Wealth Creation through Integrated Development of the Potato Production and Marketing Sector in Kenya, Uganda, and Ethiopia

Final Report

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I. Abbreviations and Acronyms

3G	Three-field generations
A2N	Africa 2000Network-Uganda
BBW	Banana bacterial wilt
BS	Basic seed
BW	Bacterial wilt
CFC	Common Fund for Commodities
CIP	Centro Internacional de la Papa (International Potato Center)
DAO	District Agricultural Office
DLG	District Local Government
DLS	Diffused light store
DPSF	District Potato Stakeholder Forum
EIAR	Ethiopian Institute of Agricultural Research
ELISA	Enzyme linked immunosorbent assay
FAO	Food and Agriculture Organization
FGs	Farmer groups
FPS	Farmer practice seed
FSS	Farmer selected seed
G1	Generation1
G2	Generation 2
G3	Generation3
KARI	Kenya Agricultural Research Institute
KAZARDI	Kachwekano Zonal Agricultural Research and Development Institute
KDSPCS	Kabale District Seed Potato Producers' Cooperative Society Ltd.
KDSPPA	Kabale District Seed Potato Producers' Association
KSPMA	Kanungu Seed Potato Multipliers' Association
LB	Late blight
MoA	Ministry of Agriculture
MSc	Master of Science
NAADS	National Agricultural Advisory Services
NARL	National Agricultural Research Laboratories
NARO	National Agricultural Research Organization
NEC	National Executive Committee
NGOs	Non-Governmental Organizations
NPDP	National Potato Development Plan
PEA	Project Executing Agency
PIA	Project Implementing Agency
PLC	Private Limited Company
PLRV	Potato leaf roll virus
PS	Positive election
PSS	Positive selected seed
PVA	Potato virus A
PVM	Potato virus M
PVS	Potato virus S
PVX	Potato virus X
t	tons
ToT	Training of Trainers
UNSPPA	Uganda National Seed Potato Producers' Association
USAID	United States Agency for International Development
WCPP	Wealth Creation Potato Project

II. Acknowledgement

The Wealth Creation Potato Project implemented in Ethiopia, Kenya and Uganda, from September 2008 to December 2012 was funded by Common Fund for Commodities (CFC). Common Fund for Commodities is further credited for granting a four-month (August – December 2012) no-cost extension period that allowed the project partners to accomplish all the project activities. Special thanks go to the International Potato Center (CIP), the Project Executing Agency (PEA) for its technical support and guidance offered to project partners throughout the project period.

Special tribute goes to the project Implementing Agencies (PIAs) that included the National Agricultural Research Institutes (NARIs) in the three project countries: Kachwekano Zonal Agricultural Research and Development Institute in Uganda, Kenya Agricultural Research Institute and the Ethiopian Institute of Agricultural Research in Kenya and Ethiopia, respectively. The Ministry of Agriculture; Kabale and Kanungu districts local governments in Uganda; Molo, Kuresoi and Bomet District Agricultural Offices (DAOs) in Kenya and West Shewa Zone (Cheleya and Tikur- inchini districts) South West Shewa (Wonchi district), Guragie zones (Gumer and Geta districts), and Tigray Zone (Atsbi district) in Ethiopia.

Our earnest gratitude goes to the private partners: TomCris Enterprise (Uganda), Solagrrow PLC (Ethiopia) and Deepa Industries Limited (Kenya) for playing a pivotal role by providing a stable market for both seed and ware potatoes and for their willingness to invest in potato processing. Participating potato farmers in the three countries are highly acknowledged for their dedication and for embracing the technologies and innovations disseminated by the project.

III. Executive Summary

The four-year project "Wealth creation through integrated development of potato production and marketing sub-sector in Ethiopia, Kenya and Uganda" was funded by Common Fund for Commodities (CFC). It was initiated in September 2008 by the International Potato Center (CIP) in partnership with the Ministries of Agriculture, National Agricultural Research Institutes (NARIs), and private companies in the three project countries. The project was wound up in December 2012. The overall purpose of the project was to demonstrate the effectiveness of poverty reduction through integrated development of the seed and ware potato production and marketing chains. This was achieved through the realization of three project objectives: (1) increase the availability of high quality seed at affordable prices; (2) increase smallholder potato farmers' income by boosting potato yields through improved seed potato quality management and crop husbandry; and (3) improve market linkages and communication between potato value chain stakeholders. The fourth objective focused on translating project results into national potato sector development plans and sharing project lessons with international partners.

At the start of the project, the expected outcomes seemed too ambitious and difficult to achieve. This was compounded by the fact that the potato sub-sector in the project countries is faced with numerous challenges, such as limited supply of quality seed, poor agronomic practices, sub-optimal levels of recommended farm inputs, lack of access to credit facilities, inefficient marketing systems characterized by *ad-hoc* sales and limited processing varieties, among others. Other major constraints especially in Kenya included the presence of broker and trader cartels that weakened farmers' unity and lack of ware potato storage facilities that aggravated the problem. As a result, brokers and traders determined the farm gate prices without considering the cost of production, quality, and prevailing prices in the major urban markets.

The project contributed to solving these problems by strengthening market linkages and communication between potato value-chain actors and service providers. It increased production of quality seed and accessibility through use of improved conventional methods and aeroponics (a new rapid method of mini-tuber multiplication), promoted seed storage technologies, and built farmers' capacity through hands-on trainings. The training covered all aspects of potato production, marketing, and utilization. The project also improved marketing efficiency by linking trained farmers to markets. This was made possible through informal and formal contract farming among the seed growers, ware potato growers and processors in the three countries. The contract arrangement strengthened farmers' negotiations skills and encouraged value chain interactions among producers, buyers, credit facilities, and other stakeholders.

The project commonly referred to as Wealth Creation Potato Project (WCPP) surpassed its targets in the amount of quality seed produced by the trained seed growers, the number of DLS constructed and/or modified (five times higher than the target 27, which ranged from 12 times in Ethiopia, four times in Uganda and double in Kenya), the number of male and female farmers trained (more than 8,700, against the target 6000, 2000 in each country), especially in Ethiopia and the number of farmers engaged in contract farming in Kenya (three times higher than the target of 100). The project was also credited for providing information on the possibility of cross-border trade for potato and its products. It conducted a feasibility study on seed and ware potato export to document strengths, weaknesses, opportunities and threats in potato trade. The project in collaboration with potato stakeholders in each project country supported the preparation of the national potato development plan as a blue print to guide the industry. This was designed to determine the level of community involvement in potato production, consumption and marketing and as a means of improving livelihoods of the communities in Kenya, Ethiopia and Uganda.

In summary the WCPP has specifically:

- ***Introduced aeroponics, a rapid seed multiplication technology in Ethiopia*****:** the project constructed aeroponics units in collaboration with a USAID funded project which is the first of its kind in Ethiopia. The project contributed consumables to smoothly run the aeroponics units constructed by the USAID-funded "3G" project in 2009/2010 at KARI-Tigoni in Kenya and at KAZARDI in Uganda.
- ***Increased mini-tuber (MT) production***: Use of the aeroponics technology increased the annual MT production from the initial 20,000 under soil-based system to over 1 million in Kenya and from about 10,000 to over 90,000 in Uganda while in Ethiopia, 114,864 MT were produced within a period of less than two years.
- ***Trained seed growers:*** The project trained 162 (75 in Kenya and 87 in Uganda) commercial seed multipliers using a workshop approach while in Ethiopia, more than 1,500 farmers were trained using block training approach. The trained farmers were charged with the responsibility of producing certified/quality declared seed which they sold to trained ware farmers.
- ***Improved pest and disease control:*** The project instituted seed inspection, indexing for latent bacterial wilt (BW) and virus infection and inbuilt feedback mechanisms to trained seed growers to inform them of the results and discuss control measures. The national potato research program in each project country was supported with laboratory chemicals and disease testing kits. Field trials to monitor aphid population dynamics were conducted on-station and in the farmers' seed fields in the three countries. The project also contributed to the implementation of a Quality Declared Planting Materials (QDPM) system by the CIP/USAID project in Ethiopia.
- ***Increased production and accessibility of quality seed***: Over 290 (93 in Ethiopia, 80 in Kenya and 120 in Uganda) tons (t) of basic seed was distributed and/or sold to trained seed farmers. An additional 49.8 t of seed was used as a revolving seed among the trained farmers in Ethiopia. The seed growers produced more than 3,500 (2,313 in Ethiopia & about 1,200 in Kenya) tons of quality seed which they sold to the trained ware farmers. The use of quality seed resulted in higher yields among the participating farmers from about 8 t/ha at the start of the project in 2008 to over 30 t/ha in Ethiopia and from less than 10 t/ha in 2008 both in Kenya and Uganda to about 14 t/ha in 2012.
- ***Trained extension officers and development agents***: Over 360 extension officers and development agents, comprising of both men and women were trained to backstop farmers in a training of trainers (ToT) approach. In Ethiopia, a total of 296 development agents were trained at Holetta Agricultural Research Centre (HARC); 61 and 7 Ministry of Agriculture (MoA) extension officers were trained in Kenya and Uganda, respectively. In Kenya and Uganda, the trainers were taken through the eight positive selection (PS) modules for two cropping seasons before they were charged with the responsibility of training Farmer Groups (FG) of 15-20 member farmers each. In addition 64 farmers were trained as trainers in Uganda.
- ***Improved the knowledge and skills of smallholder ware growers****:* Over 8,700 farmers organized in 390 farmer groups (FGs) received comprehensive trainings in ware and seed potato production, marketing and utilization. The training covered pest and disease identification and control, farm hygiene, seed production and post-harvest management. Each FG was given a Farmer Field Aid booklet and a picture book to help them identify important pests and diseases. In Ethiopia, a total of 140 FGs comprising of 3,390 households were trained in seed potato multiplication and management of which 79% were male and 21% female headed households. In addition, more than 15,000 ware potato growers were trained. In Kenya, 137 FGs comprising of 3,085 farmers (47% women) and in Uganda 113 FGs with membership of 2,235 (60% women) were trained using the "select the best" positive selection methodology.
- ***Enhanced adoption of diffused light stores (DLS*****):** Through trainings, farmers were shown the importance of DLS. More than 160 DLS units (110 in Ethiopia, 19 in Kenya and 38 in Uganda)

were constructed with a seed storage capacity of about 800 t. Out of this, 56% of the units were supported by the project, while 43%, mainly in Ethiopia and Uganda, were constructed by the farmers without external support, vividly showing the effect of training in constructing DLS.

- ***Strengthened market linkages***: The project focused on improving market linkages along the potato value chain. Trained seed multipliers were linked to pre-basic and basic seed producers which included the national programs (EIAR, KARI-Tigoni and KAZARDI) and private farms such as Kisima farm in Kenya and to the trained ware farmers. Similarity, trained ware farmers were linked to processors and other buyers. Contractual arrangement facilitated by the project benefited both the farmers and the processors in Kenya and the seed company in Ethiopia. Three potato processors (Deepa, Norda and Chirag Industries in Kenya) and one seed company (Solagrow PLc) engaged about 500 (171 in Ethiopia and more than 400 in Kenya) smallholder farmers in contract farming.
- ***Improved farmers income and household food security***: The trained farmers recorded increased production as a result of using improved varieties, quality seed and recommended agronomic practices and proper crop protection measures. For example, farmers in Atsbi Eastern-Tigray, Ethiopia planted three new potato varieties (Gudene, Jalene and Gorebella) and produced more than 64 t of healthy seed and 20 t of ware potatoes which earned the group more than US$ 40,700 within a period of less than 4 months.
- ***Created awareness on importance of using quality seed and other seed technologies***: Several on-farm experimental trials (over 150), field days (over 70), trade fairs and exhibitions (over 40) were organized with about 120,000 people in attendance. Some of these events were covered by the local FM stations while in Ethiopia and Uganda they were also covered on the national and regional TV stations.
- ***Enhanced diffusion of improved varieties***: The project facilitated the diffusion of new late blight tolerant potato varieties. For example, in the highlands of Ethiopia farmers were not able to grow potatoes in the main rain season (June - September) because of the high late blight disease incidence. However, with the introduction of late blight resistant varieties, farmers were able to grow potatoes in the long rains and harvest starting from September. This bridged the gap of food insecurity during Sept. to Nov. hunger period and this has had an impact on farmer's livelihoods.
- ***Emphasized production of potatoes as a business***: A majority of the trained farmers, particularly seed growers and the contracted farmers ventured farming potato as a business.
- ***Facilitated formation of local stakeholder forums***: To enhance improved communication and interactions along the value chain, a local potato stakeholder forum composed of farmer's representatives, traders, MoA staff, and researchers was established in all the project sites.
- ***Achievements will ensure Sustainability***. Extensive training, improved infrastructure, increased quality seed production and availability, increased productivity, market linkage and a strong value chain approach obtained by the project will ensure sustainability of the project achievements post the project.

1. Introduction

1.1 Project Overview

The project, "Wealth Creation Through Integrated Development of the Potato Production and Marketing Sub-sector" was implemented in Ethiopia, Kenya and Uganda. The project started in June 2008 in Ethiopia and in September 2008 both in Kenya and Uganda. It was completed in December 2012 after a four-month no-cost extension. The project was funded by the Common Fund for Commodities (CFC) with significant in-kind support by the International Potato Center (CIP, Project Executing Agency), national research institutes, Ministry of Agriculture and private sector partners in the three project countries.

The overall goal of the project was to improve the livelihoods of smallholder potato producers in Ethiopia, Uganda and Kenya through integrated development of the seed and ware potato production and marketing chains. The purpose was to demonstrate the effectiveness of poverty reduction through integrated potato sector development in the pilot intervention areas and to disseminate this approach to a wider scale. To achieve the purpose, the project pursued four specific objectives: (1) Increase the availability of high quality seed potatoes at affordable prices, (2) increase smallholder potato farmers' income by boosting yields through improved seed potato quality management and crop husbandry, (3) improve market linkages and communication between potato value chain stakeholders, and (4) translate project results into national potato sector development plans and share project lessons with international partners.

1.2 Project Implementing Partners and Locations

In Ethiopia, project implementing partners were: Ethiopian Institute of Agricultural Research (EIAR), MoA and Solagrow PLC (a private seed potato producing company). The project was implemented in Holetta Agricultural Research Center of EIAR, West Shewa Zone (Cheleya and Tikur- Inchini districts), South West Shewa (Wonchi district), Guragie zone (Gumer and Geta districts), and Tigray Zone (Atsbi district). In Kenya the Kenya Agricultural Research Institute (KARI-Tigoni), MoA (Bomet, Kuresoi, and Molo districts) and Deepa Industries Ltd, (a private potato processing company) implemented the project. In Uganda, the partners were Kachwekano Zonal Agricultural Research and Development Institute (KAZARDI) of the National Agricultural Research Organization (NARO), MoA (Kabale, and Kanungu districts) and TomCris (a cottage private potato processing firm).

1.3 Importance of Potato

Potato is a high yielding tuber crop with a short cropping cycle of about 3-4 months. This, coupled with high potential yield of about 40 t/ha, makes the potato a suitable crop for places where land is limited and labor is abundant (FAO, 2008) such as in sub-Saharan Africa. Potato is a smallholder cash crop of the future with a potential to improve their livelihoods and reduce poverty. Furthermore, it can provide a cheap but nutritionally rich staple food, contributing protein (low in amount, but high in biological value), vitamin C, zinc, and iron. Potato offers employment opportunities to all those involved in potato value chain from production to consumption. Generally the sub-sector in Ethiopia and Uganda has not been well developed, while in Kenya it is on the right track of development, although far below its potential.

Ethiopia: Potato first introduced to Ethiopia by Schimper, a German Botanist in 1858 is now an important crop for smallholder farmers in the highlands, serving as both cash and food security crop. It is one of the crops with the highest growth rates in the country as a result of increasing markets especially in urban areas, change in eating habits of the youth (Tesfaye *et al.,* 2010) and the high yields it gives. This represents an opportunity for resource poor growers to generate additional income. The crop is cultivated by over one million households for food and income generation in about 160,000 ha (Gebremedhin, *et al.*, 2001). Currently potato is a widely grown crop in the country because of the favorable climatic and edaphic conditions. Potato production has the potential to fill the gap in food supply during the 'hungry months' of September-November before grain harvests in December.

Kenya: Potato is the second most important food crop after maize. Cultivated by about 800,000 farmers, potato is a staple food and a cash crop for many rural and urban families. In 2009, the country produced about 3 million t of potatoes from 131,047 ha of land valued at KES 46 billion ($541 million USD) - consumer prices. Potato is labor-intensive and generates employment along its value chain. Most of the potato produced is consumed and processed locally with minimal imports and exports. Nearly all potatoes are grown in monoculture and marketing practices are inefficient.

Uganda: Potato serves as a food security as well as an income generating crop, mainly in potato growing areas of southwestern and eastern highlands of Uganda. It has gained popularity in urban areas as a major food in fast food restaurants. The crop is also increasingly becoming more popular for food in mid-altitude and non-traditional growing areas, substituting banana which is under the threat of banana bacterial wilt (BBW) disease. The potato production level is approximately 690,000 t from about 101,000 ha.

1.4 Constraints to Increasing Potato Productivity

The potato subsector is faced with numerous problems in the three project countries, resulting in low productivity of less than 10 t/ha. Average yields of over 25 t/ha in Uganda and Kenya and over 35 t/ha in Ethiopia are, however, being attained by progressive farmers using quality seed potato of improved varieties coupled with improved management practices, under the same rain-fed conditions.

Most of the constraints are common to the three project countries and these include shortage of good quality seed tubers (Kinyua *et al.,* 2001), lack of adaptable and disease resistant varieties (Olanya *et al.*, 2001; Berga *et al.,* 2005;) sub-optimal production practices (Gebremedhin *et. al.,* 2008), unreliable weather conditions in particular inadequate rainfall, poor postharvest practices, poor infrastructure and limited processing and value addition. There are also country specific constraints; for example, Ethiopia mentioned a weak public extension system as one of the major challenges it faces. Uganda pointed out high cost of fertilizers, low input use, adulterated agro-inputs, and unpredictable weather as unique to the country. Kenya singled out unpredictable macroeconomic influence, inefficient market and marketing; failure to enforce the potato regulatory policies, poor infrastructure, and inadequate product development associated with entrepreneurial skills and high investment costs, particularly to establish large processing plants.

2. The Focus of the Project

The main focus of the WCPP was to create wealth through integrated development of potato production and marketing chains in the target areas. The project envisioned that a modest increase in cash income through improved potato farming could have a major impact on the quality of life of a large number of smallholder farmers and other players in the potato value chain in relation to food security, nutrition, household income and education. The project also focused on improving stakeholders' interaction through formation of cooperatives and farmer groups to enhance farmers' negotiating power.

To achieve this, the following specific tasks were undertaken;

i. Trained seed and ware potato farmers in all aspects of potato production, marketing, and utilization;
ii. Increased production of quality seed and accessibility through use of improved conventional methods and aeroponics (a new method for rapid MT multiplication);
iii. Promoted seed technologies for own seed supply in particular through the small seed plot technique and positive selection;
iv. Promoted seed storage technologies notably diffused light store;
v. Improved marketing efficiency by linking trained farmers to direct markets for both seed and ware potatoes;
vi. Strengthened farmers' negotiating skills through increased knowledge and access to information;
vii. Encouraged value chain interactions among producers, buyers, credit facilities, and other stakeholders;
viii. Conducted a feasibility study on seed and ware potato export to document the strengths, weaknesses, opportunities and threats (SWOT analysis) in potato import and export trade; and
ix. Developed a national potato development plan (NPDP) for Kenya and prepared documents that will lead to developing a NPDP for Ethiopia and Uganda in collaboration with stakeholders as a blue print to guide the sub-sector.

3. Project Achievements

The main project achievements of the four-year WCPP detailed in the following sections include: more quality starter seed (MT, pre-basic and basic seed) produced by national potato research programs and by the private sector; more quality seed (certified, clean and quality declared) availed to farmers; increased productivity of ware potato; capacity building for farmers, researchers and extension workers; improved market linkages; and development of potato sub-sector development plan.

3.1 More Quality Seed Made Available to Farmers

Quality seed is a key component in increasing potato productivity. The genetic potential for yield of a potato variety is determined by the use of healthy seed (Endale *et al.*, 2008). Unavailability of seed potato in the required quantity and quality is probably the most important factor contributing to low tuber yields (Berga and Gebremedhin, 1994; Gildemacher, 2012). The project aimed at ensuring supply of quality seed by improving own-saved seed using the "select the best" positive selection (PS) method and by instituting stringent measures through routine field inspection and indexing of tubers against latent bacterial wilt (BW) and viruses. Effects of quality seed were demonstrated through successive training and awareness creation among the farmer groups. These together with demonstrations and involvement of local media enhanced transfer of knowledge on potato technologies and in turn increased demand for quality seed.

3.1.1 Aeroponics: Enhanced Production and Utilization of Mini-tubers (MT)

The most feasible way in which the growing demand for potatoes can be satisfied is through increased productivity. There are known crop husbandry technologies and practices that can improve potato productivity (Endale *et al.,* 2008). Seed, a basic component in potato production and which accounts for 40-50% of its production costs (Wagoire *et al.,* 2005; Gebremedhin *et al*., 2008,) is in short supply (Wagoire *et al.,* 2005; Endale *et al*., 2008) and expensive, especially for smallholder farmers.

Prior to the project, the national potato programs in the three countries depended on low-productivity, sterilized soil substrate-based techniques to generate MT (Plate 1). Use of stem cuttings planted in open fields and green houses were employed to rapidly increase MT. Later tissue cultured potato plantlets on sterilized soil substrate were used in screen house to generate generation 1 (G1) clean MT. Both methods were typified with low productivity.

To enhance production and utilization of MT, pre-basic and basic seed, the project constructed aeroponics units in Ethiopia in collaboration with USAID funded project. It contributed by procuring consumables used in the aeroponics units supported by the USAID-funded "3G" project at KARI-Tigoni in Kenya and at KAZARDI in Uganda. Massive production of MT using aeroponics significantly reduced the multiplication cycles of seed from nuclear to basic seed from over six to three generations and shortened the time needed to avail basic seed to seed farmers by the national potato research program. Clean MT produced through aeroponics i.e. (G1) were multiplied twice under field conditions to generate pre-basic seed as G2 and basic seed as G3. Basic seed was then distributed through sales to trained seed potato multipliers for further multiplication and generation of improved seed for subsequent production of ware potatoes. This method complemented with conventional rapid multiplication methods such as tissue culture increased the amount of quality seed in the system.

Ethiopia: There are two aeroponics units located at the Holetta Agricultural Research Center (HARC). One was built with funding from the CFC while the second was built by USAID. Since the construction of the aeroponics units in 2009/10, more than 114,000 MT were produced from both units (Plate 1).

Plate 1. Left: Mini-tubers produced under screen house in 2012. Right: Plantlets in the CFC funded aeroponics unit and minitubers of Belete variety (insert) produced in the aeroponics unit in Holetta Research Center, 2009.

The MT comprised of the newly released varieties; Belete, (105,468 MT), Gudanie (2,142), Jalene (2,595) and Awash (4,989). In addition, a total of 227,333 MT of various clones and released varieties were produced in the screen houses (Table 1).

Table 1. Minitubers produced under screen houses at Holetta Agricultural Research Center, Ethiopia

No	Variety/clones	2008	2009	2010	2011	2012	Total
1	Different clones	15041	-	1692	6043	-	22776
2	Jalene	3760	-	7440	1979	-	13179
3	Guassa	1200	-	1080	-		2280
4	Gudene	1800	-	1352	9231	27135	39518
5	Belete	0	-	-	42871	102999	145870
6	Awash	228	228	-	1254	-	1710
7	Gorebela	1264	-	-	-	-	1264
8	Zengena	516	-	-	-	-	516
9	Tolcha	220	-	-	-	-	220
10	Total	24029	228	11564	61378	130134	227333

The yield obtained from the aeroponics in Ethiopia was less than expected, primarily due to high temperatures and suboptimal use of the nutrient solution during the months of January-May. To reduce the temperature, a shade-net was installed. High vegetative growth of the plants could have also contributed to reduced number of MT per plant. The nutrient solution recommended by CIP may need further study to determine the optimum solution for Holetta condition so as to obtain higher number of MT per plantlet.

Because of the project intervention, the capacity for producing MT at HARC is increased from 1,050 in 2008, (Berga *et al.*, 2009) to 200,852 MT in 2012 of which 70,718 were produced under aeroponics and 130,134 under screen houses.

Kenya: The aeroponics system was supported by the USAID-funded "3G" project and the CFC project provided consumables. With the use of aeroponics, mini-tubers production increased from the initial 20,000 under soil based system to over 1 million (Figure 1). This was mainly due to public private partnership initiative which saw more private firms invest in MT production.

Uganda: As was the case in Kenya, aeroponics system was supported by the USAID-funded "3G" project and WCPP provided consumables. With the introduction of aeroponics, annual MT production rose from about 10,000 to over 90,000 (Table 2).

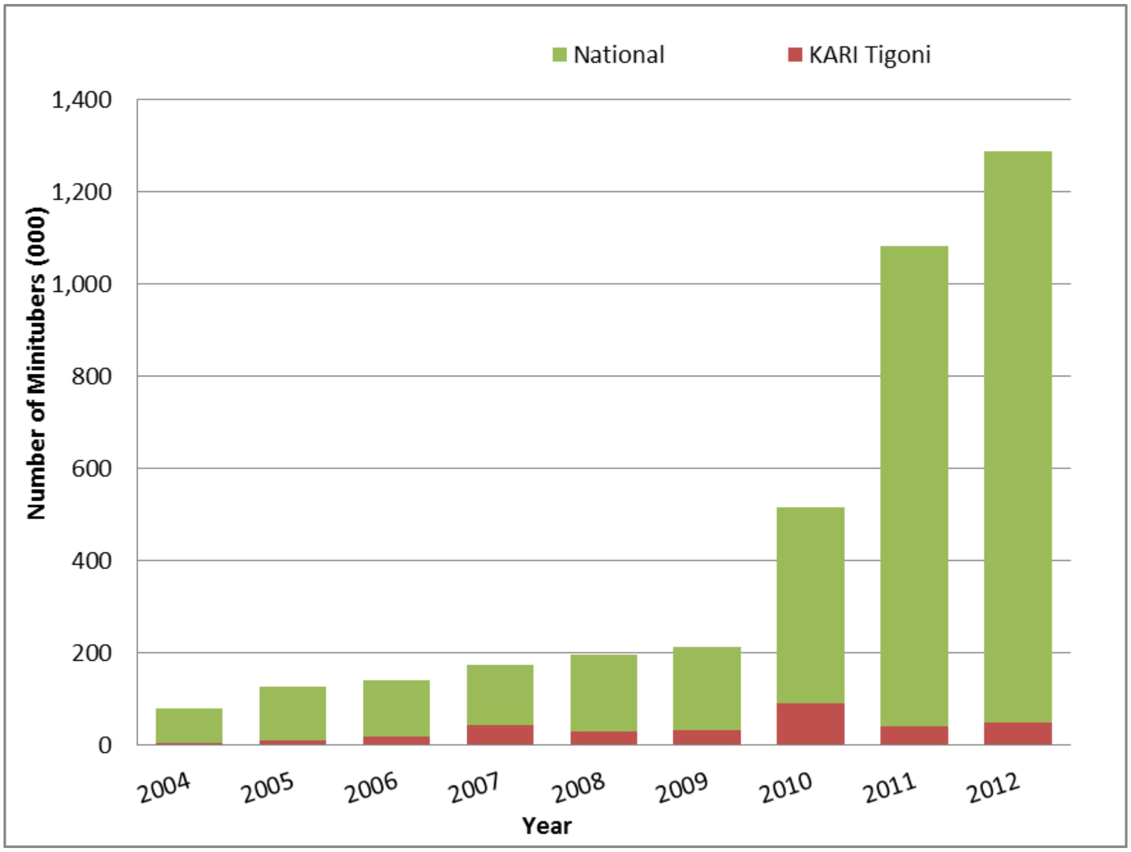


Figure 1. Annual production of mini-tubers in Kenya for 2004–2012

Table 2. Average annual MT production under soil substrate system in 2007-2009 and aeroponics 2009-2010 at KAZARDI, Kabale, Uganda

	Average number of minitubers		
Variety	Soil substrate*	Aeroponics**	Aeroponics to soil productivity ratio
Rutuku	1,247	6,653	5.3
Kachpot1	875	45,493	52.0
Victoria	8,862	40,774	4.6
Total	**10,983**	**92,920**	**8.5**

*and ** are average MT production of three years on 100 m^2 in soil substrate and one year production on 70 m^2 under aeroponics, respectively.

Some varieties performed better than others under aeroponics, for instance, Kachpot1 and Victoria did better than Rutuku and Kinigi. In the first production cycle 60,721 MT were produced with an average of 46 MT per plantlet, but the number dropped to 32,199 and 31,859 for the second and third cropping cycles, respectively. The low multiplication ratios in the second and third production cycles were caused by temperature inversion that occurred in June 2010 and January-February 2011.

3.1.2 Organization of Farmer Groups and Cooperatives

The project organized farmers in groups or in cooperatives based on diagnostic survey results, farming system, priority community problems, and commitment of the farmers to follow the project plan of action. As such only farmers who were willing to be involved in the farmer research group were selected. Selected farmers fully participated in the management of the trials: planting and subsequent application of cultural practices as well as construction of DLS which were done according to the research recommendations. Both farmers and researchers made periodic assessments of the crop performance at the trial sites.

Overall more than 8,700 farmers organized in 390 farmer groups (FGs) received comprehensive trainings in ware and seed potato production, marketing and utilization. The training covered pest and disease identification and control, farm hygiene, seed production and post-harvest management. Every FG was given a Farmer Field Aid booklet and a picture book to help them identify important pests and diseases.

Ethiopia: A total of 139 FGs (65 in Guragie zone, 53 in West Shewa zone, 20 in Southwest Shewa zone and one in East Tigray (Atsibi)) were identified and trained in group dynamics before they were trained in potato technologies. The group in Atsbi was later transformed into a successful cooperative called Shewit Seed Potato Producers Cooperative.

Kenya: A total of 137 FGs were identified and trained in group dynamics before they were trained in potato technologies. In Bomet district, farmers formed Bomet Potato Growers Association.

Uganda: A total of 113 FGs were identified and trained in group dynamics before they were trained in potato technologies. Two seed potato producers' associations, one in Kabale and Kanungu, were formed with the main objective of multiplying basic seed into more improved seed for use in ware potato production. The two seed associations are independent of KAZARDI and have their own management structures and funding.

3.1.3 Increased Production of Pre-basic, Basic Seed and Certified Seed

Production of pre-basic and basic seed is the mandate of the National Agricultural Research Institutes (NARIs) in the three countries. Basic seed is then sold to trained seed growers for further multiplication before selling to ware farmers as quality declared seed or certified seed. With the higher number of mini-tubers, national potato programs were able to produce more pre-basic and basic seed within a short period of time and thus trained seed growers got access to more seed for multiplication.

Ethiopia: A total of 139 FGs (65 in Guragie zone, 53 in West Shewa zone, 20 in Southwest Shewa zone and one in East Tigray (Atsibi)) comprising of 3,390 households were trained in seed potato multiplication and management of which 79.3% were male and 20.7% female headed households. The group in Atsbi was later transformed into a successful Shewit Seed Potato Producers Cooperative.

A total of 3,072 t of quality seed mainly for Gudene and Jalene varieties was produced at Holetta Agricultural Research Center. Out of this, 93.3 t (Table 3) of pre-basic seed was distributed and/or sold to the trained seed producing groups established in six project districts, between 2008 and 2012. In addition, 49.8 t of seed was used as a starter seed under the revolving seed system (Table 3). This was done as a strategy to scale up the technology to the newly formed farmer groups within the project districts.

From these starter seeds, a total of 2,313 t of relatively healthy seed was produced by the trained seed multipliers and used for ware production.

Table 3. Amount of seed potato supplied to the project districts during the period 2008-2012, Ethiopia

District	Variety	2008	2009		2010		2011		2012		Total (tons)	Seed
		HARC	HARC	Revolving	HARC	Revolving	HARC	Revolving	HARC	Revolving	HARC	Revolving
Cheliyia	Jalene	2	1	1.6	0.7	1.49	2	-	0.4	0.6	6.1	3.7
	Gudenie	2	-	1	1.8	-	4	2	2	6.5	9.8	9.5
	Guassa	3	1	1	-	0.58	2	1	-	0.9	6	3.4
T/Inchini	Jalene	2.6	-	2	-	-	-	-	-	0	2.6	2
	Gudenie	1	-	1	-	-	8	-	4	5	13	6
	Guassa	1.6	0.5	1	-	-	-	-	-	-	2.1	1
Wonchi	Jalene	3	1	2	-	-	2	-	1	-	7	2
	Gudenie	3	1	2	-	-	6	-	1	1.6	11	3.6
Gumer	Jalene	0.5	1	0.5	2.5	1	2	2	-	-	6	3.5
	Gudenie	0.5	1	-	5	1	6	4.5	2	-	**14.5**	**5.5**
Geta	Jalene	-	0.6	-	2	0.6	2	2	1	1.9	**5.6**	**4.5**
	Gudenie	-	-	-	2	-	6	2	1	2.3	**9**	**4.3**
	Guassa	0.5	-	0.4	-	0.4	-	-	-	-	**0.5**	**0.8**
Total		**19.7**	**7.1**	**12.5**	**14.1**	**5.07**	**40**	**13.5**	**12.4**	**18.7**	**93.3**	**49.9**

Kenya: The project increased the number of knowledgeable seed growers in the project districts. It recruited and trained 75 individual seed multipliers and 14 farmer groups, consisting 362 members. The seed multipliers procured over 80 t of basic seed potato worth about USD 42,350 from KARI-Tigoni and Kisima farm which they multiplied further before selling to trained ware growers. The trained seed multipliers produced more than 1,100 t (Figure 2) of clean seed potato worth about USD 745,000 It is important to note that some of the trained seed multipliers especially in Molo and Kuresoi district applied to Kenya Plant Health Inspectorate Service (KEPHIS) for certification and were able to produce certified seed. This supplemented certified seed from the formal system mainly from Agricultural Development Corporation (ADC Molo).

