range from: unfavorable environment conditions (35.29 percent); high potato demand from other districts and countries (29.41 percent); poor market infrastructure (29.41 percent); poor road network (20.59 percent); the lack of or limited processing and value addition of ware potatoes (14.71 percent), and; poor linkages and coordination of ware potato producers, traders, processors, and consumers (14.71 percent). The findings on key barriers to market performance point to the challenges faced by value chain actors as a result of the market infrastructure and the environment that is less supportive to their operations. To the extent that the environment is less enabling to market operations, actors will continue to face high transaction costs and small gross margins.

10. POLICIES AND ENABLING ENVIRONMENT

Uganda government aims at developing a competitive, profitable, and sustainable agricultural sector, under the on-going private sector led and market-oriented economy (MAAIF, 2010). Currently, the agriculture sector in the country employs 66 percent of the labor force and has potential to increase economic benefits through investments in increased productivity and value addition. There are efforts to enhance agricultural production, productivity, and value addition by promoting commercialization, mechanization, and agro-processing.

The agricultural sector in Uganda is organized into various wider programmes of: production and productivity; market access and value addition; creating an enabling environment, and; institutional strengthening (MAAIF, 2010). Under these programs, there are six priority sub-programmes, which include: the agricultural advisory services, agricultural technology development (research), increased value addition and market access, pest and disease control, water for agricultural production, and regulatory services. According to MAAIF (2012) these sub-programmes were drawn from an elaborate consultative process with stakeholders. The on-going policy implementation work to revamp agricultural commodity value chains falls under the sub-programme of value addition and market access.

Potato is currently not among the eight crops[4] of national strategic importance as defined in the 20 sub-programmes of the Agricultural Sector Development Strategy and Investment Plan (DSIP) also commonly known as "Non-ATAAS". The criterion used to select the crops is largely based on their potential to contribute to high caloric intake of Ugandans. The selected crops of national strategic importance include: maize, coffee, beans, cassava, bananas, sweet potatoes, oil seeds (groundnuts, simsim, and sunflower), and horticultural products. Ware potato is however recognized as one of the strategic commodities with potential to boost income of value chain actors (MAAIF, 2010, Mbowa and Mwesigye, 2015). Arguably, potato crop provide food, employment, and income, and it is an excellent source of low fat carbohydrates. Women are also heavily involved in the production and supply of root and tuber crops.

10.1 Poverty Eradication Action Plan (PEAP)

The cornerstone of Uganda's policy framework was the long-standing and widely respected Poverty Eradication Action Plan (PEAP), which was first drawn up in 1995, adopted in 1997, and later expired in 2008. The Uganda PEAP set out four main goals, namely: fast and sustainable economic growth and structural transformation; good governance and security; increasing the ability of the poor to raise their incomes; and increasing the quality of life of the poor (Ellis and Bahiigwa, 2003, GOU, 2001). The revised 2003 edition of the PEAP had five pillars that are credited for helping to address the observable increases in income inequality by focusing on agriculture, and promoting actions that empower women and their land rights (GOU, 2004). Poverty eradication was adopted as a major national goal for the Ugandan government in 1995, with a long-term goal of reducing the incidence of income poverty to less than 10 percent by 2017 (MFPED, 2010).

[4] Several strategic enterprises were compiled by SAKSS- PMA Secretariat using scores based on NAADS gross margin study and statistics from different UBOS and IFPRI survey data sets (See Republic of Uganda (2010), page 113-115). These are the enterprises being promoted by MAAIF through its DSIP in different agricultural production zones for the period 2010-2013.

10.2 Plan for the Modernization of Agriculture (PMA)

Consistent with the PEAP pillars, the government adopted a strategy dubbed the Plan for the Modernization of Agriculture (PMA) in 2000. The mission of PMA was to eradicate poverty by transforming subsistence agriculture to commercial agriculture (GOU, 2000). The policy thrust of the PMA was to implement a comprehensive integrated policy package covering seven priority areas. Through the PMA, the government of Uganda pursued the goal of poverty eradication based on the theme of "a profitable, competitive, sustainable and dynamic agricultural and agro-industrial sector".

The aim of PMA was to achieve four specific objectives namely: (i) to increase incomes and improve the quality of life of poor subsistence farmers; (ii) to improve household food security; (iii) to provide gainful employment; and (iv) to promote sustainable use and management of natural resources. There is also an increasing recognition that the implementation of PMA during the period 2001-2009 only managed to improve two pillars (the agricultural research and agricultural advisory services) out of the seven PMA investment pillars.

10.3 National Development Plan and other important policy frameworks

The PEAP was replaced by the National Development Plan (NDP) in 2010 as the new five-year policy and planning framework(GOU, 2010). The NDPs represent the primary government national strategic plan and guide for the country's fiscal strategy (World Bank, 2015). A five year Agricultural Sector Development Strategy and Investment Plan (DSIP) for each of the five year NDP periods is also developed and implemented (GOU, 2011). The DSIP consolidates and harmonizes all the existing policy frameworks in the agricultural sector into one coherent plan tasked to bring about agricultural transformation.

The aim of NDP is to achieve prosperity for all through improved agricultural productivity, improved rural household incomes, effective food and nutrition security, and reduced poverty by transforming agriculture into a profitable, competitive, sustainable, and a dynamic primary and agro-industrial enterprise, beginning with the first six operational years from 2010/11 to 2014/15 (MAAIF, 2010). And while the DSIP does not have a coherent strategy to improve the state of market infrastructure, it supports interventions that address challenges in the storage and market infrastructure, including market buildings (MAAIF, 2010). This on-going policy intervention is expected to: help preserve the quality of produce for marketing and processing, reduce marketing costs for households, and help farmers benefit from agricultural commercialization.

The DSIP, NDPI, and NDPII therefore provide a road map that guide public actions and investments on issues related to agricultural priorities over the five year period up to 2019/20. The theme of NDP II is "Strengthening Uganda's Competitiveness for Sustainable Wealth Creation, Employment and Inclusive Growth', with the aim of attaining middle income status by 2020 defined by the per capita income level of USD 1,033. The focus is placed on investment in increasing production and productivity in twelve selected enterprises namely, cotton, coffee, tea, maize, rice, cassava, beans, fish, beef, milk, citrus and bananas along the agricultural value chain (MFPED, 2015). The National Development Plan (NDP II) also offers a platform to advance Uganda's vision from a peasant to a modern and prosperous country by 2040, while ensuring that no one is left behind. The NDP II takes forward a number of unfinished interventions from NDP I but also introduces a new set of strategic interventions that are consistent with the new and emerging national context.

10.4 Uganda Vision 2040

The Uganda Vision 2040 is a statement of Uganda government's aspiration to transform the country from a peasant to a modern and prosperous country within 30 years (by 2040). The Uganda government intends to transform the country from a low-income economy with a per capita income of USD 788 in the financial year of 2013/14 to a competitive upper middle-income country with a per capita income of USD 9,500 in 2040 (Byamugisha, 2014, GOU, 2007). In the short-term, Uganda is seeking to become a middle-income country by 2020 (NRM Manifesto, 2016).

By 2040, Uganda expects to have realized its vision of a transformed economy, where commercialization of agriculture and urbanization are two key processes contributing to raised productivity and transformation. Achieving these two processes requires an efficient land use amidst the increasing pressure on land; improved agricultural production and productivity; better access to agricultural markets; inclusive value addition, including storage; an enabling environment, and; strong institutions of farmers and other value chain actors. All these policies recognize the role of smallholder agriculture in transforming agricultural sector in the country.

10.5 Current interventions and strategies

The government is championing the capacity building of farmers and other actors in the agricultural commodity value chains. The aim is to strengthen their participation in commodity value chain development, resource mobilization, and management. There are on-going interventions supporting farmers with access to affordable agricultural credit services country-wide to procure farm inputs and good storage facilities for the priority crops, excluding potato crop. There are on-going efforts to support local governments with competent and motivated extension personnel to facilitate the sensitization of farmers about best farming practices and market information. The national programme of National Agricultural Advisory Service (NAADs) is engaged with enhancing agribusiness skills of farmers and distribution of high quality seedlings and seeds.

The government's focus is therefore on specific interventions that aim at: (i) revamping the single spine agricultural extension system; (ii) enhancing investment in agro-processing facilities for coffee, tea, citrus and diary in partnership with the private sector; and (iii) revitalizing cooperatives and collective marketing (MFPED, 2015). There is commitment to promote private sector investment (based on the private sector-led strategy) in agriculture to: increase production and productivity; improve access to markets of agricultural products; expand exports; eradicate income poverty through value addition and integration, strengthening institutions in the sector, and ensuring sustainable economic growth and development. No doubt, improvements in the performance of the public sector are expected to remove constraints that prevent the private sector, including all ware potato value chain actors, from investing in different agricultural products value chains, thus, reaching a higher path of economic growth in the country.

Summary

Potato crop is currently not recognized among the key crops of national strategic importance. The crop is however highly praised as one of strategic commodities with potential to boost income and food security of value chain actors. The current national thrust is geared towards working with the private sector to develop a competitive, profitable, and sustainable agricultural sector. During a 10 year period (1999-2009), the government of Uganda implemented the Poverty Eradication Action Plan (PEAP) and Plan for Modernization of Agriculture (PMA). These two complementally plans made significant contributions

towards: addressing the observable increases in income inequality by focusing on agriculture; empowering women, strengthening women rights to land; improving agricultural research, enhancing agricultural advisory services delivery, and; reducing income poverty among farmers.

In 2010, government replaced the PEAP with the National Development Plan (NDP) as the new five-year policy and planning framework for period between 2010 and 2030. Although still at a small-scale, interventions under the NDP aim at achieving prosperity for all with a focus on promoting: agricultural productivity through efficient use of modern inputs and water; agricultural production through better extension service and mechanization; rural household incomes through commercialization; effective food and nutrition security; diversification into high value products, and; value addition through agro-processing, and; use of better postharvest physical handling practices. Work is ongoing to reduce poverty and revamp agricultural commodity value chains, a task that falls under the sub-programme of value addition and market access.

A five year Agricultural Sector Development Strategy and Investment Plan (DSIP) works hand in hand with NDP, with the aim to consolidate and harmonize all the existing policy frameworks in the agricultural sector into one coherent plan. The DSIP provides guidance and targets to various aspects of interventions under NDP in the agricultural sector, including: access to extension service delivery, access to quality farm inputs, use of postharvest handling practices, access to better seed, and the quality of storage and market infrastructure.

Other important policies include the decentralization policy that is helping districts to boost production and consumption of potato as one of the priority enterprise supported through NAADS and NGOs activities, and; on-going public investments in the country, especially in the areas of rural roads and telecommunication which reduce transaction costs and other market imperfections. The new policy framework recognizes the role of smallholder agriculture in transforming agricultural sector, and has ushered in an enabling environment for farmers, entrepreneurs, and investors to make informed and value-enhancing decisions. Under the guidance of Vision 2040, the government aspires to transform the country from a peasant to a modern and prosperous state by 2040.

11. POSTHARVEST LOSSES ALONG THE VALUE CHAIN

Value chain actors engage in different ware-potatoes postharvest handling practices in order to keep the tubers in good quality and free from undesirable circumstances, including: moisture loss, chemical changes, and physical damage in form of bruises, cuts, and rot. Postharvest handling largely determines final quality and whether a crop is sold for fresh consumption or used as an ingredient in a processed food product. Postharvest management (PHM) comprises various technologies and practices undertaken by VC actors to handle ware potato produce right from the field up to the stage of final consumption. The current PHM practices utilized by VC actors to minimizing postharvest losses and deterioration range from: sorting, washing or cleaning, grading, weighing, storage, transporting, and packing.

Ware potato losses may be experienced in the pre-harvest, harvest, and postharvest stages. *Pre-harvest losses* occur before the process of harvesting begins, and may be due to damage by insects, weeds and pests. *Harvest losses* occur between the beginning and completion of harvesting, and are primarily caused by improper harvesting techniques and tools. *Postharvest losses* occur between harvest time and up to the moment of human consumption. PHL refer to any loss or damage in quantity and quality that occurs from harvest to consumption (Buzby & Jeffrey, 2011).

Postharvest losses may include on-farm losses due to cuts, bruises, and rot, as well as losses along the chain during transportation, off-farm storage, and processing. Postharvest losses also occur as a result of product deterioration that emanate from delays in utilization. Noteworthy is that the traditional ways of looking at agricultural productivity as the solution to food security is no longer tenable. Engaging in appropriate PHM practices can minimize losses, increase access to more food, and further make a contribution towards maintaining healthy food systems in the country.

11.1 Postharvest ware potato physical losses and economic losses

Uganda is a tropical country, characterized by poor pre-storage and in-storage practices that worsen the problem of postharvest losses due to deterioration. Most farmers store only for short periods of time in their houses or in old rudimental stores, often in poor conditions (MAAIF, 2010). This compels farmers to sell early in the harvest season to avoid losses caused by rapid deterioration. With better assistance on postharvest handling, farmer and other value chain actors' groups can bulk, clean, grade, and store their produce more effectively and improve profitability by fetching higher prices during the period of scarcity.

Postharvest losses are divided into "*physical losses*" and "*economic losses.*" According to Naziri et al., (2014), *physical losses* refer to the percentage of product that is deteriorated to a point of becoming unfit for human consumption. This implies that the product affected by physical losses does not have alternative use or residual value. On the other hand, *economic losses* refer to the percentage of product that is partially spoiled or damaged and: (a) whose market price is discounted or (b) cannot be used for what it was initially meant for. The product affected by economic losses has an alternative use or residual value. For example bruised ware potato tubers are sorted out by retailers and sold behind the stalls away from the sight of ordinary consumer, to a special category of consumers willing to pay a discounted price for the product or extracted chips.

The adoption of postharvest handling techniques, including storage, helps value chain actors to: handle ware potatoes with care to avoid damage (cutting, crushing, and bruising); cool the tubers immediately

to maintain them in cool conditions; cull or remove damaged tubers; increase shelf life of potatoes, and; keep the crop in good quality while awaiting a selling opportunity when price is good.

Postharvest storage conditions are critical to maintaining quality, given that each crop has an optimum range for storage temperature and humidity. The quality of ware potato is also a multi-dimensional phenomenon, described by a set of characteristics and attributes that are either perceived subjectively (Grunert et al., 2004), or measured analytically (Becker, 2000). In the case of potatoes, as for other annual crops, the price is high when there is scarcity of wares in the market and very low in the bump harvesting season (Campenhout et al., 2012). The absence of adequate storage facilities may compel many agricultural households to store the crop produce at their homesteads.

Different stages of potato value chains in Uganda face quite a number of challenges that range from: limited access and high cost of agro-inputs; limited access to improved seed; limited access to finance as result of lack of collateral and long loan application processes; high seasonality of production cycle and extreme weather conditions, and; lack of organized storage that translates to high postharvest losses among farmers, traders, and processors (Mbowa and Mwesigye, 2015). The adoption and use of improved storage facilities can help reduce the challenges of seasonality and fluctuations in price, thus stabilizing profit margins and income.

Value chain actors are unable to successfully market their produce due to poor feeder roads, poor communication facilities, high costs of electricity, lack of pre-cooling and pack houses, limited access to cold and dry storage facilities, and lack of suitable means of transportation (MAAIF, 2010). There can be high transport costs of moving potato produce from the farm gate to primary and secondary markets, compared to the transport between urban markets. Improving transport, storage, and market infrastructure can therefore reduce marketing costs so that households in more remote areas can benefit more from commercialization.

11.2 Pre-harvest practices and harvest activities

The study findings indicate that about 96 percent of farmers experience substantial potato losses during the process of production, harvesting, and sale. Results in Table 28 reveals that the proportion of farmers experiencing potato losses in Eastern Uganda is highest during harvesting (95.69 percent), production (91.38 percent), storage (79.31 percent), sales and marketing (77.59 percent), and is least during other stages (20.69 percent). The magnitude of potato losses were also ranked by majority farmers to be very high during production; high during harvesting; fairy high during storage; low during sales and marketing, and; very low during other stages. There is therefore an urgent need to mitigate potato losses across potato farms, especially during harvesting, production and storage.

Use of major harvesting tools leads to a damage of about 239.36 kg of potatoes per acre of farm land (Table 29). The use of hoes appears to create more damage at 277.29 kg/acre, followed by the use of sticks and hands at 113.89 kg/acre and 33.33 kg/acre respectively. About 22 percent of all damaged potatoes at farm level fall under the category of physical losses. This is the proportion of potatoes that is too damaged to use in any way, and thus thrown away. Furthermore, engaging in the second round of harvesting in the same garden recovers about 208.75 kg/acre, while potato loss as a result of what remains in the ground even after the second round is estimated at 132.47 kg/acre. Farmers are therefore encouraged to use tools carefully when harvesting. They also need to engage in the second round of potato harvesting if they are to effectively minimize losses.

Table 28: Potato losses and corresponding rank at different stages of the supply chain

Particulars	Production		Harvesting		Storage		Sales & marketing		Other stages	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Potato loss mostly happening during production and each stage of supply chain										
No	10	8.62	5	4.31	24	20.69	26	22.41	92	79.31
yes	106	91.38	111	95.69	92	79.31	90	77.59	24	20.69
Farmer rank of potato losses at different stages										
Very high losses	43	40.57	39	35.14	19	20.65	9	10		
High losses	37	34.91	47	42.34	12	13.04	12	13.33		
Fairy high losses	13	12.26	20	18.02	28	30.43	26	28.89	1	4.17
Low losses	11	10.38	3	2.7	25	27.17	32	35.56	6	25
Very low (least) losses	2	1.89	2	1.8	8	8.7	11	12.22	17	70.83
Total	106	100	111	100	92	100	90	100	24	100

Table 29: Quantity (kg/acre) of potato damaged by different major tools used during harvesting

Variable	Farmers	
	Obs	Mean
Quantity (kg/acre) of potato damaged by major tools used during harvesting per acre of land	116	239.36 (217.05)
Out of 10 damaged potatoes, number affected to have to be thrown away	116	2.20 (1.31)
Proportion of damaged potatoes that have to be thrown away	116	0.22 (0.13)
Quantity (kg) of potatoes damaged per acre of land when harvesting using hands	9	33.33 (70.71)
Quantity (kg) of potatoes damaged per acre of land when harvesting using sticks	9	113.89 (147.96)
Quantity (kg)of potatoes damaged per acre of land when harvesting using hoes	116	277.29 (251.45)
Quantity (kg) of potatoes damaged per acre of land when harvesting using ox/donkey plough	1	100.00 (-)
Average quantity of potatoes (kg/acre) gathered in 2nd round of harvesting	116	208.75 (144.43)
Potatoes(kg/acre) loss due to what remains in the ground after 2 rounds of harvest	116	132.47 (148.07)

Notes: (i) Standard deviations are in parentheses

Figure 24: Traditional stores of ware potato in Kapchorwa and Benet districts

Figure 25: Ware potato in a low cost ambient store, ready for marketing

Figure 26: An improved low cost ambient ware potato store in Eastern Uganda

11.3 Sorting and grading of ware potatoes

All actors along the ware potato value chain were asked whether they engage in sorting and grading. Evidence in Table D1, Annex D, shows that a large proportion of actors actually sort and grade potatoes. This proportion is highest (86.21 percent) for farmers, followed by processors (76.47 percent), traders (70.83 percent), and consumers (63.53 percent). Farmers mostly grade potatoes during harvesting (67.71 percent), when preparing to sell (20.83 percent), and just before storing the tubers (11.46 percent). The grading of potatoes by farmers and processors is mostly done based on tuber sizes depending on whether they are small, medium or large. Conversely, the majority of traders (wholesalers and retailers) grade potatoes by removing damaged potatoes.

According to results in Table 30, for each acre of potato harvested, farmers sort out the equivalent of 3,887 kg (78.64 percent) of medium and large sized potatoes; 591 kg (13.4 kg percent of small potatoes; 258.2 kg (6.63 percent) of cut and bruised potatoes; 244 kg (6.95 percent) of greening potatoes, and lastly; 67.5 kg (3.79 percent) of off-type variety potatoes. Our estimates show that farmers harvest on average 3,172 - 6,689 kg of potatoes per acre depending of the season and production system used (See results in Table 10).