The biggest challenge that faced the seed multipliers especially in Molo and Kuresoi districts was the frequent changes in varietal preference by ware farmers. For example, varieties Tigoni, Asante and Kenya Karibu were more preferred when the project began in 2008, while Zangi (a farmer selected variety) gained popularity from 2010 becoming the most preferred variety in 2012. This posed a challenge to promotion of quality seed since the variety had not been officially released and hence the national potato program could not produce the basic seed. However other CIP-bred varieties released in 2010 namely Kenya Mpya and Sherekea are slowly being adopted by the trained farmers. The WCPP project bought 20,000 MT of these varieties for further multiplication by seed multipliers. The project also entered Zangi in the 2012 national performance trial (NPT) and seed multiplication will start once it is officially released.

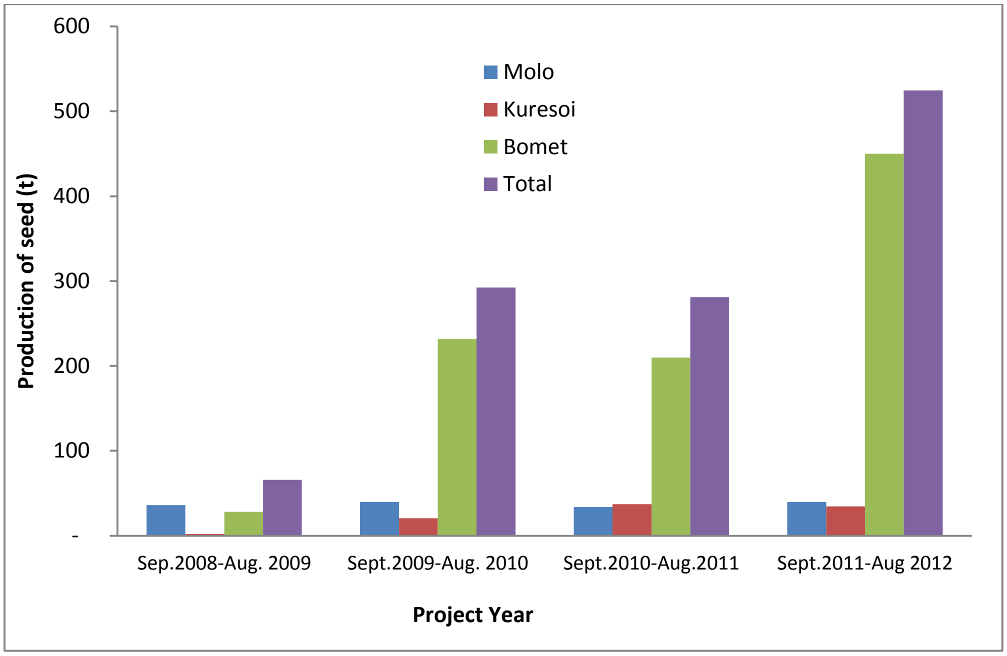


Figure 2. Amount of quality seed produced by the trained seed multipliers in Bomet, Kuresoi, and Molo districts, Kenya 2008 -2012.

Uganda: The project facilitated capacity building for farmers to have access to quality seed for further multiplication for ware potato farmers. A total of 87 (18F and 69M against the targeted 60) farmers were trained on quality seed production and management techniques. However, some farmers dropped out of seed production business and 35(10F and 25M) farmers are actively multiplying basic seed.

Over 130,000 MT (G1) of the different varieties produced in the aeroponics unit were multiplied under field conditions at Kalengyere Research station. About 28 t of pre-basic seed (G2) was produced and these generated over 133 t of basic seed (G3) over a period of four cropping seasons (Table 4). Over 90% of the basic seed was distributed to different seed multiplier groups for further multiplication while the remaining was used as experimental material for different trials. The groups that received the seed included the two farmer associations established with the support of the project, Uganda National Potato Producers' Association (UNSPPA) and CARE-Uganda

Table 4. Amount of pre-basic and basic seed produced during the 2010-2012 crop season at Kalengyere Research Station, Uganda

Variety /season	2010B		2011A		2011B		2012A		Total	
	G2	G3	G2	G3	G2	G3	G2	G3	G2	G3
Victoria	5.7	12.4	0.4	10	5.8	17.2	4.6	20.9	16	60.5
Kachpot1	7.3	6.1	1.35	16.2	-	17.4	-	18.8	8.6	58.5
Rutuku	1.1	-	1.8	-	-	6.3	-	8.1	2.79	14.4
Total	14.1	18.5	3.55	26.2	5.8	40.9	4.6	47.8	27.39	133.4

3.2 Access to Quality Seed for Ware Potato Production

Low potato yields have been attributed to use of poor quality seed among other factors. Majority of the smallholder farmers in the project countries recycled tubers from previous harvest. When seed potatoes are re-used from own saved seed, the yield decreases due to seed degeneration. Seed degeneration is caused by build-up of diseases which are passed on through the tubers (Gildemacher *et al.*, 2007). Low yields are also attributed to limited availability of appropriate seed storage facilities known to enhance healthy sprouts and storability in good physiological conditions. To improve the quality of available seed potato for ware production, the project adopted various strategies including improvement of own seed supply through PS, training of seed multipliers and linking them to basic seed producers, routine field crop inspection and proper storage management. The project used hands-on promotional strategies like demonstrations, field days and trade fairs to increase awareness in importance of using quality seed.

3.2.1 Positive Selection: Improving Own Saved Seed

Positive selection methods are used primarily in informal seed potato multiplication to select a disease-free mother plant as a starting point (Salazar, 1996). The project used PS methodology to train ware potato farmers on how to improve own seed supply. Developed by CIP, PS focuses on "learning-by-doing" and has been shown to increase potato yields by up to 30%.

The principle of "Select the Best' PS is to peg healthy looking plants during plant growth, harvest them separately and use the tubers as seed for subsequent planting. The hands-on training method followed eight training modules which farmers had to complete in two seasons. In addition to the eight modules, other topics covered during the training included: clean seed production, participatory research, pests and disease management, postharvest handling and utilization. PS Training Manual, Farmer's Aid and the Picture Book were translated into local languages: Amharic in Ethiopia, Kiswahili in Kenya, and Runyankole-Rukiga in Uganda.

Before training the farmers, extension agents and selected farmers were trained in a training of trainers (ToT) approach. In Ethiopia, a total of 296 trainees, comprising of zonal agriculture experts, supervisors and development agents were trained at Holetta Agricultural Research Centre (HARC). In Uganda, 7 extension officers and 64 farmers (46M/20F) were trained as trainers; while in Kenya 61 extension officers were trained. All the group facilitators, trained farmers and district development agents received copies of the translated PS training materials.

Ethiopia: Over 12,552 ware potato growers were trained. Of these over 1,552 ware potato growers ware trained in improved ware potato production and management using the PS method. The remaining 11,000 smallholder ware potato growers were given a 1 to 2-day intensive training instead of going through the long PS modules based on farmers' request.

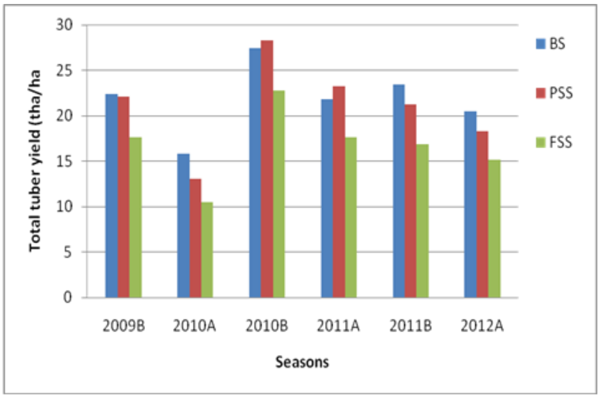
Kenya: A total of 137 FGs comprising of 3,085 farmers (1,610M/1,475F, 47% women, against the target of 120 FGs, comprising 2,000 farmers) underwent the positive selection training modules. Each FG was given 10 kg of basic seed or certified seed to compare its performance with positive selected seed (PSS) and farmer selected seed (FSS), as required in Module 4 (experimental trials). Farmer group members who attended at least seven out of the eight modules were awarded with Certificate of Participation (CoP) as required in Module 8 (Evaluation and Graduation) (Plate 2).

Plate 2. Top. A member of Tajimu FG in Molo explains what Module 3 involves. Right. Members of Arise & shine FG in Kuresoi harvest their pegged plants.

Uganda: A total of 113 FGs with 2,235 members (877M (39.2%)/1,358 F (60.8%). The targeted number was 2,000 farmers. Similar to Kenya, each FG was given 20 kg of basic seed to compare its performance with PSS and FSS as required in Module 4. Farmer group members who attend at least seven out of the eight modules were awarded with Certificate of Participation (CoP) as required in Module 8 (Evaluation and Graduation) (Plate 3).

Plate 3. Harvesting positive selection experimental seed in Hamurwa-Kabale (Sept.2009).

From potato demonstration trials conducted with farmers at different sites and locations in the three countries, benefits of positive selection were observed in terms of reduced incidences of bacterial wilt (BW) and virus diseases and consequently increased yields. For instance, in Uganda PSS yielded significantly higher than FSS, while yield differences between PSS and basic seed (BS) were not significantly different, as shown in Figure 3. Different seed types showed a similar trend in average tuber weight (grams) with BS being higher than PSS which was in turn higher than FSS, averaging 64.7, 60.95 and 50.3 grams per tuber, respectively.



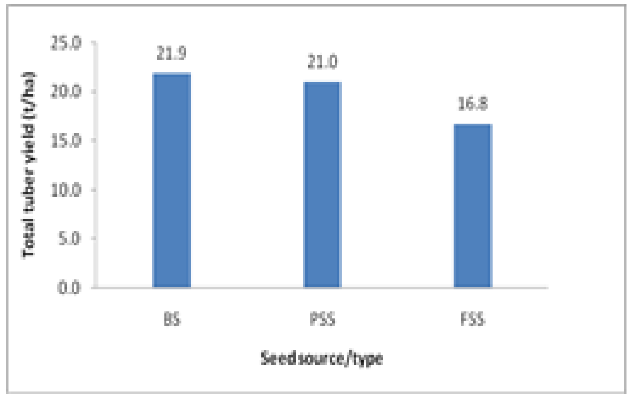


Figure 3. Yield gains from positive selected seed potato and the average yield for three seed types for the period 2009-2012 in Kabale and Kanungu districts, Uganda

Similar results were obtained in Kenya. In Molo district, certified seed had the highest yield of 15.2 tons/ha, PSS yielded 11.6 tons/ha and FSS was the lowest at 8.0 tons/ha. In Bomet, PSS gave over 11 t/ha more yields than the farmers' seed. This shows that if potato farmers could adopt positive selection technique for their own seed it will substantially increase their potato productivity by 10.5% in Molo and 47% Bomet. The results underscored the importance of training farmers on how to produce own seeds given that at least 95% of the farmers in the project countries use seed potato from informal sector.

3.2.2 Diffused light Store for Seed Quality Enhancement

A pragmatic approach to overcome the storage problems of seed potato is to use the diffused-light store (DLS), which can be newly constructed or improvised from an existing on-farm storage structure. Diffused light store is based on the use of indirect natural light and good ventilation or air flow without the need to have a cold store to control excessive sprout growth and associated storage loss. It is a low cost method of storing seed potatoes hence deemed affordable to many smallholder farmers. In all the project countries, the project procured roofing materials (i.e. corrugated iron sheets and nails) for construction of DLS, while NARIs provided the skilled personnel for construction and farmers supplied the timber and/or bricks and the required labor. This activity was done in collaboration with the USAID-funded 3G project in Kenya and Uganda to acquire aphid-proof netting to some DLSs to protect seed from aphids and hence reduce the risk of potato viruses Y (PVY) and potato leaf Roll Virus (PLRV) transmission and hence reduce the rate of seed potato degeneration.

Ethiopia: A total of 110 DLS with seed storage capacity of over 400 t were constructed in the target Woredas by seed multipliers with technical support from MoA and EIAR. Six of these DLSs with seed storage capacity of 25-30 tons, (one in each project implementation district), were constructed for communal use with partial support from the project (Plate 4). The number constructed was 12 times higher than initially planned in the project, i.e. 9 DLSs. Although many other farmers built small capacity DLS with their own money, creating the awareness on its importance was credited to the project.

Plate 4. Diffused light stores constructed in (a) Ethiopia and (b) in Uganda. The one in Uganda is fitted with aphid proof nets.

Kenya: The project supported construction of 19 DLS with storage capacity ranging between 2 to more than 10 tons in the three project districts. The final number of DLS constructed was double the target: 19 against the initial plan of 9 DLSs.

Uganda: The project supported construction of 12 on-farm demonstration DLS in Kabale and Kanungu districts, six in each district (Plate 4). Through collaboration with the USAID-funded “3G” project, three more on-farm DLS were constructed, making a total of 15 DLS each with storage capacity of 8 t. Additional 23 DLSs were constructed by farmers using locally available materials, after observing the usefulness of DLS in keeping seed potato quality. The final number of DLS constructed (38) was four times higher than the target off 9.

3.3 Seed Quality Assurance

Potato Leaf Roll Virus, PVY and (BW) are some of the common seed-borne diseases of high economic importance in the three project countries. In Ethiopia for instance, BW was spread to many new Woredas (districts) in Amhara and Tigray regions in just a few years through infected seed tubers from a potato belt called Shashemene, a well-known hotspot area for bacterial wilt (Dereje and Gebremedhin, 2012). In Kenya and Uganda most potato growing regions have BW (Berga *et al., 2001*, Kinyua *et al.*, 2001). This disease is both soil- and seed-borne and can cause serious damages to potato production if phytosanitary measures are not incorporated into seed production and distribution system. As such production and distribution of seed calls for stringent measures and a well-designed value chain that is different from that of ware potato production.

Production of good quality planting material should be properly designed to suit the circumstances of potato producers that exist in the country (Adane *et al.*, 2010). One of the methods that the WCPP instituted was the use of seed inspection, indexing and inbuilt feedback mechanisms to inform the farmers of the results and discuss control measures. To enhance this, the national potato research programs were supported with laboratory chemicals and disease testing kits for latent BW and virus infections. At farm level, field seed crop inspections were conducted for maintenance of quality standards. Field trials to monitor aphid population dynamics were conducted on-station and in the farmers’ seed production fields in the three countries.

3.3.1 Seed Inspection and Indexing

Ethiopia: Healthy planting material was distributed to seed producers groups and cooperatives. The seed which was grown at the Holetta Agricultural Research Center was inspected and indexed for both virus and bacterial wilt. In collaboration with extension experts and seed farmers, the research team frequently inspected farmers' seed tubers.

In collaboration with the CIP/USAID project, a Quality Declared Planting Materials (QDPM) system was introduced (Plate 5). The QDPM scheme provides guidelines on the production of clean, disease-free planting materials of vegetatively propagated crops (FAO, 2010). The scheme, meant to be implemented primarily by seed producers at community levels or by field extension workers aims at improving the physiological and phytosanitary quality of planting materials available to smallholders.

Plate 5. Farmers being trained in production of Quality Declared Planting Materials (QDPM), Holetta (left), and Atsibi (right), 2012

Kenya: To ensure production of quality seed, field inspection and indexing of farmers' seed for BW and viruses were routinely done by the national regulatory body (KEPHIS) and KARI-Tigoni. The diagnostic test results were communicated back to farmers to give advice on good management. More than 250 farmers' samples were collected and tested for BW (Plate 6). Aphid surveillance was done to monitor aphid population using yellow traps in farmers' fields in the three project districts. The results showed that by following stringent measures, farmers can produce BW-free seed. Several in-field trainings and follow-up visits were conducted to sensitize farmers on effects of BW on yield and potato productivity.

In some cases farmer's samples tested positively for BW even after only one field generation. The possibility of the high infection rates was due to water runoff from neighbouring infected farms, use of unhygienic tools, trespassing over the seed plot from infected soils. For instance, infection was high during the 2011 short rains and this was the first time that majority of the samples tested positive for BW. Farmers whose samples tested positive for BW were advised to sell their potatoes for consumption only.

Plate 6. Viral and Bacterial wilt diagnostic testing at KARI-Tigoni on samples taken from farmers' fields in Bomet, Molo and Kuresoi districts

Aphid population trials were conducted to find out the suitability of an area for seed production. The mean number of aphids on a plant increased erratically over the weeks in the three project districts. In Bomet district, there were significant differences in aphid population across the different locations from the 2nd week through to the 9th week (Figure 4). The finding emphasized the need for progressive scouting for aphids and spraying accordingly. Importantly, the project recommends that seed should be produced in areas where aphid population pressure is low.

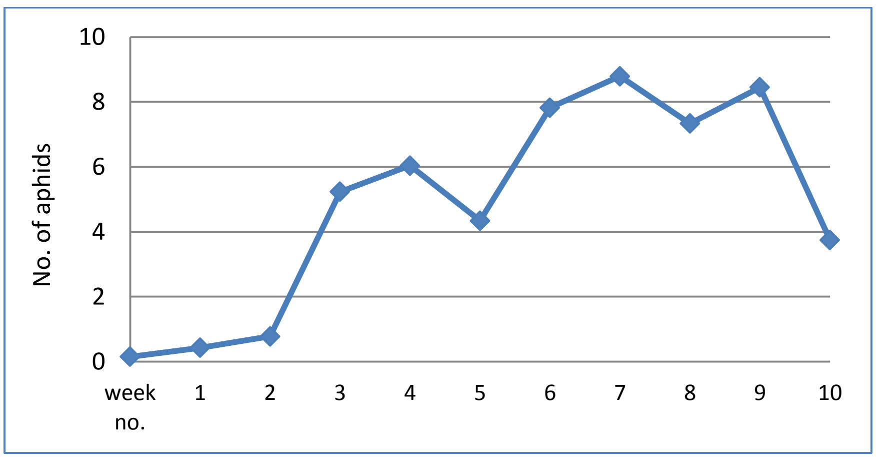


Figure 4. Aphid population dynamics in potato crop planted in Bomet, Kenya, April –July 2012

Uganda: In collaboration with the national potato research program at KAZARDI, the project supported and conducted field seed inspection visits and indexed harvested seed tubers against latent BW and virus infections every season. Laboratory results showed significant improvements in seed quality produced by farmers in 2012 (Table 5). This implies that farmers gained knowledge and skills in quality seed potato production and maintenance.

Additionally, to create more awareness on seed quality, seed tuber samples from different seed types/sources were put in trials and indexed against latent BW and virus infections. Results showed that positive selected seed had reduced BW by about 13% within a period of two years 2010-2012 (Table 5). The reduction in virus incidence was also significant. The only viruses detected were PVX and PVS which are mainly transmitted through contact and do not have as much economic importance as PLRV and PVY that are transmitted by aphids. Laboratory results for seed samples from trained commercial seed farmers and demonstration trials were given and explained to farmers and stakeholders. It is this information that is used by seed buyers' especially Local Government programs like the National Agricultural Advisory Services (NAADS) to procure seed from trained farmers.

Table 5. Results for latent BW indexing of seed potato produced by seed multipliers in Kabale and Kanungu-Uganda, 2010A – 2012A seasons.

Sub-county	**2010A**			**2011B**			**2012A**		
	Samples	Clean samples	BW latently infected samples	Samples	Clean samples	BW latently infected samples	Samples	Clean Samples	BW latently infected samples
Bubare	8	5	3	11	5	6	-	-	-
Hamurwa	7	6	1	7	7	0	7	6	1
Rutenga	4	4	0	-	-	-	6	6	0
Mpungu	8	7	1	5	5	0	5	5	0
Total	27	20 (81.5%)	5 (18.5%)	23	17 (73.9%)	6 (26.1%)	18	17 (94.4%)	1 (5.6%)

Field trials on population dynamics, with no insecticide application were conducted on-station to determine critical periods for aphid infestation for farmers to take management interventions, such as cutting the foliage to reduce infection. The trials were conducted at Kachwekano and Kalengyere research stations, 1,850 and 2,300 m.a.s.l, respectively for three seasons. Aphid counts were recorded on a weekly basis and results showed more aphid infestation at Kachwekano than Kalengyere station which is at a higher altitude with lower temperature than Kachewkano. It was further revealed that aphid population build-up starts from third week after crop emergence up to sixth week when a population decline starts (Figure 5). Therefore, farmers were advised to start monitoring aphids three weeks after emergence for management interventions.

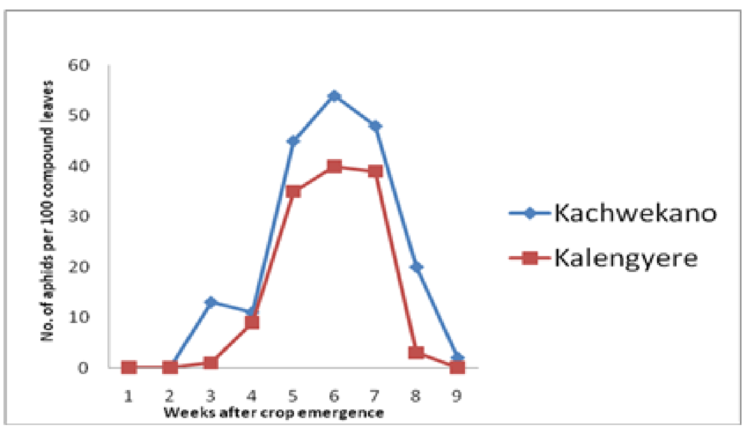


Figure 5. Aphid population dynamics in a potato crop planted at Kachwekano and Kalengyere stations (2011B season)

3.3.2 Partnership and its Significance for Quality Seed Potato Production

During its implementation period, the WCPP project worked in close collaboration other projects by complementing each other in areas of common objectives and geographic interventions.

Ethiopia: The CFC project worked closely with USAID-funded project in Ethiopia. The two projects constructed one aeroponics unit each at HARC and shared costs for common equipment such as generator, pumps and containers for spraying nutrient solutions and training. The USAID-funded project provided market for the CFC seed producers. The partnership helped in improving availability of healthy seed tubers both at research and on-farm levels in the country. The other partners in the project were government institutions, including the District Administrations, MoA, Women and Youth Affairs, and a private seed grower, Solagrow Plc. All institutions were helpful in the production of healthy seed in their respective areas of intervention.

Kenya: A functional partnership between private and public sector which started in September 2008 enabled the project to substantially increase production and utilisation of quality seed potato. The partnership involved CIP, MoA, KARI, private companies, farmers, transporters and financial institutions. Through this partnership, the project increased production of quality seed, enhanced its accessibility, promoted seed storage technologies, and built farmers' capacity through hands-on trainings covering all aspects of potato production, marketing, credit facilitation and utilization.

Deepa Industries Ltd (a processor) contracted farmers to supply quality tubers for processing into crisps, and one of the requirements was that farmers got clean seed potato from a reputable source. This necessitated potato value chain players to come together i.e., seed multipliers, researchers, MoA and the banks to address this problem.

Uganda: Quality seed potato production was mainly handled by the National Potato Research Program at KAZARDI which trained the Uganda National Seed Potato Producers' Association (UNSPPA) in seed multiplication and distribution. As a result of the CFC project interventions, two more seed potato associations: Kabale Seed Potato Farmers' Cooperative Society Ltd and Kanungu Seed Potato Multipliers' Association were established and have taken up the business of quality seed potato production and distribution. These seed associations have disseminated quality seed potato and improved potato varieties to even non- traditional potato growing areas, especially in Mpungu and Kayonza sub-counties in Kanungu district.

While private investment in the production of MT (G1) and pre-basic seed has not yet taken off in Uganda, KAZARDI started collaborating with the recently introduced Bio-Innovate project to enhance public-private partnership by identifying and involving private investors in quality seed potato production, especially in MT production using aeroponics. If this takes off, it will complement the achievements of the WCCP.

3.4 Increased Productivity of Ware Potato

The WCPP brought about a significant increase in potato productivity by promoting the use of improved seed potato, disease and pest management and agronomic practices. These were disseminated to farmers through farmer participatory experimental trials, demonstrations, trainings, field days, trade fairs and this enhanced seed and ware potato market linkages.

3.4.1 Dissemination of Technologies for Increased Productivity

Ethiopia: More than 17 field days/open days were held in the project intervention areas aimed at creating awareness on potato technologies and strengthening linkages between seed producers and ware potato growers and between ware potato producers and buyers. Seven of these field days were organized by the farmers themselves while Solagrow PLc, a commercial seed grower, organized two additional open/field days. The field days were held both at flowering stage and at harvest to demonstrate tolerance levels of the released varieties to late blight and yield advantages of using quality seed and improved agronomic packages and improved varieties.

The field days attracted more than 2,100 people and were broadcast on national TV and Radio programs, using different local languages. Different stakeholders, including politicians, MoA staff, researchers, district administrative staff, and neighboring farmers participated. Also, the project facilitated the exchange visit involving representatives of farmer groups and extension staff from the different project districts.

Ten demonstrations on potato utilization were held and attended by 1,050 people (894F/156M), composed of participating and non-participating farmers, agricultural development agents, and health extension officers (Plate 7). The farmers who attended the demonstration on utilization were impressed by the technologies disseminated and promised to put into practice what they learned in their own households as well as teach others (Table 6).

Plate 7. Demonstration on utilization of potatoes in Ethiopia,

In 2011 offseason, two farmer participatory experiments (one each in Geta and Gumer) were conducted, focusing on the effects of fertilizer and spacing with four popular varieties. The yield potential of the four varieties was also demonstrated. Although the yields at both sites were low due to shortage of rainfall, the results showed a positive response in yield to fertilizer levels. Fertilizer application resulted in significant tuber yield increases of 6-9 t/ha compared to the control, although differences in yields among the different fertilizer levels were not significant ($p \leq 0.05$) at both sites (Figure 6). It seems that farmers need to apply the lowest levels of fertilizer considered here to get good yields and avoid wastage.

However, the experiment should be repeated, including under normal rainfall conditions and economic analyses conducted before a conclusion is reached. This underscores the need for soil fertility improvement in bridging the existing yield gaps. Among the four varieties used, Gera had the highest yield at both sites (25 t/ha in Gumer and 41 t/ha in Geta) and yielded almost twice higher than the variety Jalene (Figure 6).

Table 6. Number of farmers, Agricultural experts/development agents and health extension workers trained in Utilization in Ethiopia, 2009-2011

District	2009/2010				2010/2011				Total	
	Farmers		DAS and Health extension agents		Farmers		DAS and Health extension agents			
	F	M	F	M	F	M	F	M	F	M
Cheleyia	69	41	1	7	80	21	6	5	**156**	**74**
Tikur-inchini	72	14	4	5	-	-	-	-	**76**	**19**
Gumer	108	14	7	1	127	-	5	7	**247**	**22**
Geta	44	10	4	5	69	-	-	2	**117**	**17**
Wonci	53	12	3	2	63	7	3	1	**122**	**22**
Degem	-	-	-	-	87	-	1	2	**88**	**2**
Total	**346**	**91**	**107**	**20**	**426**	**28**	**15**	**17**	**894**	**156**

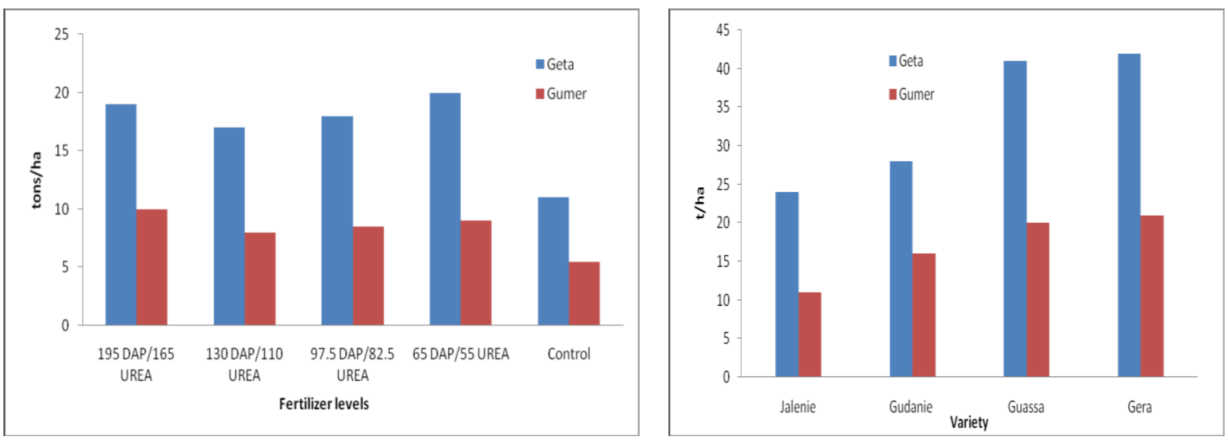


Figure 6. Effect of fertilizer levels on potato yield and performance of four popular varieties grown during off-season in Geta and Gumer, Ethiopia, 2011

Kenya: Over 70 on-farm improved technology trials demonstrating seed types, fertilizer rates and new varieties were established. Over 50 field days, trade fairs, and exhibitions were held at the trial sites (Plate 8). More than 8,500 people (48% women) attended these awareness creation activities. Some of these events were covered by the local FM radio stations. Three seed trade fairs were held at seed multipliers' farm: two in Kuresoi and one in Bomet where more than 680 farmers attended.

Plate 8. Field days held in Molo district, June 2011.

Uganda: More than 73 demonstration trials on different technologies; positive selection, disease and pest management and improved management practices were established (Plate 9). The trial sites acted as training sites where farmers would convene and get hands-on trainings.

Farmers compared use of full-packaged improved potato practices (use of clean seed, fertilizer, row planting, disease and pest management, ridging and other management practices) and farmer local management practices (farmer's seed, no fertilizer, planting without rows, no ridging and minimal or no disease management). Full package management practices gave more tuber yields/ha, number of tubers per plant and a higher average tuber weight (g) than the farmer management practices (Figure 7).

Plate 9. Left; Harvesting of potato demo on improved management practices Vs Farmers management practices in Rutenga-Kanungu (February,2012), Right: A well-managed ware potato crop by a ware potato producer in Kabale, Uganda (June 2011)

Eleven field days were held at demonstration trial sites and over 2000 farmers and other stakeholders, researchers, extension workers, the media and local government leaders attended. The participants witnessed that PSS significantly increased yield as compared to FSS. Also noted was increased yields attributed to use of improved management practices and varieties. The field days also involved radio news reporters: Voice of Kigezi (VoK) radio, FM (local radio), where information on technologies tested with farmers was broadcast on radio. This widened the coverage by reaching those who did not participate in the field days.

To increase awareness on use and importance of quality seed, each of the 113 trained FGs was availed with a bag (80 kg) of improved seed procured from trained seed multipliers by the project for training and multiplication purposes. Additionally, 73 FGs received 20 kg each of basic seed for comparing with PSS and FSS (Figure 3). Each beneficiary group passed over seed to a new group after harvesting so that all FGs got access to such seed. The health and quality of seed was monitored before seed was distributed from one farmer to the other.

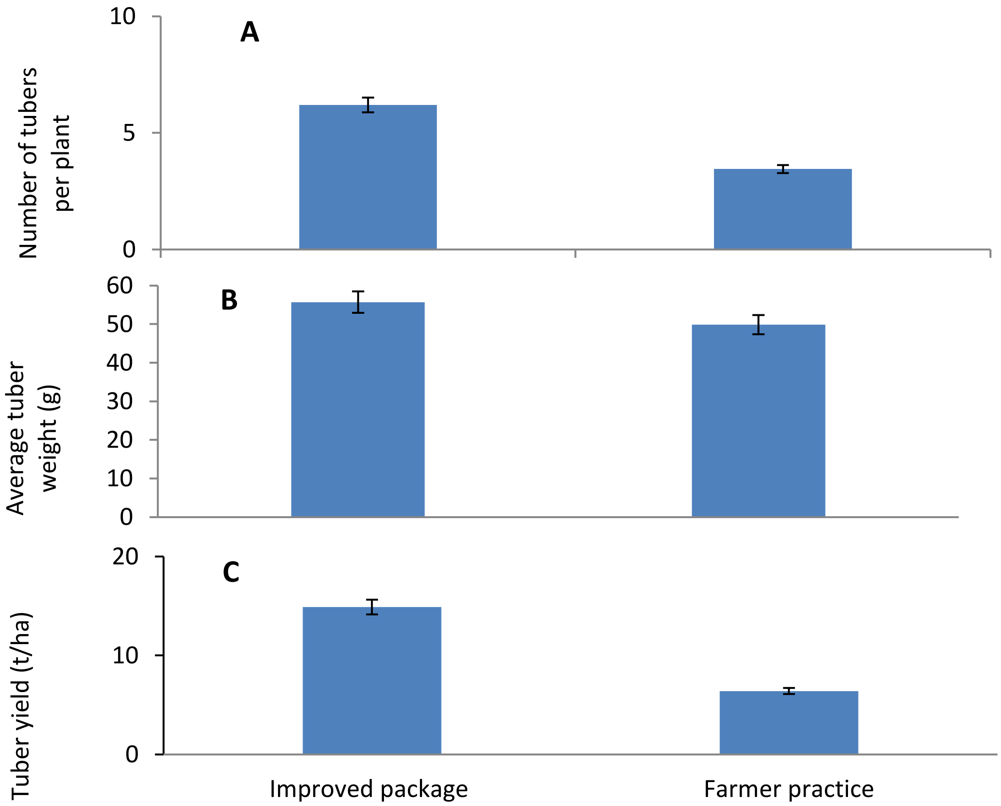


Figure 7. Mean tuber yields of 24 sites for improved and farmer packages of potato management practices for three seasons (2011A- 2012A) in Kabale and Kanungu districts, Uganda.

It is also important to note that some vulnerable farmer groups of Muramba People Living with HIV/AIDS and Muramba People with Disabilities, Kigaga women Stretcher groups, all in Kanungu, were each given 6 bags (480 kg) improved seed, as support from the project.