Table 30: Quantity of particular category of potato sorted out per 1 acre farm size harvest

	Farmers (n=116)			
Variable	Obs	Mean	Min	Max
Quantity sorted out				
Quantity of small potatoes(kg) sorted-out of per 1 acre farm size harvest	116	591.87 (524.16)	20	2500
Quantity of medium and large potatoes (kg) sorted-out of per 1 acre farm size harvest	116	3886.71 (3059.10)	50	10000
Quantity of cut and bruised potatoes(kg) sorted-out of per 1 acre farm size harvest	116	258.25 (198.24)	10	1200
Quantity of greening potatoes (kg) sorted-out of per 1 acre farm size harvest	116	244.06 (129.24)	20	1000
Quantity of off-type variety potatoes (kg) sorted-out of per 1 acre farm size harvest	116	67.51 (6.38)	20	100
Proportion of quantity sorted out				
Proportion of small and potatoes (kg) sorted-out of per 1 acre farm size harvest	116	13.40 (9.03)	3.3	85
Proportion of medium and large potatoes (kg) sorted-out of per 1 acre farm size harvest	116	78.64 (12.55)	7.5	98
Proportion of cut and bruised potatoes(kg)sorted-out of per 1 acre farm size harvest	116	6.63 (4.01)	0.6	25
Proportion of greening potatoes(kg)sorted-out of per 1 acre farm size harvest	116	6.95 (4.38)	0.8	31.3
Proportion of off-type variety potatoes(kg) sorted-out of per 1 acre farm size harvest	116	3.79 (0.86)	1.3	5.6

Notes: (i) Standard deviations are in parentheses

Different categories of potato sorted out by farmers are utilized in various ways. Results in Table D2, Annex D indicates that about 70.97 percent is sold, 20.43 percent is thrown away as waste, 3.23 percent is consumed at homes, 3.23 percent is used to pay for labor, while 1.08 percent each is used as seed and livestock feed. Most of the small potato tubers are used for seed and home consumption; over 93 percent of medium and large sized potatoes is sold; cut and bruised potatoes are to a large extent consumed at home or thrown away; while the greening and off-type variety potatoes also consumed at home to a large extent.

Source of potato damage and their transportation

Various sources of ware potato damage were reported to encompass: crop diseases (45.95 percent), insect damage (13.51 percent), floods (10.81 percent), dry conditions or rain shortage (6.31 percent), animal damage (4.5 percent), and none of these (18.92 percent).

We find that 68.97 percent of farmers transport their produce to various destination market places. Farmers transport potatoes mainly on their heads and using donkeys. They transport potato from gardens to their homes, from gardens to roadside markets, and from villages to district towns. Traders mostly transport ware potatoes using pick-ups and trucks (57.89 percent); by carrying on the head or at the back (29.82 percent), and; donkeys and ox-carts (8.77 percent). On the other hand, processors prefer using motorcycles (51.61 percent), hand carts (16.13 percent), pick-ups and trucks (12.9 percent), humans and donkeys (each at 6.45 percent).

11.4 Participation in storage and the current level of postharvest Losses

Not many farmers have adopted improved storage facilities for ware potatoes in the study area. Responses from the FGDs reveal that farmers and other value chain actors in Eastern Uganda store ware potato mainly using: the floor of houses (especially mud houses), cribs made from local materials, on wooden purlins, in the corners of houses, deep in the soil, stacked in sacks covered with tarpaulins, and under the shades of trees. With these types of storage techniques, value chain actors are able to keep potatoes in good quality for a period of about 2-4 weeks depending on the variety.

According to responses from traders and processors, the less susceptible potato varieties to postharvest degradation include: Kabale, Wanale, Kisoro, and Kenya (see results in Table D3, Annex D). Distinctively, results in Table D4, Annex D shows that the varieties of Sebei, Mbale, and Singo are the more susceptible to postharvest degradation.

The level of participation in ware potato storage is highest among consumers (78.83 percent), followed by farmers at 56.03 percent, processors at 41.18 percent, and is lowest among traders at 37.5 percent (see results in Table 31). All the value chain actors use storage techniques that are rudimental and inefficient. For instance, results in Table 31 further reveals that farmers mostly keep potato tubers covered in a mud floor house (23.73 percent), followed by keeping potatoes in a dark area or corner in the house (22.03 percent), dark store (20.34 percent), and heaping potato on a mud floor (16.95 percent), among others.

Traders mostly store potatoes using dark stores (20 percent), stores that allow light to pass through (12 percent), and covering tubers on the mud floor (12 percent). About 21.43 percent of processors prefer to store potatoes by heaping them on a concrete floor. Most consumers (72.88 percent) keep potatoes uncovered on concrete floor, on mud floor (8.47 percent), and in dark corners of the house (6.78 percent),

among others. We did not find any evidence in the data that ware potato VC actors actually use modern ambient stores in the study area.

Table 31: Participation in storage and modes of storage that currently exist in the study area

Particulars	Farmers		Traders		Processors		Consumers	
	Freq.	%age	Freq.	%age	Freq.	%age	Freq.	%age
Do you store potatoes after harvesting (0 = No; 1 = Yes)								
No	51	43.97	45	62.5	20	58.82	18	21.18
Yes	65	56.03	27	37.5	14	41.18	67	78.82
Total	**116**	**100**	**72**	**100**	**34**	**100**	**85**	**100**
If store potatoes, where do you do it from?								
Dark store	12	20.34	5	20	1	7.14		
Store allowing light	5	8.47	3	12				
Dark area/corner in the house	13	22.03					4	6.78
Kept uncovered in a concrete floor house	1	1.69			2	14.29		
Kept covered in a concrete floor house			1	4	2	14.29		
Kept covered in a mud floor house	14	23.73	3	12				
Kept uncovered in a mud floor house	2	3.39	1	4				
Kept in maize store good enough to limit germination							1	1.69
Heaped in concrete floored store			1	4	3	21.43	2	3.39
Heaped in a wooden floored store	1	1.69	2	8				
Heaped in mud floored store	10	16.95	2	8	1	7.14		
Gunny bags placed in open	1	1.69	1	4	2	14.29		
Leave in bag, tie the top and keep in dark room/corner							2	3.39
Kept in a bag on mud floor with ash							5	8.47
Uncovered on the concrete floor					2	14.29	43	72.88
Uncovered in the field			2	8				
Kept on vehicle			2	8				
Heaped on wooden strips outside			2	8				
Placed in improved store with a wire mesh					1	7.14		
Crisps are kept sealed and stored in a cool dry place							1	1.69
Peeled and kept in the refrigerator							1	1.69
Total	**59**	**100**	**25**	**100**	**14**	**100**	**59**	**100**

Actors along the value chains engage in potato storage in order to achieve various objectives, which include among others: setting aside potatoes for seed, waiting for a good market price, ensuring constant availability of potatoes to consumers, keeping unsold potato in a good condition, and to keep enough

potatoes for home consumption. Additional details on why actors engage in potato storage are summarized in Table D5, Annex D.

Results in Table D6 indicate that value chain actors, who do not store ware potatoes, attribute this to: lack of improved storage facilities, fear of shrinkage and loss of tuber weight, fear of loss due to rot and germination, and their ability to buy enough potatoes on demand, implying less need for storage.

Farmers were asked to report their level of access to training on potato production and management. Their responses indicate that: a substantial proportion (57.76 percent) has indeed received training on thematic areas of production and management of potatoes; 50 percent of farmers received training on potato storage, while only 41.38 percent receiving training on potato marketing, business investment, and management.

The willingness to pay to store a 100 kg bag of ware potato for up to 4 months after harvest in the modern ambient store is estimated at UGX 3,641 among farmers, UGX 575 among traders and UGX 824 among processors (see results in Table E2, Annex E). The low willingness to pay may indicate limited perception of the benefits that can be accrued by storing potatoes for a few additional weeks. There is need therefore to increase the level of capacity building through promotion of stores and training, especially on aspects of postharvest handling, marketing and investment along the ware potato value chains.

11.5 Use of various indigenous methods to mitigate postharvest potato losses

Over 50 percent of traders and consumers and about 38 percent of processors agree that actors along ware potato value chains practice different indigenous methods to mitigate postharvest losses. Note that in Table D7, Annex D, key local technologies practiced by traders, processors and consumers range from: spreading the tubers on the floor in the house; putting potatoes on pallets (not the ground); covering potatoes with tarpaulins; purchasing potatoes according to demand (just enough at the time); scattering potatoes on the dry clean ground uncovered; proper sorting during purchases; putting potatoes in a granary; regular sorting out spoilt and rot potatoes; using improved storage facility made of a wire mesh; taking note of the days potatoes have spent in storage, and; putting potatoes in box.

Noteworthy it is the prevailing low level of market exchange of stored potato in the study area. As presented in Table D8, Annex D, a very small proportion (14.66 percent) of farmers has attempted to sale potato stored for a relatively long period of time. Substantial proportion (48.23 percent) of farmers agrees that buyers along the supply chain can easily detect potatoes stored for a long time. Respondents indicated that stored potato tend to shrink in size which gives the tubers an appearance of softness (26.92 percent); does not have a fresh appearance (11.54 percent), and; weigh less compared to fresh tubers (11.54 percent) among others. Stored potatoes therefore face stiff competition from fresh potato. However, it must be noticed that during periods of scarcity large amount of stored potatoes are imported from Kenya.

The longer the tubers are stored, the more they lose freshness, weight, moisture, and color. Use of better and modern storage techniques may help prevent the negative attributes of storing potato. About 57.76 percent of ware potato farmers face significant challenges of adopting postharvest storage facilities. Ware potato farmers need support in order to adopt these innovative technologies.

Challenges faced and required support to adopt postharvest storage facilities

Results in Table D9, Annex D, presents some of the key challenges faced by farmers in adopting postharvest storage facilities. They include lack of access to stores in the area (23.53 percent); use of poor and uncertified seed potato (17.65 percent); the tendency of potato tubers to rot easily, especially when harvested in rainy conditions (10.29 percent); high costs of constructing, using, and maintaining stores (10.29 percent); limited knowledge about PHL management and storage (10.29 percent); limited skills in store construction (8.82 percent), and; the desire to get quick cash which limits the use of storage (7.35 percent).

Farmers would like to receive varying support in order to adopt modern postharvest storage facilities (Table D9). These range from interventions that: promote the construction and use of low cost modern stores (36.76 percent); improve and provide better quality seed potato (17.65 percent); construct communal stores for organized groups (14.71 percent); train farmers on how to construct and use stores (10.29 percent); improve training on pest control techniques (7.35 percent); provide farmers with subsidies on materials for store construction (4.41 percent), and; promote access to affordable loans at low interest rates (4.41 percent).

11.6 Level of postharvest losses in the study area

Value chain actors were asked to reveal whether they experience any loss or damage during ware potato storage. Results in Table 32 indicates that value chain actors face storage PHLs, which are very common among farmers (78.46 percent of respondents), followed by potato consumers at 69.41 percent, traders at 44.44 percent, and is least at 35.29 percent for ware potato processors.

Table 32: Proportion of value chain actors experiencing postharvest losses and causes of PHL

	Farmers		Traders		Processors		Consumers	
Particulars	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Do you experience any losses/ damages during storage? (0 = No; 1 = Yes)								
No	14	21.54	40	55.56	22	64.71	26	30.59
yes	51	78.46	32	44.44	12	35.29	59	69.41
For those experiencing losses, what are the first main causes								
Rotting	49	98	31	96.88	9	75		
Pests and diseases	1	2	1	3.13	3	25		
Total	**50**	**100**	**32**	**100**	**12**	**100**		
For those experiencing losses, what are the second main causes								
Pests and diseases	18	81.82	10	62.5				
Greening /germination of tubers	1	4.55	2	12.5				
Stores are small	2	9.09						
Loss of weight due to withering	1	4.55						
Harvesting immature tubers			1	6.25				
Moisture reduction			3	18.75				
Total	**22**	**100**	**16**	**100**				

Out of the total PHLs suffered by value chain actors, losses during storage appear to be highest (17.48 percent) among farmers, followed by 15.79 percent for processors, and is least at 12.9 percent for traders (see Table 33). Potato damage is highest on the farm, during potato processing, at the level of household consumption, during transport and handling, and under the wholesale market conditions in that order.

Table 33: Potato damage experienced at various stages of production and marketing

Particulars	Farmers		Traders		Processors		Consumers	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Different damage at various stages								
On the farm	22	21.36	4	6.45				
Household consumption	21	20.39	7	11.29			77	98.72
In storage	18	17.48	8	12.9	3	15.79		
During processing	17	16.5	15	24.19	15	78.95		
During transport and handling	7	6.80	5	8.06				
Other stages	6	5.83	5	8.06				
At the delivery point	5	4.85	3	4.84	1	5.26	1	1.28
At the collection/bulking point	4	3.88	5	8.06				
Wholesale market conditions	3	2.91	10	16.13				
Total	**103**	**100**	**62**	**100**	**19**	**100**	**78**	**100**

The above finding contradicts observations of participants of the FGDs, who agreed that the highest PHLs normally occurs during storage, followed by harvesting stage, and is least during sales and marketing stage. The use of inappropriate harvesting tools such as hoes can inflict cuts and bruises on potato tubers (up to 2 bags of spoilt potatoes out of every 40 bags). During the marketing stage, potato losses are mainly the result of unavoidable delays, use of poor transport facilities, and careless loading and offloading practices.

Utilization of the deteriorated (partially spoiled) ware potato products

Consumers were asked to reveal whether they have ever bought partially spoiled or damaged potatoes just because they are less expensive. Results show that 72.94 percent of consumers have never bought partially spoiled or damaged potatoes, a proportion that is much higher than 15.29 percent who buy the product sometimes and 11.76 percent who rarely buy the product. Furthermore, results reveal that its only 27.78 percent of traders and 8.82 percent of processors who engage in the buying of potatoes that have already incurred some quality deterioration at discounted price. Over 72 percent of consumers, traders, and processors do not buy partially spoiled or damaged potatoes in the study area.

Most value chain actors attribute the high PHL faced along the value chain to inadequate use of PHM technologies and practices. The extent to which agribusinesses face ware potato postharvest loss as a result of inadequate use of postharvest technologies or practices was: (i) highly ranked as "*very much*" by 30.56 percent of traders and 31.03 percent of processors; (ii) ranked "*much*" by 29.17 percent of traders and 20.69 percent of consumers; (iii) ranked "*somehow*" by 36.11 percent of traders and 27.59 percent of processors, and; (iv) ranked "*not at all*" by 4.17 percent of traders and 20.69 percent of processors.

There is therefore strong correlation between PHLs experienced by potato value chain actors and the perception about the use of inadequate postharvest technologies or practices. It is not surprising that about 90 percent of traders and 76.47 percent of processors show optimism that using improved storage facilities to keep excess potatoes for some time in every season would ensure sufficient consumer value and guarantee increased level of profitability.

All value chain actors utilize the totally deteriorated and partially spoiled ware potato products in various ways, namely: throwing them away as waste, using them for home consumption, using them for sale, using them for seed, and giving them to laborers as in-kind payment in that order as indicated in Table 34.

Table 34: Utilization of totally deteriorated and partially spoiled ware potato products

	Farmers		**Traders**		**Processors**		**Consumers**	
Particulars	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Utilization of the totally deteriorated and partially spoiled ware potato products								
Throw away as waste	79	70.54	31	44.93	18	62.07	30	38.46
Home consumption	26	23.21	15	21.74	10	34.48	38	48.72
Used as seed (e.g. after greening)	3	2.68	7	10.14			8	10.26
Processed into compost manure	2	1.79						
Giving to laborers as wages	1	0.89	4	5.8				
Livestock feed	1	0.89	1	1.45			1	1.28
Used for sale			11	15.94	1	3.45	1	1.28
Total	**112**	**100**	**69**	**100**	**29**	**100**	**78**	**100**

Consumption of potatoes that have been stored in good conditions for 1-4 months

The question of whether consumers would purchase and consume potatoes stored in good conditions for 1-4 months was analyzed using data collected from consumers. Contrary to popular views, results of this analysis reveal a significant proportion (89.41 percent) of consumers willing to buy and consume potatoes stored in good conditions for a period between 1-4 months. Over 94 percent of consumers regard potato stored for 1-4 months as either very good (35.71 percent) or good (58.33 percent), which implies that stored potato is liked.

a) ***On-farm level***

Farmers face various types of PHLs on ware potato tubers, and these include: bruises, rotting, cuts, greening, sprouting, thefts, and softening of tubers when stored or kept for a long time.

Cause and mitigation measures

Participants in the FGDs raised a number of major causes of PHLs experienced by value chain actors, especially at farm level. These causes range from: (i) harvesting pre-mature and over grown potato tubers, as a result of limited food in the household, lack of money, and limited access to hired labor; (ii) poor harvesting skills including harvesting when it is raining and the use of inappropriate harvesting tools; (iii) use of poor quality packaging materials in form of old bags and those that allow heat to build up; (iv)

exposure to diseases and infections, including late blight and bacterial wilt which cause rotting of potato tubers; (v) poor handling skills of laborers during packaging, loading, transit, and offloading of potatoes; (vi) stepping on stacked bags which bruises potatoes and the practice of over-filling potato bags which creates a heavy load conducive to damage when handled carelessly; (vii) the use of inferior processing technologies together with the lack of cold storage and limited use of natural preservatives, and; (viii) the incidences of thefts and related losses at various stages of the supply chain, including in gardens, during transit, in storage, and during marketing.

It is also evident from results in Table 35 that the main causes of potato damage include: potato wilt disease and exposure to heat (43.56 percent); poor harvesting techniques that lead to cuttings and bruises (30.69 percent), the effect of harsh weather, including harvesting the tubers amidst too much rainwater (7.92 percent), the effect of pests (4.95 percent), and poor storage facility (4.95 percent).

Table 35: Main reasons or causes of potato damage incurred by farmers in the study area

Particulars	Farmers	
	Freq.	Percent
Main reasons or causes of potato damage in the study area		
Potato wilt disease and exposure to heat	44	43.56
Poor harvesting techniques/cutting/bruises	31	30.69
Weather effect (harvesting amidst too much rainwater)	8	7.92
Pests	5	4.95
Poor storage facility	5	4.95
Poor inputs i.e. seeds and fertilizers	3	2.97
Bruising during transportation	2	1.98
Weight loss during transportation/storage	1	0.99
Poor farm management/failure to spray	1	0.99
Too much heat in the sack	1	0.99
Total	**101**	**100**

A larger proportion (83.62 percent) of potato farmers claim that the tools they use to harvest potatoes play a significant role in inflicting some potato damage. Harvesting tools in the study area range from: hoes (84.48 percent), ox plough (11.21 percent), sticks (2.59 percent), hands (0.86 percent), and forks (0.86 percent).

The issue of strong correlation between labor types used to harvest and the amount of damage inflicted on tubers was also raised by 83.62 percent of potato producers. It is evident that 92.93 percent of potato producers agree that the use of casual labor is associated with the highest damage on tubers, followed by labor from relatives and friends at 4.04 percent, family labor at 2.02 percent, and is least (1.01 percent) for the use of oxen and donkey plough.

Mitigation measures

According to the responses of the FGDs, postharvest losses can be reduced if value chain actors are sensitized to appreciate the need to: (i) train laborers and paying them a small incentive to handle the potato carefully to minimize bruises and cuts; (ii) supervise laborers and equip them with better

harvesting skills to reduce damage during harvesting, loading and offloading, and; (iv) adopt appropriate packaging such strong gunny bags and handling cans to keep potato tubers cut free during transportation.

About 70.69 percent of farm households attempts to prepare potatoes before harvesting in order to minimize PHLs. The highest proportion (66.27 percent) of farmers leaves the shoot to dry, whereas it is only 39.76 percent that practices dehaulming. Most farmers (61.61 percent) make an effort to protect potato tubers from direct sunshine after harvesting. There are other ways farmers use to protect harvested potato, including: putting them in the shade (44.44 percent); packing potato in bags (31.94 percent), moving tubers into storage immediately after harvesting (15.28 percent), and covering potato tubers with leaves (8.33 percent). Interestingly, only 55.17 percent of farmers actually remember to conduct a second round of harvesting on the same garden with the aim of collecting potatoes initially left behind in the ground.

Farm households also minimize postharvest losses by engaging in the following key practices: gentle and soft handling of the potato sacks including driving truck loads carefully (indicated as the main practice by 21.74 percent of respondents); packing potatoes well in strong gunny bags (14.13 percent); gentle loading and proper unloading of potato tubers on tracks (7.61 percent); use good quality sacks for packaging (7.61 percent); carrying potatoes on heads instead on donkeys (7.61 percent); covering potatoes with tarpaulins from rain water (5.43 percent); sorting out the spoilt tubers (5.43 percent); handling donkeys carefully with relevant support techniques (5.43 percent), and; being diligent in supervising all operations at 4.35 percent (Table D10, Annex D).

Extent of physical losses

Traders transact the largest quantities of potatoes, while farmers handle the least quantity of marketable potato production in a year. Results in Table 36 show that the proportion of tubers that are too damaged to be consumed and therefore thrown away (physical losses) in last 2 years is estimated at: 9 percent among farmers and consumers, it is highest (31 percent) among processors, and intermediate at 11 percent among traders (wholesalers and retailers).

The level of postharvest losses from various disaggregated stages of production (farm level) and marketing (right from purchase to destination points) was computed based on quantity and percentage measures. Results indicate that farmers experience a total of 15.69 kg of damaged potatoes out of the 100kg bag of potatoes produced (Table D12, Annex D).

In addition, results in Table D12 show that the proportion of totally damaged potatoes for the farmers is highest (8.05 percent) on the farm, followed by 5.96 percent during household consumption, 5.52 percent during storage, 3.06 percent during transport, 2.65 percent at bulking point, 1.89 percent during wholesale market conditions, 0.77 percent at the delivery, and is least (0.04 percent) during processing stage.