More information on seed and other potato technologies and project achievements was disseminated to end-users and stakeholders through radio talk-shows and programs on local FM radios, Voice of Kigezi FM in Kabale and Kanungu broadcasting FM in Kanungu districts. Two radio talk-shows were conducted, one in each district.

3.4.2 Linking Seed Producers to Ware Potato Producers

Ethiopia: The project established linkages between seed multipliers, ware potato growers, agro-input dealers and service providers by bringing them together during stakeholders' forums, trade fairs, and/or public trade and demonstration fairs. The project advertised the events in local newspapers in Amharic and English languages as seed promotional tool for healthy seed potato in the different project districts. This helped locate healthy seed at the time the farmers wanted to plant improved varieties.

Over 20,000 people, including higher government officials attended trade fairs held at Hawassa, the capital city of SNNPR and some seed farmers from Gumer and Geta exhibited their produce (Plate 10). Other public trade and demonstration fairs were held in Mekelle and Adigrat, the capital cities of Tigray and Eastern Tigray zone, respectively. The fairs were attended by more than 35,000 people including urban dwellers, farmers, zonal and district bureau of agriculture staff and higher regional government officials. In all the trade and demonstration fairs, CFC participants displayed seed tubers of the varieties: Jalene and Gudenie. Many were attracted to the CFC project stand because of the high-quality potato tubers and products that were displayed. Moreover, the fairs were broadcast on national and regional TVs and radio programs. This helped introduce farmers' produce to more people as the media reaches almost the entire country.

Private starch processing enterprise YASCAI was identified to facilitate direct market linkages to the ware potato growers, but the company withdrew from using potato as a raw material due to high prices and shifted to other produce such as cassava that is less expensive.

Plate 10. Farmers at Atsibi displayed the different products (left); Right: one of the cooperative members in Atsibi explaining how the cooperative has progressed from 2008 to 2010.

Kenya: The project team kept contact with seed multipliers in the three districts to make sure ware potato farmers accessed quality seed potato easily. This eased distribution problems of seed by seed growers. The contact also acted as a reliable source of information on new varieties. Some seed multipliers sold their seed outside their respective districts, thanks to the linkages created by MoA staff and other stakeholders. The contract farming in Bomet also helped to link seed multipliers to ware growers. In the contract agreement, it is a requirement that those who enter into such arrangement should access quality seed potato from a reputable source.

Uganda: Three trade fairs (2 in Kabale and 1 in Kanungu) were conducted as a way of linking seed potato producers to ware potato farmers. The then Minister of defense and currently the Prime Minister of Uganda, Honorable Amama Mbabazi (Plate 11, in yellow shirt) and Resident District Commissioner (RDC) for Kabale presided over the functions in Kanungu and Kabale, respectively in 2011, while during the third fair held in March 2012, the speaker of Parliament of Uganda, Rt. Hon. Rebecca Kadagga was the chief guest and visited the project stall. During such occasions, KAZARDI exhibited the different released potato varieties to seed and ware potato farmers. Potato processors (TomCris and Uganda

Industrial Research Institute (UIRI)) exhibited their products as well. Through their interactions, ware potato farmers became aware of where seed farmers are located to buy clean seed potato from.

Plate 11. Left: Trade fair conducted in Kayonza-Kanungu, Uganda (March 2011), Right: Trade fair at Kabale stadium-Uganda (March 2012)

3.4.3 Direct linkages Between Producers, Processors and Retailers

The contractual arrangement facilitated by the project benefited both the farmers and the processors in the case of Kenya and Uganda and the seed company in the case of Ethiopia.

Ethiopia: Solagrow engaged 171 farmers in contract farming. These farmers were trained and are now able to produce quality seed on behalf of Solagrow. In the first season of the contract, 24 farmers were able to plant 3 hectares of seed and provided more than 50 tons of healthy seed tubers. Solagrow also supported some ware farmers in getting direct market in the main cities to ensure that demand for seed farmers is created. Solagrow Company contracted seed growers to supply the company with seed which they in turn the sold to ware potato growers.

Kenya: Direct supply of potato to Deepa Industries Ltd by trained farmer groups in Bomet district started in October 2009. Between September 2009 and December 2012, the company has engaged over 350 households over a period of three seasons. Deepa Industries Ltd was involved in the development of the project as a private sector. The company is renowned for its high quality potato products which include potato crisps (Plate 12) in various designs and flavors: Flat slices, Crinkle cuts, Sticks and Fingers and potato based Ethnic snacks. Two additional processors, Norda and Chirag industries entered into contractual agreements with trained farmer groups in the same district starting December 2010 and January 2012, respectively.

The three processing companies engaged farmers under contract farming arrangement to supply quality potato on a weekly basis, i.e. Deepa (45 t/week), NORDA (10 t/week) and Chirag Industries (5 t/week). By end of the project in December 2012, more than 860 t of ware potato worth over KES 16 million (KES 84=1US$) had been purchased by DEEPA Industries. Over 140 tons worth KES 4.1 million were delivered to NORDA Industries and about 79 t worth KES 2.4 million were delivered to Chirag Industries.

Despite the many challenges encountered under the contract farming, contracted farmers continued to benefit in terms of increased income; improved access to assured markets and often higher prices than in open markets; better access to credit facilities; regular extension advice; and coordinated transport arrangements. Similarly, the company reduced processing losses substantially due to improved quality of tubers supplied to them through the contractual agreement.

Some of the changes witnessed among the contracted farmers included purchase of more land by some growers, increased investments in education, construction of permanent houses, and purchase of dairy cows and motor vehicles/cycles, among others. Mr. Faraz Ramji, CEO Norda, expressed satisfaction on the quality of potatoes delivered to the company. Similarly Mr. Amin, the Managing Director (MD) of Chirag Company, was also happy with the quality of potatoes delivered for processing.

Plate 12. Left: Deepa Industries potato crisps. Right: Norda industries potato crisps in one of the chain supermarkets in Nairobi.

Uganda: TomCris Enterprises, a potato processor engaged farmers to supply quality tubers. Tomcris together with KAZARDI trained over 50 FGs in production of quality ware potatoes. However, by the nature of FGs not owning land, it was not possible to have contract farming with FGs but rather farmers grew ware potatoes individually and later sold it to TomCris. To enhance the process, three potato traders were identified and trained on quality ware potato production, who later supplied TomCris and other identified buyers.

The new entrant Tropical Heat Uganda Ltd, a branch of Deepa Industries Ltd in Kampala, Uganda, tested various varieties in Uganda for processing qualities and Kachpot1 was preferred. The rest of the varieties tested; Rutuku, Nakpot5 and Kinigi (Plate 13) did not meet the required standards due to high browning.
One of the potato traders, Mr. Sanyu William, was linked to Tropical Heat Uganda Ltd for him to buy quality ware potatoes from farmers and supply the potato factory in Kampala-Uganda.

Plate13: Results for Potato varieties tested by Tropical Heat-Uganda Ltd (September 2012)

3.5 Improved Communication Between Potato Value Chain Stakeholders

To improve the market linkages and value chain interaction and communication, the WCPP initiated the establishment of local potato stakeholder's forums. Linkages created during trade fairs, stakeholders' forums and field demonstrations helped improve farmers' perception of a "seed potato" and other technologies. To farmers any tuber from whichever source was equally good for planting, but with the project's awareness creation, they started demanding quality seed from a reputable source.

Ethiopia: Four stakeholder's forums were established, one each in Gumer, Geta, Tikur Inchini and Chelea districts. The members of the local stakeholders included District Heads of Departments of MoA, Administration, Women & Children Affairs, Health Affairs, Youth and Sport Affairs, Government Communication Affairs, Co-operatives as well as EIAR Staff and CFC-Project Coordinator. Each forum met every six months in the MoA office of the respective districts.

Kenya: Three stakeholders' forums namely Bomet potato stakeholders' forum, Molo Potato stakeholders' forum and Kuresoi Potato stakeholders' forum were established**.** The forums met regularly to review policy issues affecting potato and other crops in the district and passed their resolutions to the larger stakeholder forums such as District Development Committee (DDC) for further discussions. Regular consultative meetings amongst farmers, researchers, extension agents, bankers, transporters and processors helped in setting priorities to solve problems encountered by potato stakeholders.

Uganda: The project supported establishment of potato stakeholder forums at sub-county and district levels. Sub-county forums merged and elected district potato stakeholder forums. These forums had representations of all the value chain actors: farmers (ware and seed), traders, brokers, input dealers, agricultural extension, research, NGOs, processors and local government/policy makers. Two district stakeholder forums were formed, one each in Kabale and Kanungu districts. These forums had responsibilities of providing a platform for potato value chain actors and to identify and pursue direct market for both ware and seed potatoes.

3.6 Challenges and Prospects for Regional Trade in Potato, and its Products

A feasibility study to document the region's prospect on potato import and export was conducted in 2009/2010 in each of the three countries. Some prospects for the exports included the current emerging demands of potato in some neighbouring countries, up-coming enterprenuers and government initiatives in potato processing, government support in product development through quality assurance, enforcement of harmonization standards and regional intergration in East Africa.

In Ethiopia, one of the key findings of the study is that there is a rapid increase in ware potatoes export in Ethiopia over the last two years to its neighboring countries (Figure 8). The imports were limited mainly to frozen chips, (>25 tons per annum) which were imported directly from Europe by two five-star hotels.

In Kenya, the main finding of the study was that Kenya exports various potato products, ware and seed potatoes to various countries in Africa and in Europe (Ng'ang'a and Kaguongo, 2012) (Figure 9). Since 2007 the highest amount of potato exports is in the form of seed and the exports are private sector driven mainly by individual companies and entrepreneurs. In spite of these exports, Kenya is a net importer of potatoes with the largest import being ware potatoes which are imported during specific months of the year (February-May). A detailed report of the feasibility study for each country is annexed (Annex 1) to this report.

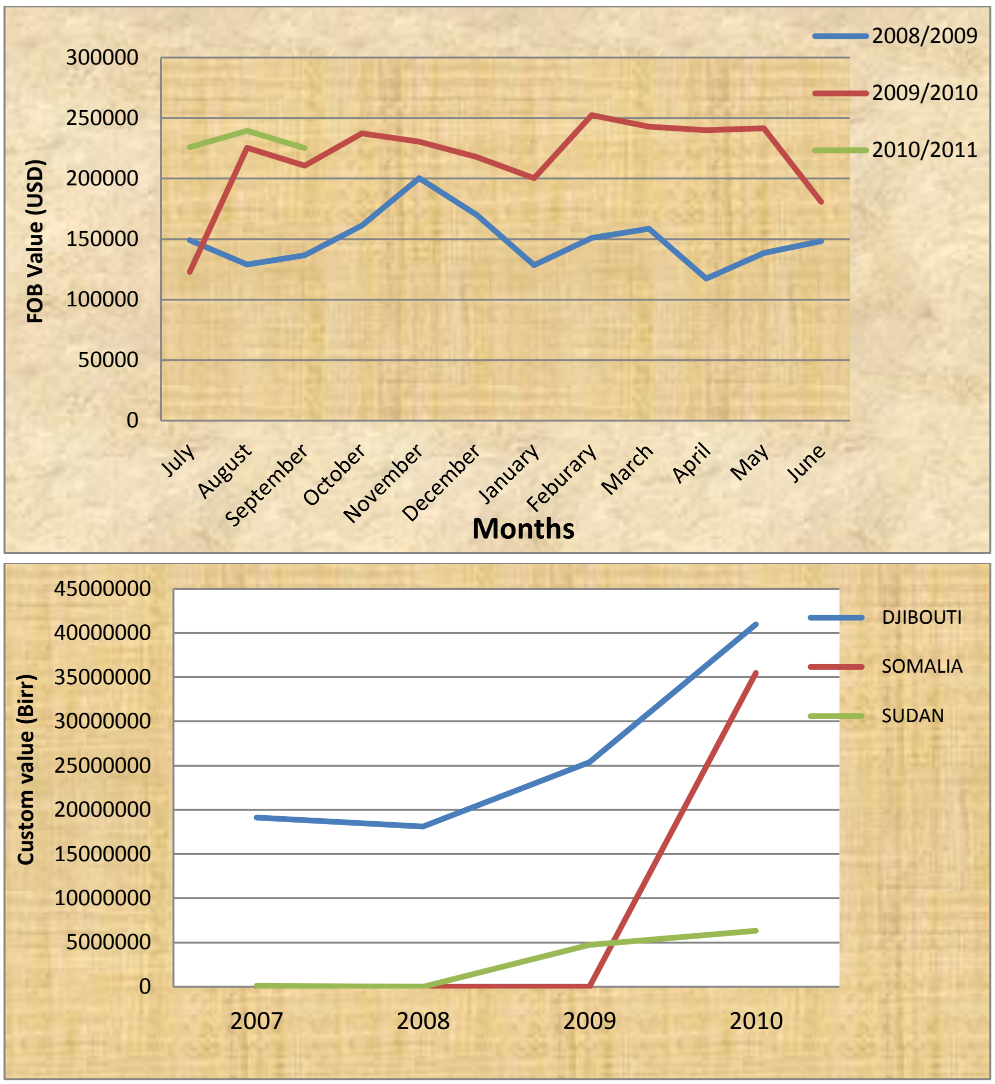
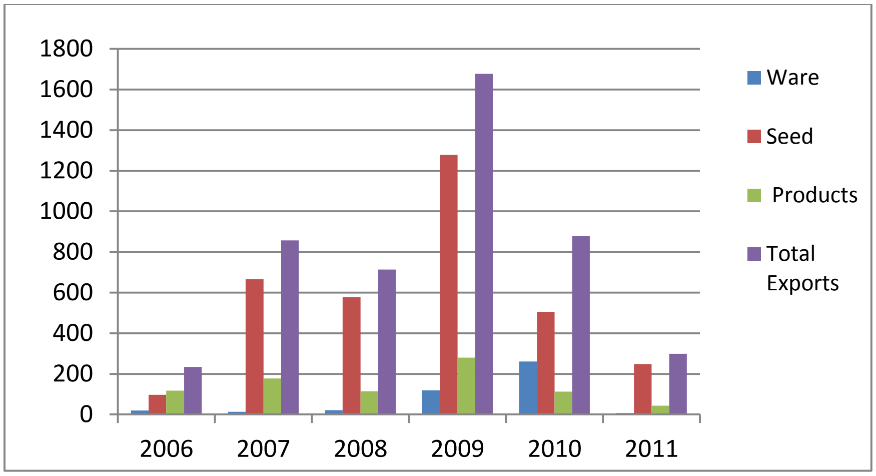


Figure 8. Monthly ware potato export from Ethiopia (top) and its destinations (Bottom) for the period 2008 to 2011.



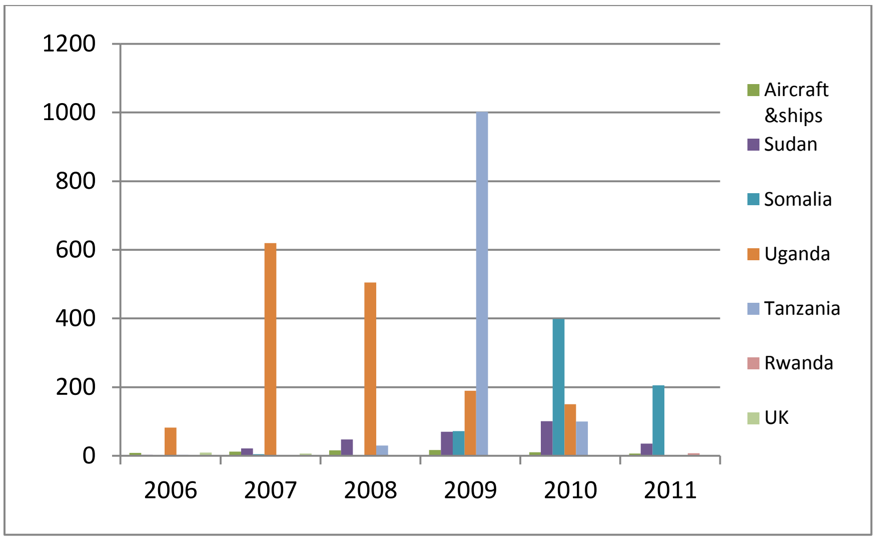


Figure 9. Quantities in tons of potatoes exported from Kenya (Top) and their destinations (Bottom) for the period 2006-2011.

3.7 Development of National Potato Subsector Plan

Despite the investments made into the potato sub-sector in the region for the last several years, growth of the subsector has not been satisfactory. This is partially due to lack of developmental plan and low ranking of potato as a strategic crop by the governments of the three countries. To successfully transform the potato subsector the project initiated the development of the potato sector development plan (PSDP) for each country. The purpose of the PSDP's is to move the potato industry from its current status to self-regulating, vibrant and competitive business venture.

The potato sector development plan (PSDP) was successfully documented in Kenya because there were many other references already documented on the sub-sector, including Seed Potato Master Plan, Potato Industry Strategic Plan, EAC Standards and CAP 326, Laws of Kenya, Legal Notices. A Committee overseeing the development of the National Potato Development Plan (NPDP) was formed in 2010 with representatives from National Potato Council of Kenya (NCPK), KARI-Tigoni, MoA, CIP and other stakeholders. The committee reviewed all potato documents and the project feasibility study report and came up with a draft PSDP which was discussed and finalised during a stakeholder workshop held in collaboration with NCPK. The PSDP (Annex 2) will serve as a blue print for potato subsectors in Kenya.
In Uganda and Ethiopia, completion of potato sub-sector development plans was not possible because of the time and resources required to developed the plan. Unlike in Kenya, there were few existing

documents and policies on potato sub-sector in both countries. As such the project initiated the process and developed the framework that will be used as a basis by other development partners and government agencies who may wish to come up with the potato development plan.

3.8 Sharing of Project Lessons at International Forums and Through Publications

3.8.1 International forums

Two posters were presented at the CIALCA International Conference held in October 2011 in Kigali, Rwanda. One of the papers was on "Rapid assessment of potato productivity in Kigezi and Elgon Highlands in Uganda" and the other on "Strategies to overcome the shortage of quality seed potato in Eastern Africa". The project participated in the 1st ASARECA General Assembly held in Entebbe, Uganda on December 14-16, 2011. The theme of the function was "Feeding our region in the 21st Century". Some posters were presented, for example, "*Research for Development Partnerships for Creating Wealth through Potato in Ethiopia, Kenya and Uganda" and another one* on CFC project achievements. The project, exhibited the different potato varieties, ware and seed potato samples, and potato processed products.

In January 2012, two members of the project implementation team participated in the second All Africa Horticultural Congress (AAHC) held in Kruger National Park, South Africa. Both gave an oral presentations entitled*: Capacity Building- A prerequisite to Technology Adoption and Sustainable Potato Production in Eastern Africa* and *Positive Selection , a tool for improving seed potato quality and potato productivity among smallholder farmers in Kenya and Uganda*. Both presentations focused on achievement of the WCPP and the 3G project. A paper extracted from the Ethiopian survey on potential of ware and seed potato was also presented at national horticulture conference.

In June 2013, two papers entitled "Potato production efficiency through contract farming in Kenya: The case for Bomet and Molo farmers" and "Quality seed potato production: Experiences from the highlands of Ethiopia" in the 9th Triennial APA Conference, June 30-July 4, 2013, were presented at the 9th Triennial African Potato Association (APA) congress held at Great Rift Valley Lodge, Naivasha, Kenya. Also published from the project were a number of popular articles in a widely read Horticulture magazine in Kenya.

3.8.2 Publications

The papers presented at the All Africa Horticultural Congress will be published in the ACTA Horticulture journal. The WCPP in Kenya partnered with NPCK, KARI-Tigoni, MoA and CIP in the preparation of the publication: "A Policymakers' Guide to Crop Diversification: *The Case of Potato in Kenya"* published by FAO in 2013.The papers and posters presented in the different conferences will be published in proceedings.

3.8.3 Video documentaries

Each project country has prepared video documentaries highlighting the project's achievements. The videos will soon be uploaded in the CIP YouTube.

4. Project Outcomes and Impacts

Over the last four years and four months (September 01, 2008 - December 31, 2012), the WCPP has yielded significant outcomes which in some cases were almost at the level of impact in the three project beneficiary countries. As explained in section 3, the project did not only strengthen farmers' knowledge through hands-on intensive trainings in both seed and ware potato production, but also linked them to markets. The project brought together stakeholders as a way of enhancing potato value chain for the benefit of all value chain actors and service providers. Through use of field days, trade fairs, exhibitions and farmer managed demonstration plots; the project has created awareness on the use of quality seed alongside recommended agronomic practices as a vehicle to bridging the existing yield gap. Indeed the project has brought about some positive changes as presented in the following case studies based on findings of the project impact assessment study (Annex 3) conducted in 2012 in the three project countries.

4.1. Increased Production and Accessibility to Quality Seed

The USAID-funded project and this CFC-funded project brought about a marked increase in the production of MT, pre-basic and basic seed by national programs in the three project countries and also the private sector in the case of Kenya. The increase in production of starter seed coupled with the high number of trained seed multipliers led to increased production and accessibility of quality seed at farm level. To ensure ware farmers get seed within a close range, the project trained several seed multipliers in each district. For example, in Bomet there were 14 commercial individual and group seed multipliers in 2012 up from two in 2008 when the project started (Box 1). Farmers are also producing own seed using small seed plot technique.

Box 1.Better accessibility to quality seed in Bomet district

"Initially there were only two seed multipliers in the district. The number has since increased to 14 (7-fold) thereby increasing the access points to clean planting materials. At the start of the project the two seed multipliers used to generate on average 40 tons of seed per season, representing only 2% of the district's requirements. Currently the seed producers generate on average 400 tons per season enough to meet 11% of the requirements. The seed multipliers are fairly distributed within the potato growing areas hence bringing seed closer to the ware producers. Closer interaction between research, extension and seed growers has helped improve productivity" Joseph Kering, D/DAO, project coordinator (2011).

4.2. Increased Ware Potato Yields

Use of quality seed of the improved varieties, recommended agronomic practices and assured markets, trained farmers in the three project countries have recorded higher yields. For example, in Ethiopia where the national average yield is about 8 t/ha, trained farmers in Cheleyia district recorded as high 45 t/ha for Gudene variety (Figure10). Farmers in Atsibi recorded as high as 32, 30 and 28 t/ha for Jalene, Gera and Gudene varieties, respectively. Occasionally farmers in Gumer and Geta got as high as 50 t/ha.

In Kenya, trained farmers increased their yields from less than 9 t/ha in 2008 to about 14 t/ha in 2012 with a few of them getting as high as 30 t/ha especially in Kuresoi and Molo districts. The yield increase was however more pronounced in Bomet district as a result of contractual arrangements (Figure 11) which necessitated the use of quality seed and correct application of other inputs.

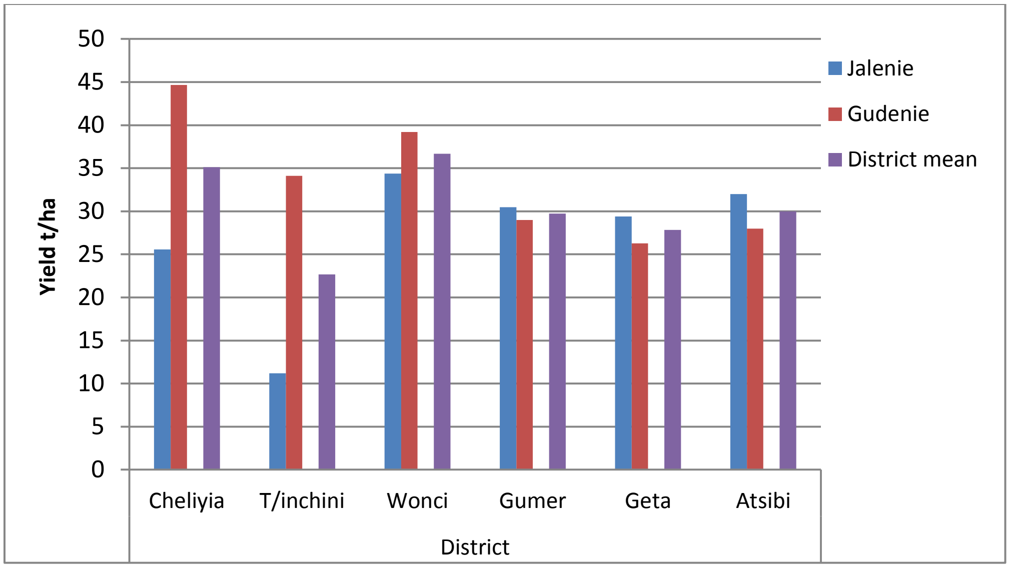
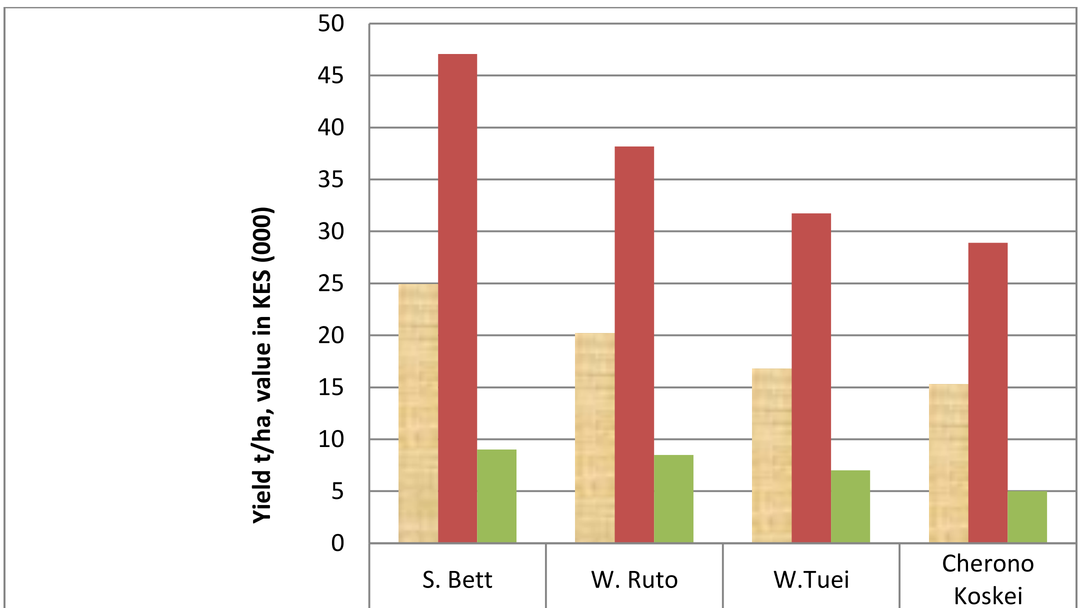


Figure 10. Mean tuber yields of the selected varieties included in the seed production across different districts, Ethiopia 2008-2012



	S. Bett	W. Ruto	W.Tuei	Cherono Koskei
Yield (t/ha) after contract	24.9	20.2	16.8	15.3
Value in KES '10,000'	47	38	32	29
Yield (t/ha)before contract	9	8.5	7	5

Figure 11. Yield increases achieved by selected farmers from the base yield of 9t/ha before the project started in Bomet district, Kenya

4.3. Enhanced Diffusion of Late Blight Resistant Varieties and their Impact

In the highlands of Ethiopia, farmers were suffering from shortage of food during the months of September to November, before grain harvests in December. Farmers were not able to grow potatoes during the long rain season that starts in June because of the high incidence of late blight, the most common and important fungal disease of the potato.

The project facilitated the diffusion of new late blight tolerant potato varieties. In 2009, when the project was in its initial year of implementation, the most popular varieties among the CFC participants were Keydinch Aba Minemene and Keyi which were highly susceptible to late blight. Other varieties that were grown included French potato, Ferengy and Shashamane also susceptible to diseases. In the year 2012, the CFC participants were growing LB resistant varieties such as Gudene (43%), Jalene (30%) and Guasa (15%). It is interesting to note that 38%, 19% and 14% of the non-participating farmers grew improved varieties Gera, Jalene and Gudene, respectively showing a clear spillover effect (Table 7). Importantly, the number of farmers growing improved varieties and acreage under potatoes increased significantly. For example, in the four project districts 11,175 farmers grew late blight resistance varieties on 1,539.4 ha (Table 8).

Table 7. Direct and spill over effect of the project in growing improved varieties by farmers (participating and non-participating) in 2012, Ethiopia

Farmer category	Variety	Farmers growing the variety (%)	Mean(acres)	Sum (acres)
Participants	Jalene	31	0.17	5.20
	Gudene	42	0.34	14.14
	Guasa	28	0.35	9.92
Non participants	Jalene	19	0.28	5.33
	Gudene	14	0.31	4.37
	Gera	38	0.57	21.50
	Guasa	6	0.36	2.14
	Local	11	0.92	10.09

Because of introduction of late blight resistant varieties, farmers were able to grow potatoes in the long rains and harvest starting from September. This bridged the gap of food insecurity during September to November hunger period and it has had an impact on farmer's livelihood as captured in Box 2.

Box 2. Late Blight Resistant Potato Varieties changed our lives

The excited farmers in the project areas of Ethiopia said that prior to the project growing potatoes in the main rain season (June - September) was not possible because of the late blight disease. "We were suffering from food insecurity during September to November before grain harvests in December. However, with the improved technologies, particularly varieties disseminated by the project and EIAR, we witnessed a good harvest during the main rains. We are very happy to see a lasting solution for the first time to the hunger that reoccurred every year. We get high yields more than 30 t/ha on average which enabled us to be food secure, boost our incomes and comfortably meet our obligations for the most demanding nationwide festival called Meskal (the finding of the true cross) and sending children to school after a long holiday season." The yields were a surprise to the farmers as the national average yield stands at about 8 t/ha.

The financial returns the potato farmers got were very significant to the extent that farmers could not believe it, as they had not seen so much from farming potatoes in their past experiences and all that happening during the main rain season, when they could not grow potatoes at all. For instance, in Atsibi the capacity of the cooperative has increased to provide input and credit to the members, as the capital of the cooperative increased from Birr 3,750 in 2008 to 1.5 million in 2012. It has been also reported that 29 of the 34 members have graduated from Safety net

Table 8. Farmers growing improved potato varieties in the main season of 2011

District/Woreda	Number of Farmers		Total farmers	Area planted
	Male	Female		
Gumer	3,063	898	3,961	807.5
Geta	3,460	784	4,244	428
T/Inchini	-	-	398	98.1
Wonchi	2,318	254	2,572	205.8
Total	8,841	1,936	11,175	1,539.4

In Kenya, through demonstrations and awareness creations, farmers started to grow CIP-bred varieties released in 2010 namely: Kenya Mpya and Sherekea in Molo and Kuresoi districts. The project bought 20,000 MT of these varieties which were given to trained seed growers for further multiplication. The project also entered Zangi, a farmers selected variety in the 2012 national performance trial (NPT) and seed multiplication using rapid multiplication techniques such as aeroponics will start once it is officially released.

In Uganda, farmers adopted improved potato varieties, especially Victoria and Kachpot 1 at the expense of local varieties like Kimuli. This has resulted in increased potato productivity to over 15 t/ha compared to less than 8 t/ha before project intervention. Use of improved varieties enabled trained seed producers' associations in the two districts of Kabale and Kanungu to earn 149.3 million Uganda shillings (59,704 US$) from seed potato sales within the seven seasons when the project operated in the area (Table 9).

From potato proceeds, some farmers and other value chain actors have purchased more land for crop cultivation, bought livestock, built houses, paid school fees for their children at various education levels and some bought household equipment.

Table 9. Amount of seed potato sold and income earned by seed multipliers in seven seasons (2009A -2012A) in Uganda

Sub-county	2009A and 2009B seasons		2010A and 2010B seasons		2011A and 2011B seasons		2012A season	
	Amount (tons)	Value (000'UShs)	Amount (tons)	Value (000'UShs)	Amount (tons)	Value (000'UShs)	Amount (tons)	Value (000'UShs)
Hamurwa	4.96	4,960	6.88	8,600	6.2	7,750	6.5	8,125
Bubare	10.72	10,720	8.4	10,500	9.1	11,375	1.4	1,750
Rutenga	12.0	12,000	9.6	12,000	14.0	17,500	8.2	10,250
Mpungu	3.28	3,280	6.56	8,200	11.8	14,750	6.0	7,500
Total	**30.96**	**30,960**	**31.44**	**39,300**	**41.1**	**51,375**	**22.1**	**27,625**

4.4 Improved Market Linkages: Transforming Potato Farming into Business Venture

In Ethiopia, it is evident that the WCPP had an impact in potato marketing as attested by majority of participating farmers. In 2009, most farmers (62%) in Ethiopia sold their potato at the village market. About 33% sold in the district/capital markets. In 2012, about 55% of the project participants sold potatoes directly to consumers, while 32% sold to NGOs. Most of the project participants (58%) sold their potato to NGOs, while 27% sold to government organizations. Majority (91%) of the participant farmers reported that in 2012, it was more convenient to sell potatoes in Ethiopia compared to four years ago. About 76% of the non-participants reported that it was more convenient to sell potatoes in 2012 compared to 4 years ago while 23% reported that the situation remained the same.

Although none of the farmers had a contractual obligation with the buyers, they fetched good income from the sale of seed and ware potatoes. For instance, Shewit Seed Potato Producers Cooperative in Atsbi gradually increased their income from Birr 391,500 (about USD 23,030) to Birr 2 million ($117,600 USD) over a period of five years (Table 10).

Table 10. Total seed produced and annual income earned by Shewit Seed Potato Producers, Atsibi, 2008-2012

Year	Amount of seed produced (tons)	Income Generated	
		EB	**US$**
2008	87	391500	23,030
2009	97	485,500	28,529
2010	145	841,580	49,504
2011	180	1,422.200	83,659
2012	250	2,000,000	117,647
Total	**759**	**5,140,780**	**302,399**

In Kenya, 16.3% of the participating farmers interviewed during the impact assessment study in 2012 were under contract arrangement with processors compared to 1.5% among the non-participants. Contracted farmers were paid a higher price of KES 18.77 per Kg in Bomet compared to KES 16. 78 per Kg paid to non-contracted farmers. Prices of potatoes in Kuresoi, Molo and Njoro were generally low on average since they were not linked to any direct market (Table 11). They sold their potatoes on open market through middlemen and they were prone to exploitation.

Farmers who participated in the project paid less on average for seed than those who were non participants in the intervention districts as shown in Figure 12. This was possible because of the linkages the project created between seed and ware growers. This translated to high productivity and net farm income for participating farmers compared to non participants in all the districts.

Table 11. Price difference in KES per Kg of ware potatoes for contracted and non-contracted farmers in Kenya

	District	**Maximum**	**Mean**	**Std. Deviation**
	Prices of ware per Kg			
Contracted	Bomet, n=28	40.00	18.77	5.80
Non-contracted	Molo, n=25	27.27	14.01	5.47
	Kuresoi, n=79	30.00	14.38	5.48
	Njoro, n=35	27.27	13.93	4.55
	Bomet, n=94	27.27	16.78	5.03

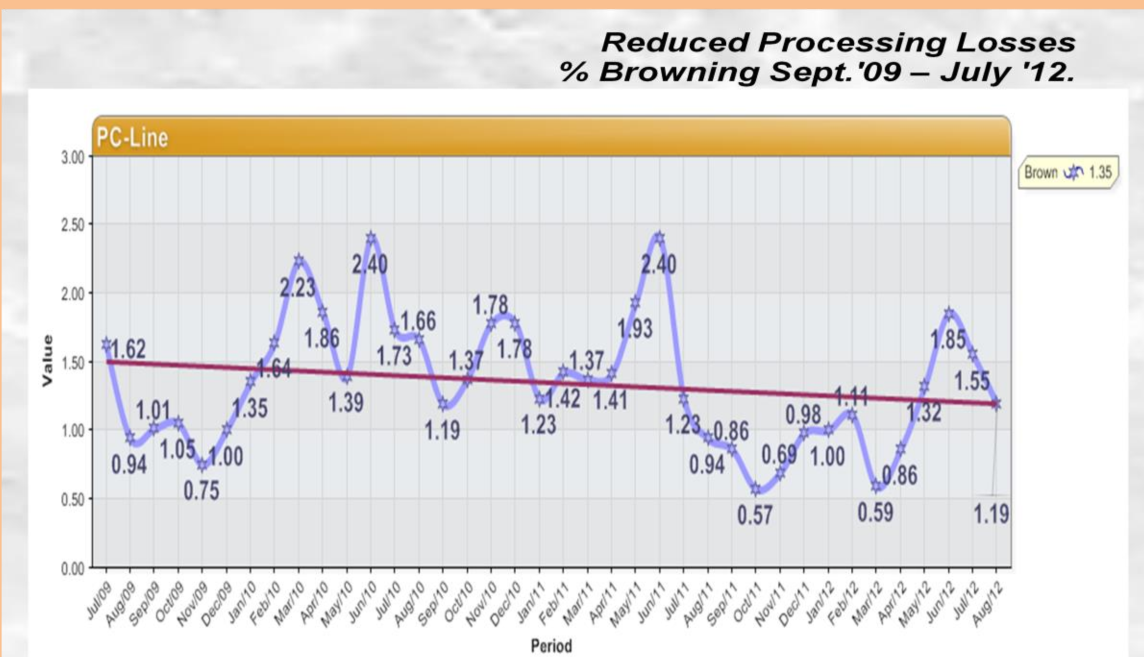
Source: WCPP Impact assessment survey report, 2012 (Annex 3)

There was also a marked improvement in the benefit: cost (B:C) ratio with farmers who were linked to the market through contract farming. Their benefit cost ratio was 1.78 meaning that farmers earned KES1.78 for every KES 1 incurred in potato production with contract, while those who were not in contract earned comparatively low with a B:C ratio of 0.63 in Molo, 0.64 in Kuresoi and 1.25 in Njoro and Bomet as shown in Figure 12. This showed that farmers in Bomet whether participants in the project or not had a higher benefit: cost ratio than from Molo, Kuresoi and Njoro. This could be attributed to spillover effects due to contract farming in Bomet district.

Box 3. Effects of contract farming in Bomet district

Contracted farmers benefited in terms of increased income; improved access to assured markets and often higher prices than in open markets; better access to credit facilities; regular extension advice; and coordinated transport arrangements. Coordinated deliveries of potatoes accompanied by tags, indicating farmer's details, improved traceability and assert responsibility of farmers to supply quality tubers.

Similarly, processors recorded substantial reduction in processing losses due to better quality row potatoes supplied by the contracted farmers. For instance, Deepa Industries Ltd (DIL) improved its crisps productivity through reduction in: browning (from 2% to 1.22%), rotting (from 1% to 0.7%) and peeling losses (from 3.60% to 2.85%) compared to the pre-project period. Coordinated deliveries of potatoes accompanied by tags, indicating farmer's details, improved traceability and defined responsibility of farmers to supply quality tubers.



Effect of contract farming on percentage yield and browning and cutting/broken losses at Deepa processing unit, 2009-2012

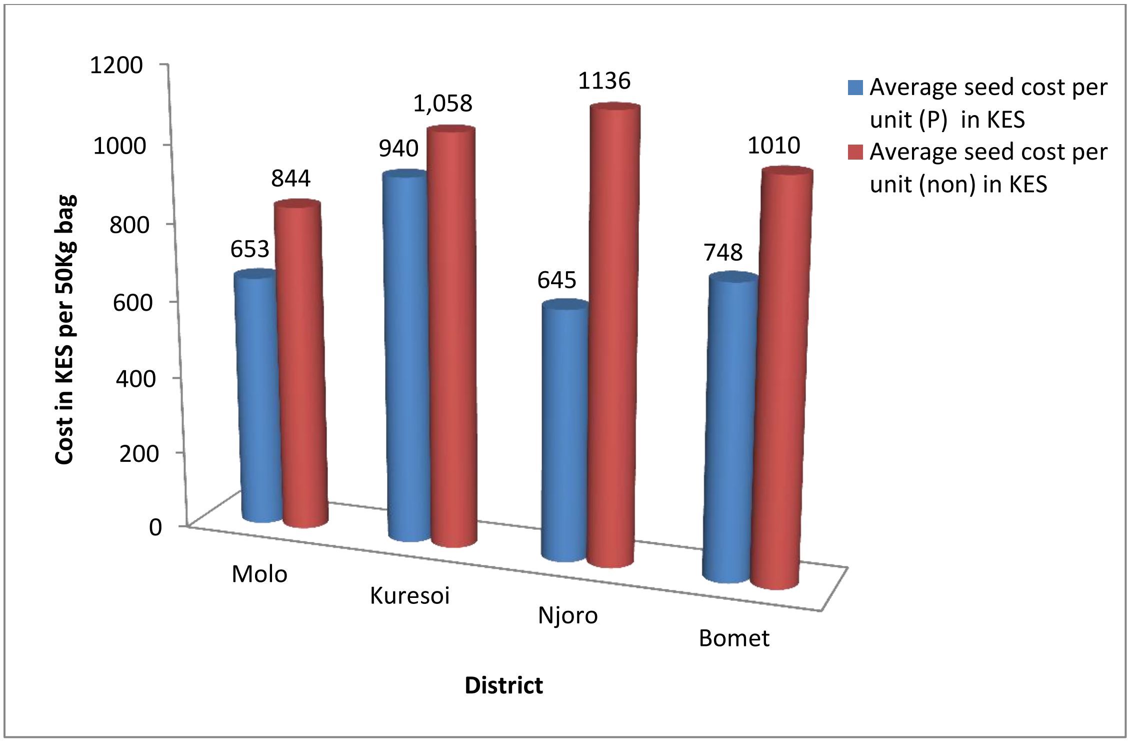


Figure 12. Average seed cost per bag for participating (P) and non-participating (non) farmers, Kenya

In 2009 when the project was in its initial year, most farmers in Uganda sold their potato to village markets (41%) and to the middlemen at the farm gate (30%). With the strengthening of market linkages by the project, participating farmers were able to sell their potatoes to larger markets as exhibited by a high number of farmers selling their potatoes to big traders (37%) in 2012. Non-participating farmers also benefited with about 31% selling their potatoes to the big traders, 28% to retailers and 18% to consumers directly. None of the interviewed farmers sold to processors. From the market point of view, there were no major disparities on the type and number of buyers for both groups. None of the farmers from both groups had a contractual agreement with buyers.

4.4 Enhanced Adoption of Appropriate Seed Storage Technology

At the start of the CFC project in 2009, many farmers (23%) in Ethiopia kept their seed potatoes covered in the field. About 18% kept their seed potatoes uncovered in the house. Others stored their seeds in dark stores (15%), dark spaces in the house (12%) and by covering them in the houses and use of granaries (15%). Only about 5% used DLS. However, in 2012, about 34% of the participants stored their potato in DLS. About 26% left their potato uncovered in the house. CFC had an impact on the participants evidenced by a large number of the participants (34%) using DLS compared to the non-participants (12%).

In Kenya 89.9% (n=166) of participants compared to 9 % (n=134) of non-participants farmers interviewed during the impact assessment study conducted in 2011/2012 reported to have heard and trained on the importance of DLS out of which 17.5% (n=129) of the participants and 9% (n=134) non-participants had constructed own DLS stores. There was a marked increase in awareness and usage of DLS compared to 2008 when only 5.3% (n=374) had heard of DLS.

The most common seed potato storage among the participant farmers in Uganda was keeping the seed potatoes covered in the house. Participating farmers shifted away from storing seeds in dark space in the ground as indicated by a drop in the practice from 23% in 2009 to 1% in 2012. The use of DLS increased from 11% in 2009 to about 19% in 2012. The percentage of farmers using DLS is higher among the participants (19%) compared to the non-participants (7%). Most farmers in the control group (i.e. non-participating) left their seeds uncovered in the house (42%), followed by storing in dark stores (19%) and covering them in the house (18%).

4.5 Spillover Effects of the Project

i. The success of WCPP was emulated by another government initiative of Kenya dubbed "National Accelerated Agricultural Input Access Program" (NAAIAP). Through the program, over 640 farmers trained by the WCPP received certified seed potato for further multiplication for own use.
ii. Initially only Deepa Industries Ltd participated in the project as a direct market for Bomet farmers. Due to publicity of the project's success in establishing potato contract farming, other processors: Norda, Chirag, Pioneer and Alphaars food contacted the project leader requesting to be linked to trained farmers so as to get supplies directly from farmers.
iii. Farmers from other regions as far as Meru (Eastern Kenya) requested to be given seed potatoes for Dutch Robjyn variety to grow and to be linked to direct markets as was the cease for Bomet farmers.
iv. Several seed and ware potato farmers other than the ones trained by the project within and outside the project districts, procured quality seed from the trained seed growers. They came to learn about the seed availability during the field days and stakeholders' forums meetings.
v. Aeroponics potato technology which was first tested at the National Agricultural Research Institutes (NARIs) by the project in collaboration with the USAID funded 3G project has been taken up by other programs. Bio-Innovate project has taken up some activities in aeroponics like the evaluation of cost-effectiveness of aeroponics minitubers production viz a-vis conventional RMTs. Also there are some private entrepreneurs who have expressed interest of venturing into the aeroponics in the three countries.
vi. "Select the Best" PS method used by participating farmers to improve on-farm seed quality has been adopted by neighbouring farmers after seeing it's importance during the field days organized by participating farmers.
vii. In Ethiopia and Uganda non-participating farmers who grow ware potatoes are constructing simple DLSs using local materials.
viii. Non participant ware potato farmers around the project area began buying improved seed potato from the trained seed potato producers.
ix. Prior to the project, farmers in Uganda had a poor perception of fertilizer use until trained seed producers used fertilizers and got better yields. Currently even some smallholder ware potato farmers outside the project are using fertilizers. They have also adopted row planting and LB disease management using fungicides together with other integrated late blight control measure components. Similarly, most farmers, including non-participants now have come to know that diseased potato plants in their fields spread disease to healthy plants.
x. In Uganda, a USAID-funded project through Self Help Africa intends to use the technology in training farmers in southwestern Uganda through farmer to farmer training approach.

4.6 Sustainability Beyond Project Duration

By involving the key actors along the potato value chain (both seed and ware) and service providers, the project partners envisaged continuation of the project activities and impact beyond its duration. Secondly, the project partners strengthened the linkages and interaction between the different actors: basic seed producers were linked to trained certified and/or quality seed multipliers who were in turn linked to the ware growers and some of the ware growers were linked to processors and other buyers. Importantly, all the participating farmers received comprehensive trainings and this has enabled them to improve the quality and increase the yields. Also, farmers were assisted to form groups and cooperatives so that they gain from the economies of scale and bargaining power.

The case for Bomet district, where in June 2012 the newly established County Government ranked potato as a priority crop and allocated funds for boosting its production, is a good example of project sustainability. Thanks to the project which unlocked the potential of the humble potato in the district. The County Government set aside land (about 5 acres) for seed production and plans are underway to construct a processing plant in Bomet town, for which KES 9 million has been ear-marked.

Another excellent example is the case for Ethiopian farmers who were not able to grow in the main rain season (June - September) due to high incidence of late blight. The introduction of late blight resistant varieties is seen by farmers as a lasting solution to recurring hunger months. The farmers had this to say about the project: "We were suffering from food insecurity during September to November before grain harvests in December. However with the improved technologies, particularly varieties disseminated by the project and EIAR, we witnessed a good harvest during the main rains. We are very happy to see a lasting solution for the first time to the recurring. We get high yields more than 30 t/ha on average which enabled us to be food secure, boost our incomes and comfortably meet our obligations for the most demanding nationwide festival called Meskal (the finding of the true cross) and sending children to school after a long holiday season."

4.7 Success Story: Farmer's Testimonials

Participating farmers are happy with the project's performance as attested by the following memorable quotes from some of the farmers:

Ethiopia

"Before the project, we had no money but now we have money. Potato has made us rich. In 2008/2009 crop season we produced and sold potato seed worth 260,000 Birr". Burda Erdamba group member, District Gumer, Guragie zone

"We plan to increase the area under seed production. We hope to produce sufficient seed to meet the district requirement and sell surplus to other districts" Dembera Peasant Association (Women's group), member, District Gumer, Guragie zone

"We used the money we got from selling potatoes in 2009 to buy oxen, improved our houses and educate our children. Now buyers come with trucks to buy our produce. Our Cooperative constructed two 12-ton DLS at a cost of 33,000 Birr." Fitie group member, District Wonchi, West Shewa

"Our area has been mainly a pulse-growing area. There was hardly any potato in the region. But after seeing the success with potato cultivation, we are planning to increase the area under seed production. We are also planning to produce ware potatoes and venture into potato processing, possibly in Macaroni production." -Woldetefem group member, District. Wonchi, West Shewa

"The capacity of our cooperative to provide input and credit to the members has tremendously increased, thanks to the project support. Our capital increased from Birr 3,750 in 2008 to 1.5 million in 2012.

Furthermore 29 of the 34 Cooperative members have graduated from Safety net" Member, Shewit Seed Potato Producers Coopration, Atsibi

Kenya

"More potato business is all I got from the project. Between November 2009 and April 2012, I delivered a total of 1,624 t of quality potatoes from contract farmers' worth over Ksh 28 million. This gave me the courage to apply for a loan in Equity Bank which I used to purchase an 8-t capacity lorry and built a modern family house. The bank trusted me because of my involvement in potato business through the project" Robert Metet, Contracted farmer and transporter, Bomet district, (2013).

"I started seed potato business after being trained by the project in 2010. Venturing into seed production has significantly boosted my income and has enabled me to pay University fees for my wife, built a decent house and improved my living standards. I owe my success to the project" Sammy Sang, seed farmer, Kuresoi district, (2012)

"Personally the project has changed my life. From the income I earned from contract farming, I was able to pay dowry, purchase a dairy cow and enrolled in teacher's training college" Salim Bett contract farmer, Bomet district (2012).

"I joined the project in 2011 as a seed multiplier and in 2012 crop season, I harvested 18 tons of quality seed from 1.3 acres. This earned me over U$6,600 (KES 540,000) from the seed sales which I used to build rental houses" David Mibei, Seed multiplier, Bomet.

Uganda

"We have been saved by potato against famine caused by this disease (referring to banana bacterial wilt disease, BBW) which has wiped out our banana plantations. Thanks to the project for promoting potato production in Kanungu." Says Mr. Rwaguma Ben, a potato farmer in Muramba-Rutenga, Kanungu district, August 2012.

"Before joining the project, I did not know how to manage potato crop and I used to plant unhealthy tubers from markets and my yields were very low. After being trained as a seed producer, I gained knowledge and skills in seed production and management and now I buy quality seed from KAZARDI and my yields have drastically increased. Through potato sales, I bought land worth UShs.1,500,000, three goats worth UShs. 240,000, paid school fees for my children and improved my potato store." Mrs. Kuhasire Annet, a seed producer from Kanungu, Hamurwa-Kabale, July 2011.

"Potato was a hear-say in Mpungu sub-county, until the Wealth Creation Potato Project extended its operation in Kanungu district. Many of us did not believe that potato could yield well in the area but this project disapproved us" Mr. Byamugisha Innocent, farmer from Mpungu-Kanungu, 2010.

5. Lessons Learned

i. With proper technical advice and backstopping, farmers are able to produce high quality potatoes.
ii. Farmers are willing to invest in clean/certified seed, as exhibited by the high number of trained seed multipliers who are currently producing seed on a commercial basis.
iii. Use of quality seed of improved varieties leads to increased tuber yields at farm level.
iv. Trade fairs, field days and demonstration fairs disseminate technologies to a wide range of stakeholders in a short period of time.
v. Farmers are able to effectively train fellow farmers. Some farmers understand and adopt more when trained by fellow farmer(s) but there should be initial introduction by the extension staff (case in Kenya).
vi. Farmers are willing to invest in technologies that give them immediate benefits, for example, DLS as indicated by the number of DLS constructed by the participating farmers.
vii. Involving media (print and audio-visual media) during field days and open days is important for technology dissemination on improved potato technologies to larger audiences.
viii. In Ethiopia, farmers were not interested in "Select the Best" PS method which takes two crop seasons. They preferred to go straight for seed potato production business after undergoing an intensive a 2-3 day course.
ix. The "Select the Best" method if carefully implemented, greatly improves seed quality by reducing disease incidences mainly BW and viruses, consequently increasing productivity.
x. Organizing farmers into farmer groups or cooperatives helps to reach more farmers in technology dissemination.
xi. It is easier for farmers to be linked to markets if they are organized in groups.
xii. A premium price above prevailing market prices is a pre-requisite for production and supply of quality ware potatoes to processors under contract. In executing contractual agreements, it is inevitable that conflicts arise so it is important to resolve such conflicts amicably in an open and transparent process that brings all actors together. It is also important to revise prices every three months so that agreements are respected by all.
xiii. Potato is a commodity that can bring people out of poverty in a short time if properly managed and seed production is a very lucrative venture.

6. Conclusion

The Wealth Creation Potato Project significantly contributed to the potato sub-sector in the three project countries. The project built both institutional and farmer (seed and ware) capacity to produce, manage and distribute quality seed which greatly improved and increased potato yields, household food security and incomes. Furthermore it enhanced potato marketing by bringing together all potato value actors. By initiating the potato sub-sector development plans, the project established the basis for future development of the potato industry by the governments and other development organizations.

Undoubtedly, the project has shown that potato in a value chain approach can significantly contribute towards poverty alleviation. It has proven that potato can be a major contributor in creating wealth for smallholder farmers. The project has set pace by encouraging potato farming as a business as farmers realized the existence of market that is ready to pay for regular supply of quality seed and ware potatoes.
Although the project achievements are laudable that the project met all its objectives, realizing full potential of the humble potato is still an arduous journey that calls for more strategic interventions and concerted efforts by all stakeholders.

7. Recommendations and future interventions

7.1 Private Sector Participation in Seed Potato Production and Distribution

i. Private public partnership (PPP) which plays a key role in seed production and distribution should be encouraged. Public sector which was represented by KARI, MoA EIAR and KAZARDI were mainly service providers and acted as a link between farmers, processors and financial institutions.

ii. Research institutions should strive to respond to farmers' needs in their research and development agenda through comprehensive participatory potato breeding, by taking into consideration the requirements and preferences of farmers, processors and other potato consumers. Zangi a farmers' variety in Kenya is now grown by more than 85% of the farmers in Molo and Kuresoi districts because of its several traits that farmers don't find in other varieties, including the officially released varieties.

iii. The bagging of ware potatoes should be standardized in Kenya. Farmers who supplied under contract in Kenya adhered to 110kg bags and neighboring farmers also adopted it. This achievement could only be strengthened if the national potato council and affiliated potato stakeholders forums will continue to pursue adherence to potato marketing standards with the local authorities.

iv. Private sector should be involved in the production of MT; pre-basic and basic seed to ensure that quality seed reaches all farmers quickly and leave the public institutions to focus on research.

v. Seed farmers offered incentives in the form of soft loans to invest in the seed business.

vi. The national potato programs need to keep backstopping the project's newly established seed producers' associations in Kabale and Kanungu, Uganda, for them to be sustainable. The two associations are not yet fully developed like UNSPPA, but are equally important for a sustainable seed production and delivery system.

vii. District local governments need to streamline procurement procedures for seed meant for farmers under the NAADS program. Quite often sub-counties under local procurements supply poor quality seed to farmers which is sourced from local markets, leaving improved seed from trained seed producers. This is a disincentive to the seed producers.

7.2 "Select the Best" Positive Selection (PS) training method

i. The PS technology needs to be scaled out to non-project areas by project partners, especially by MoA and NAADS program under district local governments and other project partners in Uganda. For example, a USAID-funded project through Self Help Africa intends to use the technology in training farmers in Southwestern Uganda through farmer to farmer training approach.

ii. Project trained farmers should be utilized by both governmental and non-governmental programs in potato production and management practices.

iii. Training manual requires to be shortened as it looks too detailed and some modules may not be relevant to farmers.

7.3 Sustaining and Scaling up Project Outputs

i. Create and maintain linkage with public and private sectors, for example, in Uganda Self Help Africa, through USAID NAADS program in establishing potato Innovation Platforms (IPs) in potato production areas.

ii. Continue awareness creation on importance of quality seed through such methods as open/field days, trade fairs and exhibitions.

iii. Adopt the Quality declared planting material (QDPM) system. The implementation of QDPM that was started in Ethiopia should be adapted by other countries in the region.

iv. Farmers should be encouraged to form associations or cooperatives and gain from economies of scale. This will help them enhance their bargaining power and negotiating skills and can easily access funds through Micro Finance Institutions.

v. Develop a workable and efficient potato contract farming policy to guide the industry and create more awareness to educate farmers and processors on its importance.

7.4 Improvements in Aeroponics

i. Conduct trials on cost-effectiveness of aeroponics minitubers production versus conventional minitubers production methods.

ii. Conduct research to determine the optimal and efficient nutrient solutions, regulating the temperature and spacing

iii. Conduct comparative trials on source of power for running aeroponics: electricity, generator power and other alternative power sources like solar and wind so that appropriate power source is identified.

iv. National potato research programs at NARIs should ensure continuity and expansion of the aeroponics for a sustained clean MT production system, but they should also look to other sustainable cheap technologies such as sand hydroponics to produce large quantities of minitubers in a short time.

v. Conduct trials to determine appropriate pesticide rates for application in green houses.

vi. National potato research program should have a stand-by technician and plumber to carryout day-today repairs on aeroponics instead of outsourcing, which results in delays adversely affecting the whole system and the production of minitubers.

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Annex 1

Report 1: Status of potato export from Ethiopia: An overview of potentials and constraints

Report 2: Potato Export Market Feasibility Study: Potato Subsector Export Market Report for Kenya

Report 3: Uganda's potato sub-sector: a diagnostic and export trade feasibility study

Status of potato export from Ethiopia: An overview of potentials and constraints

Final Report

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Acknowledgment

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List of Acronyms

CIP	International potato centre
CSA	Central Statistical Authority
CFC	Common Fund for Commodities
DLS	Diffused Light Stores
EDB	Ethiopian Development Bank
EHDA	Ethiopian Horticulture Development Agency
EHPEA	Ethiopian Horticultural Producers and Exporters Association
EIAR	Ethiopian Institute of Agricultural Research
ES	Ethiopian Standards
EIA	Ethiopian Investment Agency
ESE	Ethiopian Seed Enterprise
EQSA	Ethiopian Quality and Standards Authority
FRGs	Farmers Research Groups
FFS	Farmers Field Schools
FOB	Free On Board
GOs	Governmental Organizations
GDP	Gross Domestic Product
HARC	Holetta Agricultural Research Centre
ISO	International Organization for Standardization
MoARD	Ministry of Agriculture and Rural Development
NGOs	Non-Governmental Organizations
NARS	National Agricultural Research System
SSA	Sub Saharan Africa
SHDI	Self-help development international
SNNPRs	Southern Nations', Nationalities', and Peoples' Regional states

USAID	United States Agency for International Development
USD	United States Dollar

Disclaimer

The conclusions and suggestions expressed in this report are based on the views of the author and do not necessarily reflect the position of Ethiopian Institute of Agricultural Research or any other stakeholder.

Summary

The Ethiopian horticulture export sector is growing rapidly. Potato is one of the commodities of the horticulture sector which has immense potentials for export. Yet export of this commodity has been limited to cross-border market until recently. Presently, there is some ware potato export to regional and international markets in response to demands in world markets. However, there is no export of seed potatoes from Ethiopia. While there are good perspectives in the potato export sub-sector, there are also key challenges in the production and marketing strategies. Ethiopia's current potato production is not so oriented to export quality requirements. The bulk of produce is sourced from small-scale farmers while few commercial growers are just beginning.

There is little value addition in the processing sector, which is a threat to the potato export sub-sector. Recently, some private investors have already engaged in the potato processing which is an opportunity for the potato sub-sector development. It also appears that quality regulation is not a trade barrier as long as the country meets required export quality standards. However, the main issues in the Ethiopian potato export market are producing quality products sustainably, identifying reliable destination markets and managing export costs. Stakeholder innovation is required to link key actors together to promote potato export. There is already established stakeholders' taskforce for the horticulture sector in which the experiences can be translated into the potato sub-sector. In this case, launching a permanent potato stakeholders' forum (e.g. Ethiopian Potato Council) is vital to accelerate development of the potato export sub-sector.

It is important that the country develop specific potato sub-sector export development plan to succeed in dynamic markets. However, developing well functioning local markets should not be overlooked, as it is the starting point for regional and export markets. It is also crucial to re-orient potato research and production in response to emerging demands. This also means that there is a need for better value addition in the potato sub-sector that ensures competitiveness in export markets. Generally, potato production and research should respond to market signals from local to global.

This preliminary report has outlined some of the key issues of the Ethiopian potato export. Detail work is necessary to collect more information from private companies, smallholder farmers, cross-border markets, unions and cooperatives. The information will lead to framing the potato sub-sector export development plan.

1. Introduction

The export-oriented horticulture sector in Ethiopia has been growing rapidly and is becoming an important component of the Ethiopian economy (Joosten, 2007). Agricultural exports from the country have been dominated by a few agro based commodities like coffee, leather and meat. Until recently, horticulture export was underdeveloped and its contribution to export was very negligible. Under the umbrella of the horticulture sector, potato is one of the major tuber crops produced largely by small-scale farmers with a prime objective of food security and recently for cash earnings. The crop is grown by approximately 1.133 million small-scale farmers (CSA, 2011). It is now recognized that the crop can contribute to foreign exchange earnings for the country given the suitable agro-ecology and infrastructure development.

This report is based on information gathered through literature reviews, qualitative interviews, secondary data and stakeholder meeting. The aim of the report is to document the current status of potato export from Ethiopia and illustrate key potentials and constraints of the potato export sub-sector.

This report highlights some of the key issues in the production of seed and ware potatoes, export trends in the last few years, an overview of key constrains and potentials and a brief conclusion in the end.

1.1 Production of ware potatoes in Ethiopia

In Ethiopia, both seed and ware potatoes are widely grown by small-scale farmers. Potato is grown in four major areas: the central, the eastern, the northwestern and southern Ethiopia (Hirpa *et al*., 2010; Figs. 1 and 2) without distinct plot and management for ware and seed potato production. According to Hirpa *et al.* (2010), potato production in the *central* area is mainly around the central highlands of Shewa, surrounding the capital city, i.e. Addis Ababa. The major growing zones are West Shewa and North Shewa, i.e., in the vicinity of Holetta Agricultural Research Centre (HARC). About 10% of the potato farmers are located in this area. Most farmers in this area grow improved varieties obtained from HARC. Average productivity of potato ranges from 8 to 10 tons/ha which is higher than the productivity in the northwestern and southern areas. The *eastern* area mainly covers the eastern highland of Ethiopia, particularly the East Harerge Zones. Very small numbers of (3%) of potato growers are found in this area. Most farmers grow local varieties except few in the vicinity of Harmaya University who are targeted by NGOs seed programs. Yet the farmers are market oriented because of the proximity of the area to major potato export destination countries such as Djibouti and Somalia. Average productivity is comparable with the productivity in the central highlands due to good farm management practices motivated by farmers' market orientation and irrigated production. The *northwestern* area of potato production is located in the Amhara region and it is the major belt of potato growing area in the country. It constitutes of about 40% of potato growers in Ethiopia. The major potato production zones are South Gonder, North Gonder, East Gojam, West Gojam and Agew Awi. Farmers in this area mainly grow local varieties and the productivity ranges from 7 to 8 tons/ha. The *southern* area is the second most potato growing region, where 30% of the potato growers are located. It is located in the Southern Nations', Nationalities', and Peoples' Regional states (SNNPRs) and partly in Oromiya region. The major production zones are Gurage, Gamo Goffa, Hadiya, Wolyta, Kambata, Siltie and Sidama in the (SNNPRS) and West Arsi in the Oromia region. Average potato productivity in this area ranges from 7 to 8 tons/ha, and in some places even bellow 7 tons/ha. Details of the production zones, planting seasons and productivity aspects of the crop are described in Hirpa *et al.* (2010).

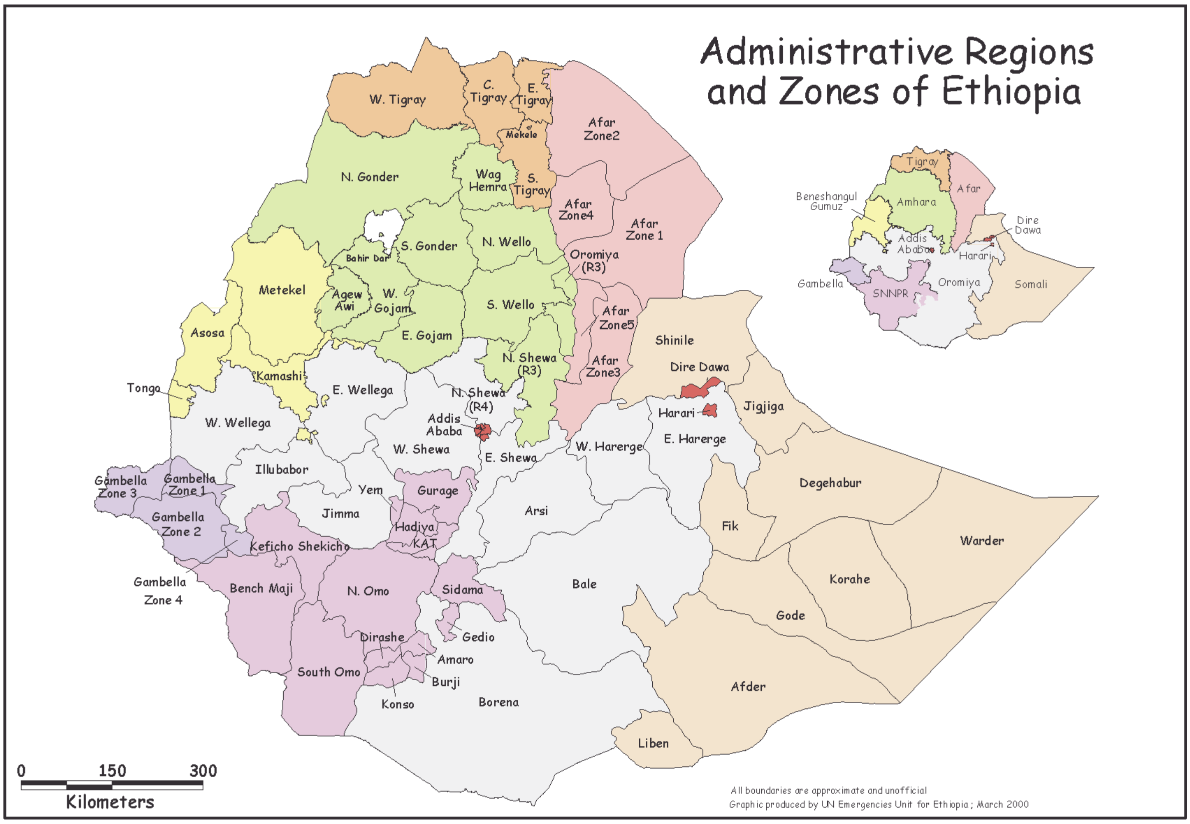


Fig.1 Administrative regions and zones of Ethiopia. UN emergencies unit of Ethiopia; March 2000

1.2 Production of seed potatoes in Ethiopia

Recently, three major types of seed[1] potato systems have been identified in Ethiopia (Hirpa *et al.*, 2010). These include the informal, the alternative and the formal seed potato system. The *informal* seed potato system is the most dominant type of the seed system by contributing about 98.7% of the seed tubers required by the country (Gildemacher *et al*., 2009a). The seed tubers needed for planting are produced and distributed by small-scale farmers without any regulation which is poor in quality (Gildemacher *et al.*, 2009b). Consequently, ware potato producers in Ethiopia are turning into informal seed multipliers for maximizing profit (Gildemacher *et al.*, 2009b). The *alternative* seed potato system is a system that supplies seed tubers produced by local small-scale farmers through financial and technical support from non-governmental organizations (NGOs) and research centres. As reviewed by Hirpa *et al.* (2010), community based seed supply systems such as Self-help Development International (SHDI) and FAO seed security project, both in eastern Ethiopia; small-scale farmers research groups (FRGs) and farmers field schools (FFS) in the central and northwestern areas of Ethiopia, supported by the Ethiopian Institute of Agricultural Research (EIAR) are good examples of the alternative seed system. Therefore, the alternative seed potato system is often backed by NGOs and research centres. This system accounts for 1.3% of the potato seed supply in the country. The *formal* seed potato system is where seed potatoes are produced by licensed private growers and cooperatives. So far, there is no public formal seed potato supply system in Ethiopia. The Ethiopian Seed Enterprise (ESE) is not engaged in the seed potato production and supply because of its limited capacity. The formal seed potato system is just beginning and its contribution to potato seed supply is negligible. Recently, there are some initiatives to this move, for example, two seed potato cooperatives are established in eastern Ethiopia and two more on process in the central area. However, there is only one private seed potato company, i.e., SolaGrow PLC. Details of these seed potato systems and their improvement options are described in Hirpa *et al.* (2010).