Table 36: Storage and quantity and proportion of postharvest losses incurred

Variable	Farmers		Traders		Processors		Consumers	
	n	Mean	n	Mean	n	Mean	n	Mean
Number of days VC actor store potato	65	28.62 (23.57)	27	6.22 (7.37)	14	4.46 (3.25)	67	2.32 (2.26)
Quantity (kg) of traded potatoes in Season 1 2015 that was stored	65	1992.31 (3880.93)	72	30359.26 (70740.73)	34	5606.25 (9478.64)		
Quantity (kg) of traded potatoes in Season 2 2014 that was stored	65	1980.00 (3817.77)	72	13418.52 (21519.37)	34	8548.33 (9613.53)		
Proportion of physical losses (potatoes too damaged) and thrown away_ in last 2 years)	51	0.09 (0.06)	72	0.11 (0.25)	34	0.31 (0.38)		
Proportion economic losses (partially damaged, sold at discounted rate in last 2 years	51	0.06 (0.07)	72	0.09 (0.12)	34	0.08 (0.18)		
Quantity of the potatoes per bag in kg							85	69.50 (35.17)
Quantity (kg) of potatoes lost due to deterioration per bag							85	6.61 (6.48)
Physical losses (kg) per bag of potatoes too damaged and thrown away_ in last 2 years							85	9.42 (6.17)
Physical losses per bag of potatoes too damaged & thrown away_ in the last 2 years							85	0.09 (0.06)

Notes: (i) Standard deviations are parentheses

The length of storing potato under business as usual situations (without deliberated effort to greatly extend shelf-life) varies across the value chain. For example, farmers store potatoes for an average period of 28.62 days compared to 6.22 days of traders, 4.46 days of processors, and 2.32 days of consumers (Table 36). Nonetheless, when value chain actors utilize some of the available conventional storage practices to their best capacity, we notice that consumers are able to keep potatoes in good conditions before deteriorating for 30 days (Table D11), followed by 24.38 days among processors, and 17.95 days among traders. This finding reveals that it is possible to increase shelf life of potato tubers to more than two months when right potato variety and modern storage facilities are utilized.

Noteworthy is that results in Table D11, Annex D indicate that the proportion of damaged potatoes as result of cuts on tubers is 27% for traders and 30% for processors; the proportion of bruised tubers is 22% for traders and 20% for processors; greening potatoes constitute 7.03% for traders and 6.63% for processors; loss due to rotten tubers is estimated 30.92% for traders and 29.93% for processors, while; other types of deterioration is approximately 4%. The largest proportion of potato damage faced by traders and processors is therefore in form of rotten tubers, followed by cuts on tubers, bruised tubers, greening tubers, and lastly other types of damage on tubers. The shelf life of freshly harvested potatoes when kept under business as usual conditions of no attempt to store is on average 2.02 weeks in the case of traders, and 1.85 weeks with regards to processors. Potato shelf life increases 5.8 weeks and to 4.58 weeks for traders and processors respectively, when kept under one or a combination of existing conventional storage practices.

Extent of economic losses

The proportion of economic losses representing the quantity of poor quality potatoes re-sold at discounted price in last 2 years is presented in Table 36. Note that this proportion of economic ware potato loss is 6 percent at farm level; 9 percent for traders, and; 8 percent for processors.

Results in Table D13, Annex D further indicate that the quantity (kg) of partially damaged potatoes or economic losses during all stages of transaction right from farm level to selling point amounts to 17.46 kg out of every 100 kg bag of ware potato. The extent of economic loss is highest (9.76 percent) at farm level compared to each of other stages of transactions, namely: the stage of bulking (3.98 percent), during transport (4.19 percent), at the delivery point (0.87 percent), during storage (2.87 percent), wholesale market conditions (1.88 percent), household consumption (4.39 percent), and during processing (0.04 percent).

b) Trading, transport, and handling level

Ware potato loss or damage at the stage of trading, transport and handling generally constitute between 7-16 percent of the total loss experienced by various actors.

Cause and mitigation measures

Major causes of ware potato losses (both physical and economic) across traders, processors, and consumers are presented in Table 37. It is clear that key causes of PHLs at trading level in order of importance ranges from: mishandling potato tubers when loading and unloading (21.54 percent); transacting in potato harvested in the rain (20 percent); poor market conditions characterized by damage due to direct sunshine or rain (16.92 percent); poor handling (dragging and dropping) of the potato tubers (12.31 percent), and; the tendency to store potato for a very long time (especially by wholesalers) before selling (10.77 percent). Other key causes of potato damage range from: use of poor means of transportation, use of poor packaging material (nylon) for tubers, short shelf life of potato variety, use of poor harvesting tools, use of poor storage methods, and delays during transportation.

Table 37: Major causes of ware potato postharvest losses (physical and economic) across actors

	Traders		**Processors**		**Consumers**	
Particulars	Freq	Percent	Freq	Percent	Freq	Percent
What is the major cause of ware potato postharvest losses?						
Mishandling when loading and unloading	14	21.54	6	24		
Harvesting in the rain/ rotting due to contact with water	13	20	5	20	10	12.66
Poor market conditions(sun/rain)	11	16.92	1	4		
Reckless handling (dragging and dropping)	8	12.31	3	12	6	7.59
Stored too long by wholesaler before selling	7	10.77	2	8		
Storing potatoes too long before selling	5	7.69	1	4	3	3.8
Bruised by the means of transport; bicycles	4	6.15	2	8		
Use poor (nylon) packaging materials	2	3.08			1	1.27
Harvesting pre mature tubers	1	1.54			3	3.8

Particulars	Traders		Processors		Consumers	
	Freq	Percent	Freq	Percent	Freq	Percent
Use poor harvesting tools such as forks/hoes for harvesting			1	4	16	20.25
Variety weakness			4	16		
Cuts and bruises cause rotting					5	6.33
Pest and disease infections					5	6.33
Exposure to a lot of sunshine in the market					1	1.27
Poor storage methods					14	17.72
Greening					2	2.53
Mixing good tubers with rotten ones					2	2.53
Delays during transportation					1	1.27
Poor/no sorting and grading					3	3.8
Rotting					4	5.06
Lack of enough fertilizers					1	1.27
Poor roads					2	2.53
Total	**65**	**100**	**25**	**100**	**79**	**100**

Rotting of potato tubers (96.88 percent) and effect of pests and diseases (3.13 percent) are reported as the main causes of damage to tubers among traders (Table 32). Other secondary causes of potato loss include greening of tubers, moisture reduction, and harvesting immature tubers.

Extent of physical losses

The proportion of physical losses in last 2 years is 11 percent among traders, wholesalers and retailers combined (Table 36). This proportion is the second highest among all value chain actors after that of processors. Results in Table D12, Annex D also show different components of physical losses at every key stage of transaction between potato purchase and sale.

Extent of economic losses

The proportion of traded potatoes affected by economic losses (price discounts) for traders is estimated at 9 percent and is one of the highest among different value chain actors (Table 36). Detailed analysis of economic losses is summarized in Table D13, Annex D, and reveals that total economic losses faced by traders (wholesalers and retailers) on average amounts to 12.13 kg out of every 100 kg bag of traded potato. This economic loss translates to 11.74 percent between the point of purchase and final sale destination. It is therefore sufficed to say that economic losses faced by traders are between 9 and 11.7 percent.

c) Processing level

Potato tubers are mainly processed into few forms of products, including boiled potato, chips, and crisps. These products are prone to deterioration when kept for long. Some of the major challenges faced by ware potato processors include: (i) high input costs e.g. oil, rent, and utilities (15.63 percent), (ii) damaged

potatoes with cuts and bruises inflicted during harvesting and transportation (9.38 percent), (iii) long time to process good quality potato products (9.38 percent), (iv) inadequate capital (6.25 percent), (v) high prices for potatoes especially during scarcity seasons (6.25 percent), (vi) unstable market prices for inputs (6.25 percent), (vii) limited market for processed potato products (6.25 percent), (viii) too much heat while processing affects quality (6.25 percent), and (ix) fire accidents while processing (6.25 percent) among others.

Cause and mitigation measures

Results in Table 30 show that rotting of tubers (75 percent) and to a less extent effects of pests and diseases (25 percent) are the main causes of damage to tubers among processors.

Extent of physical losses

The proportion of physical losses in the last 2 years at the processing level is highest at 31 percent among processors, compared to 11 percent at the trading level and 9 percent at both farm and consumption levels (Table 36).

Results in Table D12, Annex D, shows that potato processors incur a total physical loss of 4.35 kg out of every 100 kg bag between the initial purchase point and selling point, which translates to 4.18 percent. Potato physical loss are further observed to be highest (1.97 percent) at the stage of processing, followed by 1.01 percent on farms, 0.86 percent at the delivery, 0.80 percent during storage, 0.64 percent under transportation, and 0.35 percent during wholesale market conditions.

The difference between loss estimate in Table 36 and that in D12, Annex D can be attributed to challenges faced by respondents in recalling the right amount potato loss. Whilst the result of 31 percent (Table 36) was derived from responses of a single question to respondents, 4.8 percent (Table D12) was derived from computing responses to disaggregated questions about potato loss.

Extent of economic losses

Results in Table 36 further reveal that the estimate for the proportion of economic losses in last 2 years at processing level is 8 percent for processors. Economic loss faced by ware potato processors right from the point of purchase to the point of sale is on average about 6.54 kg out of every 100 kg bag, which translates to 5.93 percent (Table D13, Annex D).

This amount of economic loss is highest at 2.40 percent during processing, 2.07 percent on the farm, 1.85 percent at the delivery, 0.91 percent during transportation and related handling, 0.61 percent during storage, 0.33 percent at the bulking point, and lastly 0.17 percent during household consumption.

d) Household consumption level

Consumers mainly purchase various potato products that range from boiled potato (39.29 percent), fresh potato (33.33 percent), chips (17.86 percent), mashed potato (8.33 percent), and crisps (1.19 percent). The key reasons for consumer preference of these potato products include: good taste (21.69 percent), easy to cook (21.69 percent), convenience of the product as source of food (21.69 percent), the fact that the potato product can be mixed with other foods like maize in the same cooking pot or serving plate (8.43 percent), the possibility of using little or no cooking oil (7.23 percent), good for healthy (6.02

percent), good quality (4.82 percent), availability only in fresh form (3.61percent), highly preferred by clients (3.61 percent), cheap or affordable (1.2 percent).

Cause and mitigation measures

A substantial proportion (51.76 percent) of consumers uses different indigenous methods and practices to mitigate postharvest losses (Table D7). These include: spreading potatoes on the floor in the house (29.55 percent); sorting out spoilt potatoes regularly (25 percent); putting potato tubers in boxes (15.91 percent); storing potatoes in the dark mud rooms (6.82 percent); scattering tubers on the clean dry ground uncovered (6.82percent); spreading ash on the floor to absorb water(4.55 percent); spreading them in an aerated room (4.55 percent); putting potatoes in a granary (2.27 percent); covering potatoes in grass (2.27 percent), and; covering potato tubers with dry banana leaves (2.27 percent).

Extent of physical losses

The proportion of physical losses in the last 2 years at the level of consumption is 9 percent (Table 33). Conversely responses from a much disaggregated questions about different types of physical losses faced reveals that consumers experience a physical loss of 5.43 kg out of every 100 kg bag of potato from the point of purchase to the point of consumption (Table D12, Annex D).Consumers therefore face a physical loss of between 5.43 – 9 percent.

e) Key recommendations for postharvest losses reduction

Suggested recommendations on how to improve the handling practices of ware potato and reduce PHLs from farm to market are summarized in Table E3, Annex E, and they include: (i) promoting the proper handling and careful loading and off-loading of potatoes; (ii) improving storage facilities and access to better storage facilities that can keep potatoes at lower temperature; (iii) encouraging actors to pack potato tubers well in sacks and not to throw them on trucks; (iv) potatoes should be transported by vehicles and without delay directly to their selling point; (v) harvesting potatoes carefully to reduce cuts and bruises (e.g. using hands or improved harvesting techniques); (vi) improving road infrastructure in order to easily access market.

Other recommendations on how to reduce PHLs also range from (vii) harvesting only mature potatoes; (vii) training farmers and all other value chain actors in proper potato handling skills; (viii) promoting the use of proper agronomic practices and management of potatoes at the farm such as spraying against pests; (ix) promoting use of better harvesting tools, including hands to reduce on cuts on tubers; (x) covering potatoes to avoid rain water wetting the tubers and protecting them from direct sunshine; (xi) packing and transporting potatoes to delivery points during the night when temperatures are low; (xii) grading and sorting potatoes tubers before packing; (xiii) improving pre-harvest management practice; (xiv) availing farmers and all value chain actors with affordable capital capital/credit, and; (xv) promoting the use of improved seed potatoes.

11.7 Supply good quality ware potato along the value chain in Eastern Uganda

Ware potato value chain actors were asked to indicate the extent to which existing supply chains in Eastern Uganda are delivering good quality ware potatoes. Their responses show that 81.03 percent, 88.89 percent, and 85.29 percent of ware potato farmers, traders, and processors respectively agree that ware potato in the supply chains is of good quality. According to Table E2, Annex E, the estimated

proportion of good quality potatoes during peak season is 77.94 among traders and 85.96 percent across processors. This proportion changes during off-peak season to 71.68 percent among traders and 87.35 percent among processors.

Improvement in ware potato quality is attributed to such key factors as: use of high yielding varieties, increasing demand of good quality potatoes in the wider market, use of varieties that mature quickly, potato varieties that are resistant to diseases and bad weather, varieties with relatively longer shelf-life characterized by less incidence of rotting, potatoes that are easily marketable due to good attributes, and increasing demand for potatoes that are good for cooking and production of chips.

Key practices undertaken by value chain actors to ensure the supply of good quality potatoes in the study area are summarized in Table E1, Annex E. Farmers mainly engage in: good management practices and use of fertilizers (22.12 percent); proper seed selection from right sources (15.04 percent); grading and sorting of potato tubers before sale (12.39 percent); better planting methods and related agronomic practices (11.5 percent); harvesting only mature potatoes (9.73 percent); effective supervision during the production process (4.42 percent), and careful harvesting of potato tubers to reduce cuts and other damages (4.42 percent).

In the case of traders, they attempt to ensure the supply of good quality potatoes by: grading and sorting potato tubers before packing (44.23 percent), buying mature potato tubers (25 percent), and transacting with reliable farmers (7.69 percent) among others. Similarly, processors grade and sort potatoes before packing (28.13 percent), process only mature potatoes (28.13 percent), repeated purchases from trusted traders (15.63 percent) among other strategies.

The good quality potatoes in the supply chain is therefore attributed to enhanced handling of mature potato tubers that are selected through right grading and sorting and in turn transacted between actors who trust each other out of repeated transactions.

Likely change in future demand of ware potato in the study area

There is great enthusiasm and prospects about the increasing future demand of ware potato in Eastern Uganda. Close to 93 percent of ware potato traders and 76.47 percent of processors agree that change in future demand of potatoes is more likely to be positive and very high in magnitude. The increasing future demand is attributed to the increasing population in the country, low potato supply at the moment, the opening of new regional markets, and the consumer preference for potato products in urban areas.

The question is whether value chain actors have the capacity or are prepared enough to effectively respond to the increasing demand of ware potato at the moment and in the future. The study analysis indicates that the majority (68.06 percent) of ware potato traders and 76.47 percent processors are convinced that they have what it takes to meet the market demand of good quality potatoes.

The capacity of traders to respond to the current ware potato market demand is mainly undermined by the lack of storage facilities for ware potato. Conversely, the increasing potato supply from farmers who receive support from traders as well as from Western Kenya, the large number of traders entering potato marketing, and improved level of awareness of the challenges and causes of unstable market price are considered the main factors enhancing the capacity of ware potato traders. In the same line, processors are more aware of the challenges of unstable prices, able to easily access capital through various sources

of credit, and beginning to get potato supplies from farmers who are pioneers of growing potatoes during the dry season.

11.8 Market constraints, opportunities, and enabling environment in Eastern Uganda

There is need to address critical gaps in areas of production, transport, postharvest handling, processing and marketing of agricultural products, including ware potato, so as to maximize the benefits from the agriculture value chains (Government of Uganda, 2015). Understanding and addressing the underlying key constraints and opportunities faced by value chain actors is very important, helps to enhance the enabling environment, and further increase the agricultural sector's contribution to wealth and job creation in the country. Noteworthy is that changes in technology, demographics, markets, government policies, and other factors in a community can create seemingly unrelated events and trends with in a community, which can be connected to realize a market opportunity.

A market opportunity is a newly identified need, want, or demand trend that can be exploited by value chain actors to fulfill the need. According to Picken (2007), there are three characteristics of a viable market opportunity, namely: (i) potential value (the capacity to generate profit), (ii) novelty (something that did not exist previously), and; (iii) the perceived desirability, moral, and legal acceptability in society. Aaker and Jacobsen (2001) defines a market opportunity as a trend or event that could lead to significant upward change in sales and profit if the actors take appropriate and strategic responses.

Major potato postharvest related problems in the study area

Some of the key postharvest problems faced by value chain actors are summarized in Table F1, Annex F. Famers face the problem of: (i) lack of stores or limited space in storage (25.81 percent); (ii) loss of weight due to use of poor storage facilities that allow moisture loss (20.43 percent), (iii) high economic and physical loss due to the rotting of tubers (16.13 percent), (vi) potato bruising due to too much rain water and exposure to bad weather conditions (8.6 percent), and (iv) theft of tubers by hired laborers (5.38 percent).

Traders face key problems of: (i) high economic and physical loss due to rotting of tubers (39.62 percent); (ii) the lack of access to improved storage facility for potatoes (18.87 percent), (iii) wastages (cuts, bruises, rotting) due improper harvesting (9.43 percent), (iv) greening of tubers when exposed to sunlight (7.55 percent), and; (v) bad weather conditions (7.55 percent).

Ware potato processors also face the problems of: (i) diseases and pests that affect potato tubers leading to poor quality (20 percent), (ii) the lack of access to improved storage facility for potatoes (20 percent), (iii) potato bruising due to too much rain water and bad weather (15 percent), (iv) damages due to poor transportation and poor handling (15 percent), (v) wastages (cuts, bruises, rotting) due improper harvesting (15 percent), and (vi) packing damaged tubers together with good ones (15 percent).

Major potato market related problems in the study area

Major potato market related problems faced by farmers, traders, and processors are presented in Table F2, Annex F. The key market related problems range from: low prices during peak season which lead to losses; price fluctuations due to perishability and seasonality of potato supply; limited market during seasons of plenty or peak supply; distant markets which causes delays in deliveries; dishonest traders and price exploitation by middlemen, and; too much market supply (over supply) during peak season.

Others market related problems range from: high prices for fresh potatoes; poor quality potatoes in terms of size (small); excess in potato supply and wastages during the peak season; bad debtors and low purchasing power of clients; slow sales that lead to damages and spoilage; displacement of traders by city authority, and; theft and unreliable workers.

Major potato transport related problem in the study area

Detailed information on transport related problems faced by farmers, traders, and processors is presented in Table F3, Annex F. Major transport problems faced are: (i) high transport cost due to bad terrain, (ii) bad roads and poor road network, (iii) poor road infrastructure that deteriorates during rainy season making transport difficult, (iv) inaccessibility and long distance between gardens and each of the homesteads and main roads, (v) lack of reliable transport means especially during peak season, (vi) bruises on potato tubers as a result of poor handling of potatoes, and (vii) delayed supply.

Other general constraints faced by value chain actors along the ware potato value chains include: limited participation of women in such nodes as brokerage and wholesaling; limited value addition opportunities and product forms; the tendency for ware potato producers to sale only when a reliable trader or transporter is available; the lack of standards, premiums, and expertise in grades and standards; highly seasonal supply of ware potato; ware potato tubers' perishability and short shelf-life; the lack of co-operatives and farmer platforms to foster collective action; limited market information and volatility in market conditions which limits planning; unscrupulous traders who tend to cheat farmers and inadequate working capital.

Major opportunities in potato postharvest in the study area

Various opportunities for potato farmers, traders, and processors in the areas of potato postharvest, marketing, and transportation are shown in Table F4, Annex F. Results in the table reveal that major opportunities include: (i) recently introduced improved storage technology in the area; (ii) access to collective and better ambient stores being constructed in the area; (iii) reliable training on storage and postharvest handling; (iv) widespread recognition of the need to supervise workers during harvesting to reduce cuts/damage; (v) the increasing role played by potatoes as a good source of food in many homes; (vi) good quality potatoes as a result of embracing the practice of sorting and grading potato tubers before transporting or purchasing them, and; (vii) the use of improved technologies in ware potato production and handling.

Major opportunities in potato marketing in the study area

Results in Table F5, Appendix F, present major opportunities for farmers, traders, and processors in aspects of ware potato marketing in the study area. Evidence reveals some of the major marketing opportunities as: (i) the increasing size of the market in terms of the large number of ware potato traders in the neighboring districts and Kampala city; (ii) increased number of customers that also reflect high demand for ware potato, (iii) the upcoming practice of storing potato tubers for longer periods before selling; (iv) good potato price that is offered during periods of scarcity; (v) the strategy of practicing collective marketing by farmers groups; (vi) enhanced linkages as a result of meeting new people as collaborators and clients, and; (vii) the adoption of sorting and grading that help to channel out higher quality potato tubers.

Major opportunities in potato transportation in the study area

Major opportunities in potato transportation in Eastern Uganda are shown in Table F6, Annex F. Note that key opportunities include: (i) roads to towns are now good and enabling value chain actors to get reasonable prices; (ii) high number of transporters especially during harvesting season; (iii) the number of trucks and other means of transportation has increased and they are now available for hire in the area; (iv) important roads are in a pipeline and will soon be tarmacked; (v) new roads are already planned for construction (e.g. community access roads); (vi) bulk potato transportation now possible as result of available heavy duty trucks; (vii) taxes are still low; (viii) most actors now handle their potato produce carefully (they engage skilled porters to carefully load and off-load potato tubers).

There are other general market opportunities that are identified by value chain actors, and these include: short distance to the main market (make it easy to sell to the immediate markets); easy to control quality (size, handling, pest management, dehaulming); the increasing direct linkage between actors and the buyers (kiosk, restaurants, schools, hotel, processor); availability of improved seed potato of market-demanded varieties that also require less agro-chemicals; potato market is developing from mushrooming super markets, schools, hotels, local markets (for consumption), and regional markets; the increasing possibilities of using lending and saving institutions to finance potato agribusiness activities; growing potato demand for export market in South Sudan; growing local demand for potato chips and crisps.

Others opportunities range from: increased bargaining power and collective action; improved access to the market (short distance) in Mbale and direct linkage to the buyers; establishment of active multi-stakeholder platforms that are strengthening the capacity of potato value chain actors; improved ware potato storage with the potential to even out market price fluctuations; increasing demand of ware potato by fast food restaurants and frozen chip processors; more banks in the area including Centenary Bank that are willing to support and finance actors along ware potato value chains, and; women and men are more equitably engaged in the production of potatoes, although with a unique disparity at the retail and wholesale VC nodes.

11.9 Enabling environment for ware potato

Ware potato farmers, traders, and processors were asked whether they have established local laws (bylaws and ordinances) that are enforced to promote a more gainful and inclusive participation in ware potato trade. Results show that a larger proportion (43.06 percent) of traders, compared to 26.47 percent of processors and 17.24 percent of farmers are governed by some kind of local laws which are making a contribution towards a more enabling ware potato market environment.

In the case of farmers, the existing bylaws are related to key aspects of: encouraging discipline and cooperation (23.53 percent); crop rotation and fallowing of land to enable land to rest (17.65 percent); terracing on farm (11.76 percent), farmers taking produce on the market on different days (11.76 percent), and prohibition of bush burning (11.76 percent).

Traders (wholesalers and retailers) also reported that there are relevant bylaws to a large extent related to: stop theft and payment defaulters (22.22 percent); wholesalers and farmers prohibited to engage in retail trade (18.52 percent); standardizing prices (11.11 percent); allocating each category of traders a common working place (7.41 percent), and; encouraging discipline and cooperation among fellow traders (7.41 percent).

Conversely the processors emphasized bylaws aiming to: properly manage waste (33.33 percent); comply with regulations on the processing of chips (33.33 percent); encourage traders to maintain good quality hygiene and cleanliness (22.22 percent), and; standardize prices (11.11 percent).

Access to credit

Access to credit among farmers appears to be higher (42.24 percent) than is the case with traders (37.5 percent) and processors at 14.71 percent. Major sources of credit in the study area include banks (Centenary, Post-bank, Finance trust, Equity, Stanbic) at 53.06 percent, followed by SACCOs (16.33 percent), farmer groups (24.49 percent), and NGOs such as UWESO (6.12 percent). Other sources of credit include: Mbale Potato Traders Dealer's Association (MPODA) and various Micro-Finance institutions. About 53.45 percent of farmers, 48.61 percent of traders and 14.71 percent of processors face the challenges of accessing adequate and timely credit in the study area.

Some of the major challenges faced in accessing adequate and timely credit include: long processing time taken by formal banks to give loans (22.81 percent); many risks faced in terms of crop failure and defaulting (14.04 percent); limited credit within groups due to limited savings (10.53 percent); strict repayment schedule (10.53 percent); high interest rate (7.02 percent); limit on amount of credit given (7.02 percent); the underlying bureaucracy (7.02 percent); many requirements such as security, large deposit on accounts (5.26 percent); long distance to financial organization (3.51 percent); fear to acquire loans (3.51 percent); high cost in terms of operator costs (3.51 percent); few financial organizations available that give out credit to actors which further limits access loans (3.51 percent), and; to some extent the nonexistence of financial institutions in the area (1.75 percent).

Summary

What are the current postharvest management practices along ware potato value chains?

Use of recommended post-harvest management (PHM) practices helps value chain actors to minimize losses, increase access to more food, and maintain healthy food systems in the country and thus contributing to improved market access and related performance indicators.

The main PHM practices utilized by chain actors to minimize PHL and deterioration range from: sorting, washing (or cleaning), grading, weighing, storage, transporting, and packing. Use of PHM techniques enables VC actors to: handle potato tubers with care to avoid damage (cutting, crushing, and bruising); maintain potato tubers in cool conditions that minimizes the effects of moisture loss, chemical changes, and physical damage; sort out damaged tubers; store potatoes in ways that increase shelf-life, and; maintain potato tubers in good quality while awaiting a selling opportunity when price becomes good.

Key local technologies and practices used by traders, processors and consumers to store potatoes range from: spreading the tubers on the floor in the house; putting potatoes on pallets (not on the ground); covering potatoes with tarpaulins; avoiding storage all together by purchasing potatoes according to demand (just enough at the time); scattering potatoes on the dry clean ground uncovered; proper sorting during purchases; putting potatoes in a granary; regular sorting out spoilt and rotten potatoes; using improved storage facilities made of a wire mesh; taking note of the days potatoes have spent in storage, and; putting potatoes in wooden box.

Potato storage in particular helps chain actors to weather the negative effects of seasonality, the rampant challenges of price fluctuations, and instability in profit margins and income. The use of storage enables VC actors to: set aside potato tubers for seed, wait for a good market price, ensure constant availability of potatoes to consumers, keep unsold potato in a good condition, keep enough potatoes for home consumption, reduce the amount of PH losses, and allow for better packaging that help to supply far-end markets.

It is important to note that most value chain actors have not adopted and do not use modern storage facilities. Ware potato storage is mostly practiced by consumers (78.83 percent), farmers at 56.03 percent, processors at 41.18 percent, and lastly traders (wholesalers and retailers) at 37.5 percent. Conversely, sorting and grading of potato tubers is highly practiced by farmers (86.21 percent), processors (76.47 percent), traders (70.83 percent), and lastly consumers (63.53 percent). While farmers mostly grade potatoes based on tuber size (whether small, medium or large), traders and other VC chain actors grade their potatoes based on both tuber size and level of damaged tubers. Farmers mainly sort potato tubers during harvesting (67.71 percent), sell (20.83 percent), and just before storing the tubers (11.46 percent).

About 90 percent of traders and 76.47 percent of processors are optimistic that the use of improved storage facilities to keep excess potatoes for some time can effectively ensure good value to consumer and improvement in the level of profitability. Different categories of potato sorted out by farmers are utilized in various ways. The recommended practice of sorting helps ware potato farmers to: sell about 70.97 percent of the potato produce as good quality potato tubers; throw away about 20.43 percent as waste, consume 3.23 percent; utilize 3.23 percent to pay for hired labor in kind, and; use about 1.08 percent as seed. Most of the small potato tubers are used for seed and home consumption. The cut and bruised potatoes are either consumed at home or thrown away. The greening and off-type variety potatoes also end up getting consumed at home.

The most utilized storage techniques are rudimental and to some extent ineffective. These storage techniques only keep potato tubers in good quality for a period of 2-5 weeks depending on the potato variety. Potato is stored mainly using: the floor of houses (especially mud houses), cribs made from local materials, on wooden purlins, in the corners of houses, deep in the soil, stacked in sacks covered with tarpaulins, and under the shades of trees. It is also evident that Wanale, Kisoro, and Kenya potato varieties are less susceptible to postharvest degradation, while potato varieties of Sebei, Mbale, and Singo are the most susceptible.

In the case of farmers, storage techniques that are mostly used range from: mud floor house (23.73 percent), dark areas (or corners) in the house (22.03 percent), dark store (20.34 percent), and heaping potato on a mud floor (16.95 percent) among others. Traders mostly store potatoes using dark stores (20 percent), stores that allow light to pass through (12 percent), and covering tubers on the mud floor (12 percent). Processors store potatoes by heaping them on a concrete floor. Consumers store potatoes on concrete floor (72.88 percent), on mud floor (8.47 percent), and in dark corners of the house (6.78 percent), among others. This finding reveals that ware potato VC actors in the study area are not yet able to use modern ambient stores.

The level of level of market exchange of stored potato in the study area is still low. A very small proportion (14.66 percent) of farmers have attempted to sale potato stored for a relatively long time. It is evident that stored potato face stiff competition from fresh ones, even when large amount of stored potato is

imported from Kenya during periods of scarcity. Consumers perceive potato tubers stored for a relatively long time to have poor attributes of freshness, weight, moisture, and color. Nonetheless, use of modern storage techniques is positively perceived by majority VC actors to maintain acceptable balance in these attributes, guarantee consumer value, and increase profitability. There is need to support ware potato farmers and other VC actors to adopt the recommended innovative storage technologies. A significant proportion (89.41 percent) of consumers is willing to buy and consume potatoes stored in good conditions for a period between 1-4 months.

The inability to store potatoes among chain actors in Uganda is largely attributed to: lack of improved storage facilities, fear of shrinkage and loss of tuber weight, fear of loss due to rot and germination, and current possibilities of buying enough potatoes on demand any time. The willingness to store a 100 kg bag of ware potato for up to 4 months after harvest appears to be low, especially among traders and processors, and it's estimated at UGX 3,641 among farmers, UGX 575 among traders and UGX 824 among processors. There is need to increase the level of capacity building through promotion of stores, improving the perception of chain actors on storage if access to markets and market performance is to greatly improve.

Existing level of postharvest losses along the value chain

Postharvest loss (PHL) denotes any loss (or damage) in quantity and quality of potato tubers after harvest up to consumption. Ware potato PHL ranges from cuts, bruises, rotting, greening, sprouts, thefts, and softening of tubers when kept for a long time. The largest proportion of potato damage faced by traders, processors, and other value chains is in form of rotten tubers, followed by cuts on tubers, bruised tubers, greening tubers, and lastly other types of damage on tubers. These losses occur along the supply chain, and especially during harvest, transportation, off-farm storage, and processing. Ware potato tubers affected by economic losses have a residual value (sold at discounted price), while those afflicted with the physical loss are too damaged to be fit for human consumption.

The proportion of value chain actors facing PHLs is highest (78.46 percent) among farmers, followed by potato consumers at 69.41 percent, traders at 44.44 percent, and it is least at 35.29 percent among potato processors. The amount of potato damage is highest on the farm, followed by losses at processing stage, consumption stage, during transport and handling, and is least under the wholesale market conditions. The use of inappropriate harvesting tools such as hoes is blamed for inflicting cuts and bruises on tubers of up to 5 percent of total potato tubers harvested.

What is the proportion of physical losses for each value chain actor?

About 96 percent of potato farmers in the study area experience substantial level of potato losses during production, harvesting, and sale. Out of these farmers, the majority face potato losses during harvesting (95.69 percent), followed by production stage (91.38 percent), storage (79.31 percent), sales and marketing (77.59 percent), and lastly other stages (20.69 percent). Potato loss is highest during production; higher during harvesting; fairy high during storage; low during sales and marketing, and; very low during other stages. Potato loss during storage is highest (17.48 percent) among farmers, followed by 15.79 percent for processors, and is least at 12.9 percent for traders. Interventions that mitigate potato losses during harvesting, production, and storage stages can greatly increase marketing efficiency of ware potato farmers.

Potato harvesting tools in the study area range from: hoes (84.48 percent), ox plough (11.21 percent), sticks (2.59 percent), hands (0.86 percent), and forks (0.86 percent). Use of different harvesting tools is strongly associated with significant levels of potato damage, which is highest (277.29 kg/acre) when hand hoes are used, higher (113.89 kg/acre) when sticks are used, and least (33.33 kg/acre) when human hands are used. Engaging in the second round of harvesting in the same garden also helps to recover about 208.75 kg/acre. The amount of potato loss in terms of tubers that remain in the ground even after the second round of harvesting is estimated at 132.47 kg/acre. Careful use of tools during harvesting and engaging in second round of harvesting can minimize losses and boost sales and income.

Postharvest loss is divided into "physical losses" and "economic losses." Physical losses refer to the percentage of product that is deteriorated to a point of becoming unfit for human consumption and is therefore thrown away. The proportion of tubers that are too damaged to be consumed and therefore thrown away (physical losses) in last 2 years is estimated at: 9 - 15.9 percent with regards farmers, 5.43 - 9 percent for consumers, 4.18 - 31 percent among processors, and 11 percent for traders. These figures were arrived at using two different questions, one response question about loss suffered in the last 2 years, and multiple responses questions about loss experienced at different stages of the supply chain in the last one year.

The level of physical losses faced by farmers along the wider and different stages of production and marketing is highest (8.05 percent) on the farm, followed by 5.96 percent during household consumption, 5.52 percent during storage, 3.06 percent during transport, 2.65 percent at bulking point, 1.89 percent during wholesale market conditions, 0.77 percent at the delivery, and is least (0.04 percent) during processing stage.

In the case of business as usual situations, farmers store potatoes for an average period of 28.62 days compared to 6.22 days of traders, 4.46 days of processors, and 2.32 days of consumers. However, when they attempt to use locally available conventional storage practices, farmers are able to keep potatoes in good conditions for more than 60 days; traders for 17.95 - 40.6 days; processors for 24.38 - 32.06 days; consumers for about 30 days. It is therefore possible to extend shelf life of potato tubers beyond 2 months, especially when a right combination of potato variety and modern storage facility is utilized.

Shelf life of freshly harvested potatoes when kept under business as usual conditions is estimated at 1.85 - 2.02 weeks. Shelf life of potatoes increases to 4.58 -5.8 weeks when kept under the existing conventional storage practices. At the moment, potato consumers mainly purchase various potato products ranging from boiled potato (39.29 percent), fresh potato (33.33 percent), chips (17.86 percent), mashed potato (8.33 percent), and crisps (1.19 percent).

What is the proportion of economic losses for each value chain actor?

Economic losses refer to the percentage of product that is partially spoiled or damaged, whose market price is discounted, and the product cannot be used for what it was initially meant for. The proportion of economic loss representing the quantity of poor quality potatoes re-sold at discounted price in last 2 years is shown to be 6 - 17.46 percent at farm level; 9 - 11.7 percent for traders, and; 5.93 - 8 percent for processors. This type of loss is high.

In the case of more disaggregated stages, the extent of economic losses is shown to be highest (9.76 percent) at farm level compared to the stage of bulking (3.98 percent), transport (4.19 percent), at the

delivery point (0.87 percent), during storage (2.87 percent), at wholesale market (1.88 percent), consumption (4.39 percent), and is least during processing (0.04 percent). It is imperative to devise ways of reducing economic loss if value chain actors are to increase their sales and income.

What are the main causes of potato deterioration?

Postharvest losses are caused by product deterioration that emanate from delays in utilization and inadequate PHM technologies and practices.

There are a number of causes of PHLs at farm level, and these range from: (i) exposure to diseases, pests and infections, including late blight and bacterial wilt which cause rotting of potato tubers; (ii) poor harvesting skills including use of inappropriate harvesting tools; (iii) exposure to heat, dry and harsh weather, including harvesting tubers amidst too much rainwater; (iv) harvesting pre-mature and over grown potato tubers to meet household demands of food, money, and hired labor; (v) use of poor storage facilities; (vi) use of poor quality packaging materials in form of old bags and those that allow heat to build up; (vii) poor handling skills of laborers during packaging, loading, transit, and offloading of potatoes; (viii) stepping on stacked bags which bruises potatoes and the practice of over-filling potato bags which creates a heavy load conducive to damage when handled carelessly; (ix) the use of inferior processing technologies together with the lack of cold storage and limited use of natural preservatives, and; (x) the incidences of thefts, animal damage, and related losses at various stages of the supply chain from gardens, during transit, in storage, and up to marketing stage.

Key causes of PHLs at trading level in order of importance ranges from: mishandling potato tubers when loading and unloading; transacting in potato harvested during the rain and which is more likely to rot; poor market conditions characterized by damage created by exposure to direct sunshine or rain; careless handling (dragging and dropping) of the potato tubers; the tendency to keep potato for a very long time especially before selling; unavoidable delays to exchange the tubers, use of poor means of transportation; use of poor packaging material (nylon) for tubers; short shelf life of some of the potato varieties; transacting in potato harvested by poor tools; dealing in potato harvested when still immature; use of poor storage methods, and; delays during transportation. At the moment, over 72 percent of consumers, traders, and processors do not buy partially damaged potatoes in the study area

The underlying market constraints and opportunities of storing potato

The most highly ranked constraints faced by farmers are: the declining soil fertility; limited access to credit to procure inputs; long distances from home to gardens; pests and diseases; low and unstable prices; inadequate supply of certified seed; lack of stores and limited access to storage facilities; limited use and access to farm inputs (fertilizers, pesticides); negative effects of drought and weather related factors; loss of tuber weight due to moisture loss under poor storage facilities; high economic and physical losses largely due to the rotting of tubers; potato damage due to exposure to rain and other bad weather conditions, and; theft of tubers by hired laborers. Some of the farm level challenges that have worsened in the most recent years are limited access to storage facilities; declining soil fertility, and; limited access to credit for procurement of inputs.

Traders (wholesalers and retailers) and processors mainly face the challenges of: poor road network; poor market infrastructure; unfavorable market environment conditions; inability to satisfy the high net demand for ware potato from other districts and neighboring countries; poor linkages and coordination between ware potato value chain actors (producers, traders, processors, and consumers), and; limited

processing and value addition on ware potato tubers. Other challenges faced by traders and processors include: high economic and physical losses; lack of access to improved storage facility for potato tubers; damages (cuts, bruises, rotting) due improper harvesting and handling techniques; bad weather conditions; diseases and pests that reduce potato quality; damages due to poor transportation and poor handling, and; packing damaged tubers together with good ones.

Common challenges faced by different potato value chain actors in Eastern Uganda range from: poor market infrastructure and market environment that is less supportive to market operations; high costs of clean and good quality seed potato; limited access and high cost of agro-inputs and improved seed; limited use of pesticides and fertilizers; high seasonality of production cycle and extreme weather conditions; widespread exposure to fake farm inputs, and; limited number of reliable farm input stockists in rural areas; weak coordination of the potato value chains. Others include: few actors engaged in some form of formal or informal contractual arrangements; limited access to finance as result of lack of collateral and long loan application processes; high costs of constructing and maintaining stores which translates into high postharvest losses; high transport cost due to bad terrain and poor road network, and; the fact that potato is currently ranked low in Uganda's national agenda of strategic investments due to lack of a targeted policy for the subsector.

Project interventions and meaningful impacts along potato value chains

Project interventions on ware potato storage and market development can create meaningful impacts along potato value chains in Eastern Uganda, especially if different value chain actors are supported to adopt modern postharvest storage and practices that maintain quality of tubers. These interventions should promote the construction and use of low cost modern stores; construction of communal stores to allow collective use and action by organized groups; equip value chain actors with skills of constructing and managing ware potato stores; provide value chain actors with subsidies on materials used for store construction; improve service delivery in the provision of clean and good quality seed potato; improve the training on pest control techniques, and; promote access to affordable loans at low interest rates.

A large proportion of consumers have a positive perception of stored ware potato for a relatively long period as long as it is still good in quality. Stored potato is currently ranked very good by 35.71 percent of consumers, good by 58.33 percent, poor by 4.76 percent, and very poor by 1.19 percent. It is therefore important to adopt strategies that take advantage of the existing widespread consumer acceptability of stored potato; sensitize consumers to appreciate the link of storing potato and price stabilization, and; further enhance the distribution channels of stored potato with standards on quality, packaging, and delivery mode. Interventions also need to identify new alternative uses of damaged potato in order to enhance income of value chain actors.

There is no doubt, project interventions along ware potato value chains can help reduce postharvest losses by: sensitizing actors to appreciate the need to train their laborers and giving them incentives to handle potato tubers carefully and to minimize bruises and cuts during harvesting, loading and offloading. The project can also emphasize the need to have effective supervision of laborers and adoption of appropriate harvesting and handling equipment.

12. CONCLUSION AND RECOMMENDATIONS

This study has assessed the current status of the ware potato marketing in Eastern Uganda, the market performance along potato value chains, the use of existing postharvest management practices and the level of postharvest losses. A number of very interesting and important findings emerge from the study based on a review of existing literature, the analysis of relevant secondary data, and four unique primary data-sets collected in Eastern Uganda, where the International Potato Centre (CIP) has project sites and target beneficiaries under the subproject "*Postharvest Innovations for better access to specialized ware potato markets*".