[1] *Seed potato* in this report refers to the potato planting material that is claimed as a seed under the existing rules and regulations in the country, and is not about the ware potatoes that are directly exported through cross-border market.

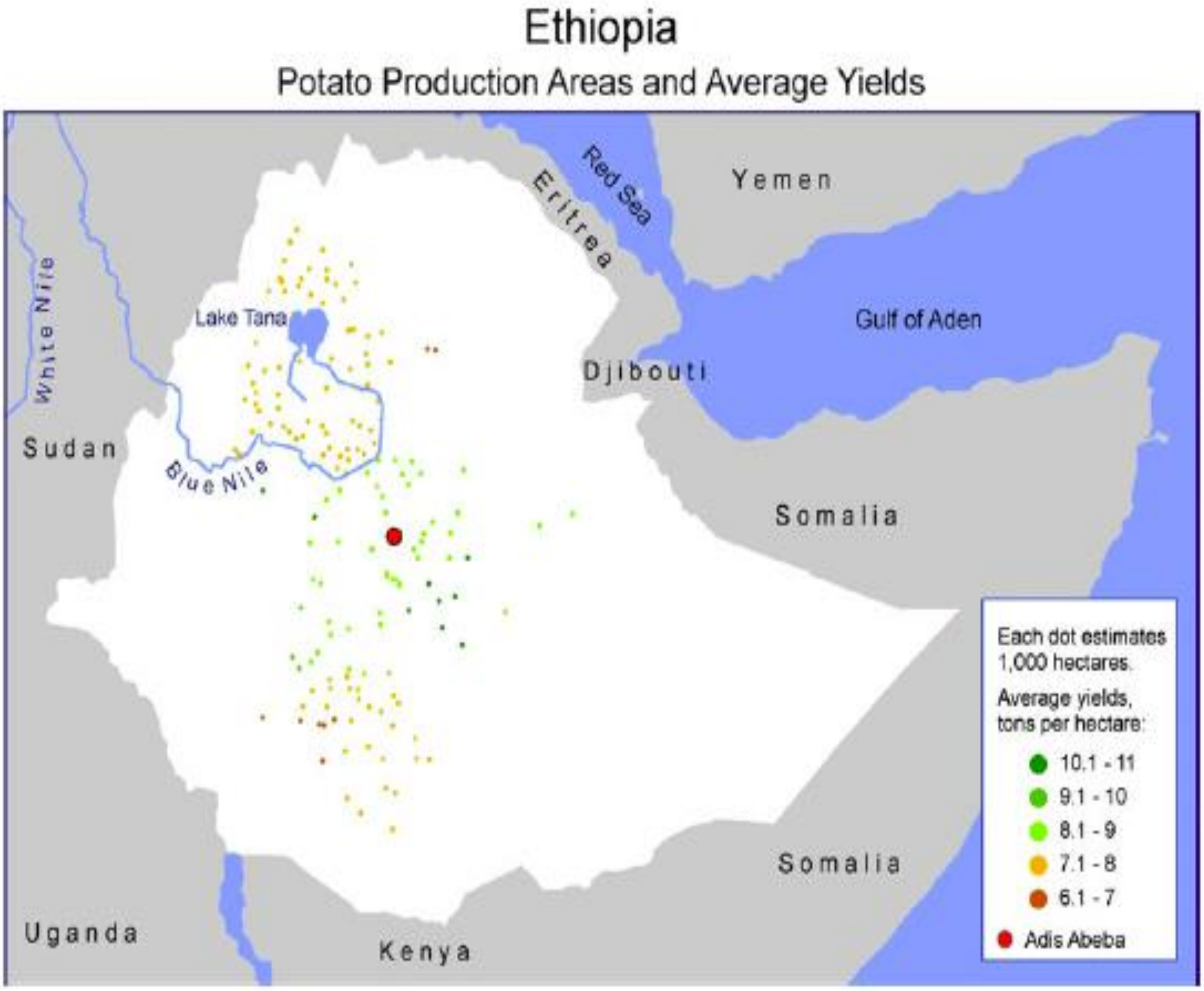


Fig. 2 Potato production areas and average yields in Ethiopia. Source: Hirpa *et al*., 2010

2. Study methods

The main study methods used in this preliminary report are qualitative interviews, secondary data and stakeholder meeting. This preliminary study was based on the following key steps:

Step 1: Literature review

Step 2: Qualitative interviews of main stakeholders related to the potato sub-sector in Ethiopia. The interviews were conducted using checklists for different institutions and respondents. A summary of the institutions and number of respondents is given in Table 1.Then this interview was concluded with a stakeholder meeting held in Addis Ababa.

Step 3: Secondary data collection from different sources and summarizing.

Step 4: Stakeholder meeting to discuss some of the key issues in production and export of the potato sub-sector. Discussions with various stakeholders during the stakeholder meeting were also used to fill some of the information gaps in this report.

Table 1. List of institutions contacted for the qualitative interviews

List of Institutions contacted	**No. of respondents**
Ethiopian Institute of Agricultural Research (EIAR)-Potato research program and CFC unit	1
Ministry of Agriculture and Rural Development (MoARD)-Phytosanitary Inspection and Certification unit	1
Ethiopian Investment Agency (EIA)	1
Ethiopian Horticulture Development Agency (EHDA)	3
Ethiopian Horticultural Producers and Exporters Association (EHPEA)	2
Ethiopian Seed Enterprise (ESE)	2
Ethiopian Quality and Standards Authority (EQSA)	1
USAID-Agribusiness and trade expansion unit	1
Ethiopian Development Bank (EDB)	1
Total	13

3. Results

3.1 Production trend of ware and seed potatoes

In Ethiopia, potato improvement research began in 1975 with the objective of developing high yielding, late blight resistant and widely adaptable varieties. Since then, a number of potato varieties have been released by research and higher learning institutions (Table 2). Small-scale farmers in the country use some of these varieties for production of potatoes. Some of the most commonly grown varieties in the country include Jalene, Gudene, Guassa and Gera.

Table 2. Improved potato varieties released in Ethiopia

Variety	Year of Release	Area of Adaptation		Maturity days	Yield (tons/ha)		Releasing Centre
		Altitude (m)	Rainfall (mm)		Research field	On-farm	
Awash	1991	1500-2000	>750	90-100	25.4	20	Holetta
Tolcha	1993	1700-2800	>750	100-115	33.1	18-27	Holetta
Menagesha	1993	2400<	>750	120-130	27	25	Holetta
Wechecha	1997	1700-2800	>750	100-115	21.8	18-20	Holetta
Alemaya 624	1987	1000-2000		90-100	25.9		Alemaya Uni.
Chiro	1998	1600-2000	700-800	75-110	32-40	25-30	Alemaya Uni.
Bedassa	2001	1700-2000	700-800	96-117	40.5	-	Alemaya Uni.
Zemen	2001	1700-2000	700-800	76-101	37.18	-	Alemaya Uni.
Zengena	2001	2000-2800	1000-1500	105	30	22.5-25	Adet
Guassa	2002	2000-2800	1000-1500	110-115	22.4	22-25	Adet
Digemegn	2002	1600-2800	750-1000	90-120	46.7	35.63	Holetta
Jalene	2002	1600-2800	750-1000	90-120	44.8	29.13	Holetta
Gorebella	2002	2700-3200	800-925	134-159	30.1	26-30	Sheno
Gera	2003	2700-3200	800-1000	>120	25.93	20.64	Sheno

Bule	2005	1700-2700	980-1398	120	39.3	38.3	Awassa
Marachere	2005	1700-2700	980-1398	120	33.3	28.4	Awassa
Shenkolla	2005	1700-2700	980-1398	120	31.5	29.1	Awassa
Gudenie	2006	1600-2800	750-1000	120	29.17	21	Holetta
Belete	2009	1600-2800	750-1000	110-120	47.19	-	Holetta

Source: HARC; - means data not available

There is a steady growth in area coverage, production and productivity of potatoes in the last nine years (Table 3). The nine years average for area, production and yield is 55, 593ha, 465,173 tons and 8.51 tons/ha respectively. The national productivity is still very low compared to what can be achieved using improved technologies. This is not surprising that there is no formal seed company producing horticultural seeds in the country. Consequently, the majority of small-scale farmers grow local varieties. This means that farmers lose about 14 times more benefit generated by using improved varieties compared to local varieties (Lemaga, 2010; See Annex 5). Research institutions are the main sources of modest amounts of starter seed potatoes for different purposes. But there is no distinction between ware and seed potatoes by the Central Statistical Authority (CSA) of Ethiopia as this is a very recent development in the country.

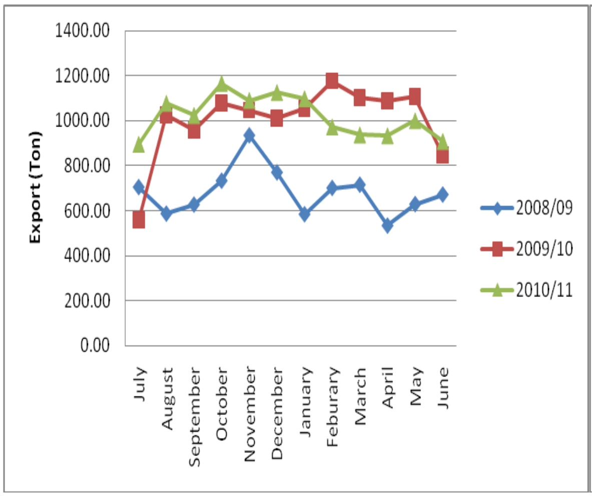
Table 3: Area, production and productivity of potato over the last nine years in Ethiopia

Cropping year	Area (Ha)	Production* (Tons)	Yield (Tons/ha)
2001/2	36,736	385,258	10.49
2003/4	54,603	509,715	9.34
2004/5	51,698	509,716	9.86
2005/6	61,812	449,996	7.28
2006/7	73,095	525,657	7.19
2007/8	50,488	402,508	7.97
2008/9	48,113	384,046	7.98
2009/10	69,784	572,333	8.20
2010/11	54,007	447,334	8.28
Average	55,593	465,173	8.51

Source: CSA; * this figure is consistent with the FAOSTAT production figure given in Annex 2

3.2 Production of ware and seed potatoes for export

Ethiopia has no export oriented potato production (e.g. variety) at the moment although the country has huge potential to produce a wide range of ware and seed potatoes. Much of the seed potato is produced with the informal seed potato system, which is poor in quality and often used by small-scale farmers in the country (See section 1.2). Yet recently modern seed potato producers such as SolaGrow PLC and some cooperatives are beginning. So far, there is no seed potatoes export and the bulk of export is dominated by ware potatoes. The produce is exported in bulk without value addition to neighbouring countries such as Djibouti, Somalia and Sudan. Therefore the export is more of cross-border market which has low value, price and quality. The bulk of ware potato for this export is sourced from small-scale farmers mainly in eastern and northwestern regions of the country due to the proximity of these areas to the destination countries (See section 1.1). There is a rapid increase of ware potatoes export over the recent years (Fig. 3).



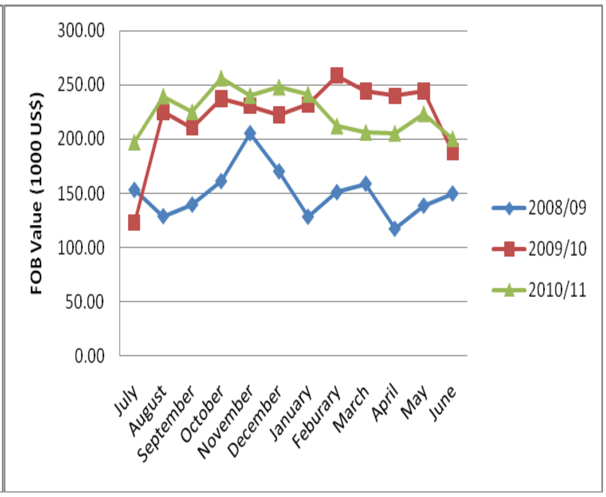


Fig. 3 A monthly ware potatoes export from Ethiopia between 2008/2009 and 2010/2011. Source: EHDA

Similar tends have been observed when comparing data from CSA. The values of both live ware potatoes and frozen[2] potatoes export have been rapidly increasing in recent years (Fig. 4). For example, the value of ware potatoes export increased from nearly 19 million Birr in 2007 to 41 million Birr in 2010. The value of frozen potatoes increased from nearly 175 thousands Birr in 2007 to 42 million Birr in 2010. The trends show that there is a huge potential of the potato sub-sector to export, which ultimately will have a positive impact on the overall growth in the national economy.

[2] CSA classifies potatoes as “seed potatoes”, that is when ware potatoes are directly exported. It does not mean that Ethiopia is exporting seed potatoes for plating material that passed the necessary certification process. The other classification is “fresh, frozen or chilled potatoes” it means that mostly whole tubers are exported after some kind of preservation/cooling or chilling. There is however a very insignificant amount of export in the form of potato starch.

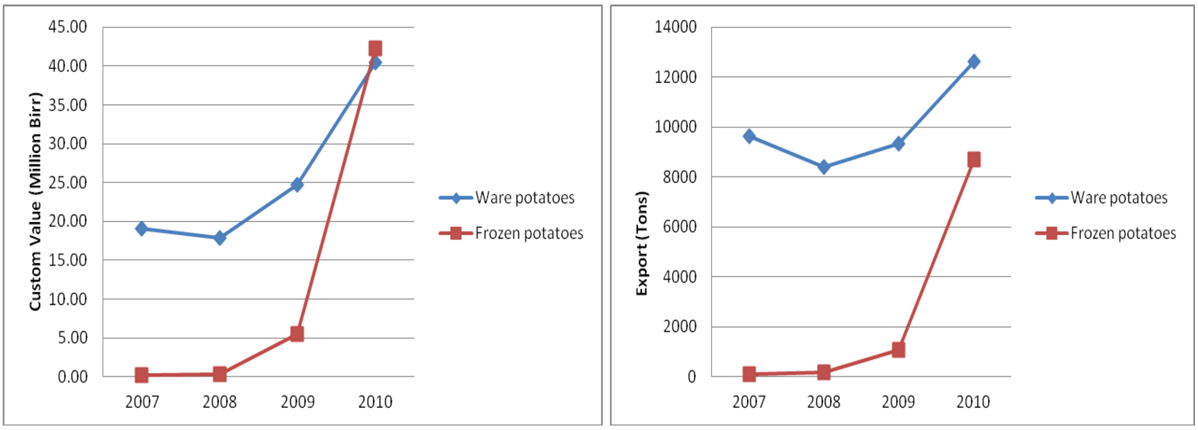


Fig. 4 Trends of ware and frozen potatoes exported from Ethiopia. Source: CSA

The major export destination countries identified were Djibouti, Somalia and Sudan (Table 4). The bulk of ware potato is exported to Djibouti largely from the eastern part of Ethiopia. This reflects the importance of cross-border market in the neighbouring countries. Similar trends have been observed when using another data source (See Annex 1). Recently, Ethiopia started to export potatoes to Middle East countries such as Yemen, United Arab Emirates (UAE), Bahrain, Qatar and Saudi Arabia. Therefore, these countries could be seen as potential export destinations for Ethiopia. These countries need 'organic' or 'ecological' potatoes due to the rising concerns of food safety standards. Ethiopia will offer a good scope for such markets because of its low input agriculture, which is desirable for Arab countries. Main exportable product for potatoes is the ware potato which is sourced from small-scale farmers and cooperatives to meet the required volume of export. The country can also export clean seed potato to different parts of Africa, using its diverse agro-ecological advantages. Potential seed potato export destinations could be sub-Saharan and some West African countries.

Table 4. Major export destination countries for Ethiopian ware potatoes

Country of destination	Export of ware potatoes (Customs Value in Million Birr)			
	2007	2008	2009	2010
Djibouti	19.127	18.123	25.396	40.970
Somalia	-	0.004	0.007	35.473
Sudan	0.093	-	4.715	6.322

Source: CSA; - means data not available

3.3 Potato production and export from Ethiopia

There is a huge gap between the quantities of potatoes produced and exported from Ethiopia (Table 5). The share of export is very insignificant, just less than 5% between 2007 and 2010. Similar trends have been observed when using FAOSTAT data (See Annex 2). Although this report is limited to analyse the quantities of potatoes consumed in the country, it seems that large production of potatoes goes to local markets, particularly where cross-border market is not possible due to the geographic location of the production areas (See section 1.1). While potato is food security crop, the current export trend forces the country to bridge the huge gap between the production and export of potatoes. This might needs to re-orient small-scale farmers toward markets through direct support similar to the large commercial farmers. This is pertinent as small-scale farmers constitute the largest share of potato production in the country.

Table 5. Potato production and export trends of Ethiopia

Year	Production (tons)	Export (tons)	Export (%)
2007	402,508	9,744	2.4
2008	384,046	8,576	2.2
2009	572,333	10,420	1.8
2010	447,334	21,318	4.8

Source: CSA

3.4 Potato import and export trends

While Ethiopian potato export is rapidly increasing in recent times, there is also a relatively small quantity of import from abroad (Table 6). This might be because there are higher star hotels which cannot meet their demands from domestic quality potato products. Although the figure is small at the moment, the trend might shift unless efficient potato processing plants are established. For example, Ethiopia imports limited amounts of frozen chips (not more than 25 tons per annum) from Europe for two major star hotels (Tesfaye *et al*., 2010). Rapid population growth and urbanization in the country is more likely to increase the demands of processed potato products. Urbanization is also expected to rise in SSA which is an opportunity for processed potato products. For example, the current 34% of SSA urban population is expected to reach 47% by 2015 with the highest rate of urbanization in East Africa (Lemaga, 2010). Therefore, it is crucial that the country benefit from potato sub-sector through value addition in the agro processing sector.

Table 6. Potato import and export trends of Ethiopia

Year	Export		Import	
	Quantity (tons)	Trade value (US $)	Quantity (tons)	Trade value (US $)
2006	61.3	13,219	75.85	145,440
2007	19,449	4,301,618	85.98	205,016
2008	17,029	3,744,286	508.35	455,969
2009	20,493	5,143,961	110.59	233,587
2010	42,571	13,066,043	149.16	347,134

Source: UN Comtrade/HS data © United Nations, 2009

3.5 Constraints and potentials of the potato sub-sector

This section deals with some of the key constraints and potentials in the potato export sub-sector. The sub sections provide a short overview of the key issues and Table 9 shows the key problems and suggested solutions to improve the sub-sector. Details of constraints and opportunities for ware, seed and processed potato products as elicited during the stakeholder meeting is presented in Annex 7.

3.5.1 Rapid multiplication

Seed potato export is almost non-exit in Ethiopia. Recently, a private company known as SolaGrow PLC emerged as a seed potato producer and exporter. Much of the seed production in the country is informal (Hirpa *et al*., 2010). Some rapid multiplication technologies (e.g. screen houses and tissue culture) are found around research centres to produce potato plantlets mainly for research purpose. Although these technologies exist, chemicals are not easily accessible and are often imported from abroad. But the Biotechnology institute at HARC is a huge potential to speed up the rapid multiplication process of seed potato production in the country.

3.5.2 Regulatory bodies

In Ethiopia, there are two regulatory bodies dealing with quality and phytosanitary issues. These are Phytosanitary Inspection and Certification unit of the Ministry of Agriculture and Rural Development (MoARD) and the Ethiopian Quality and Standards Authority (EQSA).

The Phytosanitary Inspection and Certification unit of MoARD receives phytosantary applications after exporters have obtained export permit/licence from the Ministry of Trade and Industry (MoTI), got bank accounts and checked their product qualities. In this case, MoARD will send experts to see the product (visual observation) to look for pest incidence and if need be to check for disease to issue the international phytosanitary certificate.

So far, the MoARD unit is not able to issue the international phytosanitary certificate for potatoes, as most customers do not meet the international standards. This is because much of the Ethiopian potato export is cross-border market which does not abide by international standards. But there is an effort to meet standards of the regional countries such as Yemen, Saudi Arabia and UAE. The MoARD unit is also responsible for cross-border market on the main roots such as Adama, Dire Dawa and Benishangul. In fact, it is possible to issue phytosanitary certificate for potatoes if exporters have the capacity to meet international standards. The international certificate is issued based on import details of the destination country. There is zero tolerance for flies and disease, and the inspection is often done during the growth stages. There are also sub units in the major outlet areas of the country (e.g. Kombolcha, Benishangul, and Dire Dawa) which are working to facilitate the phytosanitary certificate issuing process. The sub units can now issue an international phytosanitary certificate independently. It seems that the regulatory issues are not that trade barriers once a framework for potato export development plan is set.

The Ethiopian Quality Standard Authority (EQSA) is responsible for the quality and standards regulation in Ethiopia, which is an important factor to meet the international standards. The EQSA certifies product qualities for inland use but the phytosanitary certificate is required to do further quality tests which is often based on "ES-ISO" standards. EQSA has already developed standards for potato related products in the country. But the country's internal seed potato system can be seriously affected because of poor internal quarantine regulation. There is a practice of bulking seed potatoes from different regions in the country, which affects the seed system given the current standards control and internal quarantine system is very loose. This is related to weak internal quarantine rules enforcement. It might be also because there is no "standard concept" in the Ethiopian seed potato system although there is a general impression of improved variety.

3.5.3 Infrastructure development

Ethiopia has a very good road infrastructure in terms of highways, although the feeder roads need upgrading. There is also a big potential for the rail network development in the country. Ship transport to Yemen and Saudi Arabia is being used for other horticultural commodities, which can be seen as another potential to reduce transport cost for exporting potatoes. It must be noted, however, that airfreight is not a cost effective way for ware potato export from the country compared to the other high value vegetables.

There are poor storage facilities with limited capacity in the country. Diffused light stores (DLS) are available in the country for decentralized seed systems through the Growth Corridor of MoARD or by establishing farmer research groups (FRGs); farmer field schools (FFS) and cooperatives. Small private potato businesses are however found here and there. Potentially, there are ongoing construction of storage facilities such as modern pack and ware houses in the eastern part of Ethiopia (e.g. Dire Dawa) and the reconstruction of the vegetable trade centre in the capital city, Addis Ababa.

3.5.4 Export development plan

Ethiopia has no specific export development plan for seed and ware potatoes. But there is export-oriented development strategy for horticulture sector (Joosten, 2007). The export development plan is positively affecting the horticulture sector; thus potato sub-sector can be integrated in this plan, i.e., by adapting this experience. In this line, the country has already established "Ethiopian Horticulture Development Agency" as part of the export development plan for horticulture sector. Some of the key tasks of the agency are described in Annex 3. The agency is a core governmental body linking stakeholders in the horticulture sector. The horticulture export development plan is intended but not limited to the following:

- Promotes export in horticulture, i.e., identifies countries of destination market for high value horticultural commodities.
- Facilitation of marketing, i.e., supporting infrastructure, training, capacity building, identify prices of destination market and investment issues.
- Marketing promotion, i.e., advises investors, sensitization of products and lobbing for foreign investors to come to Ethiopia.

Presently, commercial farms are beginning to export ware potatoes to Middle East countries. EHDA has advised the farms to have a 'variety focus' in their export plan. However, the farms have not yet started producing their own potatoes, but are sourcing from fragmented small-scale farmers who grow improved varieties which have no export standard quality characteristics. Small-scale farmers are not the prime focus of the agency; as a result they do not get significant direct support in the export plan. Furthermore, as the cross-border market is also informal, it has received less attention by the agency and hardly considered in the export plan. Consequently, the unit price of ware potatoes when exported to Djibouti is not different from the Addis Ababa market. This is associated with huge postharvest losses given the warm agro-ecology of the eastern part of Ethiopia. It is thus crucial to improve the main 'export' in the cross-border market through value addition. Recently, Ethio-Djibouti commission has been established to improve the cross-border market between the two countries. The commission seeks to improve export quality in Ethiopia and increase the unit price from Djibouti. Thus EHDA engaged to support the Dire Dawa area farmers from the perspective that they have commercial characteristics. But where is the place of small-scale farmers in the export development plan? Subsequent projects and strategies should include small-scale farmers in export development plans, which can offer good market access to rural farmers, contributing to poverty reduction.

3.5.5 Effects of common markets

Literally, there is a room to increase export volume through these common markets. But Ethiopia's export of potato sub-sector is at its infant stage and is not ready at the moment. Small-scale farmers who are the key sources of export provide less volume and quality. Therefore, it requires a huge effort to maintain the required quality and volume of production. Ethiopia, therefore, needs to improve the production or the supply side, including variety, productivity, extension, quality and quantity. From this perspective, the effect of these common markets on Ethiopian potato export is negligible at least at the current situation. This is also partly because even the local potato markets are not functioning well. It is critical to make the Ethiopia potato sub-sector competitive to ensure sustainable participation in export markets. In this light, protection schemes for export are not likely to work. This is because many SSA countries are economically poor and the chances for subsidizing agricultural products are very low.

3.5.6 Packing

Sac is the main packing material used for ware potatoes particularly in the eastern part of the country. There is much postharvest loss due to the warm temperature, which is hindering export in the main cross-border market, i.e. Djibouti. EHDA has offered technical training for exporters involved in vegetable or potatoes to minimize the problem. Generally, there is an impression that packing is not an obstacle for future export, although the current concept itself is not so profound for potatoes. This is because potato is not very sensitive compared to the other high value vegetables. Therefore, relatively small investments of packing can make export feasible.

3.5.7 Value addition

In Ethiopia, there is no quality concept per se by consumers. Potato production is not well oriented to quality requirements because the main production objective has been to increase yield and disease resistance. This quality problem also translates into the processing sector. Although potato processing is almost nil at the moment, it would be difficult to get a uniform variety for processors because small-scale farmers are growing many varieties. Ethiopia has no large processing plants except only small-scale chips makers on the road sides and some hotels and restaurants. This warrants the need for value addition especially when new potential destination countries are emerging (Section 3.2). Recently, there are 25 private investors registered, most of them engaged in potato related business (Annex 4).Yet only three of them are in operational phase at the time of the study. This recent development is one step forward for the potato sub-sector; it now signals potato actors to move from improving production to facilitating markets both local and global. This is because even the local market pays, and thus in realistic terms well developed local markets lead to international markets. For example, the processing of potatoes into chips adds value to the potato chain, whereby small-scale farmers can benefit from such local markets (Table 7). In this case, small-scale farmers can be linked with a potential potato processor because some private growers (e.g. SolaGrow PLC) have processing quality potato varieties that can be used by farmers.

Table 7. Profits from processing 100kg chips in Ethiopia

Indicators	Values
Total cost (Birr)	242
Gross margins (Birr)	828
Net margins (Birr)	586
Net margins (US$)	68.90

Source: Lemaga, 2010

3.5.8 Information flow

The flow of information in the Ethiopian potato export sub-sector can be seen from two main perspectives. These are large commercial farms and small-scale potato growers. For the commercial farms, there are a number of ways to bridge potato products and destination markets. These include: i) access direct customers who are already importing horticultural commodities from Ethiopia, ii) use Ethiopian embassies abroad for promotion, iii) use foreign embassies in Ethiopia, and iv) exhibition or trade fairs. This is facilitated and organized by EHPEA and EHDA. This is an example of already established foundation for public-private partnerships to promote the Ethiopian horticulture export. Therefore, this already established foundation of information flow can be used to link large commercial potato producers with destination markets.

For the small-scale farmers, the information flow seems asymmetric. MoARD is the main body in charge of small-scale farmers, which is not export-oriented when it comes to potatoes. It is realized that the link between small-scale farmers and EHDA is very weak. The agency focused on large commercial farms compared to small-scale farmers who contribute much of the GDP. It is crucial that the agency addresses small-scale farmers' constraints to ensure successful participation in the export market. This would directly complements to the wider policy agenda expanding horticulture development in the country.

3.5.9 Cost of production

Production and transport costs are not that expensive for potato export compared to the other horticultural sub-sectors such as floriculture and high value vegetables. Relevant costs may include modern grading systems and washing facilities. Companies may rent in refrigerated containers and minimize inland transportation cost using various cost-effective sourcing mechanisms. Other than this, no complicated machinery is required for this commodity.

In the small-scale farmers' context, Glidemacher *et al.* (2009b) found that potato producers are profitable even under the current situation of seed and ware potato market and farmers do not need to invest in renewing their seed stock (Table 8). In all the study areas covered except Awi, the authors found that the current cost of seed potatoes is higher than the calculated acceptable price for high quality seed potatoes. They further noted that quality seed potatoes can fetch nearly 50% price premium under the current production and pricing systems. Moreover, returns on cash investment for potato production in major potato growing areas are 'healthy' in the country (Gildemacher, 2010; Annex 6). In Ethiopia, seed potato is sold at a premium of at least US $ 10-20 per 100kg over ware potatoes (Lemega, 2010). Consequently, ware potato growers are turning into informal seed potato multipliers for profit. These positive signals would create wider market opportunities for small-scale potato growers as they are the main suppliers to different collectors or large commercial farms. It can also motivate enforceable contracts if out grower schemes are used as a strategy to link small-scale farmers with large commercial farms.

Table 8. Acceptable price premium for high quality seed potatoes in Ethiopia

Indicators	West Shewa	North Shewa	Awi	Average
Average yield (Mg/ha)	7.7	12.3	5.1	7.9
Production costs ($/ha)	366	358	394	375
Seed rate (Mg/ha)	1.1	1.1	1.6	1.3
Ware price ($/Mg)	62	79	91	74
Total yield gain (Mg/ha)	1.8	2.9	1.2	1.9
Value yield gain ($/ha)	114	232	111	139
Min. MRR[3]	200	200	200	200
Acceptable investment ($/ha)	38	77	37	46
Acceptable seed price ($/Mg)	98	148	115	110
Acceptable additional cost seed over ware (%)	58	87	26	49
Current additional cost seed over ware (%)	121	199	5	

Source: Glidemacher *et al.*, 2009b

[3] MRR is Marginal Rate of Return; A MRR of 200% in a three-season period is considered fair by the authors to assure small farmers are willing to invest in high quality seed potatoes.

Table 9. An overview of key problems and suggested solutions to improve potato export

Problem	Tangible Solutions	Potential actors
There is weak promotion in the potato sub-sector. Consequently, potato markets and customers are not matching.	Expand promotion activities which are often positive and dynamic. There is a need for stakeholder innovation to attract investment in the sub-sector. This could be improving the links between embassies and exporters, attracting Ethiopian Diaspora for both proceed and seed potatoes business. Ethiopia can use already established stakeholder taskforce for horticulture sector to promote the potato export sub-sector.	EHDA, EHPEA, Embassies
There is gap in export destination market assessment.	Bridging potato demand and supply, i.e., connecting investors in Ethiopia to destination countries. There is a need to have a detailed scoping study on potato export market assessment to identify the key quality requirements to ensure sustainable export market participation.	EHDA, EHPEA and Ministry of Trade-export promotion service. This public-private partnership might be a good foundation to identify suitable destination markets.
Small-scale farmers who produce the bulk of potatoes do not get enough support compared to the few large commercial farms.	Small-scale farmers should be included in the export development plan or develop export plan which is also inclusive of small farmers. This may need to strengthen small farmers' capacity through technical, commercial and institutional innovations.	EHDA, EHPEA , MoARD, CFC, NGOs
Potato production is fragmented and often difficult to meet the right volume of supply for export.	Establish out grower schemes in the four major potato growing areas, and link these to cross-border market outlets.	Private investors, NGOs, CFC
Value addition and processing sector is almost none-exist.	There is a need to develop the required variety, improve productivity (yield/ha), i.e., to meet the required quality and volume of produce. It also means strengthening the seed and ware potato systems.	Research institutions-EIAR, Regional research centres, higher learning institutions, and international research institutions
Formal seed potato production is almost none-exist in Ethiopia.	First, identify key market outlets before the seed potato production. Second, re-orient Ethiopian potato research and production to export seed quality requirements.	Seed Enterprises, private sectors, NGOs, Research institutions

3.6 SWOT analysis of the Ethiopian potato export sub-sector

A comprehensive SWOT analysis for the fruit and vegetables business sector has already been documented (Wersinga and Jager, 2009). This section deals with a brief summary of SWOT analysis for the potato export sub-sector. The list is not exhaustive but only highlights the key issues relevant for the potato sub-sector. Figure 5 shows the summary of the SWOT analysis.