Ware potato production and consumption in in Eastern Uganda

Potato growing in Eastern Uganda is rapidly transiting from subsistence oriented production to mainly commercial production. The increase in area cultivated, yield, and improved access to agricultural extension service are making a significant contribution to overall potato production in the country. Farmers are allocating a substantial proportion of their land to potato growing. They are able to adjust potato farm sizes through land rental and sales market that are functional and widespread. Potato productivity across farm households though found to be growing, it is still low mainly due to a combination of low soil fertility, use of poor agronomic practices; presence of pests and diseases; use of poor quality seed potato, and inadequate use of yield enhancing inputs such as fertilizers. A large number of potato producers, especially men are growing the crop on commercial scale.

Most potato farmers recycle the own produced seed at least twice or three times before buying new planting material. There is need therefore to improve the availability and use of clean and better performing seed potato in Eastern Uganda. A vast potential to increase potato production, productivity, marketing, and value addition on fresh ware potato exist in Eastern Uganda. A targeted policy on roots and tubers sector, including potato subsectors is imperative, if farmers and other value chain actors are to effectively tap in the existing huge potential of potato production, marketing and value addition in Uganda.

Potato is ranked low in Uganda's national agenda set by the current Agricultural Sector Development Strategy and Investment Plan. This notwithstanding, ware potato is the third most consumed root and tuber crop in Uganda after cassava and sweetpotato. The supply and demand for potato in Uganda is growing faster than any other root crop. The per capita consumption of ware potato in the country has been increasing steadily at a low rate since 1961, but started to decline in recent years, especially after 2007. This phenomenon may be attributed to unsatisfied net-demand of potatoes, wastages along different market channels, poor marketing, and inconsistency in market supplies due to price fluctuations and limited value addition that can effectively satisfy consumers with value for their money.

Very few farmers and other value chain actors currently engage in effective storage of ware potato to help weather challenges of seasonality and price fluctuations in a year. No doubt, the marketable period of fresh potato tubers is short due to inconsistent supply of potato tubers, high perishability and therefore short shelf life. Value chain actors need to store ware potato during the excess supply months of January, June, July, August, and December with an anticipation of selling the stored tubers at a good price during the period of scarcity, namely the months of March, April, May, September, October, and November. The price of potato varies across each of the two growing seasons, with a higher price received in the second season of the year compared to the first season. Ware potato price per bag is also shown to increase by 121 percent on average between peak and off-peak seasons.

Compared to female value chain actors, male actors engage more in strategic postharvest activities that directly contribute to tuber quality and income generation. To the extent that men are able to access market information easily, they are able to benefit more by selling potato tubers at better price. The underlying trust issues between farmers and traders also continue to undermine the smooth flow and equitable distribution of benefits derived from access to market information in the study area. This notwithstanding, there is huge potential to boost potato production, productivity, and marketing in Eastern Uganda.

The current ware potato marketing system in Eastern Uganda

Market supply of ware potato is inconsistent throughout the year. Value chain actors face seasonal fluctuations in market price of ware potato and yet price of processed potato products is relatively stable. Potato is sold mainly on per bag basis, with each bag weighing between 80kg and 120kg. The standard bag of potatoes weighs 100kg after leaving the main bulking point in Mbale town. The lack of exchange standards in the study area means that value chain actors rely more on a negotiation processes to determine the terms of exchange, including price of ware potato. Potato prices are mainly set by traders depending on tuber availability and distance to target markets. Some of the key determinants of market price received by value chain actors include the level of trust built among actors (which is largely based on the extent of repeated transactions), experience in marketing, negotiation skills, and access to market information.

Key players along the ware potato value chains include: farmers, agents (or brokers), local traders, urban wholesalers, urban retailers, processors, and consumers. Various institutions such as schools, hotels, and hospitals also procure and consume ware potatoes in large quantities. Some of the government agencies and research organizations are active in spearheading breeding, multiplication and distribution of improved seed potato to farmers. A significant number of ware potato farmers sell their tubers either directly to local consumers or to a range of intermediary traders, who in turn, sell ware potato to consumers in rural, peri-urban, and urban market centers.

Market channels that are largely informal and processing of fresh ware potato is still limited to few forms of products such as: boiled potato, chips, and crisps. Farmers and traders mainly engage in low cost value adding activities of sorting, grading, washing, scrubbing, packaging, and storage. The low level of value addition, dis-organization, and limited upgrading along ware potato value chains reduce the level of market performance, quality of ware potato tubers marketed, and income generated by value chain actors. Value addition on fresh potato tubers is driven by actors who are: males compared to females, reliable in the way they relate with other actors based on trust, relatively younger and more educated and least burdened with dependents (have small family sizes) in their homesteads.

The use of improved storage facilities for ware potato is very low in the study area, and this partly explains why a substantial proportion of potato tubers supplied along the value chains in the off-season is of low quality. Value chain actors in the study area largely use traditional storage techniques which are inefficient in both holding capacity and ability to extend shelf-life of tubers. The duration of storage of potatoes varies inversely with quantity of potato handled at a time by value chain actors. For instance, traders who handle a large quantity of potatoes store the tubers for a shortest period of time before selling. Improved and locally adapted ambient stores were introduced recently in pilot project sites CIP project.

Value chain actors (farmers, wholesalers, retailers, and processors) are not well organized, but have established informal potato hubs that are helping to define exchange standards, including use of weight based system as a basis of price determination. Mbale town is the current potato hub in Eastern Uganda where traders from different places meet to re-weigh, sort, and package potatoes before shipping them to different higher end markets such as Kampala city Lira, and export markets South Sudan and other neighboring countries. All potato transactions in Uganda are currently based on weight based system as opposed to eye ball estimation.

Value chain linkages between ware potato farmers and each of the local traders, wholesalers and retailers appear to be strong. Weak linkages however exist between both farmers and traders and each of the cooperatives and processors. Contrary to popular expectations, ware potato farmers, cooperatives, wholesalers, and retailers along ware potato value chain enjoy substantial levels of trust. Only ware potato processors seem to face the challenge of mistrust literally with every other value actor along ware potato value chains. A very large proportion of farmers sell their ware potato produce mostly at farm gate and to a less extent in nearby markets. Long marketing channels are mostly used by men and especially during periods of peak potato supply.

Existing level of market performance in Eastern Uganda

Wholesalers transact the highest quantity of ware potato per route, while processors operate the least quantity of potato per week. The number of times VC actors engages in the buying and selling of ware potato is highest for retailers followed by processors, wholesalers, and is least for farmers. The average selling price per kg of potatoes at farm gate and other destination market varies across value chain actors, and is highest (5,829.2/kg) for processors, followed by UGX 670.8/kg for retailers, UGX 626.1/kg for wholesalers, and its least (UGX 376/kg) for farmers. Conversely, processors incur the highest (UGX 570.3) variable marketing costs per kg of potato, followed by wholesalers at UGX 103.3, retailers at UGX 34.3, and lastly farmers at UGX 10.95.

The capacity of processors is very low and this is reflected by the average low volume of potato tubers they handle. Transport and packaging costs are the main marketing costs incurred by farmers and other value chain actors. Like farmers, other value chain actors have not yet appreciated the cost of storage and postharvest losses as important cost item that needs immediate attention. Consequently, not many actors along the value chain can attach the actual monetary value on storage costs.

The magnitude of value addition on fresh ware potato tubers is highest for processors, followed by wholesalers, retailers, and lastly farmers. Market performance in terms of value addition is highest with processors, followed by wholesalers, retailers, and is least across ware potato farmers. Ware potato marketing is a profitable business for all value chain actors, with highest gross margins among processors, followed by farmers, retailers, and lastly wholesalers. Although, potato wholesalers and retailers incur the highest marketing costs as indicated by the ratio marketing costs to gross margins, they are also more likely to make more money from potato business in any period given their high turnover. The marketing infrastructure is still less supportive to actors along potato value chains in the study area. To the extent therefore that the environment is less enabling to market operations, actors will continue facing high transaction costs and relatively small gross margins.

Different ware potato storage practices, priorities, and their impacts in Eastern Uganda

The main PHM practices utilized by chain actors to minimize PHL and deterioration range from: sorting, washing (or cleaning), grading, weighing, storage, transporting, and packing. The use of PHM techniques enables VC actors to: handle potato tubers with care to avoid damage (cutting, crushing, and bruising); maintain potato tubers in cool conditions that helps to minimize the effects of moisture loss, chemical changes, and physical damage; sort out damaged tubers; store potatoes in ways that increase shelf-life, and; maintain potato tubers in good quality while awaiting a selling opportunity when price becomes good.

Very few value chain actors store potato tubers using improved modern storage facilities. The level of participation in ware potato storage is highest among consumers, followed by farmers, processors, and lastly traders (wholesalers and retailers. Sorting and grading of potato tubers is highly practiced by farmers, followed by processors, traders, and lastly consumers. Value chain actors' grade potatoes based on tuber size (whether small, medium or large) and by sorting out damaged tubers. The majority of VC actors agree that adoption of improved storage facilities not only helps to keep excess potatoes for some time, but also ensures good value to consumer and improved the level of profitability.

The most utilized storage techniques are rudimental, there are to some extent ineffective, and fall in the category of traditional stores and related techniques. These stores are inefficient in capacity and only able to keep potato tubers in good quality for a short period of 2-5 weeks depending on the potato variety. Value chain actors mainly store potatoes using: the floor of houses (especially mud floor houses), cribs made from local materials, wooden purlins, in the corners of their houses, covering potato tubers deep in the soil, stacking tubers in sacks covered with tarpaulins, and heaping potato tubers under the tree shades. Other common storage techniques include: keeping potato tubers in a dark area (or corner in the house), dark stores, stores that allow light to pass through, heaping potato tubers on a mud floor and concrete floor, and keeping potato tubers on the mud or concrete floor when they are either covered or uncovered.

Market exchange of stored potato in the study area is still at a low level, although there are clear indications that consumers are more willing to purchase potato tubers stored in good conditions for a period between 1-4 months. Only a very small proportion (14.66 percent) of farmers have attempted to sale potato tubers stored for a relatively long period.

Good quality potatoes in the supply chain is attributed to better handling of mature potato tubers that are selected through right procedures of grading and sorting and transacted in a timely manner between responsible actors who trust each other as a result of repeated transactions. There is need therefore to promote the adoption and effective management of innovative storage technologies through effective sensitization and capacity building across actors in potato value chain. Additional training on aspects of postharvest handling, marketing, and investment along the ware potato value chains is also imperative.

Existing level of postharvest losses along ware potato value chains in Eastern Uganda

Ware potato PHL ranges from cuts, bruises, rotting, greening, sprouts, thefts, and softening of tubers when kept for a long time. The largest proportion of potato damage faced by traders, processors, and other value chains is in form of rotten tubers, followed by cuts on tubers, bruised tubers, greening tubers, and lastly other types of damage on tubers. Use of inappropriate harvesting tools such as hoes can inflict cuts and bruises on tubers of up to 5 percent of total potato tubers harvested. Use of different harvesting

tools is strongly associated with significant levels of potato damage, which is highest when hand hoes are used, higher when sticks are used, and least when human hands are used. Farmers are the most commonly affected by PHLs, followed by potato consumers, traders, and lastly processors. The amount of potato damage is highest on the farm, followed processing stage, consumption stage, transport and handling stage, and is least under the wholesale market conditions.

The level of physical and economic losses is high in Eastern Uganda. Potato loss is very high during the production stage, followed by stages of harvesting, storage, sales and marketing, and is very low in other stages. Engaging in second and third round of potato harvesting helps farmers to reduce on amount of losses incurred. We find that failure to conduct the second round of potato harvesting in the same garden creates a substantial loss of up to 208.75 kg/acre. The third round of harvesting can also recover about 132.47 kg of additional potato tubers per acre.

Ware potato processors face the highest physical losses (4.18 - 31 percent), followed by farmers (9 - 15.9 percent), traders (11 percent), and lastly consumers (5.43 - 9 percent). The proportion of economic loss representing the quantity of poor quality potatoes resold at discounted price in last 2 years is highest for farmers (6 - 17.46 percent), followed by traders (9 - 11.7 percent) and its least (5.93 - 8 percent) for processors.

Potato loss is mainly caused by: rotting of tubers, greening of tubers, congestion in stores, loss of weight due to moisture loss, effect of pests and crop diseases including potato wilt disease, animal damage, exposure to heat and extreme dry conditions, other types of harsh weather (floods and wetting), poor harvesting techniques that cause cuts and bruises, and use of poor storage facilities. Postharvest losses are caused by product deterioration due to delays in utilization and inadequate use of PHM technologies and practices.

Postharvest losses at farm level are mainly caused by: (i) exposure to diseases, pests and infections, including late blight and bacterial wilt which cause rotting of potato tubers; (ii) poor harvesting skills including use of inappropriate harvesting tools; (iii) exposure to heat, dry and harsh weather, including harvesting tubers amidst too much rainwater; (iv) harvesting pre-mature and over grown potato tubers to meet household demands of food, money, and hired labor; (v) use of poor storage facilities; (vi) use of poor quality packaging materials in form of old bags and those that allow heat to build up; (vii) poor handling skills of laborers during packaging, loading, transit, and offloading of potatoes; (viii) stepping on stacked bags which bruises potatoes and the practice of over-filling potato bags which creates a heavy load conducive to damage when handled carelessly; (ix) the use of inferior processing technologies together with the lack of cold storage and limited use of natural preservatives, and; (x) the incidences of thefts, animal damage, and related losses at various stages of the supply chain from gardens, during transit, in storage, and up to marketing stage.

At the trading level, key causes of PHLs in order of importance ranges from: mishandling potato tubers when loading and unloading; transacting in potato harvested during the rain and which is more likely to rot; poor market conditions characterized by damage created by exposure to direct sunshine or rain; careless handling (dragging and dropping) of the potato tubers; the tendency to keep potato for a very long time especially before selling; unavoidable delays to exchange the tubers, use of poor means of transportation; use of poor packaging material (nylon) for tubers; short shelf life of some of the potato varieties; transacting in potato harvested by poor tools; dealing in potato harvested when still immature;

use of poor storage methods, and; delays during transportation. At the moment, over 72 percent of consumers, traders, and processors do not buy partially damaged potatoes in the study area

The underlying market constraints along the ware potato value chains in Eastern Uganda

Key constraints faced by farmers include: the declining soil fertility; limited access to credit to help procure farm inputs; long distances from home to gardens; effect of pests and diseases; low and unstable farm-gate and market prices of potato tubers; inadequate supply and high cost of certified clean seed; lack of stores and limited use of storage facilities; inadequate use and access to farm inputs (fertilizers, pesticides); high seasonality in potato supply and negative effects of extreme weather conditions; loss of tuber weight due to moisture loss under poor storage facilities; high economic and physical losses largely due to the rotting of tubers; potato damage due to exposure to rain water and other bad weather conditions, and; cheating and theft of tubers by hired laborers and others.

Traders (wholesalers and retailers) and processors mainly face constraints that range from: poor road network; poor market infrastructure that is less supportive of their market operations; unfavorable market environment and conditions; limited capacity to satisfy the high potato demand from other districts and neighboring countries; poor linkages and weak coordination between ware potato value chain actors; low and unstable market prices of potatoes, and; limited processing and value addition on fresh ware potato tubers.

Other constraints faced by all value chain actors include: high economic and physical losses due to crop perishability and short shelf-life; lack of access to improved storage facilities for potato tubers; damages (cuts, bruises, rotting) due improper harvesting and handling techniques; bad weather conditions; diseases and pests that reduce potato quality; damages due to poor road transport and handling; packing damaged tubers together with good ones; few actors able to engage in some form of formal or informal contractual arrangements; limited access to finance and inadequate working capital as a result of lack of collateral and long loan application processes; high costs of constructing improved storage facilities; high transport cost due to bad terrain and poor road network; limited access to market information and processing technologies; high transaction costs as a result of poor marketing infrastructure (lack of standards, premiums, and collective action), and; low prioritization of potatoes in the current Uganda's national agenda of strategic investments and the lack of a targeted policy for the subsector.

The underlying market opportunities along the ware potato value chains

A market opportunity refers to a trend or existing events that can lead to significant upward change in sales and profit patterns if ware potato value chain actors take appropriate and strategic responses. Major opportunities faced by ware potato value chain actors range from: the recently introduced improved storage technology in the area that relies on local materials; new possibilities of using better ambient stores currently being promoted in the area to even out market price fluctuations; reliable training that is received occasionally on storage and other postharvest handling practices; widespread recognition among farmers to invest time and resources in supervising workers during harvesting to reduce on tuber damage; the increasing role that potato crop is playing as a good source of food and income in many homes; good quality potato tubers are being channeled out as a result of good practices of sorting and grading tubers before selling; the use of improved technologies in ware potato production and physical handling, and; improved access to market information through mobile phones and mushrooming radio stations.

Most potato value chain actors should exploit a number of other marketing opportunities that include: the increasing size of potato market in terms of the number of ware potato traders in the neighboring districts and Kampala city; increasing number of customers and demand for ware potato; gains from the new and upcoming practice of storing potato tubers for relatively long periods before selling; clear understanding on how to take advantage of the good potato price offered during periods of tuber scarcity; the new and expanding culture of practicing collective marketing within farm groups to increase bargaining power; enhanced linkages among actors as a result of frequent meetings with new collaborators and clients; the large number of transporters especially during the harvesting season, and; the increased number of trucks and other means of transportation available for hire anytime in the area.

Other general market opportunities identified by value chain actors include: being able to sell tubers immediately due to short distance to the main market; actors now aware and find it easy to control potato quality (through size grading, careful handling, pest management, dehaulming); the increasing direct linkage between value chain actors and potato buyers; improved seed potato now available in the study area; increasing potato demand (as a result of direct linkages to mushrooming super markets, schools, kiosks, hotels, local markets, fast food restaurants, frozen chip processors, and regional markets); the increasing possibilities of using lending and saving institutions to finance potato agribusiness activities; growing potato demand from export market in South Sudan; growing local demand for processed potato chips and crisps; establishment of active multi-stakeholder platforms that are strengthening the capacity of potato value chain actors to lobby and voice out their interests, and; more banks in the area including Centenary Bank that are willing to support and finance actors along ware potato value chains.

Project interventions on ware potato storage and related meaningful impacts

Project interventions on ware potato storage are mainly grounded in technological and institutional innovations with potential to increase potato sales and income of value chain actors. The adoption and use of improved storage facilities in particular: reduce the negative effects of seasonality in market supply to even out market price; promote the adoption of recommended postharvest management practices to maintain quality and reduce postharvest losses; facilitate effective dissemination of market information; promote training of actors on various techniques of handling of ware potato tubers carefully to avoid damage (cutting, crushing, and bruising); promote technologies and practices that maintain potato quality and extend the shelf-life while awaiting a selling opportunity at a better price; promote practices of sorting and culling damaged tubers and other items; increase shelf-life of potato tubers through use of better varieties and handling; facilitate development of organized market channels with reliable aspects of bulking, check-off payments, and enforcement of quality standards; encourages better targeting and inclusive market participation of value chain actors (especially women and the poor); and enhance the harnessing of available opportunities for value addition and agro-processing in the region.

Other meaningful impacts of potato storage interventions along the value chain include: the construction and use of low cost modern stores; facilitating the construction of communal stores for collective use by members of organized groups of value chain actors; equipping value chain actors with skills of constructing and managing ware potato stores; providing value chain actors with subsidies on materials used for store construction; improving service delivery in the provision of clean and good quality seed potato; improving training on pest control and physical handling of tubers to reduce losses; promoting access to affordable loans at low interest rates; equipping actors with entrepreneurial skills to help them take advantage of existing widespread consumer acceptability of potato tubers stored for some time; promoting alternative uses of partially damaged potato to enhance potato utilization and income.

Recommendations

There is need to ensure consistent supply of good quality potato tubers, stabilize market price, and enhance market performance of ware potato farmers and other value chain actors in Eastern Uganda. Policy makers, researchers, service providers, and development practitioners including the International Potato Centre (CIP), can work together to implement the following suggestions:

Enhance potato production, productivity, and consumption

- Promote agricultural smart technologies that enhance soil fertility and mitigate negative effects of climate change. It is important to encourage the adoption and widespread use of good quality and yield enhancing inputs such as organic manure, inorganic fertilizers, pesticides, clean seed potato, and agro-forestry practices.
- Promote the use of recommended agronomic practices at farm level, including dehaulming, harvesting only tubers that are mature, and use of appropriate harvesting tools to minimize cuts and bruises on potato tubers. Use of labor enhancing technologies also reduces labor costs and unnecessary drudgery.
- Improve the availability, access, and use of clean, good quality, and better performing seed potato of varieties with longer dormancy period in the study area. Community based seed multiplication centers should be established to increase the supply of affordable and most preferred seed.
- Support public investment in the development of irrigation schemes, intensive cultivation, and use of small-scale irrigation technologies among potato producers to ensure increased supply of potato in periods of scarcity.

Strengthen potato marketing, postharvest loss reduction, and value addition

- Improve the coordination, content, and speed at which market information is disseminated across all value chain actors to help them cope with challenges of low prices, unstable prices, and linking up with a potential buyer or seller. This can be accomplished through use of mobile phones, radios, and other platforms.
- Improve access to commercial and agricultural bank services in the area. These financial institutions should be encouraged to provide affordable services and packages to different actors engaged in potato production and market operations along the value chains.
- Build capacity, train, and continue sensitizing value chain actors on the importance of effective potato storage, management of collective potato storage, and other management aspects related to pre and postharvest potato handling practices, marketing, and upgrading of ware potato value chains.
- Strengthen the capacities for construction and adoption of low cost but improved ware potato stores among farmers and other actors along potato value chains. The stores should use locally available materials that are more affordable.
- Promote efficient marketing models that help to: maintain the quality of tubers through effective sorting and grading of tubers before packing, reduce transaction costs, minimize exploitation, and enhance potato tuber sales and income.
- The existing marketing models should be encouraged to adopt reliable weight based system all through, enhance linkages between different actors through use of clear and acceptable standards of exchange that enhance trust with the buyers, and use cooperative and other collective action marketing channels that harness bargaining power, efficiency of potato hubs and bulking centers, and the enforcement of formal and informal contracts with potato buyers.

- Advocate for an increase in public investment in the development of road and market infrastructure to reduce transport and marketing costs incurred by value chain actors. Low transaction costs stimulate an inclusive and increased participation on potato marketing, which benefits all actors.
- Adopt strategies that increase investment in potato value addition, facilitate increase in volume of potato tubers supplied to the market meet the existing huge net demand, and effective upgrading of marketing activities of different actors along the potato value chains.
- Support the entrepreneurial training, apprenticeship, and growth of incubation centers for potato value adding activities to boost innovation, marketing, and the supply of processed potato products (such as frozen chips, baby food, and crisps) across fast food restaurants, grocery shops, and super market outlets.

Improve potato market organization, utilization of gender roles, and government policy

- Promote interventions that enhance the transformation and better coordination of actors along the entire potato value chain. This can be achieved through establishing strong linkages among actors, and strengthening internal organization of producer marketing groups with elements of good governance, accountability, and trust.
- Champion equitable utilization of gender roles, empowerment of women in agricultural activities, and increased participation of women and men actors in the potato production, storage, wholesale trade, and retail marketing. It is important to embrace targeted flow of resources and incentives that promote inclusive adoption of appropriate technology and equitable distribution of benefits.
- Organize potato value chain actors into producer marketing groups and to strengthen their: social capital endowment, ability to mobilize resources through savings, creativity on matters of reducing marketing risk and potential to boost potato sales and income.
- Encourage active membership of different value chain actors to the local and national multi-stakeholders' platforms to speak with one voice, get to be heard, and together generate a positive response on matters that hurt their agri-businesses from policy makers and other players in the private sector.
- Support organized potato farmers and other value chains to register with government and operate as recognized agri-business entities in order to acquire the papers, participate, and benefit from existing formal market supplies with government institutions (schools, universities, prisons, hospitals, etc.), private sector, and markets in the neighboring countries.
- Reach out and engage policy makers and technical people within government through advocacy and dialogue to reinstate potato crop back on the list of priority crops of the country. Potato crop plays an important role of increasing food security and income in many districts of Uganda.

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ANNEX A

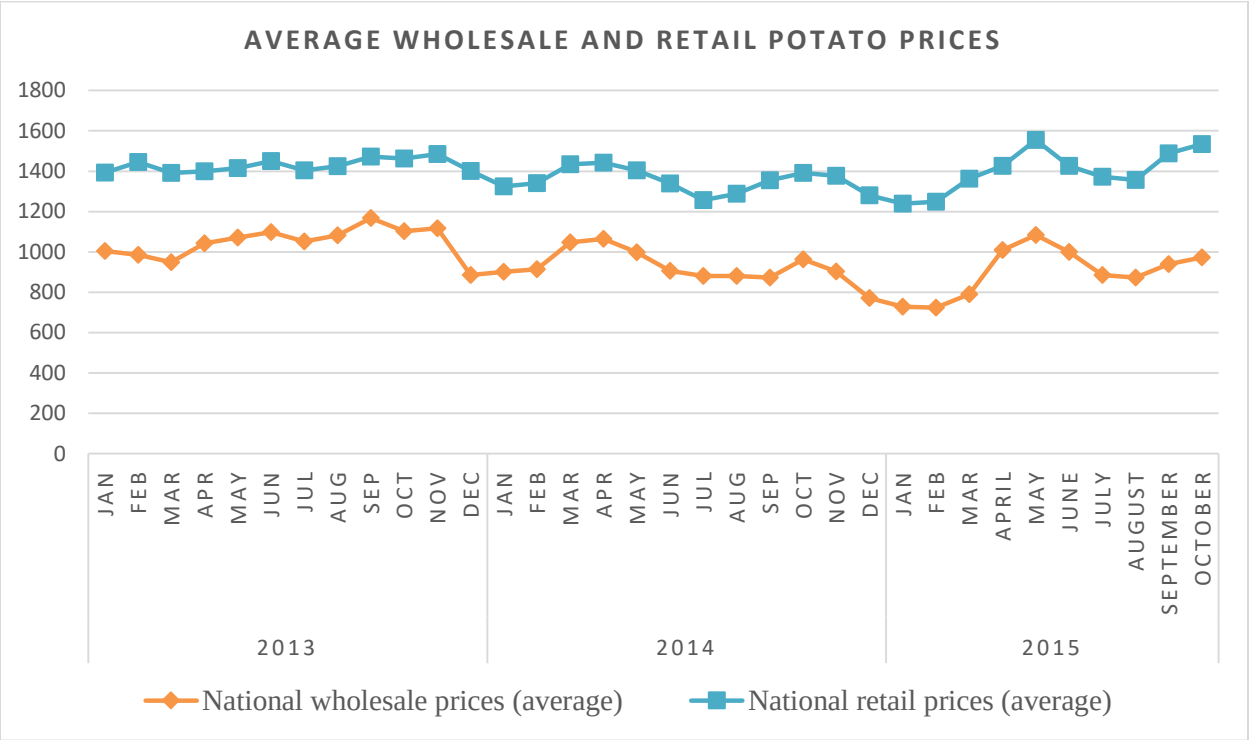

Figure A1: Average wholesale and retail ware potato price in Uganda
Source of price data: Farm gain

Table A1: Selected sub-counties in the study area

Sub-county name	Farmers			Traders			Processors			Consumers	
	Freq.	Percent		Freq.	Percent		Freq.	Percent		Freq.	Percent
Benet	22	18.97		8	11.11					15	17.65
Kapuchesombe	33	28.45		6	8.33					14	16.47
Wanale	61	52.59		1	1.39					20	23.53
Mbale Industrial Area				20	27.78		9	26.47		10	11.76
Kampala Central Division				7	9.72		9	26.47		9	10.59
Kawempe Division				8	11.11		5	14.71		5	5.88
Kiira Town council				5	6.94		3	8.82		1	1.18
Nakawa Division				4	5.56		5	14.71		4	4.71
Kapchorwa Trading Centre				6	8.33		3	8.82			
Makindye Divison				3	4.17						
Mengya				2	2.78						
Mtoto				1	1.39						
Piswa				1	1.39					1	1.18
Bubeze										1	1.18
Bunatsoma										2	2.35
Nakaloke										1	1.18
Northern Division										2	2.35
Total	116	100		72	100		34	100		85	100

Table A2: Ethnicity of household head in the sampled study data-set

	Farmers			Traders			Processors			Consumers	
Ethnicity of household head	Obs.	Pct.		Obs.	Pct.		Obs.	Pct.		Obs.	Pct.
Aringa	1	0.95									
Badama	1	0.95									
Bafumbira				2	3.17		2	12.5			
Baganda				18	28.57		2	12.5		10	14.93
Bagwere				1	1.59						
Bakiga							1	6.25		1	1.49
Bakonjo							1	6.25			
Bamasaba	58	55.24		21	33.33		4	25		28	41.79
Basoga							1	6.25			
Batooro				1	1.59						
Banyankore				1	1.59						
Banyarwanda				1	1.59						
Banyole										3	4.48
Iteso				1	1.59		1	6.25			
Langi										1	1.49
Lugbara							1	6.25			
Madi							1	6.25			
Iteso										1	1.49
Samia										1	1.49
Tepeth	45	42.86		17	26.98		1	6.25		22	32.84
Not Ugandan							1	6.25			
Total	105	100		63	100		16	100		67	100

Table A3: Membership to farm groups and status of crop choice across farm households

Particulars	Freq.	Percent
Are you an active member of any farm group in this area? (0 = No; 1 =Yes)		
No	33	28.45
Yes	83	71.55
If yes, what is the name of the farmer group?		
WASWAPPA	22	26.51
Mengya Integrated Farmers Association	13	15.66
Bushuiyo Womens Group	7	8.43
Wanale Highland farmers Association	4	4.82
Kepchesombe farmers group	3	3.61
Bonio womens group/mixed group	2	2.41
Chebukat Women Bee Keeping	2	2.41
Chekwasta Farmers Group	2	2.41
Kapleko Maize Growers	2	2.41
Koyomokey Womens Group	2	2.41
Atar river bank	1	1.2
Benet Mount Elgon Indigenous Organization	1	1.2
Bubentsye Yetana Farmer Group	1	1.2
Buhankho Group	1	1.2
Buhoba tubana group	1	1.2
Bushuiyo VHT Dairy Farming and T	1	1.2
Chebukat Development Association	1	1.2
Cheripkaa Farmer Group	1	1.2
Kabaro Sisters Group	1	1.2
Kabatesi Farmer Group	1	1.2
KADIFFA	1	1.2
Kalpak Banana Women Group	1	1.2
Kwoti SACCO	1	1.2
Lule farmers group	1	1.2
Magale womens group	1	1.2
Pioneer Group	1	1.2
Piswa Barley Farmer Group	1	1.2
Reds international	1	1.2
Rural Enterprise Development Service	1	1.2
Shikulu Farmers Group	1	1.2
UWESO	1	1.2
VECO	1	1.2
Wepilya farmers group	1	1.2
Wepiria Farmers Association	1	1.2
Total	83	100

ANNEX B

Table B1: Major reasons why households choose to grow potatoes

Particulars	Ist crop		2nd crop		3rd crop		4th crop	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Cash crop	74	63.79	13	11.3	3	3.3	2	5.26
Early maturity	20	17.24	12	10.43	39	42.86	5	13.16
Food crop	11	9.48	66	57.39	6	6.59	3	7.89
Ready market in the area	5	4.31	2	1.74	9	9.89	7	18.42
High yielding	4	3.45	9	7.83	3	3.3	5	13.16
Available seeds	1	0.86			1	1.1		
Fetch higher prices	1	0.86			2	2.2		
Easy to grow			1	0.87	5	5.49	1	2.63
Can easily be stored as seed					1	1.1		
Availability of fertile soils the area			1	0.87	1	1.1	1	2.63
Seeds can easily be accessed			1	0.87	1	1.1		
Less inputs needed in production							1	2.63
To multiply seeds					2	2.2	1	2.63
Its profitable			3	2.61	1	1.1		
Not so perishable like other crops					1	1.1		
Food security			3	2.61	2	2.2		
Less time in management and easy			1	0.87	3	3.3	1	2.63
Soil fertility conservation					2	2.2	2	5.26
Easy to prepare			1	0.87				
For crop rotation			1	0.87	6	6.59	7	18.42
Cheap labor			1	0.87	1	1.1		
Less expenditure in production					1	1.1	1	2.63
Longer shelf life than other vegetables					1	1.1	1	2.63
Total	116	100	115	100	91	100	38	100

Table B2: Farm households' comment on existing levels of land access in the area

Particulars	**Farmers**		
	Freq.	Percent	Cum.
Household's assessment of land access or ownership in the area			
Not enough	89	76.72	76.72
Enough	23	19.83	96.55
More than enough	4	3.45	100
Total	**116**	**100**	
Reasons for exiting nature of land access/ownership in the household			
High demand to grow more crops/diversification for sale and consumption	27	24.77	38.53
Bigger family/population density makes land not to be enough	15	13.76	13.76
There is always land available for farming	15	13.76	95.41
More land needed for children to inherit for their own agriculture production	11	10.09	48.62
More land needed for commercial farming	11	10.09	58.72
Need more land for grazing demand to facilitate education/pay fees	10	9.17	77.98
Cannot cultivate all of it (land) alone	5	4.59	100
More land needed to grow potatoes due to rising potato market	4	3.67	64.22
More land needed for food security	3	2.75	66.97
More land needed for agro forestry purposes	2	1.83	60.55
Not enough to rent-out	2	1.83	68.81
Many family needs so need more land	1	0.92	78.9
Seeds remain after planting	1	0.92	79.82
Land is difficult to get even when you have money to buy	1	0.92	80.73
Land is an asset for old age, so need more of it	1	0.92	81.65
Total	**109**	**100**	

Table B3: Potato varieties grown by farmers under different production systems

Particulars	First season A (Jan - June), 2015		Second season B (July -Dec), 2014		Overall in a year (last 12 months)	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Potato variety grown, overall						
Kabale red	53	50.48	47	50.54	53	45.69
Victoria	41	39.05	28	30.11	41	35.34
Wanale	7	6.67	11	11.83	13	11.21
Magabond	2	1.9	1	1.08	2	1.72
Sebei	1	0.95			1	0.86
Wanale red	1	0.95	1	1.08	1	0.86
Magpot white			1	1.08	1	0.86
Lwangume			2	2.15	2	1.72
Civilian			2	2.15	2	1.72
Total	**105**	**100**	**93**	**100**	**116**	**100**
Potato variety grown, under rain-fed production system					41	35.34
Kabale red	52	49.52	46	51.69	55	47.41
Victoria	42	40	28	31.46		
Wanale	7	6.67	9	10.11	12	10.34
Magabond	2	1.9	1	1.12	2	1.72
Sebei	1	0.95			1	0.86
Wanale red	1	0.95	1	1.12	1	0.86
Lwangume			2	2.25	2	1.72
Civilian			2	2.25	2	1.72
Total	**105**	**100**	**89**	**100**	**116**	**100**
Potato variety grown, under irrigated production system						
Victoria	2	66.67	3	13.04	3	12.5
Kabale red	1	33.33	17	73.91	18	75
Wanale			2	8.7	2	8.33
Magpot white			1	4.35	1	4.17
Total	**3**	**100**	**23**	**100**	**24**	**100**

Table B4: Main challenges faced by farmers in potato production

Particulars	Very important		Important		Not important	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Limited use of storage facilities	19	19.19	9	13.64	1	6.25
Drought and weather related factors	17	17.17	7	10.61		
Inadequate supply of certified seed	16	16.16	4	6.06		
Pests and diseases	14	14.14	4	6.06	1	6.25
Limited access to inputs such as fertilizers and pesticides	12	12.12	5	7.58		
Declining soil fertility	7	7.07	13	19.7	1	6.25
Shortage of land	5	5.05	1	1.52	3	18.75
Low and unstable prices	2	2.02	3	4.55	3	18.75
High transportation costs	2	2.02				
Limited use of irrigation	1	1.01	1	1.52	1	6.25
High losses due to spoilage in handling	1	1.01	1	1.52	2	12.5
Limited access to credit to procure inputs	1	1.01	6	9.09	1	6.25
Difficult to transport/bulkiness	1	1.01				
Poor quality seeds	1	1.01	2	3.03		
Low market demand for ware potato			1	1.52		
Mechanization in production and harvesting			1	1.52	1	6.25
Extended bags					2	12.5
Long distances from home to gardens			3	4.55		
Expensive seed potatoes			1	1.52		
High labor costs due to limited laborer			1	1.52		
High input costs such as that of seed			1	1.52		
Theft of inputs such as planted seeds			2	3.03		
Total	99	100	66	100	16	100

Table B5: Main source of seed potato and frequency of buying in the study area

Particulars	Farmers (n=116)		
	Freq.	Percent	Cum.
Household's main source of seed potato			
Bought from local trader/market	60	51.72	86.21
Own stock/harvest (recycled)	25	21.55	21.55
Bought from local seed producer/farmer	13	11.21	34.48
From private sources in Kampala	12	10.34	100
Gift from friends/neighbors, relatives	2	1.72	23.28
Clean/Positively selected seed producer	2	1.72	87.93
Community-based seed group/Cooperative	2	1.72	89.66
Household's main source of seed potato			
Total	116	100	
Frequency (after how many seasons) of buying new seed potato			
1-3 Seasons	89	78.76	98.23
4-6 seasons	13	11.5	19.47
Never buy new seed	9	7.96	7.96
7-10 Seasons	1	0.88	99.12
Over 10 seasons	1	0.88	100
Total	113	100	
Who decides how much potato to grow of what variety?			
Household head	62	53.45	53.45
Household head and Spouse	48	41.38	98.28
Spouse	4	3.45	56.9
household head and Other	1	0.86	99.14
Other	1	0.86	100
Total	116	100	
Who sells the potato crop produce?			
Household head	84	72.41	72.41
Household head and Spouse	25	21.55	99.14
Spouse	6	5.17	77.59
Other	1	0.86	100
Total	116	100	
Who decides how to use money from the ware potato sale?			
Household head	34	29.31	29.31
Spouse	3	2.59	31.9
Household head and Spouse	77	66.38	98.28
household head and Other	1	0.86	99.14
Other	1	0.86	100
Total	116	100	

Table B6: Household members responsible for various ware activities across farm households

Particulars	Planting (1)		Weeding (2)		Seed selection (3)		Pre-harvest (4)		Dehaulming (5)		Harvesting (6)	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
Who is most responsible for planting activity												
Women and men equally	54	46.55	49	42.61	34	29.57	38	36.19	28	28.57	54	46.96
Women, men and Children	28	24.14	18	15.65	6	5.22	3	2.86	3	3.06	17	14.78
Women	19	16.38	37	32.17	20	17.39	13	12.38	10	10.2	28	24.35
Men	12	10.34	5	4.35	52	45.22	44	41.9	46	46.94	14	12.17
Women & all children	3	2.59	5	4.35	3	2.61	3	2.86	3	3.06	2	1.74
Men with all children												
Women with girls			1	0.87								
Men with boys							4	3.81	8	8.16		
Total	**116**	**100**	**115**	**100**	**115**	**100**	**105**	**100**	**98**	**100**	**115**	**100**

Particulars	Transport from field to home (7)		Bagging (8)		Storage (9)		Transport to market (10)		Selling in the market (11)	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
Who is most responsible for planting activity										
Women and men equally	14	12.39	13	11.5	28	29.79	4	4.82	24	29.63
Women, men and Children	3	2.65	5	4.42	5	5.32	1	1.2		
Women	3	2.65	15	13.27	18	19.15	2	2.41	4	4.94
Men	75	66.37	67	59.29	38	40.43	65	78.31	49	60.49
Women & all children	7	6.19	3	2.65	4	4.26	1	1.2		
Men with all children	1	0.88	1	0.88						
Women with girls										
Men with boys	10	8.85	9	7.96	1	1.06	10	12.05	4	4.94
Total	**113**	**100**	**113**	**100**	**94**	**100**	**83**	**100**	**81**	**100**

Table B7: Preference and reasons for preferring certain potato varieties

Particulars	Farmers		Traders		Processors		Consumers	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Do you have preference for certain potato varieties? (0 = No; 1 = Yes)								
No							8	9.41
Yes							77	90.59
The main ware potato varieties grown/ traded in the study area								
Kabale/ Kabale red	51	43.97	26	36.62	7	21.21	40	51.28
Victoria	43	37.07	1	1.41	2	6.06	8	10.26
Wanale	9	7.76	1	1.41	6	18.18	17	21.79
Lwangume	3	2.59						
Nakpot 1- 4/5	3	2.59						
Sankena	2	1.72						
Kachpot	1	0.86						
Kakumi	1	0.86						
Magpot	1	0.86	1	1.41				
Makapon White	1	0.86						
Wanale red	1	0.86						
Agriculture			4	5.64				
AT			1	1.41				
Buwezo Rwanda)			1	1.41				
Civilian			1	1.41			3	3.85
Cruza			4	5.63				
Kapchorwa/Sebei			2	2.82	4	12.12		
Kasese					1	3.03		
Kenya			4	5.63				
Kinigye					1	3.03		
Kisoro					4	12.12	2	2.56
Kooki			1	1.41				
Masaka			2	2.82				
Mbale			13	18.31	3	9.09		
Mubende			2	2.82				
Red							2	2.56
Shanky			4	5.63	1	3.03		
Singo					4	12.12	4	5.13
Wanale white			3	4.23			1	1.28
White							1	1.28
Total	116	100	71	100	33	100	78	100

Table B8: First key reasons for market preference of certain potato varieties

Particulars	Farmers		Traders		Processors		Consumers	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
The first key reasons for the market preferring the variety								
Cheap			31	43.66				
Extended big bag			13	18.31	1	3.13		
Highly demanded			9	12.68				
Good for mashing			7	9.86	1	3.13	3	3.8
Good taste			3	4.23	1	3.13	18	22.78
Grown nearer/accessibility			2	2.82				
Good price			2	2.82			1	1.27
Big tubers			1	1.41	3	9.38	1	1.27
Early maturity			1	1.41				
Good quality/ not diseased			1	1.41			2	2.53
Availability/only available in that season			1	1.41			4	5.06
High yielding							3	3.8
Good processing attributes					7	21.88		
Longer shelf-life					1	3.13	5	6.33
Good for chips					16	50	17	21.52
Crunchy					1	3.13		
Makes good chips					1	3.13		
Doesn’t mash when cooked							14	17.72
Good cooking abilities							8	10.13
High dry matter content							3	3.8
Total			71	100	32	100	79	100