SWOT summary	
Strengths ▪ Favourable climate and soils ▪ Facilitating government policies ▪ Low costs of production ▪ Geographical location ▪ Public-Private sector partnerships ▪ Potentials for irrigation ▪ Transport ▪ Code of Practice in floriculture sector	**Weaknesses** ▪ Constant quality supply ▪ Exportable varieties ▪ Packaging ▪ Storage facilities ▪ Technical Knowhow ▪ Market Information ▪ Local markets
Opportunities ▪ Demand for potatoes in major markets ▪ Demand for processed potato products ▪ Ecological and fair trade production ▪ Institutional environments	**Threats** ▪ Competition ▪ Stringent standards

Figure 5: SWOT analysis for potato export from Ethiopia; adapted for the potato sub-sector from Wersinga and Jager (2009)

3.6.1 Strengths

Climate and soils

Ethiopia has excellent climate to grow seed potatoes in the highlands. Therefore, it is feasible to export seed potatoes to different African countries using the country's agro-ecological advantage. Among African countries, Ethiopia has the greatest potential for potato production: 70% of its arable land - mainly in highland areas above 1500 m.a.s.l - is believed to be suitable for potato production (FAO, 2008). The good soil conditions also mean higher potential for high quality and quantity potato production.

Government policies

Ethiopian Government has identified agro processing as one of the key investment priority areas. Thus the policy encourages investors involved in export of processed potato products through various benefits. Such benefits include customs duty and income tax exemption for agriculture or agro-industrial investments. The types of incentives available to both foreign and domestic investors can be viewed at (www.ethioinvest.org).

Cost of production

Land and labour are relatively cheap in the country for an intensive potato production. Production costs are not that expensive compared to the other commodities in the horticulture sector. It requires modern grading system and washing facilities, and it is possible to rent refrigerated containers for storage and transportation.

Geographical location

Ethiopia has a strategic location at the crossroads between Africa, the Middle East and Asia. This offers the country wide market opportunities.

Public–private partnerships

The huge involvement of the private sector in the floriculture sector development can directly translate into the potato export because experience has already been developed. An example is the close collaboration between the private sector-EHPEA and the public sector- EHDA.

Potential for irrigated production

Large production of potatoes at the moment is rain-fed but the country has a huge potential for irrigated production provided irrigation infrastructure is developed.

Transport

The proximity of Ethiopia to Africa, Asia and Middle East countries means lower transport cost for potato export. The country also has good road network to link potato producers with markets. The rail network plan is also one of the potentials to reduce inland cost of export. However, airfreight is expensive to make export of this commodity profitable.

Code of Practice

Experiences gained in the development of Code of Practice from the floriculture sector will benefit the potato sub-sector. For high value vegetables, 'Euro GAP' certification is underway, which might apply for potatoes as well.

3.6.2 Weaknesses

Constant quality supply of potatoes

In Ethiopia, there is no value addition, which makes the potato sub-sector export very weak. Large share of export is dominated by ware potatoes. There is also no constant supply of quality potatoes in sufficient quantities-there is no export development plan. This will lead to a low position in export compared with other organized competitors like Kenya and Egypt.

Storage facilities

There are limited capacities in ware and pack houses as well as cold storage facilities. Yet, small-scale level diffused light stores (DLS) for seed potatoes are found at small-scale farmers' levels.

Technical know how

Technical knowledge for export oriented potato production and research is limited. Potato production and research has mainly been focused on addressing constraints related to small-scale farmers, i.e., improving yield, disease resistance and wider adaptability. In addition, production has mainly been targeted to improve food security and hence hardly oriented to markets signals.

Varieties

There is limited assessment whether the current potato varieties have been demanded in the export sub-sector. Ethiopia's potato breeding program should now start to consider exporters' opinion on the demanded quality attributes for export market.

Market information

There is limited information about export markets for potato sub-sector. This is also because the sub-sector is just at its infant stage. There is a need to conduct scoping studies to identify suitable export market outlets particularly in the Middle East countries. Detailed scoping study has been conducted to identify market opportunities for Ethiopian horticulture exports in some Middle East countries (DFID, 2003).

Local markets

There are no well functioning local markets in the potato sub-sector. Markets are often facilitated either by research institutions or other GOs and NGOs mainly in the informal seed potato system. For the ware potatoes, there is a low consumption rate similar to the other vegetables in the country. This offers little scope to develop well functioning local markets. This is also associated with little value addition except some chips makers in major towns of the country.

3.6.3 Opportunities

Demand for potatoes in major markets

There is a growing demand for Ethiopia's 'organic' potatoes in the Middle East countries such as Saudi Arabia, UAE, Bahrain, and Yemen. Moreover, the current low value regional export sector, i.e., cross-border market in Djibouti, Sudan and Somalia can have a huge potential if improved through proper investments.

Demand for proceed potato products

Demand for processed potato products is increasing in different markets including the EU. This will be a good opportunity for Ethiopia if it improves its agro-processing sector to meet the requirements of the EU standards.

Ecological and fair trade production

Demand for ecological and fair trade products is increasing as a result of consumer's concerns to food safety issues particularly in the European markets. Ethiopia can offer good scope for ecological products, as the country is characterized by low input agriculture.

Institutional environments

There is a very conducive institutional environment for expanding the potato export sub-sector. Development banks offer loans for investment proposals targeted for export especially when linked to agro-processing sector. There are benefits and support when investing in the country. There is already established foundation for stakeholder innovation in the horticulture sector in which the experiences can be translated into the potato export sub-sector. Details of institutional environment in the fruits and vegetable sector in Ethiopia are described in Wersinga and Jager (2009).

3.6.4 Threats

Competition

There is an increased competition of countries with a strong position in the potato export sub-sector. Ethiopia is just beginning from the scratch, which makes it less competitive in this sector both in the EU and Middle East markets.

Stringent standards

Stringent requirements in terms of quality, traceability and consistency of products supply by the rapidly growing dynamic supermarkets may be an export barrier for Ethiopia. These standards would become more complex for the country given local potato markets are not yet well developed. This notion becomes relevant in the sense that capacity gained from strong local markets translate into stronger regional and international markets.

4. Main conclusions

The export oriented horticulture sector in Ethiopia is rapidly growing. Potato sub-sector is also emerging as one of the exportable commodities with a rapid increase in export value. Cross-border market is identified as the main export outlet for the commodity. But the value of this market is low because of the poor quality of produce exported to neighbouring countries such as Djibouti, Somalia and Sudan. Recently, there has been some potato export to regional and international markets, which provided an interesting opportunity for Ethiopia. But there is no export of seed potatoes from Ethiopia.

While there are positive signals in the potato export sub-sector, there are also key challenges in the production and marketing strategies. Ethiopia's current potato production is not export oriented. The bulk of produce is sourced from small-scale farmers who grow many varieties with sub-optimal management. Therefore, the country's production/supply is questionable in meeting the right exportable variety, volume and quality. Thus, potato production should be directed in response to local to global market signals.

Value addition in potato processing is scant, which has a negative implication on the export value. Recently, private investors have already taken licence to participate in the processing sector, which is an opportunity for the potato sub-sector development.

As long as Ethiopia meets international standards for potato export, the quality regulation seems not a trade barrier. Experiences from other commodities will be translated into potato quality regulation. However, the main issues to be considered in the Ethiopian potato export are producing quality products sustainably, identifying reliable markets and managing export costs.

Stakeholder innovation is required to link key actors together to promote potato export. There is already established foundation for the horticulture sector; the experiences can be translated into the potato export development plan. In this line, establishment of a permanent potato stakeholders' forum (e.g. Ethiopian Potato Council) would be vital to accelerate development of the Ethiopian potato export sub-sector.

In light of the findings, the following suggestions for potato export sub-sector to different markets were made.

1) Cross-border market

In Ethiopia, cross-border market is not encouraged at policy level because of the low value of produce exported. This is often because of the poor quality of the produce exported as well as poor export logistics (handling, packing, storage, transport, etc) into the key neighbouring countries. In order to improve this export channel, there is a need for clear demand assessment of export destination countries; value addition; and adjusting production (quality and quantity) through improved varieties and post-harvest management (e.g. storage facilities and cold rooms). Furthermore, out growers schemes can be a good sourcing mechanism to ensure continuous supply and low transaction costs. This might enable a coordinated production that will not happen when dealing with individual farmers. There needs to be clear information flow so that production is in response to markets. This means that the country needs to have export development plan, which gives a direction on what to produce and at what price beforehand. Thus enhancing the out grower scheme is one way to improve cross-border markets.

2) Regional and international markets

In Ethiopia, export to regional and international markets is just beginning. It is known that Ethiopia can grow both ware and seed potatoes given the diverse agro-ecological setting. But the question is can it be exported profitably? This requires a clear fact finding from the export destination countries. These include assessing the required varieties (shape, size, dry matter content etc), standards, and transport costs both inland and overseas. Moreover, expanding infrastructure such as pack and ware houses for storage and supporting potato processing sub-sector are key elements to participate in these dynamic markets. Given its geographical location and suitable production ecology, the country has a competitive advantage in these markets for a wide range of potato products.

3) Local markets

In Ethiopia, local potato markets are weak. The bulk of the potatoes are sold in local markets without any standards. In fact, informal seed growers are benefiting from selling seed potatoes for fellow small-scale farmers. Improving market access for small-scale farmers through direct support by facilitating production and marketing constraints might help improve local markets. Some of the options include:

- Coordinated production in terms of space and time to minimize market glut and ensure constant supply of produce
- Strengthening producers organizations (e.g. cooperatives) through business support
- Establishing enforceable out grower scheme contracts that are both business and development motivated
- Scaling up and scaling out of successful seed potato systems for a better quality potato production in the country
- Establish a transparent market information system for producers

5. The way forward

This preliminary report has outlined some of the key issues in the Ethiopian potato export sub-sector. Detail work is necessary to gather more information from private companies, small-scale farmers, cross-border markets, unions and cooperatives. The information will lead to framing the sub-sector plan in the future. It is crucial that the country develop specific export development plan for potato to participate in dynamic export markets. Yet developing well functioning local markets should not be overlooked, as this is the starting point for the far regional and export markets. It is also crucial for re-orienting potato research and production in response to markets. This also means promoting value addition in the potato sub-sector to ensure competitiveness in the rapidly changing markets.

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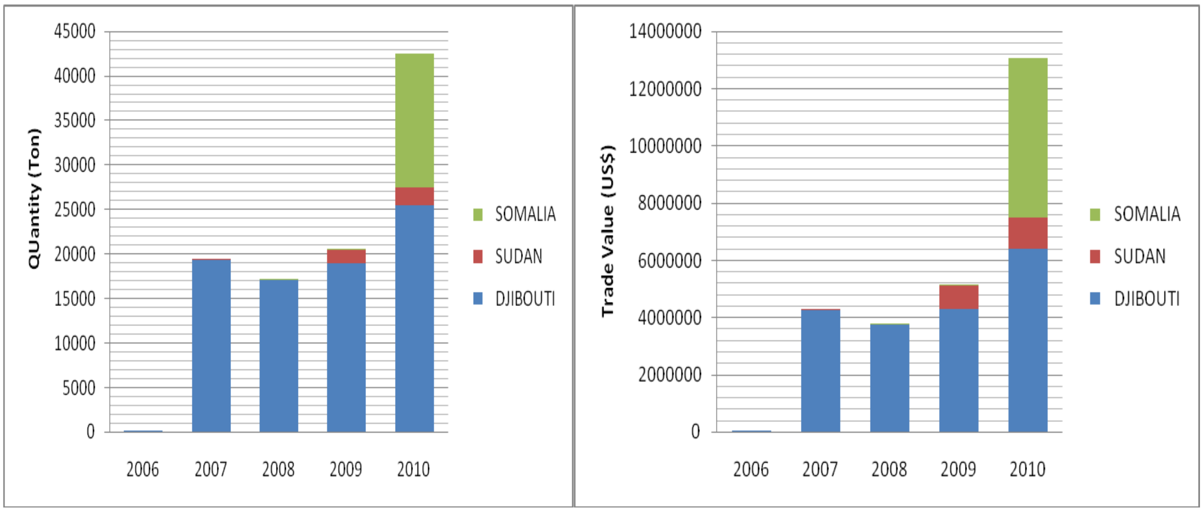
Annexes

Annex 1. Trading countries for Ethiopian potatoes



Source: UN Comtrade/HS data © United Nations, 2009.

Annex 2. Potato production and export trends of Ethiopia

Year	Production (tons)	Export (tons)	Producer price (US $/ton)
2000	385,000	3,247	92.5
2001	415,000	1,615	67.4
2002	385,258	4,318	72.4
2003	509,715	5,539	97.7
2004	509,716	5,473	97.3
2005	449,996	56	97.7
2006	449,995	28	103.5
2007	525,657	9,703	186.6
2008	402,508	8,456	202.1
2009	572,333	NA	209.3

NA=data not available. Source: FAOSTAT© FAO Statistics Division, 2011

Annex 3. Main tasks of the Ethiopian Horticultural Development Agency (EHDA)

The Ethiopian Horticultural Development Agency has been established in 2008 as an autonomous Federal Government Agency under the MoARD. The main target groups of the agency are commercial farmers or investors. The major tasks of the agency include:

- Capacity development to ensure quality products
- Marketing and promotion activities
- Facilitates investment in the horticulture sector
- Facilitates logistics such as transport and postharvest management issues
- It coordinates a task force organized from various stakeholders: These include:
  - ✓ MoARD-Phytosanitory Inspection and Certification unit
  - ✓ EHPEA-commercial producers and exporters
  - ✓ Logistic companies (Ethio-Hort share company)
  - ✓ Federal police-to expedite the transportation time to minimize post harvest losses of perishable products
  - ✓ Customs Authority-to facilitate freely importable goods or shortening the process e.g. Cold rooms, cars etc
  - ✓ Ethiopian Airlines-to facilitate cargo services for high value horticultural commodities
- In addition, the agency collaborates with other stakeholders such as USAID-Agribusiness and Trade Expansion unit in various issues. For example, EHDA collaborates with USAID to study the following key issues:

  - ✓ Study if export is feasible in terms of cost (e.g. for packing, transport, custom duty, where to export it etc)
  - ✓ Study whether it is economical to export in a certain country for some commodities
  - ✓ Capacitating EHDA project experts and horticultural producers through technical trainings (This is also supported through the Royal Netherlands Embassy in Addis Ababa).

  Source: Interviews

Annex 4. Private sector investors involved in potato related business in Ethiopia

Year	Business	Status
1992	**Potato** Chips Processing and Flavour Powder Production	Operation
1998	**Potato** chips processing	Operation
1999	Food processing Industry/Fruit Juice & **Potato** chips/	Pre-Implementation
2004	Corn Flakes & **Potato** Chips Manufacturing Project	Pre-Implementation
2005	Vegetable Production (**Potato** and Onion)	Pre-Implementation
2006	Production of **Potatoes**	Pre-Implementation
2006	Seed Potato Production and Export Farm	Pre-Implementation
2007	Manufacturing of **Potatoes** Chips	Pre-Implementation
2008	Farming & Processing of Tomato & **Potato**	Implementation
2008	Farming of **Potatoes** & Production of Potato Chips	Pre-Implementation
2008	Fish Processing, **Potato** Farming Processing (Expansion)	Pre-Implementation
2008	Maize, **potato** & Hot pepper	Pre-Implementation
2008	Maize, sesame, Niger, wheat, pepper, onion, **potato**, mango Prod.	Pre-Implementation
2008	Onion, **Potato**, Sorghum	Pre-Implementation
2008	**Potato** Processing Factory	Pre-Implementation
2008	**Potato** Processing Factory	Pre-Implementation
2008	**Potato** and Corn Chips Manufacturing	Pre-Implementation
2008	Processing & Packaging of Meat, Fish & **Potato**	Pre-Implementation
2008	Tef, wheat, sorghum, barely, banana, avocado, mango, **potato**, coffee	Pre-Implementation
2008	Vegetable Farming& Processed of Onion, **Potato** and Beans	Pre-Implementation
2009	Processing of Tomato & **Potato**	Pre-Implementation
2010	Farming and processing of organic garlic, tomato, **potato** and ginger	Pre-Implementation
2010	Farming of rice, sweet **potatoes** and peanut	Pre-Implementation
2010	Farming of wheat, bean and **potato**	Pre-Implementation

Source: Ethiopian Investment Agency (EIA).

Annex 5. Benefit-cost analysis of using local and improved potato varieties (Birr/ha)

Cost/Benefit item	Local variety	Improved variety
Gross benefit	4800	40000
Costs		
• labour	673	770
• inputs	1668	4639
Total cost of production	2341	5409
Net benefit	2459	34591
Net benefit (US $)	342	4564

Source: Lemaga, 2010 based on a 2004 field data

Annex 6. Average production costs and revenues of potato production in major production areas of Ethiopia

Indicators	West Shewa	Awi
Investments	180	91
▪ Cash investments	69	146
▪ In kind investments	233	305
▪ Fa investments	7.7	5.1
Revenues	62	91
▪ Yield (t/ha)	480	469
▪ Price ($/t)	62	91
▪ Gross margin ($/ha)	480	469
▪ Net margin (opp. cost; $/day)	115	75
▪ Return on family labour ($/day)	1.97	1.55
▪ Return on cash investment ($/$)	1.7	4.1

Source: Gildemacher, 2010

Annex 7. Opportunities and constraints in export market for seed, ware and processed potato products

A. Seed production			
Function	Actor	Challenges	Opportunities
Research	Research institutes	▪ Lack of trained personnel ▪ Sources of germplasm	▪ New technologies such as aeroponics are available ▪ Rapid multiplication facilities ▪ Demands of seed potato is high
	Universities	▪ Staff turn over ▪ No full time researcher ▪ Poor research capacity	▪ Recharging capacity through new employees in the research system ▪ International relations through partnerships and common research interests
	Privates	▪ Market	▪ Low production cost particularly labour and low starting capital to initiate potato related investment ▪ Good policy environment that encourages and facilitates promotion of agriculture and agro-processing sector
Basic seed production	National Agricultural Research System (NARS)	▪ Same as above ▪ Storage and transportation cost ▪ Perishability	▪ High seed demand in different countries ▪ Potential for quality seed production due to suitable agro-ecology of the country ▪ Cheap labour in the country ▪ Capacity building initiatives in training of horticulture experts for example Ethiopian Horticulture Development Agency in collaboration with the Netherlands Embassy cooperation
Seed production	Farmers, FRG, Cooperatives, individual farmers	▪ No proper knowledge and package ▪ Storage facilities ▪ Soil and tuber borne diseases ▪ Lack of credit ▪ Expensive inland transport	▪ Conducive environment for seed production in different agro-ecological zones of Ethiopia ▪ High seed demand in the country as there was no active formal seed potato producing company so far ▪ Low production cost/cheap labour in the country
	Commercial Growers	▪ Land is expensive ▪ Marketing system	▪ Incentives from the government, particularly related to import of duty free goods, taxes, financial support etc

		▪ Lack of seed	▪ High seed demand (internal and external) ▪ Cheap labour ▪ Possibility of year round production of potatoes by combining rain fed and irrigation
Commerce (trade)	Traders	▪ Lack of knowledge and skill ▪ Expensive transport ▪ Lack of market transparency	▪ Communication system is expanding-telephones, emails etc ▪ Infrastructure such as road networks expanding, rail networks are under way ▪ Geo-position of the country is conducive being close to Middle East and Europe
	Government organizations	▪ Service expenditure	▪ Export opportunities for hard currency (revenue)
Retail	Retailers	▪ Transport cost ▪ Market information ▪ Lack of trust of consumers	▪ Good market (high demand)
Consumers (seed buyers)	Farmers	▪ Input price and availability ▪ Knowledge ▪ Lack of processing ▪ Transport cost and land	▪ Food habit is changing following the country's economic growth, and would be an opportunity for potato seed producers

B. Ware production			
Basic seed provider	National Agricultural Research System (NARS)	▪ No export oriented breeding for potato so far	▪ High demand of ware potatoes at the moment (Middle East countries)
Seed providers	Seed companies (private and GOs)	▪ No continuous supply of seed ▪ No required variety	▪ Seed producing companies are emerging (e.g. SolaGrow PLC.)
Seed potato producers	Commercial farmers	▪ No alternative varieties for disease and pest tolerance	▪ Technology shopping is supported by the Country's agricultural policy
Ware production	Commercial farmers	▪ Transport problem-expensive, monopolized (both inland and sea transport), ▪ Unstable market price fluctuation	▪ Rail network, expansion of road network, ▪ High demand of ware potatoes in the middle east countries (size and shape), ▪ High suitability of agro-ecology in the country to grow quality potatoes ▪ Government policy support
	Small-scale farmers (individual farmers, FRGs, cooperatives)	▪ Lack of knowhow on the export market, ▪ Coordination problems, inland transport problem, ▪ Lack of infrastructure such as storage facilities, ▪ Price fluctuation	▪ Interest of commercial growers to engage in out grower schemes ▪ Demand for high volume of production from destination countries ▪ Government support for unions/cooperatives ▪ Requires low initial capital to be engaged in production
Marketing	Whole sellers, Retailers	▪ No constant supply /quality of ware potatoes, ▪ Cool storage/pack house problems ▪ Lack of market information	▪ Many potato investors are emerging ▪ No production risk compared to the producers ▪ International institutions such as European Commission are supporting traders for quality products-e.g. making vegetable trading centre at Dire Dawa and the possibility of providing cold storage facilities

C. Products chains			
Specific inputs	Breeders	▪ Limited capacity, specific germplasm.	▪ CIP, Research centres, Gov supporting policy, SolaGrow PLC., potential demand.
	Multipliers	▪ Lack of processing variety, quality seed, skill of production.	▪ Stable potential market.
	Traders	▪ Weak market linkage, small market.	▪ Stable potential market
Production of processing potatoes	Farmers (FRG, Cooperatives)	▪ Variety, quality and quantity seed, higher input price, constant product quality, and high price of ware potato.	▪ Organized National Agricultural Research System (NARS) and Extension (MOARD, Cooperatives).
	Commercial growers	▪ High price of ware potato.	▪ Direct link to processors.
Transformation	Packers	▪ Lack of technical skill.	▪ Branding
	Ware house service providers	▪ Limited capacity, technical skill, and perishability.	▪ Seasonal production- low price during excess production.
	Processors	▪ Lack of continuous supply and keeping standards.	▪ Growing markets in the country.
Trading & distribution	Whole sellers	▪ Transportation, market information and linkage.	▪ Growing markets.
	Distributors	▪ Transportation	▪ Growing markets would create or initiate better road construction, rail transport, sea transport etc-to achieve national goals of Growth and Transformation Plan.
	Exporters/traders	▪ Transportation and market information.	▪ Growing markets would induce better transport services and communication development by the Ethiopian Government.
Retail sales	Shops, supermarkets	▪ Aging, continuous supply and setting standards.	▪ Growing markets, change in consumption habit.
	Hotels and restaurants	▪ Setting standards.	▪ Growing markets, increasing tourism.

POTATO EXPORT MARKET FEASIBILITY STUDY

1/6/2011 | Potato subsector export market report for Kenya

Nancy Ng'ang'a and Wachira Kaguongo

POTATO EXPORT MARKET FEASIBILITY STUDY

POTATO SUBSECTOR EXPORT MARKET REPORT FOR KENYA

SUMMARY

Kenya currently exports potato products (crisps, frozen chips, flours, granules etc), ware and seed potatoes with seed exports being dominant. The current exports are private sector driven and are done by individual companies and entrepreneurs. In spite of these exports Kenya is a net importer of potatoes with the largest import being ware potatoes which are imported during specific months of the year even though there are production gluts and subsequent wastages during other months of the year. The ware potatoes produced are of a low quality and are in excess quantities during certain months of the year and in short supply during other months. Any export efforts geared towards ware potatoes would have to focus on first stabilizing supplies in the country and then on improving the quality of the tubers to make them competitive for the export market. Current seed production is insufficient for the country's own use despite the exports being done but there are numerous efforts being made to remedy the situation.

Currently (2011) ware exports are lowest at 7tons compared to seed (249tons) and potato products (43tons). An expanded export possibility exists as current ware potato production can be doubled through the use of quality seed and recommended production practices and supply can be evened out through the use of improved stores. Various initiatives to improve the quality, quantity and supply of ware potatoes are being executed by government and various stakeholders in the potato industry.

Since 2007 the highest amount of potato exports is in the form of seed that have been exported into specific countries within the COMESA region and this market can be expanded further in the next 5 years especially in countries where seed currently used is either of poor quality or is imported from distant countries like the Netherlands and South Africa at high cost and with strenuous logistics.

The export of potato products was 43tons in the 1st half of 2011 although it was 117tons last year. Within the EAC there are accepted harmonized standards for potato products as well as the KEBS diamond mark of quality assurance. The seed and ware certifying agency (KEPHIS) is internationally recognized hence seed and ware potatoes certified by the agency would be regionally and globally accepted. The country thus has a reputable capacity to guarantee quality of its potatoes and potato products to make them competitive.

Kenya thus has the capacity to produce and export potatoes and potato products but the industry has been disjointed with no representation in the national arena and without any shared vision and agenda; with any advancement in the industry occurring from individual persons, companies or organizations working independently. With the formation of national potato council of Kenya to coordinate the

activities of the industry and play the role of advocacy and lobbying, and with the formulation of national seed potato master plan and national potato strategy paper, coupled with the renewed vigor by the government, development agents and other stakeholders the export potential can be exploited and filled in the next five to ten years.

The government and subsector lacks potato export development plan which would focus on promoting potato export. There is need for strategic plan to ensure seed, ware and potato products are produced and marketed competitively. Improving potato production which is currently at sub-optimal level and curbing the large losses along the value chain through improved handling and standards would increase available seed and ware potato for possible export. Evening out supply throughout the year would minimize ware imports and reduce losses. Kenya thus has the potential to produce an extra 3,091,946 tons (through improved productivity-2,657,946 and reduced losses- 325,000tons) from its current acreage, some of which could be available for export after satisfying local demand.

There is need for a comprehensive study to quantify demand and export potential of seed, ware and potato products.

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ACRONYMS

ADC	Agricultural Development Corporation
COMESA	Common Market for Eastern and Southern Africa
EAC	East African Community
FAO	Food and Agriculture Organization of the United Nations
FIPS	Farm Input Promotions Africa
GoK	Government of Kenya
GTIL	Genetics Technologies International Limited
GIZ-PSDA	Germany International Technical Corporation-Promotion of Private Sector Development in Agriculture
IFAD	International Fund for Agriculture Development
ISO	International Organization for Standards
KARI	Kenya Agricultural Research Institute
KEBS	Kenya Bureau of Standards
KRA	Kenya Revenue Authority
KENAPOFA	Kenya National Potato Farmers Association
KEPHIS	Kenya Plant Health Inspectorate Services
Ksh	Kenya Shilling; Ksh123 = 1 €; Ksh92 = 1 USD
NPCK	National Potato Council of Kenya
SHoMAP	Smallholder Horticulture Marketing Programme

INTRODUCTION

World Production

According to FAOSTATS[1] the total world potato production in 2008 was 325.6 million tons from 18 million hectares. African production comprised only 9% of total world hectarage and 6% of total world tonnage. Although Kenya is among the countries with the largest land area under potatoes its yields are among the lowest (5 tons/ha). South Africa has the highest yield (35tons/ha) followed by Egypt (26 tons/ha) (Table 1).

TABLE 1: EAST AFRICAN COUNTRIES AND LARGET POTATO PRODUCERS IN AFRICA-2008

Countries	Area		Production		Yields
	Ha	African %	Tons	African %	Ton per ha
Egypt	137,517	9%	3,567,050	19%	26
Malawi*	205,043	13%	2,993,818	16%	15
Nigeria	263,000	16%	1,105,000	6%	4
Rwanda	130,000	8%	1,162,000	6%	9
South Africa	60,000	4%	2,098,581	11%	35
Kenya	120,000	8%	600,000	3%	5
Tanzania	125,000	8%	650,000	3%	5
Uganda	97,000	6%	670,000	3%	7
Eastern Africa	788,072	49%	6,904,011	36%	9
Africa	1,597,703	100%	19,268,989	100%	12

*Include sweetpotatoes

World trade

In developed countries most potatoes are eaten in processed form and chips are the most predominant potato products. Trade in potato products accounts for about four percent of world production, a proportion similar to rice. The international market for potatoes has five main segments; (i) seed potato (ii) ware potatoes (iii) frozen chips (iv) crisps and other potato snacks and (v) starch. World exports of frozen chips are valued at US$2 billion and that of fresh potato at US$1.8 billion (FAOSTAT), and trade in seed potato is valued at US$400 million (worldseed.org). The frozen chip market grew rapidly in the past decade and exceeded the value of fresh potato exports for the first time in 1998. Frozen chips will continue to be the leading area of growth in potato trade in the next decade.

Unlike the rest of the world, most potato in Eastern African countries is sold fresh and unprocessed (Ferris et al., 2002). However, there is considerable potential to expand the consumption of processed products in urban centers in the region. This is because potato which is increasingly becoming a common menu to most of the population is also widely produced in the region.

[1] http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor: by Jan2011

Potato marketing and export in Kenya

The government of Kenya recently launched the Agriculture Sector development Strategy 2010-2020 whose strategic thrust on increased productivity, commercialization and competitiveness of agricultural commodities is expected to enable the agricultural sector to export more outputs (GoK, 2010). This in turn is expected to earn more foreign exchange and create employment. Improving agribusiness and market access are viewed as some of strategic activities leading to achieving the government's ever eluding endeavor for a paradigm shift from subsistence agriculture to agriculture as a business that is profitable and commercially oriented. The government also recognizes the importance of improving quality and safety standards as vital to ensuring that agricultural commodities from farmers are competitive in regional and global markets.

In Kenya, potato is the second most important crop after maize and is grown by an estimated 800,000 farmers in small scale farms. The annual production of the crop was estimated at USD 109million at farm gate prices and the industry employs thousands as market agents, transporters, processors, vendors and exporters and the value of the crop at consumer prices is about KSh.26 billion per year[2]. The current crop area is estimated at 158,000 hectares with an average yield of less than 10 tons per hectare (Kaguongo et al., 2010). In 2008 Kenya exported less than 1000tons of potatoes and potato products out of the estimated 1.3milion tons produced indicating that potatoes are sold almost entirely in the domestic market but there is increasing demand for potatoes which is linked to changes in consumption habits, mainly in urban centres, where chips are increasingly becoming a popular part of the diet.

Although the sector has a high potential for addressing food insecurity due to its potentially high productivity per unit area and the high population depending on potatoes for employment, income and food the sector is bedeviled by production and marketing challenges that limits its contribution to the economy. By virtue of the high numbers of small scale farmers and actors in the value chain that depend on the sector for their livelihood and incomes; potato becomes a strategic crop for the government and development agents. Improving productivity and competitiveness of the sector has enormous potential of improving food security and earning increased foreign exchange for the country through export to the regional and global markets.

However, information on export status and potential is insufficient or lacking for the potato industry in Kenya. Understanding the export potential is vital to development of strategic plans for the potato subsector in the country. The purpose of this study is to get an overview of export potential for seed, ware and potato products in Kenya.

Objectives of the study

The major objective of the study is to get an overview of the potential of potato export market for Kenya.

[2] http://www.gtzpsda.co.ke/index.php?option=com_content&view=article&id=18&Itemid=55

Specific objectives

- Evaluate constraints and opportunities for seed, ware and potato products
- Examine the way forward in improving potato export market

Methodology

The study evaluated the current status of the subsector and performed a SWOT analysis on functions and operators at different levels of the value chain. The study targeted key informers, stakeholders and exporters in the country. It used heuristic and analytical methods for situation analysis where existing reports and interviews were used as the main sources of information. The activities undertaken as part of this study include the following:

(a) Desk research
(b) Interviews with various stakeholders in the potato subsector:
  - government departments and regulatory authorities;
  - farmers associations;
  - individual farmers, processors and exporters;
  - embassy officials, NGO's ;

(c) Stakeholders meetings and discussions to consult various groups of stakeholders to check the validity of gathered information and obtain their views

Kenya Potato Subsector

The Kenyan Irish Potato subsector, like other agricultural commodity sectors in the country; is not well organized, coordinated or integrated. Producers, transporters, marketers, wholesalers and retailers are fragmented and tend not to cooperate or work together, with some players, such as brokers being considered as an evil that must be endured. There is a national farmers' organization for potato farmers (Kenya National Potato Farmers Association-KENAPOFA) but it is structurally and operationally ineffective. A national Potato council (NPCK) which is in it's formative stage, was officially registered in September 2010 and officially launched on October 25th 2010 is charged with the role of coordinating the subsector activities and lobbying for necessary regulations and policies. The current lack of organization is a major factor that isolates the subsector from regional or global markets but it is hoped that a functioning council and farmers' association will go a long way in coordinating and consolidating the activities of the industry making it more competitive.

Ware Potato export

Production and demand

Potato is highly positioned as both a food and cash crop in Kenya and it is planted twice a year, and occasionally three times in some districts. Production is concentrated at mid to high altitudes above 1,000 meters above sea level. Most production is rain fed and there is minimal storage of tubers once they are harvested meaning that supply and prices vary greatly within the year with price gluts immediately after harvest and exorbitant prices in the period before planting when there is minimal harvesting going on. In 2008, Kenya produced 1,301,704 tons of potato from 158,386 ha, indicating a national yield of 8.2 tons/ha which is much lower than the potential yield of 25 tons/ha under rain fed conditions. It was therefore possible to produce an additional 2,657,946 tons of potato from the same acreage in 2008, if farmers had produced at the potential level. There is thus an enormous potential to produce more potatoes from the current acreage by improving on yields through use of improved quality seed and recommended agronomic packages.