ANNEX C

Table C1: Change in potato demand and preference of potato varieties

Particulars	Farmers	
	Freq.	Percent
How is the demand for potatoes changing in this area?		
Increasing demand	97	85.84
Same demand	7	6.19
Low demand	6	5.31
No demand sometimes	3	2.65
Total	**113**	**100**
Please give reasons for this type of change?		
Population growth	22	23.16
Limited supply in seasons of scarcity	20	21.05
Many traders	11	11.58
Many farmers grow potatoes	10	10.53
New markets e.g. Soroti, Tororo	6	6.32
Other substitute foods are scarce	6	6.32
Low prices due to availability of alternative food crops	6	6.32
Potato business is profitable	4	4.21
Many benefits from potatoes food	3	3.16
Introduction of Kabale variety	3	3.16
Quality variety	1	1.05
Fast maturity	1	1.05
Good road network	1	1.05
Few traders	1	1.05
Total	**95**	**100**

Table C2: Whether there are linkages between value chain actors (VC) in the study area

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Whether there linkages between each VC actor and farmers (1=yes; 0=otherwise)						
No			21	29.58	25	75.76
yes	115	100	50	70.42	8	24.24
Total	115	100	71	100	33	100
Whether there linkages between each VC actor and cooperatives (1=yes; 0=otherwise)						
No	61	57.01	45	65.22	30	90.91
Yes	46	42.99	24	34.78	3	9.09
Total	107	100	69	100	33	100
Whether there linkages between each VC actor and wholesale traders (1=yes; 0=otherwise)						
no	5	4.42	2	2.78	9	27.27
yes	108	95.58	70	97.22	24	72.73
Total	113	100	72	100	33	100
Whether there linkages between each VC actor and retailers (1=yes; 0=otherwise)						
no	34	30.91	3	4.29	8	23.53
yes	76	69.09	67	95.71	26	76.47
Total	110	100	70	100	34	100
Whether there linkages between each VC actor and processors (1=yes; 0=otherwise)						
no	76	76.77	30	43.48	15	46.88
yes	23	23.23	39	56.52	17	53.13
Total	99	100	69	100	32	100

Table C3: Nature of linkages between value chain (VC) actors in the study area

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Nature of linkages between each VC actor and farmers						
Verbal arrangements	55	47.83	30	56.6	3	27.27
Informal	53	46.09	23	43.4	8	72.73
Written agreement	7	6.09				
Total	115	100	53	100	11	100
Nature of linkages between each VC actor and cooperatives						
Informal	22	38.6	11	36.67	5	83.33
Written agreement	19	33.33	9	30		
Verbal arrangements	16	28.07	10	33.33	1	16.67
Total	57	100	30	100	6	100
Nature of linkages between each VC actor and traders						
Verbal arrangements	62	55.86	43	60.56	16	66.67
Informal	48	43.24	24	33.8	8	33.33
Written agreement	1	0.9	4	5.63		
Total	111	100	71	100	24	100
Nature of linkages between each VC actor and retailers						
Verbal arrangements	42	52.5	42	60	18	66.67
Informal	38	47.5	25	35.71	9	33.33
Written agreement			3	4.29		
Total	80	100	70	100	27	100
Nature of linkages between each VC actor and processors						
Informal	29	76.32	19	45.24	7	36.84
Verbal arrangements	9	23.68	23	54.76	12	63.16
Total	38	100	42	100	19	100

Table C4: Linkages and existing level of trust with other value chain actors

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
If there are linkages, level of trust between each VC actor with other farmers						
Some trust	67	59.29	30	56.6	5	45.45
A little trust	41	36.28	16	30.19	6	54.55
No trust	4	3.54	6	11.32		
Distrust	1	0.88	1	1.89		
Total	113	100	53	100	11	100
If there are linkages, level of trust between each VC actor with cooperatives						
Some trust	25	45.45	19	63.33	1	16.67
A little trust	15	27.27	3	10		
No trust	9	16.36	6	20	4	66.67
Distrust	6	10.91	2	6.67	1	16.67
Total	55	100	30	100	6	100
If there are linkages, level of trust between each VC actor with traders						
A little trust	52	46.85	26	36.62	10	43.48
Some trust	32	28.83	36	50.7	12	52.17
No trust	25	22.52	9	12.68	1	4.35
Distrust	2	1.8				
Total	111	100	71	100	23	100
If there are linkages, level of trust between each VC actor with retailers						
A little trust	40	50.63	25	35.71	15	57.69
Some trust	23	29.11	36	51.43	10	38.46
No trust	13	16.46	9	12.86	1	3.85
Distrust	3	3.8				
Total	79	100	70	100	26	100
If there are linkages, level of trust between each VC actor with processors						
No trust	14	36.84	4	9.52	6	33.33
A little trust	11	28.95	17	40.48	6	33.33
Some trust	8	21.05	19	45.24	5	27.78
Distrust	5	13.16	2	4.76	1	5.56
Total	38	100	42	100	18	100

Table C5: Value Chain (VC) actor's meeting frequency with other organization in a year

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Frequency of meeting between other farmers with other VC actors' organization in a year						
Irregularly	44	41.51	31	64.58	8	88.89
Many times	30	28.3	8	16.67	1	11.11
Once	12	11.32	5	10.42		
Three times	12	11.32	1	2.08		
Twice	8	7.55	3	6.25		
Total	106	100	48	100	9	100
Frequency of meeting between cooperatives with other VC actors' organization in a year						
Irregularly	27	48.21	17	58.62	4	80
Many times	15	26.79	2	6.9		
Once	9	16.07	4	13.79	1	20
Three times	4	7.14	2	6.9		
Twice	1	1.79	4	13.79		
Total	56	100	29	100	5	100
Frequency of meeting between traders with other VC actors' organization in a year						
Irregularly	56	57.73	39	57.35	18	85.71
Many times	17	17.53	19	27.94	2	9.52
Once	9	9.28	3	4.41		
Twice	8	8.25	4	5.88		
Three times	7	7.22	3	4.41	1	4.76
Total	97	100	68	100	21	100
Frequency of meeting between retailers with other VC actors' organization in a year						
Irregularly	43	59.72	40	60.61	20	90.91
Three times	11	15.28	3	4.55		
Many times	7	9.72	17	25.76	2	9.09
Twice	6	8.33	2	3.03		
Once	5	6.94	4	6.06		
Total	72	100	66	100	22	100
Frequency of meeting between processors with other VC actors' organization in a year						
Irregularly	31	83.78	29	74.36	12	85.71
Once	3	8.11	2	5.13	1	7.14
Three times	2	5.41	5	12.82	1	7.14
Twice	1	2.7	3	7.69		
Total	37	100	39	100	14	100

ANNEX D

Table D1: Status of sorting and grading of ware potato tubers along the value chain

Particulars	Farmers (n=116)		Traders (n=72)		Processors (n=34)		Consumers (n=85)	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Do you sort and grade your potatoes? (0 = No; 1 = Yes)								
No	16	13.79	21	29.17	8	23.53	31	36.47
Yes	100	86.21	51	70.83	26	76.47	54	63.53
Total	**116**	**100**	**72**	**100**	**34**	**100**	**85**	**100**
If yes, at what stage do you grade your potatoes?								
During harvest	65	67.71						
When selling/preparing to sell	20	20.83						
Just before storing the tubers	11	11.46						
Total	**96**	**100**						
How do you sort and grade potatoes?								
Grade by sizes churns, small, medium, large	43	43.43	13	26	14	56		
Remove churns/Small stock for seed	23	23.23	1	2				
Remove greening tubers	17	17.17						
Grade by variety	8	8.08						
Remove damaged potatoes	5	5.05	33	66	9	36		
Do not grade	2	2.02	3	6	2	8		
Through others methods	1	1.01						
Total	**99**	**100**	**50**	**100**	**25**	**100**		
If yes, how are potatoes graded or sorted?								
Grade by sizes-churns, small, medium, large			27	71.05	6	60		
Remove churns/small for seed			6	15.79	1	10		
Remove damaged ones			4	10.53				
Grade by variety			1	2.63	2	20		
Remove greening tubers					1	10		
Total			**38**	**100**	**10**	**100**		

Table D2: Farm level utilization of potato obtained from 1 acre farm size harvest

Particulars	Farmers	
	Freq.	Percent
Use of all potatoes obtained from 1 acre farm size harvest		
Sell	66	70.97
Throw away as waste	19	20.43
Home consumption	3	3.23
Pay labor	3	3.23
Seed	1	1.08
Livestock feed	1	1.08
Total	**93**	**100**
Use of small potatoes(kg) sorted-out of per 1 acre farm size harvest		
Seed	52	58.43
Home consumption	30	33.71
Sell	6	6.74
Pay labor	1	1.12
Total	**89**	**100**
Use of medium and large potatoes (kg)sorted-out of per 1 acre farm size harvest		
Sell	83	93.26
Home consumption	4	4.49
Seed	2	2.25
Total	**89**	**100**
Use of cut and bruised potatoes (kg)sorted-out of per 1 acre farm size harvest		
Home consumption	59	71.08
Throw away as waste	15	18.07
Sell	7	8.43
Pay labor	2	2.41
Total	**83**	**100**
Use of greening potatoes (kg) sorted-out of per 1 acre farm size harvest		
Seed	17	70.83
Throw away as waste	3	12.5
Home consumption	1	4.17
Sell	1	4.17
Livestock feed	1	4.17
Pay labor	1	4.17
Total	**24**	**100**
Use of off-type variety potatoes(kg) sorted-out of per 1 acre farm size harvest		
Home consumption	2	50
Sell	1	25
Throw away as waste	1	25
Total	**4**	**100**

Table D3: Potato varieties that are less susceptible to postharvest degradation or loss

Particulars	Farmers		Traders		Processors		Consumers	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Potato varieties traded that are less susceptible to postharvest degradation								
Kabale			23	38.33	12	46.15		
Wanale			9	15	8	30.77		
Kisoro			9	15	2	7.69		
Kenya			3	5				
Kooki			2	3.33				
Wanale red			2	3.33				
Wanale white			2	3.33				
Agriculture			2	3.33				
Rakai			1	1.67				
Mubende			1	1.67				
Civilian			1	1.67				
Shanky			1	1.67				
Victoria			1	1.67	1	3.85		
Masaka			1	1.67				
Mbale			1	1.67	2	7.69		
Tooro			1	1.67				
Kinigye					1	3.85		
Total			**60**	**100**	**26**	**100**		

Table D4: Potato varieties that are more susceptible to postharvest degradation or loss

Particulars	Farmers		Traders		Processors		Consumers	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Potato varieties traded that are more susceptible to postharvest degradation								
Sebei			15	28.85	4	23.53		
Mbale			8	15.38	3	17.65		
Singo			6	11.54	1	5.88		
Kabale			6	11.54	2	11.76		
Victoria			3	5.77	2	11.76		
Kenya			2	3.85				
Kapchorwa			2	3.85				
Cruza			2	3.85				
Agriculture			2	3.85				
Kisoro			1	1.92	3	17.65		
Wanale white/Wanale			1	1.92	1	5.88		
Shanky			1	1.92				
Masaka			1	1.92				
Buwezo(Rwanda)			1	1.92				
Magpot			1	1.92				
Lwangume					1	5.88		
Total			52	100	17	100		

Table D5: Reasons for engaging in ware potato storage and incurring losses

Why do you store potatoes Harvested	Farmers		Traders		Processors		Consumers	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
If yes, why do you store potatoes?								
To set aside seed potatoes	32	50	1	4				
For home consumption	15	23.44	1	4				
To wait for buyers	8	12.5	10	40				
To wait for better prices	6	9.38	7	28				
To package them well	2	3.13						
once to reduce effect of rain	1	1.56						
To get the required quantities from far			1	4				
Lack of market			1	4				
Unsold potatoes have to be store			4	16				
To improve the quality of the processed					1	7.69		
To ensure constant availability of potatoes					11	84.62		
Cater for emergencies					1	7.69		
Total	**64**	**100**	**25**	**100**	**13**	**100**		

Table D6: Reasons for not engaging in ware potato storage and incurring losses

Particulars	Farmers		Traders		Processors		Consumers	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
If not, why don't you store ware potatoes for longer period?								
No improved storage/no stores	36	46.15	15	44.12				
To avoid storage losses (shrinkage and loss of weight)	20	25.64	1	2.94				
Fear of losses for potatoes easily perish/rot/germinate	9	11.54	1	2.94	5	25		
High family demand cannot allow for storing	6	7.69						
There is ready market	4	5.13	2	5.88	4	20		
New harvest on the market after 3 month	2	2.56						
Limited space	1	1.28			1	5		
Minimize rotting			11	32.35				
Limited capital			1	2.94				
Poor Market conditions			1	2.94				
Buy according to demand			1	2.94	8	40		
Poor market structures			1	2.94				
Need for money urgently					2	10		
Total	**78**	**100**	**34**	**100**	**20**	**100**		

Table D7: Indigenous methods used to mitigate postharvest ware potatoes losses

Particulars	Traders		Processors		Consumers	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Whether there are different indigenous methods/practices used to mitigate postharvest ware potato losses						
No	31	43.06	21	61.76	41	48.24
Yes	41	56.94	13	38.24	44	51.76
Total	**72**	**100**	**34**	**100**	**85**	**100**
If yes, what are these local technologies/practices?						
Cover with tapelines	5	12.2				
Putting them on pallets (not the ground)	6	14.63				
Spreading them on the floor in the house	6	14.63	5	35.71	13	29.55
Improved store with a wire mesh			1	7.14		
Proper storage (in a hole & covering with grass/soil)	2	4.88				
Loading carefully	2	4.88				
Packing & transporting when temperature is low	2	4.88				
Harvesting mature potatoes	2	4.88				
Purchasing according to demand/just enough at the time	1	2.44	3	21.43		
Cover under shade	2	4.88				
Drying for short time in the sun	1	2.44				
Regular turning in the storage room	1	2.44				
Store in dark mud rooms	2	4.88			3	6.82
Scatter on the clean dry ground uncovered	2	4.88	2	14.29	3	6.82
Place bags in the open	2	4.88				
Putting in a granary	3	7.32			1	2.27
Sorting out spoilt potatoes, regularly	2	4.88			11	25
Inquire about the days it has spent in			1	7.14		
Proper sorting during purchases			2	14.29		
Spread ash on the floor to absorb water					2	4.55
Putting in box					7	15.91
Covering potatoes in grass					1	2.27
Covering with dry banana leaves					1	2.27
Spreading in an aerated room					2	4.55
Total	**41**	**100**	**14**	**100**	**44**	**100**

Table D8: Potato storage and adoption of postharvest storage facilities

Particulars	Farmers (n=116)	
	Freq.	Percent
Have you sold potato that has been stored for a long time? (0 = No; 1 =Yes)		
No	99	85.34
Yes	17	14.66
Total	**116**	**100**
Are buyers able to detect potatoes stored for long; 1=yes; 0=otherwise		
No	60	51.72
Yes	56	48.28
Total	**116**	**100**
If yes, how do stored potatoes compete with freshly harvested potatoes		
Stored shrink and become soft in appearance	14	26.92
Stored don't look fresh	6	11.54
Stored reduce in weight and freshness	6	11.54
Some water is lost and has a new weight	4	7.69
Can compete well because fresh color	4	7.69
Stored are less moist while fresh are moist	4	7.69
Buyers don't mind so long as it's in the market	3	5.77
Stored potatoes during off season	3	5.77
Stored potatoes change color from fresh ones	2	3.85
They are clean unlike fresh ones	2	3.85
Fresh potatoes are hard and easily noticed	2	3.85
Proper storage	1	1.92
Stored potatoes are not watery	1	1.92
Total	**52**	**100**
Whether farmers face significant challenge of adopting postharvest storage facilities? 0 = No; 1=yes		
No	49	42.24
Yes	67	57.76
Total	**116**	**100**

Table D9: Challenges faced and support required for farmers to adopt storage facilities

Particulars	Farmers	
	Freq.	Percent
Challenges faced by farmers in adopting postharvest storage facilities in the study area		
No access to stores/stores not available	16	23.53
Poor and uncertified seed potato	12	17.65
Potato rot easily, especially when exposed to rain water	7	10.29
Stores expensive to construct, use, and maintain	7	10.29
Limited knowledge about PHL management & storage	7	10.29
Limited skills in store construction	6	8.82
The desire to get quick cash	5	7.35
Limited space at homes for storage	3	4.41
Pests and diseases e.g. rats eat potatoes	2	2.94
Low incomes	1	1.47
Limited capital	1	1.47
Theft of stored potatoes	1	1.47
Total	**68**	**100**
Support needed to promote the adoption of postharvest storage facilities in the study area		
Promote construction/and the use of low cost & improved stores	25	36.76
Improve and provide better quality seed potato	12	17.65
Construct communal stores for organized groups	10	14.71
Train farmers in how to construct and use stores	7	10.29
Improve training on pest control techniques	5	7.35
Provide farmers with subsidies on materials for store construction	3	4.41
Promote access to affordable loans (with low interest rates)	3	4.41
Promote better access to market information and markets	2	2.94
Form groups with evolving fund	1	1.47
Total	**68**	**100**

Table D10: Main practice used by farmers to minimize potato loss during transportation

Particulars	Farmers	
	Freq.	Percent
How do you minimize the level of potato damage/loss during the transportation of ware potato?		
Gentle handling of the sacks (soft dropping/careful driving)	20	21.74
Packing potatoes well in strong gunny bags	13	14.13
Gentle/proper loading on tracks (not over loading/offloading)	7	7.61
Use good quality sacks	7	7.61
Carrying potatoes on heads instead on donkeys	7	7.61
Cover them from rain and water with tapelines	5	5.43
Sorting out the spoilt ones	5	5.43
Handling donkeys carefully and support provision	5	5.43
Supervision	4	4.35
Utilizing improve roads to speed up movement of potatoes without decay	2	2.17
Selling at farm gate	2	2.17
Not loading when it's raining	2	2.17
Transporting potatoes direct to selling	2	2.17
Sowing the top of gunny bags with sisal	2	2.17
Load potatoes only on trucks	2	2.17
Cover them from sunshine	1	1.09
Immediate transportation and sale of potatoes	1	1.09
Early harvesting when there is no rain	1	1.09
Use motorcycles with instruction	1	1.09
Use of wheelbarrows	1	1.09
Removing soil before transportation	1	1.09
Using containers trucks	1	1.09
Total	**92**	**100**

Table D11: Different damages to potato tubers and variation in shelf-life in the study area

Variable	Traders		Processors		Consumers	
	Obs	Mean	Obs	Mean	Obs	Mean
Proportion of cut tubers out of 100 percent damage incurred	72	26.80 (21.43)	34	29.67 (18.31)		
Proportion of bruised tubers out of 100 percent damage incurred	72	22.11 (14.76)	34	20.19 (10.83)		
Proportion of greening potatoes out of 100 percent damage incurred	72	7.03 (6.88)	34	6.63 (3.71)		
Proportion of rotten tubers out of 100 percent damage incurred	72	30.92 (27.26)	34	29.93 (15.37)		
Proportion of other type of deterioration of out of 100 percent damage incurred	72	40.00 (9.63)	34	3.75 (1.44)		
Shelf-life (in weeks) of potatoes after harvest under business as usual scenario (no storage practice)	72	2.02 (2.46)	34	1.85 (1.32)		
Shelf-life (in weeks) of potatoes after harvest under conditions of existing storage practices	72	5.80 (6.54)	34	4.58 (3.15)		
Length of time (in days) different storage practices/technologies keep potatoes in good condition before deteriorating	72	17.95 (14.99)	34	24.38 (5.04)	85	30.11 (31.03)
Length of time (in days) actors usually store potato (between purchasing and sale/processing)?			34	4.46 (2.04)	85	30.11 (31.03)

Notes: (i) Standard deviations are in parentheses

Table D12: Totally damaged potatoes (physical losses) out of 100 kg bag purchased and sold