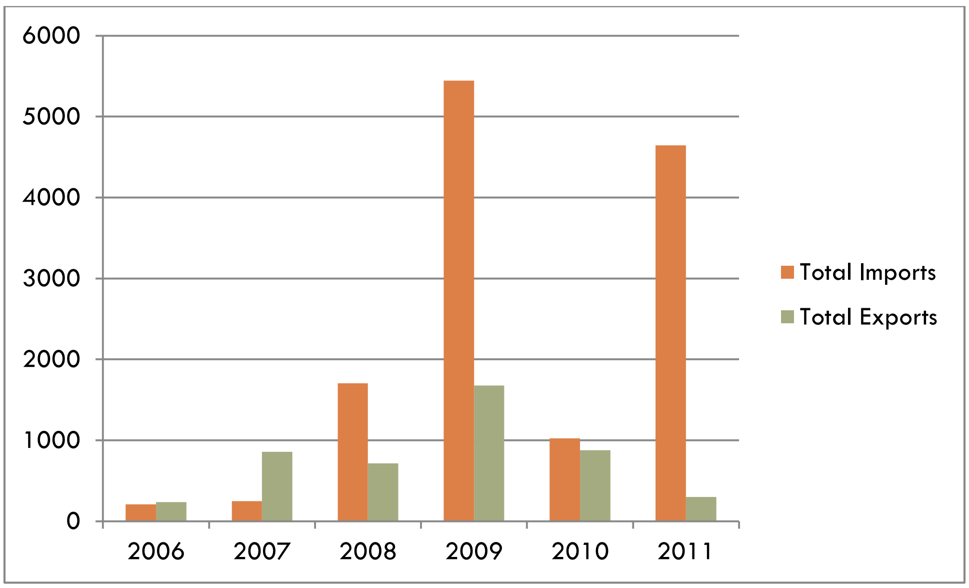
Due to the supply and price fluctuations most farmers tend to harvest immature tubers so as to take advantage of the early prices before supply increases and prices reduce. Potato tubers thus tend to be immature with a peeling soft skin that is very susceptible to damages and rots and thus they do not store well and have a short shell life and consequently high spoilage rate. This poor quality of tubers is one of the greatest constraints to the exportation of ware potatoes from Kenya as the tubers produced cannot compete with those from other regions of the world as they are unattractive, disease prone and do not store well. Similarly, such low quality ware potato are not good for processing due to the high level of sugar content and spoilage which leads to a high percentage of wastes.

Poor tuber quality combined with losses along the value chain translate to an estimated loss of 15-20% of potatoes along the value chain which is equivalent to 325,000- 434,000 tons worth 4.7-6.3 billion for year 2008. Improving agronomic practices especially that of allowing tubers to reach maturity and proper post harvest care of potatoes is critical to raising the prospects for Kenya's potato export market. The current Ministry of Agriculture extension message is aimed at getting farmers to allow their potato crops to mature. This initiative is expected to be supported by the construction of collection centers being built under the IFAD program (SHoMaP) for Horticulture crops where compliance for quality and health standards will be enforced. These collection centres have the potential to improve on the quality of marketed potatoes in potato producing areas. The initial centres are to be built in Meru and Nyandarua districts.

Potato exports and imports

Kenya imports and exports significant quantities of potatoes and potato products (Figure 1) with the quantity of imports surpassing that of exports since 2008 with the highest imports of 5,400tons in 2009. This quantity is expected to be exceeded by this year's imports that currently stand at 4,600tons as of July this year. Exports peaked in 2009 at 5,400tons and have gradually reduced every year since then (Figure 1). Kenya is thus a net importer of potatoes and this deficiency must first be addressed before a case for exports can be made.

FIGURE 1: QUANTITIES (TONS) OF POTATO IMPORTED AND EXPORTED



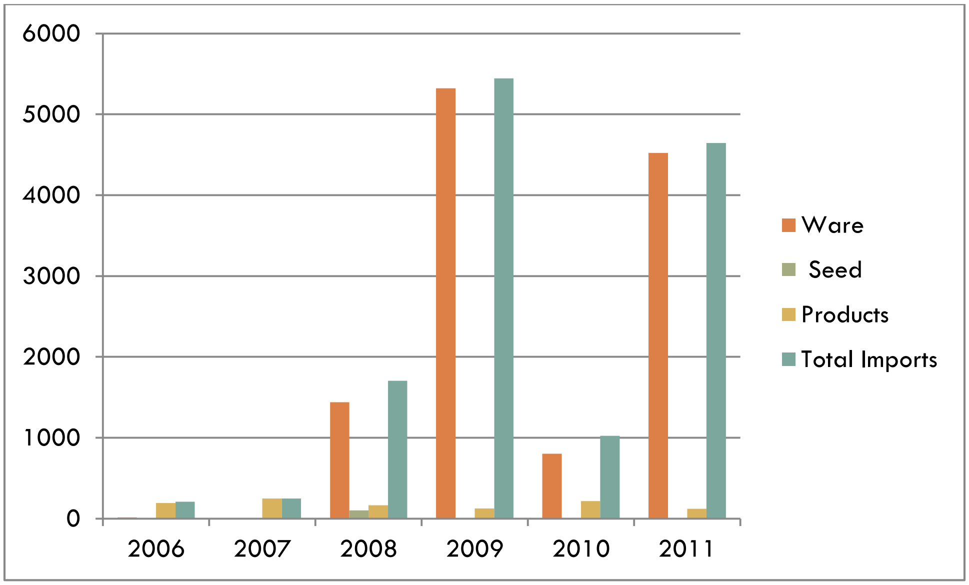
Source: KRA (1st August 2011)

POTATO IMPORTS

Since 2008 most of the potato imported into the country was in the form of ware potatoes but in the preceding years imports were mainly in the form of products (

Figure 2). Quantities of potato products imported have ranged from a low of 122tons from the 1st 6 months of 2011 to a high of 279tons in 2007 and 213tons in 2010. Imports of seed potatoes have been minimal except in 2008 when 100tons of seeds were imported.

FIGURE 2: QUANTITIES (TONS) OF POTATOES IMPORTED IN THE LAST 5 YEARS



Source: KRA (1st August 2011)

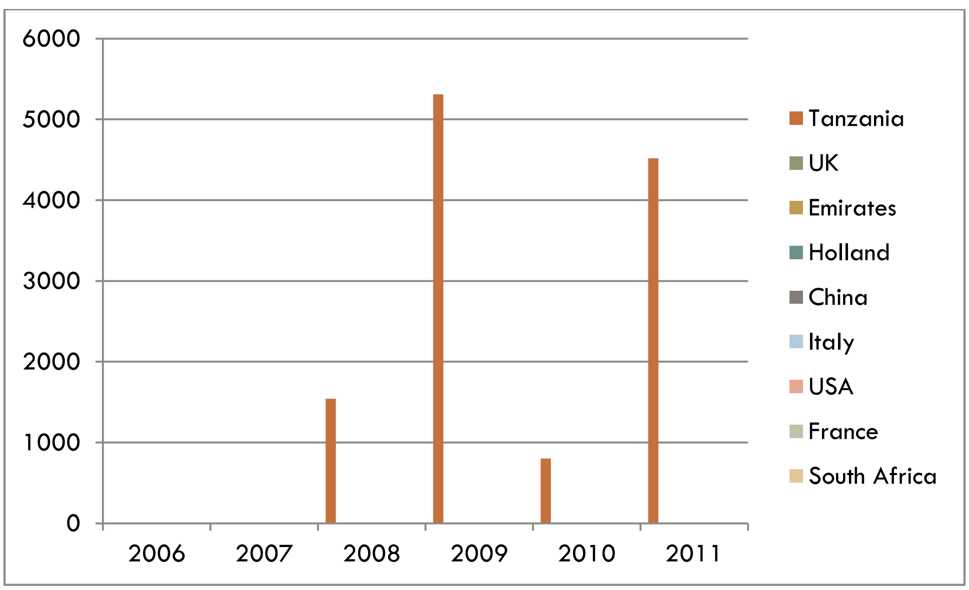
Source of seed and ware imports

The highest quantities of imports in the last 5 years have been from Tanzania with minimal quantities coming from other countries (

FIGURE 3). Most of these imports have been in the form of ware potatoes (Figure 2**FIGURE 1**) meaning that Kenya has been importing ware potatoes from Tanzania which suggests that contrary to popular belief among practitioners in the industry Kenya is not self sufficient in ware potatoes.

Since 2008 most imports from Tanzania have been done in March and April except in 2010 when they were done in July and August and were minimal (less than 500tons). In 2009 imports continued into May and June (appendix 1) probably due to reduced production as a result of the displacement of farmers due to the tribal clashes that rocked the country in 2008. During the months of March and April there are usually no potatoes in the country as farmers who plant using the rains are either planting or have just planted and so tuberization has not occurred and even immature tubers are unavailable.

FIGURE 3: QUANTITIES (TONS) OF WARE AND SEED POTATO IMPORTED FROM DIFFERENT COUNTRIES



Source: KRA (1st august 2011)

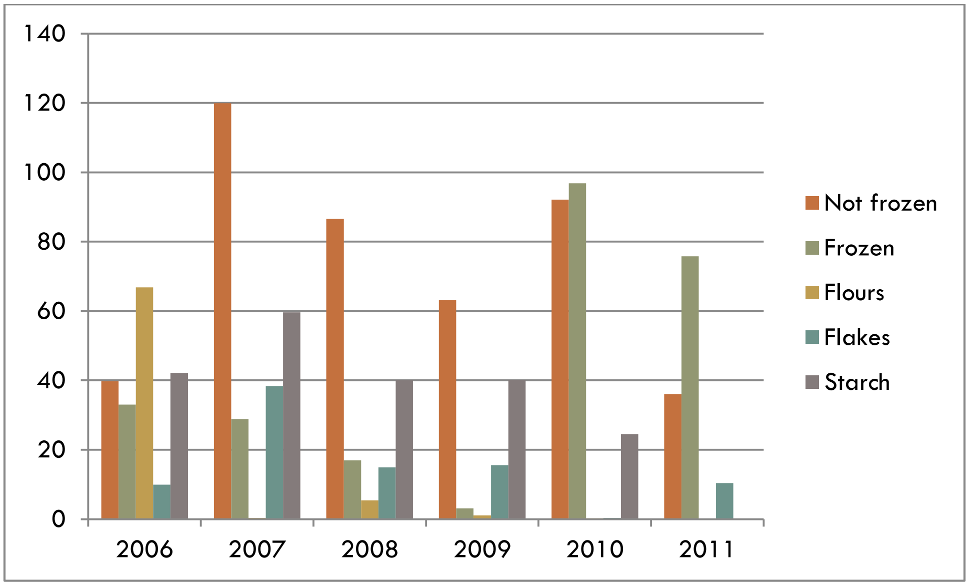
Imports of potato products

Potato products imported into the country have varied over the last 5 years with the quantities of non frozen products (defined as potatoes that are prepared or preserved other than vinegar or acetic acid and not frozen) being the highest imported potato product in 2007, 2008 and 2009. Quantities of frozen potato products have been the highest imported product in 2010 and in the 1st half of 2011. The largest quantity of 67tons of potato flour was imported in 2006 but quantities have decreased since then to zero so far in 2011. Potato flake imports were highest in 2007 at 38tons but quantities are now about

10tons as of the 1st half of 2011. Starch imports were highest in 2007 at 59 tons and hovered around 40 tons in 2006, 2008 and in 2009 before dipping to 24tons in 2010 and to less than 0.1tons in 2011 (

Figure 4).

FIGURE 4: QUANTITIES (TONS) OF DIFFERENT IMPORTED POTATO PRODUCTS

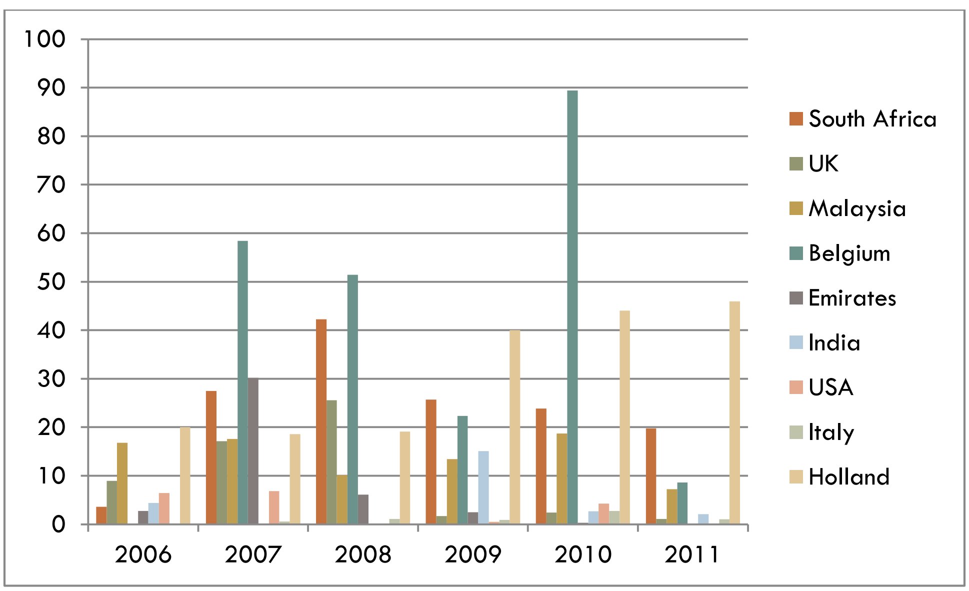


Source: KRA (2nd August 2011)

Sources of potato product imports

The highest quantity of potato products have been imported from Holland this year as well as in 2009 and in 2006 but in 2007, 2008 and 2010 the highest quantity of potato products were imported from Belgium. In 2006 significant quantities were also imported from Malaysia. Other important sources of potato products are the Emirates (2007), the UK and India (Figure 5).

FIGURE 5: QUANTITIES (TONS) OF POTATO PRODUCTS IMPORTED FROM VARIOUS SOURCES

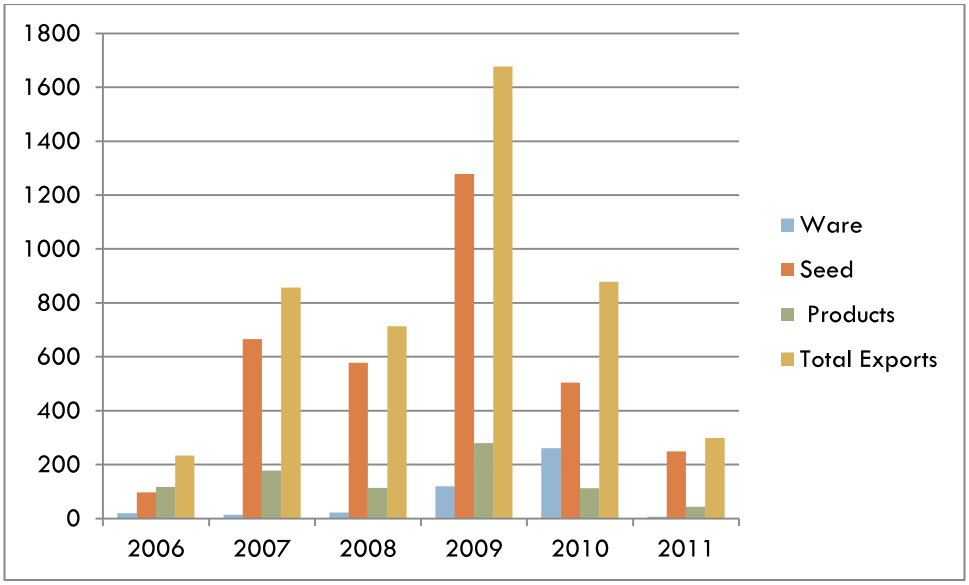


Source: KRA (1st August 2011)

POTATO EXPORTS

Since 2007 most potato exports have been in the form of seeds with exports being highest in 2009. The second highest quantity of exports was in the form of potato products except in 2010 when larger quantities of ware potatoes were exported compared to potato products (Figure 6).

FIGURE 6: QUANTITIES (TONS) OF POTATOS EXPORTED



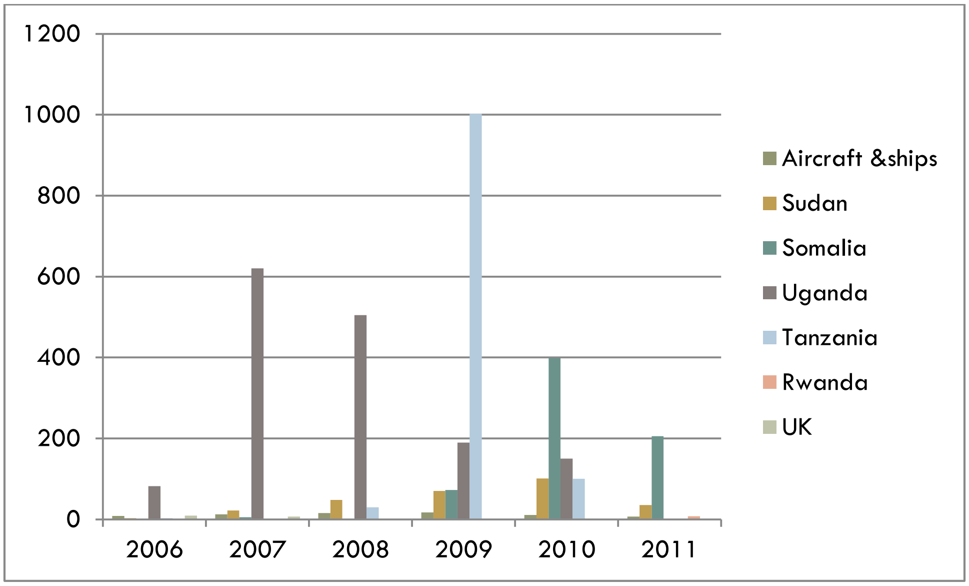
Source: KRA (1st August 2011)

Exports destinations of seed and ware potato products

Most exports were in the form of seeds (Figure 6) with the highest quantity destined for Uganda in 2006, 2007 and 2008; for Tanzania in 2009 and for Somalia in 2010 and 2011 (

Figure 7).

FIGURE 7: QUANTITIES (TONS) OF SEED AND WARE EXPORTS AND THEIR DESTINATIONS

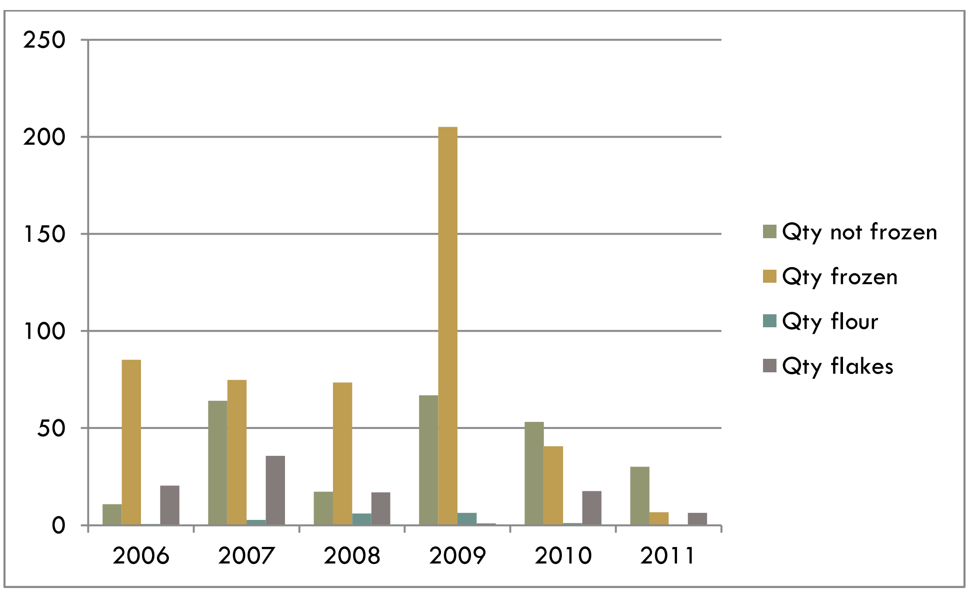


Source: KRA (1st August 2011)

Export of potato products

Frozen potato products were exported in the highest quantities in 2006, 2007, 2008 and 2009. Non frozen products were exported in the highest quantities in 2010 and 2011 (Figure 8). There were also minimal quantities of potato flour and potato flakes exported.

FIGURE 8: QUANTITIES (TONS) OF EXPORTED POTATO PRODUCTS

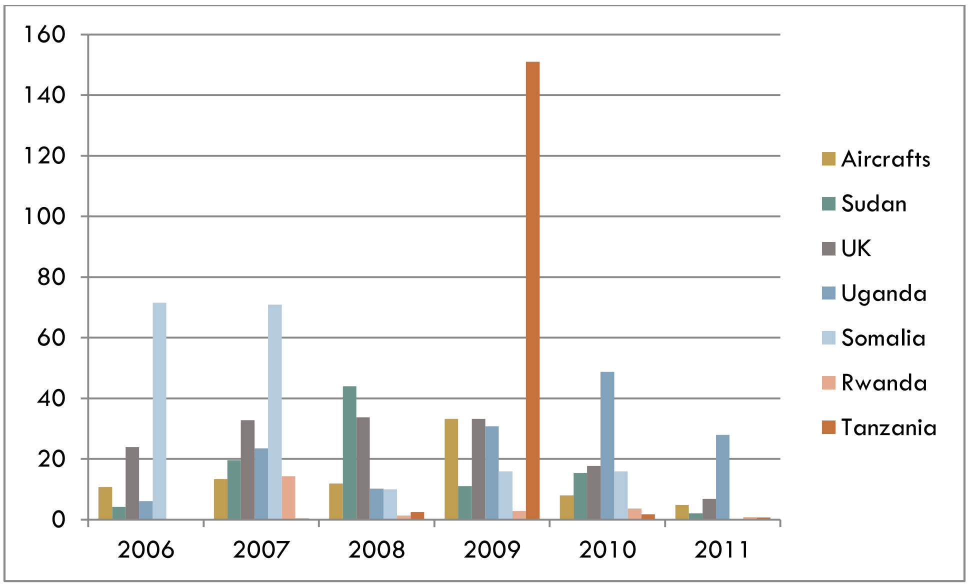


Source: KRA (August 1st 2011)

Destinations of exported potato products

In 2006 and 2007 the largest quantity of potato products were exported to Somalia followed by the UK but in 2008 it was to Sudan followed by the UK. In 2009 the largest quantity of potato products were exported to Tanzania and in 2010 and into 2011 to Uganda (Figure 9).

FIGURE 9: QUANTITIES (TONS) OF EXPORTED POTATO PRODUCTS AND THEIR DESTINATIONS



Source: KRA (August 1st 2011)

Values of potato exports and imports

The value of exports increased steadily from 2006 and dipped in 2011. It was highest in 2010 at FOB value of 570,000USD and lowest in 2006 at FOB[3] value of 205,000USD while the value of imports was highest in the first half of 2011at CIF[4] value of 659,000USD and lowest in 2006 at CIF value of 185,100USD (

[3] **Free On Board (FOB)** – An international trade term of sale in which, for the quoted price, the seller/exporter/manufacturer clears the goods for export and is responsible for the costs and risks of delivering the goods past the ship's rail at the named port of shipment. The Free On Board term is used only for ocean or inland waterway transport {Globe Express Services Dictionary of International Trade (Incoterms 2000)}.

[4] **Cost, Insurance and Freight (CIF)** – An international trade term of sale in which, for the quoted price, the seller/exporter/manufacturer clears the goods past the ship's rail at the port of shipment (not destination). The seller is also responsible for paying for the costs associated with transport of the goods to the named port at destination. However, once the goods pass the ship's rail at the port of shipment, the buyer assumes responsibility for risk of loss or damage as well as any additional transport costs. The seller is also responsible for procuring and paying for marine insurance in the buyer's name for the shipment. The Cost and Freight term is used only for ocean or inland waterway transport {Globe Express Services Dictionary of International Trade (Incoterms 2000)}.

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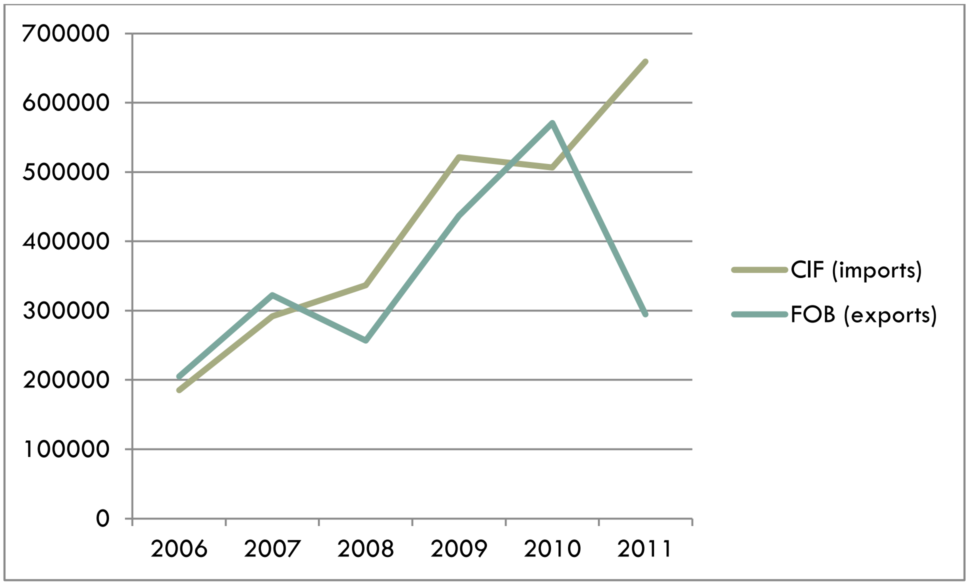
Figure 10).

Figure 10: value (USD) of potato imports and exports



Source: KRA (1st August 2011)

Production and exports

Improving potato production which is currently at sub-optimal level and curbing the large losses along the value chain through improved handling and standards would increase available seed and ware potato for possible export. Kenya has the potential to produce an extra 3,091,946 tons (through improved productivity-2,657,946 and reduced losses- 434,000 tons) from its current acreage, some of which could be available for export after satisfying local demand. The losses incurred along the value chain are higher than what the country imports. But developing, disseminating and adoption of appropriate seed and ware potato storage facilities will be critical to ensure the smoothening out of supply throughout the year and thus minimizing imports during the months of April and March.

Major constraints

- Disorganized industry with players and actors working independently and lacking ethics and regulations to guide functions in the value chains that would lead to a competitive industry
- High dependency on rain fed farming and lack of storage facilities lead to fluctuations of prices, irregular supply and poor quality tubers due to tendency to harvest early
- Lack of appropriate storage leads to fluctuation of supplies and necessitates importation in April and March
- Limited production and supply of high quality seeds and non-use of good production practices lead to low productivity
- Lack of suitable varieties, low productivity and poor handling along the value chain lead to high losses in the industry.
- There is lack of strategic plan that focuses on competitiveness and export market

Key Opportunities

- The formation of National potato council of Kenya, which is a actors and stakeholders forum has the potential to organize and steer the sector to a robust and competitive industry
- The renewed energy and goodwill of the government, development agents and other stakeholders could potentially lead to addressing the bottlenecks such as storage facilities, roads, extension service and enforcement of standards and regulations
- Promising technologies and practices such as aeroponics, DLS and clean and positively selected seed production methods are available and in early stage of adoption and have enormous potential to increase quality seed in the country which will lead to increase ware production

Seed Potato

Production and demand

At present there are only 3 registered potato seed merchants selling certified potato seed in Kenya and these are 2 quasi government institutes namely the Kenya Agricultural Research Institute (KARI) and the Agricultural Development Corporation (ADC); and a private company, Midlands. Cold storage capacity is only available at KARI-Tigoni (40 tons) and ADC (2,000 tons). Kisima Farm Company, which has recently joined the seed potato industry, has cold storage previously used for other agricultural commodities. Midlands is currently not selling certified seed but it is focusing its efforts on field testing and building up stock of three varieties and also field testing 3 new varieties to evaluate their field performance. Midlands is establishing a cold storage capacity of 1,200 tons that will be used for potatoes as well as other commodities.

Kisima farm started off as a mini-tuber producer using aeroponics and has expanded operations to include multiplying and selling of small quantities of certified seed potato under KARI's merchant status. During the 2010 short rains Kisima farm had about 20 acres under certified seed; KARI had 21 acres under basic seed, while ADC had 18 acres under certified seed. This was a major improvement from previous years when total basic seed hardly exceeded 20 acres. Kisima, KARI-Tigoni and ADC do not have a distributor for their seed and farmers requiring seed have to travel to either Meru (Kisima), Tigoni (KARI) or Molo (ADC) which is both expensive and time consuming.

A major constraint faced by KARI and ADC in certified seed production is KEPHIS delays in inspection which slows the whole process and sometimes leads to major losses. Although the registered seed merchants do not meet the country's need for certified seed which is estimated at 35,000-50,000 tons the current efforts by the Kenyan government, development agents and stakeholder are likely to boost production hence innovations in production and agribusiness should target local, regional and global markets to ensure competitiveness. There is also an accreditation bill in parliament that would authorize KEPHIS to accredit private sector players to do inspection on it's behalf.

In 2010 Kenya exported 150 tons of seeds to Uganda and 100 tons to Tanzania and has in the past also exported about 13 tons to Sudan in 2008 and 9tons to the UK in 2006 (Appendix 2). Kenya thus has a customary reputation as a seed exporter.

A potential for seed export also exists in the area of mini-tubers that have been produced through aeroponics. Their greatest advantage being that they are not bulky and so can be transported by air, road or rail at a lower cost. Additionally, the aeroponics production method is soilless hence no soil borne pathogens and since they go through certification procedure they would be competitive in both regional and global markets. However, terms of trade and regulations for exporting mini-tubers would have to be drawn since it would be a new commodity in the market.
There are currently 8 aeroponics units supported by various development partners (USAID, Korea etc) but there is need for more players if this potential is to be exploited. But these units are fairly new and only 3 of them (KARI, GTIL, Kisima) have been in operation for more than a year.

Major constraints

- There are very few seed multipliers and no distributor leading to shortage of quality seed in the production areas of the country
- The inadequate capacity of KEPHIS is limiting timely and wide coverage of inspection of certified seeds
- There is lack of marketing infrastructure for seed and the limited certified seed produced lacks distributors
- Lack of land for basic seed production and multiplication at KARI-Tigoni and ADC has been a bottleneck in production of certified seeds

Key Opportunities

- There is renewed interest in seed industry which is attracting more investors and is likely to lead to increased seed production.
- The new technologies, such as aeroponics has enormous potential to increase pre-basic seed or minitubers production which are free of soil born disease hence suitable for export

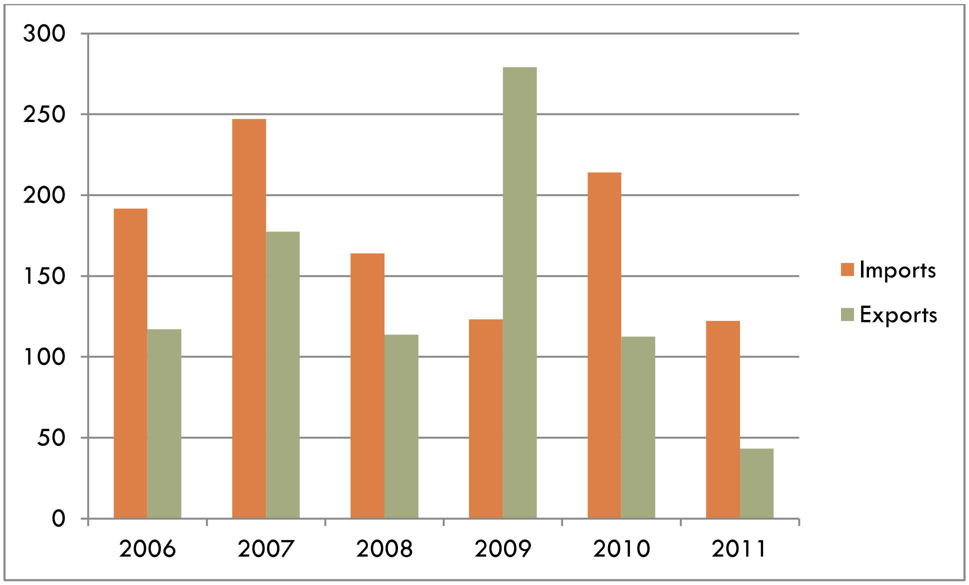
Processed potatoes

Production and local demand

The demand for processed potato products is high and is increasing proportionally with urbanization in the east African countries and the neighboring countries. Imports of potato products have surpassed exports in the last 5 years except in 2009 when exported quantities were more than double the quantity of imports (

Figure **11**). There are concurrent imports and exports of frozen and non frozen products but only imports of potato starch (Figure 4 & Figure 8) with the highest quantities imported mainly from Holland, Belgium and South African. The main limitations for increasing local processing of potato products are lack of suitable processing varieties, lack of information, and lack of processing technologies and irregular supply of quality tubers. However there are quite a few cottage, a number of medium and large processing companies that operate despite the various challenges.

Figure 11: Quantities (tons) of potato products Imported and exported



Source: KRA (1st August 2011)

Crisps

The only major variety suitable for processing (Dutch Robyjin) is highly susceptible to diseases especially late blight. This is a major drawback that leads to low adoptability by small scale farmers who are lacking in resources and management skills.

There are a number of companies and cottage industries processing potatoes but we will take an in depth look at just one (Tropical heat) so as to glean some insights into the industry.

Tropical heat (Deepa) industry is one of the largest crisps processors in the country and produces a number of potato products (sticks and Indian snack foods [chevra, chevda etc]) besides crisps for the local market as well as for export. Deepa exports about 4.5 tons of potato crisps to Uganda, Tanzania and Rwanda; and about 15 tons of processed potato products to the UK each month. The company foresees a growth in the consumption of potato products in the region and therefore plans to start processing factories in Uganda and Tanzania to meet this growth, after they identify suitable processing varieties in each country. Products exported to the UK are put into containers and sea freighted. Products to the COMESA region and the UK are exported duty free. Exportation to the UK is done under the EUR 1 certificate that gives preferential tariffs to specific developing countries so as to boost their economic growth.

Despite various interventions, poor quality tubers remain the major constraint in potato processing, where small tuber sizes and high sugar content cause major losses. This usually results to production break downs that waste time (up to 1hour) and also results in the lowered production of salted crisps and a resultant increase in flavored crisps as a remedial measure since salted crisps are more tolerant to browning. The broken crisps resulting from small tubers are sold at a lower price (35% of the normal price) making them unprofitable for the company.