Variable	Farmers (n=116)		Traders (n=72)		Processors (n=34)		Consumers (n=85)	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Quantity(kg) of totally damaged potatoes on the farm, out of 100 kg bag purchased and sold	116	7.81 (6.09)	72	4.86 (5.53)	34	1.10 (1.09)		
Quantity(kg) of totally damaged potatoes at bulking/collection point out of 100 kg bag purchased & sold	116	2.65 (3.19)	72	0.88 (1.40)	34	0.00 0.00		
Quantity(kg) of totally damaged potatoes during transport/handling, out of 100 kg bag purchased and sold	116	3.06 (3.16)	72	3.96 (4.55)	34	0.64 (0.57)	85	2.31 (4.74)
Quantity(kg) of totally damaged potatoes at the delivery point, out of 100 kg bag purchased and sold	116	0.77 (1.43)	72	3.81 (4.18)	34	0.93 (0.99)		
Quantity(kg) of totally damaged potatoes in storage out of 100 kg bag purchased and sold	116	5.52 (4.63)	72	3.17 (3.86)	34	0.82 (0.85)	85	5.43 (6.90)
Quantity (kg) of totally damaged potatoes during wholesale market conditions, out of 100kg bag purchased and sold	116	1.89 (2.13)	72	2.52 (2.86)	34	0.42 (0.88)		
Quantity (kg) of totally damaged potatoes during household consumption, out of 100 kg bag purchased	116	5.96 (3.94)	72	1.13 (2.58)	34	0.00 0.00		
Quantity (kg) of totally damaged potatoes during processing, out of 100 kg bag purchased	116	0.04 (0.19)	72	0.00 0.00	34	1.97 (3.04)		
Quantity (kg) of totally damaged potatoes during other stages, out of 100 kg bag purchased & sold	116	0.00 0.00	72	0.00 0.00	34	0.00 0.00		
Quantity (kg) of totally damaged potatoes during all stages, out of 100 kg bag purchased and sold	**116**	**15.69 (13.07)**	**72**	**11.54 (10.88)**	**34**	**4.35 (2.78)**		
Proportion(%) of totally damaged potatoes on the farm, out of 100% bag purchased and sold	116	8.05 (6.45)	72	4.56 (5.29)	34	1.01 (0.99)		
Proportion (%) of totally damaged potatoes at bulking point, out of 100% bag purchased and sold	116	2.65 (3.19)	72	0.85 (1.36)	34	0.00 0.00		
Proportion (%) of totally damaged potatoes during transport/handling, out of 100% bag purchased and sold	116	3.06 (3.16)	72	3.66 (4.37)	34	0.64 (0.57)	85	2.31 (4.74)
Proportion (%) of totally damaged potatoes at the delivery, out of 100% bag purchased and sold	116	0.77 (1.43)	72	3.80 (4.18)	34	0.86 (0.85)		

Variable	Farmers (n=116)		Traders (n=72)		Processors (n=34)		Consumers (n=85)	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Proportion(%) of totally damaged potatoes in storage, out of 100% bag purchased & sold	116	5.52 (4.63)	72	3.07 (3.77)	34	0.80 (0.84)	85	5.43 (6.90)
Proportion(%) of totally damaged potatoes during wholesale market conditions, out of 100% bag purchased and sold	116	1.89 (2.13)	72	2.37 (2.61)	34	0.35 (0.74)		
Proportion(%) of totally damaged potatoes during household consumption, out of 100% bag purchased and sold	116	5.96 (3.94)	72	1.13 (2.58)	34	0.00 0.00		
Proportion(%) of totally damaged potatoes during processing, out of 100% bag purchased and sold	116	0.04 (0.19)	72	0.00 0.00	34	1.97 (3.04)		
Proportion(%) of totally damaged potatoes during other stages, out of 100% bag purchased and sold	116	0.00 0.00	72	0.00 0.00	34	0.00 0.00		
Proportion(%) of totally damaged potatoes during all stages, out of 100% bag purchased and sold	**116**	**15.90 (13.14)**	**72**	**11.00 (10.61)**	**34**	**4.18 (2.72)**		

Notes: (i) Standard deviations are parentheses

Table D13: Partially damaged potatoes (Economic losses) out of 100 kg bag purchased and sold

Variable	Farmers (n=116)		Traders (n=72)		Processors (n=34)	
	Obs	Mean	Obs	Mean	Obs	Mean
Quantity(kg) of partially damaged potatoes on the farm, out of 100 kg bag purchased and sold	116	9.76 (8.00)	72	6.19 (6.25)	34	2.20 (2.00)
Quantity(kg) of partially damaged potatoes at bulking/collection point, out of 100 kg bag purchased and sold	116	3.98 (4.33)	72	2.02 (2.27)	34	0.33 (0.49)
Quantity(kg) of partially damaged potatoes during transport/handling, out of 100 kg bag purchased and sold	116	4.19 (3.36)	72	3.04 (4.82)	34	0.91 (0.87)
Quantity(kg) of partially damaged potatoes at the delivery point, out of 100 kg bag purchased and sold	116	0.87 (1.74)	72	3.13 (3.54)	34	1.85 (2.94)
Quantity(kg) of partially damaged potatoes in storage, out of 100 kg bag purchased and sold	116	2.87 (4.01)	72	2.48 (5.26)	34	0.61 (0.70)
Quantity(kg) of partially damaged potatoes during wholesale market conditions, out of 100 kg bag purchased and sold	116	1.88 (2.99)	72	2.73 (4.18)	34	0.00 0.00
Quantity(kg) of partially damaged potatoes during household consumption, out of 100 kg bag purchased and sold	116	4.39 (5.94)	72	1.71 (2.74)	34	0.17 (0.35)
Quantity(kg) of partially damaged potatoes during processing, out of 100 kg bag purchased and sold	116	0.04 (0.19)	72	0.00 0.00	34	3.06 (4.17)
Quantity(kg) of partially damaged potatoes during other stages, out of 100 kg bag purchased and sold	116	0.00 0.00	72	0.00 0.00	34	0.00 0.00
Quantity(kg) of partially damaged potatoes during all stages, out of 100 kg bag purchased and sold	**116**	**17.46 (17.16)**	**72**	**12.13 (13.97)**	**34**	**6.54 (5.47)**
Proportion(%) of partially damaged potatoes on the farm, out of 100% bag purchased and sold	116	9.76 (8.00)	72	5.82 (5.92)	34	2.07 (1.89)
Proportion(%) of partially damaged potatoes at bulking point, out of 100% bag purchased and sold	116	3.98 (4.33)	72	1.94 (2.23)	34	0.33 (0.49)
Proportion(%) of partially damaged potatoes during transport/handling, out of 100% bag purchased and sold	116	4.19 (3.36)	72	3.00 (4.83)	34	0.91 (0.87)
Proportion(%) of partially damaged potatoes at the delivery, out of 100% bag purchased and sold	116	0.87 (1.74)	72	3.10 (3.54)	34	1.85 (2.94)

Variable	Farmers (n=116)		Traders (n=72)		Processors (n=34)	
	Obs	Mean	Obs	Mean	Obs	Mean
Proportion(%) of partially damaged potatoes in storage, out of 100% bag purchased and sold	116	2.87 (4.01)	72	2.48 (5.26)	34	0.61 (0.70)
Proportion(%) of partially damaged potatoes during wholesale market conditions, out of 100% bag purchased and sold	116	1.88 (2.99)	72	2.63 (4.17)	34	0.00 0.00
Proportion(%) of partially damaged potatoes during household consumption, out of 100% bag purchased and sold	116	4.39 (5.94)	72	1.65 (2.73)	34	0.17 (0.35)
Proportion(%) of partially damaged potatoes during processing, out of 100% bag purchased and sold	116	0.04 (0.19)	72	0.00 0.00	34	2.40 (3.48)
Proportion(%) of partially damaged potatoes during other stages, out of 100% bag purchased and sold	116	0.00 0.00	72	0.00 0.00	34	0.00 0.00
Proportion(%) of partially damaged potatoes during all stages, out of 100% bag purchased and sold	**116**	**17.46 (17.16)**	**72**	**11.74 (13.86)**	**34**	**5.93 (5.27)**

Notes: (i) Standard deviations are parentheses

ANNEX E

Table E1: Practices undertaken to ensure supply of good quality potatoes in the area

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
What do you normally do to ensure the supply of quality of ware potatoes						
Good management practices fertilizing s	25	22.12				
Proper seed selection from right source	17	15.04				
Grade or sort them before sale	14	12.39				
Better planting methods	13	11.5				
Harvesting/buying mature potatoes	11	9.73	13	25		
Supervision during production process	5	4.42				
Carefully harvesting to reduce cuts wit	5	4.42				
Buy new seed after every two seasons	4	3.54				
Good postharvest management	3	2.65				
Dehaulming	3	2.65				
Keeps some produce for own seed	2	1.77				
Proper transportation	2	1.77				
Transporting immediately after harvesting	2	1.77				
Protecting ware potatoes from rain	2	1.77	1	1.92		
Early planting and storing seed	1	0.88				
Good handling	1	0.88				
Proper storage	1	0.88				
Use of new bags/proper packaging	1	0.88	1	1.92		
Delivering potatoes myself	1	0.88				
Grading/sorting potatoes before packing			23	44.23	9	28.13
Dealing with reliable farmers/dealers			4	7.69		
Maintaining a good relationship with other VC actors			2	3.85	2	6.25
Buying from middlemen to avoid losses d			2	3.85		
Honesty when dealing with traders			1	1.92	5	15.63
Sells varieties preferred by customers			1	1.92		
Supplying potatoes in time/and with spicing			1	1.92	2	6.25
Paying farmers increased price than pre			1	1.92		
Honesty when dealing with customers			1	1.92	2	6.25
Selling/processing mature potatoes harvested			1	1.92	9	28.13
Processing on demand					2	6.25
Using fresh oil every time					1	3.13
Total	**113**	**100**	**52**	**100**	**32**	**100**

Table E2: Variation in potato quality and market price during peak and off-peak seasons

Variable	Farmers (n=116)		Traders (n=72)		Processors (n=34)		Consumers (n=85)	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Peak season								
Proportion of good quality potatoes during peak season			72	77.94 (11.54)	34	85.96 (10.02)		
Proportion of medium quality potatoes during peak season			72	27.38 (12.36)	34	17.41 (5.42)		
Proportion of poor quality potatoes during peak season			72	12.60 (9.87)	34	14.17 (15.28)		
Average purchase price per kg of good quality potatoes during peak season	116	354.14 (103.14)	72	444.09 (173.74)	34	939.78 (292.11)	85	537.39 (214.53)
Average purchase price per kg of medium quality potatoes during peak season			72	381.79 (182.06)	34	955.17 (297.25)	85	439.47 (198.84)
Average price (UGX/kg) of poor quality potatoes during peak season	116	202.16 (128.10)						
Average purchase price per kg of poor quality potatoes during peak season	116	668.10 (313.42)	72	316.93 (191.69)	34	825.43 (245.61)	85	283.40 (134.60)
Average sale price per kg of good quality potatoes during peak season	116	361.64 (273.49)	72	612.27 (233.62)	34	4318.72 (969.24)		
Sale price per kg of medium quality potatoes during peak season			72	487.92 (202.26)	34	3889.22 (419.85)		
Sale price per kg of poor quality potatoes during peak season			72	325.46 (169.33)	34	1750.00 (61.55)		
Off-peak season								
Proportion of good quality potatoes during off peak-season			72	71.68 (18.14)	34	87.35 (9.09)		
Proportion of medium quality potatoes during off peak-season			72	22.30 (12.18)	34	14.31 (5.20)		
Proportion of poor quality potatoes during off peak-season			72	10.44 (10.08)	34	11.21 (13.91)		
Purchase price per kg of good quality potatoes during off peak season			72	783.72 (361.55)	34	1651.23 (167.91)	85	1206.26 (496.12)

Variable	Farmers (n=116)		Traders (n=72)		Processors (n=34)		Consumers (n=85)	
	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Purchase price per kg of medium quality potatoes during off peak-season			72	645.39 (329.74)	34	1541.38 (129.45)	85	989.94 (451.67)
Purchase price per kg of poor quality potatoes during off peak-season			72	420.15 (256.06)	34	1399.14 (157.93)	85	654.30 (270.66)
Sale price per kg of good quality potatoes during off peak season			72	1060.45 (470.25)	34	5960.35 (2891.27)		
Sale price per kg of medium quality potatoes during off peak season			72	897.92 (449.92)	34	2941.09 (1029.16)		
Willingness to pay (UGX/bag)of 100kg of potatoes for up to 4 months after harvest	116	3641.38 (3103.60)	72	574.89 (348.15)	34	824.35 (512.19)		

Notes: (i) Standard deviations are parentheses

Table E3: How to improve the handling of ware potato to reduce PHLs from the farm to market

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
How should the handling practices of ware potato from the farm to market be improved?						
Proper handling/careful loading and off loading	13	12.87	4	5.71	2	6.45
Improving storage facilities/access to better storage facilities	12	11.88	12	17.14	1	3.23
Pack well in sacks not throwing them on trucks	10	9.9				
Transport potatoes in good facilities (vehicles or bodaboda) direct to selling point	9	8.91	5	7.14		
Harvesting carefully to reduce cuts and bruises (e.g. using hands)	9	8.91			1	3.23
Improving roads to easily access market	9	8.91	1	1.43		
Harvesting mature potatoes	7	6.93	6	8.57	2	6.45
Farmers/other value chain actors should be trained in proper potato handling skills	6	5.94	5	7.14	2	6.45
Good agronomic practices/management of potatoes at the farm/spraying against pests	6	5.94	5	7.14	3	9.68
Use of better harvesting tools e.g. use of hands to reduce on cuts	4	3.96	7	10		
Covering potatoes to avoid rain water wetting potatoes/sunshine	4	3.96	5	7.14	2	6.45
Packing and transporting at night when temperatures are low to deliver fresh potatoes	4	3.96	1	1.43	9	29.03
Packaging properly/avoid packing wet potatoes with too much soil	2	1.98	1	1.43	2	6.45
Use proper packages (carrier boxes like is the case with tomatoes to reduce on bruises	2	1.98	3	4.29	1	3.23
Good handling of donkeys carrying potato	1	0.99				
Use of nets like in the case of onions	1	0.99				
Grading and sorting of potatoes before packing	1	0.99	8	11.43	5	16.13
Providing/seeking reliable and timely market information	1	0.99				
Removing all the soil before packing			2	2.86	1	3.23
Cover trucks during transportation with tapelines			1	1.43		
Ensuring that only fresh potatoes reach/sell in the market			1	1.43		
Traders in markets need a permanent place/stop shifting every time			1	1.43		
Use of basins			1	1.43		
Avoid heaping			1	1.43		
Total	**101**	**100**	**70**	**100**	**31**	**100**

ANNEX F

Table F1: Major potato postharvest related problems

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Postharvest related problems faced						
No stores/limited space for storage	24	25.81				
Loss of weight due to use of poor storage facilities/water loss	19	20.43	1	1.89		
High economic and physical loss due to rotting of tubers	15	16.13	21	39.62		
Potato bruising due to too much rain water/bad weather	8	8.6	2	3.77	3	15
Theft by hired laborers	5	5.38				
Damages due to poor transportation/ look good outside	4	4.3			3	15
Potatoes affected by diseases and pests/poor quality	4	4.3	1	1.89	4	20
Lack access to improved storage facility for potatoes	3	3.23	10	18.87	4	20
Wastages(cuts, bruises, rotting)due improper harvesting	3	3.23	5	9.43	3	15
Limited knowledge about storage	2	2.15				
Greening of tubers when exposed to sunlight	2	2.15	4	7.55		
Limited labor	2	2.15				
Rotting of seed potato when under storage	1	1.08				
Children encroach on stored potatoes	1	1.08				
Poor harvesting tools damages potato tubers			1	1.89		
Damaged tubers are packed with good one			2	3.77	3	15
Bad weather conditions			4	7.55		
Wastages due to harvesting immature potatoes			2	3.77		
Total	**93**	**100**	**53**	**100**	**20**	**100**

Table F2: Major potato market related problems

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Market related problems faced						
Low prices leads to losses	48	43.64	25	35.21	10	38.46
Price fluctuations	25	22.73				
Limited market in seasons of plenty	14	12.73				
Distant markets which causes delays	6	5.45				
Dishonest traders/ price exploitation by middlemen	5	4.55	2	2.82	1	3.85
Too much market supply during peak season	3	2.73				
Losses/spoilage during marketing delays	2	1.82			1	3.85
Traders collude and reduce prices/exploitation	2	1.82				
Lack of information about market and prices	2	1.82				
No/poor market infrastructure	2	1.82	2	2.82		
Compelled to sale due to the urgent need for cash	1	0.91				
High prices for fresh potatoes					4	15.38
Poor quality potatoes of small size			6	8.45		
In peak seasons there more supply& more wastages/ loses			5	7.04		
Bad debtors/low purchasing power of clients			4	5.63		
Low sales/demand lead to damages/spoilage			4	5.63	1	3.85
Displacement of traders by city authority			3	4.23	2	7.69
Distant markets			3	4.23		
Theft/unreliable workers			3	4.23	1	3.85
High market dues/taxes			2	2.82	1	3.85
Unreliable weather conditions			2	2.82		
High competition in markets due to ma			2	2.82	1	3.85
Lack of enough capital to buy high prices inputs			2	2.82	2	7.69
Unstable supply			2	2.82		
Unsorted/potatoes packed with soil affects quality			1	1.41		
Bulling (e.g. Women traders are insulted			1	1.41		
Working along the roadside is risky due to accidents			1	1.41		
Congestion in markets due small space			1	1.41		
Darkening of oil during processing					1	3.85
Unfavorable working hours					1	3.85
Total	**110**	**100**	**71**	**100**	**26**	**100**

Table F3: Major potato transport related problem

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Transport related problems faced						
High transport cost due to bad terrain	33	34.02	12	25.53	2	22.22
Bad roads/poor road network	17	17.53	9	19.15		
Poor road as during rainy season, transport difficult	17	17.53				
Long distance between gardens & homesteads/main roads, inaccessibility	12	12.37	3	6.38		
Lack of reliable transport means especially during peak season	10	10.31	3	6.38		
Bruises due to poor handling of potatoes	5	5.15	1	2.13	4	44.44
Theft of the potato produce	2	2.06	2	4.26		
Less donkeys yet they are expensive to maintain	1	1.03				
Delayed supply			5	10.64	2	22.22
High taxes/ expenses on roads			3	6.38		
Bad terrain			3	6.38		
Vehicles get mechanical problems			2	4.26		
Donkeys cause damages to potatoes			1	2.13		
Proper handling during loading,			1	2.13		
Inaccessible selling points			1	2.13		
High border costs			1	2.13		
High fuel prices					1	11.11
Total	97	100	47	100	9	100

Table F4: Opportunities in potato postharvest handling in study area

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Postharvest related opportunities						
Introduced improved storage technology in the area	21	35.59				
Collective and better stores are being/to be constructed in the area	12	20.34	10	34.48	2	28.57
Gets training on storage and postharvest handling	8	13.56	5	17.24		
Supervision during harvesting reduce cuts/damage	8	13.56				
Potatoes good source of home food	6	10.17				
NGOs are showing interest in providing stores	2	3.39				
Cheap labor	1	1.69				
Can retain some produce as seed	1	1.69				
Sort and grading before transporting/purchasing			4	13.79	5	71.43
Improved technologies			4	13.79		
Few damages on potatoes if kept well			2	6.9		
Ready market/ demand			2	6.9		
Not so perishable like tomatoes			1	3.45		
Selecting potatoes of good quality at farm gate			1	3.45		
Total	**59**	**100**	**29**	**100**	**7**	**100**

Table F5: Major opportunities in potato marketing in the study area

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Market related opportunities						
Increased market/number of traders in neighboring districts and Kampala city	25	25.51	4	5.97	8	27.59
Increased number of customers/demand	19	19.39	19	28.36	4	13.79
Storing for long periods before selling	17	17.35				
Good prices offered during some periods	16	16.33	18	26.87		
Practicing collective marketing/farm groups	9	9.18	1	1.49		
Meeting new people/collaborators/client	4	4.08	3	4.48	3	10.34
Selling irrigated potatoes fetch higher	3	3.06				
Improved market infrastructure/ marketing channels	2	2.04	1	1.49	2	6.9
Improved telecommunication in the area	1	1.02	2	2.99		
Use of technology helps look out for buyers that offer high prices	1	1.02				
Reduced competition in the market	1	1.02				
Storage facilities are being/ to be constructed					1	3.45
High quality potatoes/sorting well adopted			5	7.46	1	3.45
Guaranteed supply			4	5.97		
Improved family standards of living			4	5.97		
Not easily perishable like carrots and			1	1.49		
Processing of other potato products like crisps easy			1	1.49	2	6.9
Use of clean seed by farmers reduces damages			1	1.49		
Available capital from other investment			1	1.49		
Buying on credit from wholesalers			1	1.49		
Allowed to sell on roadside during seasons of plenty supply			1	1.49		
Working at your convenience					2	6.9
Processing according to demand					2	6.9
Good and improved customer care					2	6.9
Exploring new markets e.g. near universities					2	6.9
Total	**98**	**100**	**67**	**100**	**29**	**100**

Table F6: Major opportunities in potato transport in the area

Particulars	Farmers		Traders		Processors	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Transport related opportunities						
Good roads to town enable us get good prices	10	24.39				
Many transporters during harvesting season	8	19.51				
Many trucks/transportation facilities now available for hire	7	17.07	5	15.63	4	66.67
Key road soon going to be tarmacked	4	9.76				
New roads, including access roads planned for construction	4	9.76	11	34.38		
Bulk transportation now possible/ big trucks available	4	9.76	2	6.25		
Roads soon to be repaired	2	4.88				
Use of animal transport in the area	2	4.88				
Low taxes			3	9.38		
Careful handling e.g. Use careful porters to load and off load			3	9.38		
Vehicles not expensive to hire/convenient system			2	6.25		
Low transportation costs/ do own potato transportation			2	6.25	2	33.33
Doesn't incur transportation costs			2	6.25		
Wholesalers free to sell supplies on trucks/act as temporary stores			1	3.13		
Less damages caused during transportation			1	3.13		
Total	41	100	32	100	6	100