Frozen chips

Njoro canners is a frozen chips manufacturer that supplies mainly to the local market. However, quite a lot of frozen chips in major supermarkets and tourist hotel are imported mainly from the Netherlands, Belgium and South Africa. The company processes 1,000 tons of ware potatoes annually producing about 333 tons of processed products. About 80% of the frozen chips (200 tons) are sold to the local market and what remains is exported to the United Nations Development Programme who distribute it to their operational areas in Uganda (more than 50%), DRC Congo (about 20%), Rwanda (about 20%) and Somalia (about 5%). The company experienced quality challenges leading to reduction of annual production from 3,000 per annum previously. This was occasioned mainly by the inability to get enough supply from farmers of the Tigoni variety which is the only suitable variety for production of frozen chips. The company uses out-grower contracts with their farmers and these have been hard to enforce. This has been aggravated by the uniqueness of potato which has very wide price fluctuations (compared to other crops) so that when prices get too high farmers tend to renegade on their contracts and sell to the more attractive ware market.

Major constraints

- Lack of suitable processing varieties and limited regular supply of quality tubers are the main bottleneck to potato processing
- Enforcements of contracts between processing companies and farmers is a major drawback. When prices of other outlets are high farmers renegade and sell elsewhere ignoring their agreement causing processing companies to either reduce production or to try and source potatoes from the ware market which tends to be costly
- The slow release of processing varieties by KARI-Tigoni is a major bottleneck in the industry.

Key opportunities

- The demand for processed potato products is high and increases proportionally with urbanization
- The high quantities of imported processed products in supermarkets and tourist hotels in East African countries is an indication of high demand for potato products and potential for Kenya's export market in the region

Legal and policy framework

Ware potatoes

Ware potato production and marketing is regulated under legal notice 44 of 2005. The legal notice has requirements in terms of quality standards (agronomic production, grading, packaging and transportation standards and regulations) as well as standards for potato processing. This legal notice is however largely ignored by all the players in the potato value chain. A high percentage of market players do not know of the existence of the law nor do they follow it. The EAC standards (discussed under EAC) define the qualities such as maturity level, tuber size and packing of ware potatoes. Any ware potatoes exported must be inspected by regulatory body to ensure they are free from specified diseases and pests that include bacterial wilt, viruses, tuber rot and brown rot.

Seed potatoes

Seed is regulated under the Seeds and Varieties Act (cap 326) and legal notice 44 of 2005. Potato is classified as a schedule II crop which means that importation of potato tubers whether seed or ware is banned except small quantities for research purposes. Importation is also permitted under exceptional conditions of drought or other natural tragedies when the minister of agriculture is allowed to declassify potato to allow for importation for a specific time period.

Both seed regulations tend to also be largely ignored by seed producers and users as 95.5% of all potato farmers use seeds saved from their own harvest or buy seeds of low quality from their neighbors or traders.

The Kenya Plant Health Inspectorate Services (KEPHIS) is mandated to regulate seeds under the Seed and Varieties Act (cap 326). KEPHIS's seed testing laboratories have received international accreditation by the International Seed Testing Association (ISTA) which gives them formal recognition that they are technically competent to carry out seed testing procedures in accordance with ISTA rules. The accreditation provides an assurance that tests conducted by KEPHIS are internationally recognized thereby facilitating trade. This is in line with what the KEPHIS website says "certified once, accepted everywhere", which makes it a strategic resource for the country in terms of seed exports due to its international recognition implying that any certified seed potato from Kenya would be accepted everywhere in the world. KEPHIS is also ISO 9001:2008 certified meaning that it meets an international standard for quality management.

Processed potatoes

Processed potatoes are regulated under legal notice 44 of 2005 with processing standards set by the Kenya Bureau of Standards (KEBS) which also enforces them. All processed products are required by law to have KEBS quality assurance stickers. Regional standards for the processing of crisps, chips and frozen chips are in the process of being put into practice (see EAC section). Companies like Deepa that export crisps and potato based Indian snack foods (bhusu, chevda, masala sticks, masala fingers and masala crinkles) are also members of an International snack association which gives their products even more credibility in the international market. Deepa also has the Kenya Bureau of Standards (KEBS) certification and their diamond mark of quality which gives their product authenticity in the local and regional market.

Export/import regulations and control

Bilateral trade agreements

Kenya has bilateral trade agreements with 15 countries in Africa (Comoros, Djibouti, Ethiopia, Lesotho, Mauritius, Nigeria, Rwanda, Somalia, South Africa, Sudan, Swaziland, Tanzania, Zambia, Zimbabwe and Libya) with an additional one under negotiation (Mozambique) and with 2 others that have expired (D.R Congo and Liberia). Those that have expired would need to be renegotiated again. The main advantage of bilateral trade agreements is that they provide a forum for the settlement of disputes while also allowing partner countries to have joint trade committees that deal with all trade issues. Conversely, in countries without bilateral agreements any trade by members of the respective countries is based on a gentleman's agreement which once violated is more difficult to get resolution too. Bilateral trade agreements thus encourage trade between members of the partner countries.

Export development plan

The government and subsector lacks potato export development plan which would focus on promoting potato export. There is need for strategic plan to ensure seed, ware and potato products are produced and marketed competitively. There is however an export development plan by the ministry of trade which comprises of a yearly schedule of shows and exhibitions carried out by the export promotion centre and interested Kenyan companies who want to showcase their services and products in different countries of the world. The potato industry could use this forum to create exposure and promote their products as other Kenyan businesses do.

Phytosanitary barriers

The Seeds and Varieties Act (cap 326) has set standards for diseases that ensure that seeds do not surpass internationally accepted disease levels. Seed certified by KEPHIS in Kenya meets the international standards and would be acceptable in any market. However, ware potatoes would have to be certified for important export diseases like bacterial wilt, brown rot etc.

Packaging

Seeds are currently packaged and sold in 50kgs bags by all the seed merchants except Kisima (a private company) that has started packaging in 10, 20 as well as the 50kg packages in line with the recommendations given in the seed potato master-plan (Wachira et al, 2009).
Ware potatoes are currently packaged and sold in oversized bags that range from 140-260 kgs contrary to legal notice 44 of 2005 and 113 of 2008 that specifies that potatoes should be packed in 110kg bags. However, the 110kg bag size specified in the legal notice is in conflict with the International Labor Organization (ILO) guidelines that specify that a person can only carry a bag of 50kg and which Kenya is a signatory too. The 110kg bags may thus need to be revised to meet the ILO guidelines. Current ware potato packaging does not meet internationally recognized standards and would have to be revised in order for Kenya to export ware potatoes in acceptable bag sizes.

Major constraints

- The government and subsector lacks an potato export development plan
- The legal notices and guidelines on production and marketing of seed, ware potatoes and processed products are not known or are largely ignored by stakeholders leading to inefficient marketing system with low quality products
- The quality of ware potato in the market and the poor packaging make them uncompetitive in the regional and global markets

Key opportunities

- The regionally and internationally recognized Kenyan quality and standard regulating bodies (KEPHIS and KEBS) make certified seeds and processed products from Kenya very completive in the region and easily acceptable in global markets
- The newly formed National potato council has the capacity to create awareness and lobby for implementation and enforcement of appropriate by-laws improving the industry

Current and potential regional export market

Kenya has exported seeds mainly to Uganda and Tanzania (

Figure 7); and imported ware potatoes mainly from Tanzania (Appendix 2) and this has been done largely by individual companies or individuals. As a country Kenya has not made any strenuous and planned efforts to supply a neighboring country with seed, ware or processed products. Imports of ware potatoes have been mainly in March and April to solve what seems to be a recurring problem in Kenya since 2008 (Appendix
Appendix 1).

Sudan

Sudan is particularly of interest because it has been importing seed potato from the Dutch. The Sudanese planting season in the Khartoum area follows very quickly after the Dutch harvest season so that the imported seed is still dormant when the Sudanese farmers need to plant and this poses p a big challenge to the farmers. A recent collaborative project (1st August 2007 to 31st September 2009) between a Dutch seed company and a Sudanese company worked at addressing this mismatch by having the local farmers multiplying the seed for one season (plant in November) and store from Feb to October when it is sold to farmers.

TABLE 2: POTATO PRODUCTION IN SUDAN

Production area	Planting/ Harvesting	Main Variety (reason liked)	Seed source	Problems	Farmer solutions
Khartoum (70% of production)	Nov-Dec/Feb-March	Alpha (silty soils and long dormancy)	Own seed, periodic imports from Netherlands	Imports arrive late/costly/ limited quantities	Cut seed potato into small pieces with 1 or 2 eyes
Jebel Marra	Nov-Dec/Feb-March (irrigation), June-July/Oct-Nov	Old British varieties introduced by early 19th Century	Farmers own seed	i) Limited quantities ii) Degeneration	Cut seed potato into small pieces with 1 or 2 eyes
Southern Sudan	Sept/Dec March/July	Old British varieties	Farmers own seed	i) Limited quantities ii) Degeneration	Cut seed potato into small pieces with 1 or 2 eyes
Kassala	Nov-Dec/Feb-March	Old British varieties	Farmers own seed	i) Limited quantities ii) Degeneration	Cut seed potato into small pieces with 1 or 2 eyes

Source: www.lanra.uga.edu/exportpotential/sudan.htm (September 2010)

Kenyan seed can easily replace the Dutch seed since she could supply high quality seed at a lower cost due to her proximity to Sudan. The greatest challenge would be transportation of the seed as congestion at the port is one of the other reasons for the seed import delays. Farmer preference for the Alpha variety would also be a constraint in the short run as this is not a recognized variety in Kenya and if it was imported it would have to go through National Performance trials before possible release as a variety for the country. Although there is no direct road transport from Kenya to Khartoum traders use an indirect route by road and water. Trucks from Kenya travel to Juba through Uganda, as the road passing through Uganda is better than that in Kenya. During dry weather it takes at least 12 hours to travel by road from Kampala to Juba. However, road transport between Juba and Khartoum is poor, unsafe, risky and unreliable. Khartoum is usually accessed by water through the North at Kosti which takes 10 to 14 days (250kms South of Khartoum). From Kosti road transport could be used to Khartoum. Transport of potato exports from Kenya to Juba and even Khartoum is thus possible though some storage measures would be needed to mitigate the heat typical of that part of the world.

In the other areas of Sudan (with 30% of country's production) with no access to certified seed the market appears to be wide open and since the farmers grow a range of varieties then supplying certified seed of Kenyan varieties that are similar to those being grown is a possibility that can be explored. Airways are other transport options since there are daily flights from Nairobi to Juba, especially for mini-tubers produced from aeroponics which are less bulky than certified seed potato.

Freight charges to Juba and Khartoum are estimated at USD 2398 for 1000tons of fresh produce (Table 3) with increased frequency of exports likely to bring more favorable freight charges.

TABLE 3: FREIGHT CHARGES (USD) FOR 1000 TONS OF FRESH PRODUCE FROM NAIROBI TO SUDAN (JUBA AND KHARTOUM)

Items	**Cost**
Freight Charges	1980
Airway bill	15
Handling charges	250
Agency fees	150
Total	2398

Source: Harry Ngari-Emerald Freights

Most of the commodities found in the Southern Sudan shops mainly originate from Kampala; hence Kenya should target to tap the potato products market especially for crisps which occur in form of Pringles. Further investigation should be done to find out what other processed potato products could be exported to Sudan.

Tanzania

Most potato is grown in the Southern Highlands (90%) with most farmers using selected tubers from own harvest or other farmers or local market as seed. The main varieties are old German varieties that have probably degenerated over the years due to their continual use. In 2009 and 2010 Kenya exported about 100tons each year to Tanzania (Appendix 2Figure 7) and a market strategy can be developed to not just continue tapping into this market but to expand it.

There is a growing urban market for crisps and frozen chips and thus a high potential for expanded market for the processed products and high potential for varieties suitable for processing industries. As a member of the EAC and of COMESA; and with a bilateral trade agreement with Kenya, trade between the two countries is very favorable. In addition the EAC standards ensure that ware and processed products meeting these standards have regional acceptability.

Export potential for seed and processed products is already being exploited but at a very low level and this can be explored further for possible exploitation. Road travel between most parts of Kenya and

Tanzania is good making export of potato and its products feasible. There has been no varietal release in Tanzania in the last 20 years while no phytosanitry inspection body exist in the country and this creates a high potential for variety and seed exports. Deepa is currently exporting crisps to this market and plans to set up an office here in the next five years and maybe a processing unit in the future.

Estimated freight charges for 1000tons of fresh produce are estimated at USD2200 from Nairobi to Dar es Salam (Table 4) and this could be lessened if road transport is used instead.

TABLE 4: FREIGHT CHARGES (USD) FOR 1000TONS OF FRESH PRODUCE FROM NAIROBI TO DAR ES SALAM

Items	Cost
Freight Charges	1785
Airway bill	15
Handling charges	250
Agency fees	150
Total	2200

Source: Harry Ngari-Emerald Freights

Uganda

Currently, the Ugandan public sector has no facilities to produce clean pre-basic seed and supplies of tissue cultured materials are obtained directly from Kenya via the International Potato Centre (CIP) and the Kenyan Agricultural Research Institute, (KARI). Kenya exported 150tons of seeds to Uganda in 2010 and there is thus potential to export mini-tubers from Kenya to continue to meet this need and if possible to expand it.

Uganda also has a rapidly growing urban market for crisps and chips and thus there is a great potential for varieties to support this industry. Since 2009 Kenya has exported about 30tons of potato products to Uganda each year and this market can be increased strategically. Being a member of both the EAC and COMESA allows Kenya to export products that she has a comparative advantage over Uganda. Export of processing varieties is also a possibility that ware potato exporters can explore. The road network between Kenya and Uganda is fairly good. Deepa industry has thus set up an office with personnel who are exploring the potential to set up a processing facility there as soon as possible. Currently the Deepa, Uganda subsidiary imports products from Deepa Kenya for the Ugandan market and thus pays the freight charges which are high and comprise about 10% of the cost of the product.

Freight charges for 1000tons of potato produce are estimated at USD 2130 (

Table 5) which can be reduced by the use of the fairly good road transport.

TABLE 5: FREIGHT CHARGES FOR 1000TONS OF FRESH PRODUCE FROM NAIROBI TO KAMPALA

Items	**Cost**
Freight Charges	1715
Airway bill	15
Handling charges	250
Agency fees	150
Total	2130

Source: Harry Ngari-Emerald Freights

Burundi

Rwanda is the traditional supplier of potatoes to Burundi and it exported 2000 tons of ware potatoes to Burundi in 2000.

DRC Congo

There is a demand for commercial potato varieties especially in the towns of Bukavu, Kinshasa and Mbuyi-Mayi. Rwanda has been the traditional supplier of potatoes to Kiviu. DRC is a member of COMESA. A lot of ware and seed potato are exported from South Africa to DRC.

Freight charges to the two nearest border towns of Kisangani and Lumbubashi are estimated to range from USD 4135 to USD 5115 (Table 6).

TABLE 6: FREIGHT CHARGES FOR 1000TONS OF FRESH PRODUCE FROM NAIROBI TO DRC CONGO

Items	**Cost**(Kisangani)	**Cost**(Lumbubashi)
Freight Charges	3720	4700
Airway bill	15	15
Handling charges	250	250
Agency fees	150	150
Total	4135	5115

Source: Harry Ngari-Emerald Freights

Djibouti

There has been a recent discussion between the Kenyan Ministry of trade and the Kenyan ministry of foreign affairs on the possibility of Kenya exporting various agricultural commodities and fresh vegetables to Djibouti; and potato was one of the commodities mentioned. Potato is consumed mainly around the major towns of Djibouti city and Dikhil as it is not a major food crop in the rural areas. The most important food commodities are sorghum, wheat flour and Belem rice.

Freight charges from Nairobi to Djibouti are estimated at USD 3115 (Table 7) for 1000tons of fresh produce.

TABLE 7: FREIGHT CHARGES FOR 1000TONS OF FRESH PRODUCE FROM NAIROBI TO DJIBOUTI

Items	Cost
Freight Charges	2700
Airway bill	15
Handling charges	250
Agency fees	150
Total	3115

Source: Harry Ngari-Emerald Freights

Effects of common markets

COMESA

The Common Market for Eastern and Southern Africa (COMESA) has 19 member countries (Burundi, Comoros, D.R Congo, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia and Zimbabwe). In the field of agriculture the member countries have committed themselves to, among other things[5], co-operate in the export of agricultural commodities. COMESA in collaboration with Clifton Packaging Group Plc, a UK based firm, has created a brand called BABA (Buy African Build Africa) with the motto "Love Africa as you love your mother…." in a bid to create a niche market for products for and from the region. The brand currently has 4 categories of products (Pure African Water, Rich African Coffee, Roasted African Nuts and Authentic African Crisps) but they have only 4 products with 3 of these being roasted products (Soya beans, peanuts and cashew nuts) and no potato products from African. There is thus an opportunity for Kenyan potato processors who don't already have a strong brand presence to take advantage of the support (knowledge transfer, world class packaging, marketing opportunities) offered under the BABA initiative.

The East African Community (EAC)

The East African Community (EAC) Common Market protocol came into force on 1st July 2010, with five partner States (Burundi, Kenya, Rwanda, Tanzania and Uganda). The establishment of the East African Community Common Market is in line with the provisions of the EAC Treaty which provides for "Four Freedoms", namely the free movement of goods; labour; services; and capital. With the purpose being to significantly boost trade and investments and make the region more productive and prosperous. The establishment of the Common Market is progressive in accordance with the relevant laws of the

[5] Other Comesa areas of cooperation in agriculture are; i) Co-operate in agricultural development, ii) Adopt a common agricultural policy, iii) Enhance regional food sufficiency, iv) Co-ordinate policies regarding the establishment of agro-industries, and v) Enhance rural development

Community and those of the Partner States. The EAC should boost trade in goods that Kenya has a competitive advantage over the 5 member states.

EAC processing standards for the processing of potato chips, crisps and frozen chips were developed in April 2010 and these became operational when the EAC protocol was put into effect on 1st July 2010 and they will replace the individual country standards within a 6 month period (by January 2011). Processors who meet these EAC standards should thus find wider acceptability for their products in the other EAC countries as would suppliers of ware potatoes for processing.

Major constraints

- The government and subsector lacks potato export development plan hence no deliberate efforts are geared towards promoting regional or global trade in the industry. Lack of suitable varieties for export as seed and ware to regional countries and the poor quality of tubers harvested are the main challenges facing the export market

Key opportunities

- The common market constitutes opportunities for expanded export market and provides treaties and avenues for regulating and promoting trade within the region and addressing any possible disputes.
- COMESA has also negotiated with Clifton Packaging Group Plc and created opportunity for exporting potato products to the region and other parts of the world.
- The development of common standards for Eastern African region is an important step in creating opportunities for export market.
- Neighboring countries such as Sudan, DRC and Burundi which have been importing seed and ware potatoes from Netherlands, Rwanda and South Africa form important targets for Kenya's export market.
- Countries in the region are importing and consuming large quantities of processed potato products and this could be replaced by products exported from Kenya.
- The road network between East African countries is reasonable which would allow free flow of the commodity but transport to the DRC is a challenge since the Mombasa-Lagos route is only a track through the DRC and this track is impassable during the rainy periods.

Marketing costs and Margins

Estimates of marketing cost and margins will guide potential investors in their investment decisions as it will complete the export potential picture.

Costs benefit analysis of certified seeds

Certified seeds are by definition seeds that are certified by KEPHIS who inspect the whole process from land and seed selection until grading. An acre of certified seed gives an average profit of USD 377 (Table 8).

TABLE 8: COSTS AND PROFITS (USD) OF PRODUCING CERTIFIED SEEDS FROM 1 ACRE OF LAND

Expected yields	**400 x 50kg bags**	**Expected revenue (USD/acre)**
Seed size I	25% - 100 bags	417.3913
Seed size II	45% - 180 bags	563.4783
Ware	15% - 60 bags	78.26087
U/grades	10% - 40 bags	83.47826
Chats	5% - 20 bags	41.73913
Total revenue expected		1184.348
Less cost of production		
Operation	**Item description**	
Ploughing	27.17 per acre	27.17391
Harrowing	19.57 per acre	19.56522
Making ridges	13.04 per acre	13.04348
Planting	8mds per acres @ USD 1.63	13.04348
Seeds	24 x 50kg bags @ USD 13.86	332.6087
Fertilizer	4 x 50kg bags @ USD 29.35	117.3913
Ridging	16mds per acres @ USD 1.63	26.08696
Spot weeding	4mds per acre @ USD 1.63	6.521739
Spraying x 3 times	1 mds @ 3 times @ USD 1.63	6.521739
Bulldock	1ltr per acre @ USD 13.04	13.04348
Sencor	1.2kg/acre @ USD 6.52	7.826087
Ridomil x 2 sprays	2kg/acre @ USD 19.57	39.13043
Roughing x 2 times	4mds per acre @ USD 1.63	6.521739
Field inspections x 3times	USD 21.20 per inspection	25.43478

Bacterial wilt	2 samples/field	26.08696
De-haulming	2mds/acres @ USD 1.63	3.26087
Harvesting	16mds per acres @ USD 1.63	26.08696
Loading	4mds per acre @ USD 1.63	6.521739
Gunny bags	160 per acre @ USD 0.43	69.56522
Sisal twine	2kg x 2rolls @ USD 2.72	21.73913
Transport	1bag@USD 0.11 per 20km radius	
Total		807.1739
Profit expected		377.1739

Source: ADC out-grower projected estimates for 2009

Cost benefit analysis of ware potato production

Ware potatoes or table potatoes are produced by the majority of farmers. For a farmer using good quality or certified seeds the returns will be higher than for one not following the recommended practice. The benefits to a farmer following recommended production packages average USD? from 1 acre of land (Table 9).

TABLE 9: COSTS AND BENEFITS FROM PRODUCING WARE POTATOES FROM 1ACRE OF LAND

Activities	Costs	Benefits

Transport costs from production areas

As expected the transport costs from the different counties vary from a high of USD 2.07 to a low of USD 0.45 for a 90kg bag of potato depending on the county and its distance from Nairobi (

Table 10) but it should be noted that most counties are expansive and the given distances and costs will vary significantly depending on the location of the production site within the county.

TABLE 10: APPROXIMATE DISTANCE AND COSTS (USD) FROM NAIROBI TO THE NEAREST PRODUCTION TOWN

Main production counties	Nearest production town	Distance from town to Nairobi (kms)*	Cost (USD) to transport 1bag weighing 90kgs to Nairobi**
Mt. Elgon	Kitale	380	2.07
Keiyo Marakwet	Eldoret	310	1.68
Kiambu	Thika	45	0.24
Meru	Meru	280	1.52
Nakuru, parts of Nyandarua	Nakuru	155	0.84
Narok, Bomet	Narok	160	0.87
Nyeri	Nyeri	165	0.90
Nyandarua	Naivasha	85	0.46

*Nairobi telephone directory, Kenya Postel directories Limited. (2010)

**Based on estimated cost from the East African Commodity Exchange of USD2.2 for 400kms

Prices expected in the countries where potatoes are to be exported

For export to be a viable option in the different countries the potatoes exported would have to attract a specific minimum price in the importing countries. Potato seeds would have to sell at a minimum of USD0.38 per kg in all the countries except DRC Congo where it would have to sell at USD0.39 per kg while ware potato prices would differ depending on the skin color with white skinned ones selling at a higher price (Table 11).

TABLE 11: EXPECTED PRICES OF SEED AND WARE POTATOES IN DIFFERENT COUNTRIES

Country	Type of potato	Average cost (USD) of 1000 tons of potato in Nairobi	Average freight charges (USD) per 1000 tons	15% profit margin	Minimum price (USD) per 1000 tons	Minimum price (USD) per kg
Sudan	Seed*	331521.7	2398	50087.96	384007.7	0.38
	Red skinned ware**	333209.4		50341.11	385948.5	0.39

	White skinned ware**	369966		55854.59	425820.6	0.43
Tanzania	Seed*	331521.7	2200	50058.26	383780	0.38
	Red skinned ware**	333209.4		50311.41	385720.8	0.39
	White skinned ware**	369966		55824.89	425790.9	0.43
Uganda	Seed*	331521.7	2130	50047.76	383699.5	0.38
	Red skinned ware**	333209.4		50300.91	385640.3	0.39
	White skinned ware**	369966		55814.39	425780.4	0.43
DRC Congo	Seed*	331521.7	4625	50422.01	386568.7	0.39
	Red skinned ware**	333209.4		50675.16	388509.6	0.39
	White skinned ware**	369966		56188.64	426154.6	0.43
Djibouti	Seed*	331521.7	3115	50195.51	384832.2	0.38
	Red skinned ware**	333209.4		50448.66	386773.1	0.39
	White skinned ware**	369966		55962.14	425928.1	0.43

*based on cost of seed from ADC (1525 per 50kg bag) + transport cost from Molo (ADC)

**based on average wholesale prices in Nairobi for the last 6 months from www.kilimo.go.ke (8th August 2011)

Processing Costs

Crisps and frozen chips varied in the conversion rate and in the price that each product attracts in the local market (Table 12)

TABLE 12: COST BENEFIT ANALYSIS (USD) FOR PROCESSED PRODUCTS

	Crisps (salted)	Frozen chips	Chips
Ware potatoes price (USD/kg)	17.4/120 = 0.1449 (to farmers) 20.65/120 =0.172 (at Nairobi factory)	0.163 (to farmers)	0.35** (wholesale Nrb market)
Conversion rate (1kg of raw potato converts to what amount of product)*	1:0.45	1:0.33	1: 0.65
Average wholesale price (USD/kg)	5.39	1.52	-
Average retailer mark up (USD/kg)	0.467	???	-

*estimates from Kari-Tigoni food technology and Njoro canning

**average prices in Nairobi from Jan to July 2011

Way forward

- Need for formulation of terms of trade and marketing guidelines for mini-tubers which is likely to form a major tradable commodity in the potato industry in the region
- There is need to fast tract policies and regulations to improve seed and ware production and marketing and lobby for adherence of legal notices to enhance the competitiveness of the industry
- There is need to promote use of appropriate production and management practices and high quality seed by farmers to increase marketable seed and ware potatoes
- The planned expansion of the KEPHIS's capacity through accrediting private sector would help in increasing production of certified seeds
- There is need for detailed studies to quantify demand of seed, ware potato and processed products in each target destination country
- There is need for a subsector export development plan which harmonized with seed potato master pan and potato strategy papers.

Conclusions and recommendations

Players in potato industry are disjointed hence the immense potential for exports is not exploited. Potato processers are constrained mainly due to lack of suitable processing varieties and low quality of ware potatoes supplied as a result of poor handling, immature tubers and mixed varieties and sizes. Although contract farming has been used to solve some of quality and supply problems the contract compliance and enforcement has been a major problem.

The numerous small ware producers rely mainly on the biannual rains leading to wide quantity and price fluctuations. Some farmers harvest early to capture the high prices before the onset of glut and this lowers the quality of ware potatoes.

Improvement of quality through sorting, proper handling and right time of harvesting is expected to improve standards of ware potato from the country. Establishing marketing structure that pay premiums for fully mature potatoes of similar sizes and packed by variety type would improve the competitiveness of the industry in the region. The proposed collection centers may help mitigate quality problems by providing bulk buying centers with standardized weights and grading, while also serving as information and quality assurance centers.

Release of more varieties that are high yielding, resistant to diseases and suitable for processing will help develop the processing industry and increase potato products available for local and export markets.

The fact that there are no strong and recognized inspection bodies in other East African countries, the involvement of KEPHIS in production of quality seed ensures certified seed produced in Kenya are competitive and acceptable in the region. Accreditation of private sector will also facilitate the processes of increasing production of certified seed.

Increasing production and formulating regulation and terms of trade for the min-tubers has potential for forming a major export commodity Kenya. Increasing basic seed production, multiplication and improving distribution will also increase availability of quality seed which could increase available seed and ware potato for export.

Development of national potato export plan showing road map to production of surplus seed, ware and potato products that are competitive regionally and globally is important in helping the industry exploit export potential in the next short term period

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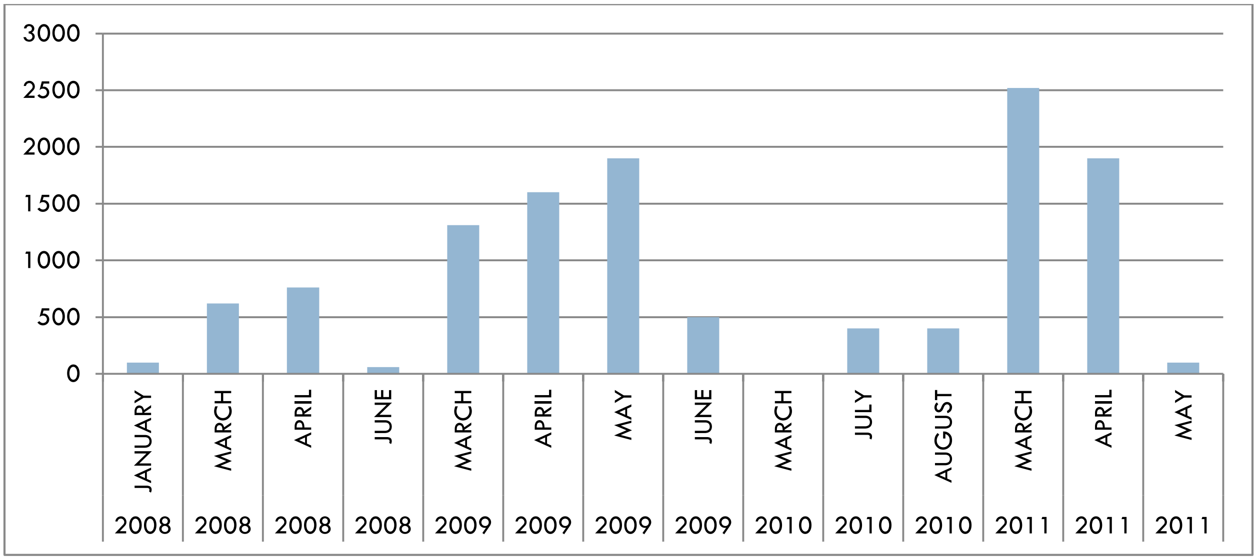
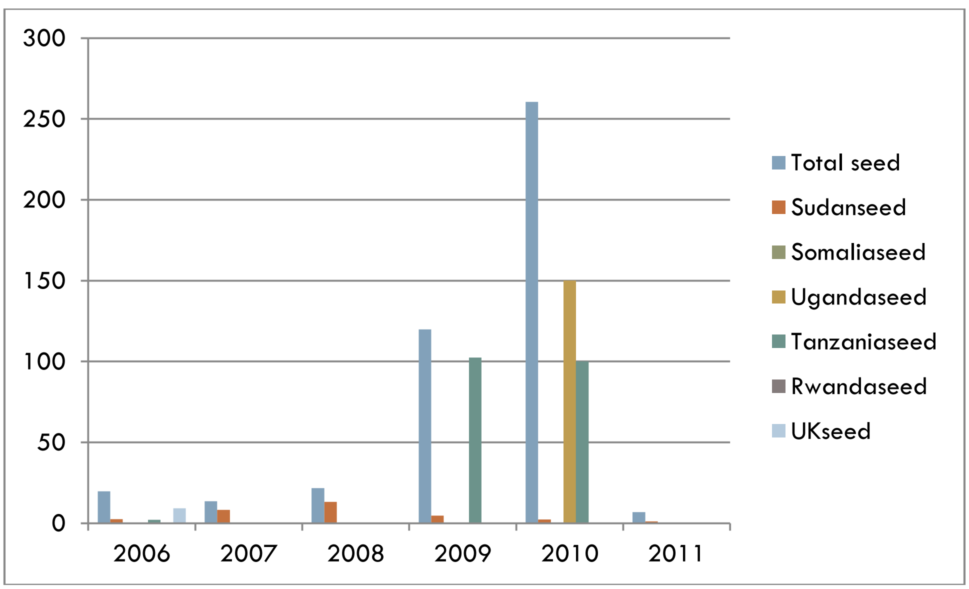
Appendix

APPENDIX 1: QUANTITIES (TONS) OF WARE POTATOES IMPORTED IN DIFFERENT MONTHS



Source: KRA (1st August 2011)

APPENDIX 2: QUANTITIES (TONS) OF SEED EXPORTED TO VARIOUS COUNTRIES



Source: KRA (1st August 2011)

Uganda's potato sub-sector: a diagnostic and export trade feasibility study

Draft Report

Submitted by

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To

KAZARDI

3/21/2011

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EXECUTIVE SUMMARY

The objective of this study was two-fold, namely (i) to review the current status of the potato sub-sector in terms of stakeholders and their roles, production, utilisation and trade of potato produce and products in Uganda; and (ii) to assess the feasibility of seed and ware potato export from Uganda.

The potato is an important crop for food and income in Uganda, most especially in the highland areas. The potato sub-sector has a number of players including farmers, traders, transporters, processors, consumers, government institutions and international agencies. About 154,000 t of potatoes valued at approximately Ush 77 billion are produced annually in Uganda. For the past five years, potato output has remained the same or even declined, although yield has slightly increased to 4.7 t/ha from 3.7 t/ha.

About 64 percent of the crop is consumed as food at farm-level and by households in urban areas and about a quarter of the output is processed into chips and crisps. About 6 percent of the crop is used as seed for reproduction and a tiny amount of the crop is exported –though export trade is not regular. At times of low output, the country also imports a small amount of seed and ware potatoes. The main trade partners for exports and imports of seed and ware potatoes are Kenya and Rwanda. Countries where Uganda imports potato products such as crisps and *Pringles* (crisps reconstituted from potato flour) are Kenya, Britain, United Arab Emirates and Malaysia.

Fair quality seed potato production in Uganda is monopolized by about 35 farmers grouped under the Uganda National Seed Potato Producers Association (UNSPPA). UNSPPA has been in existence for over a decade but the association has not significantly expanded in membership and output. Currently, UNSPPA uses 20 t of basic seed from KAZARDI to produce about 250 t of fair quality seed per season. Due to monopoly, UNSPPA members earn high profits from seed potato production.

Ware potato cultivation is very profitable compared to cultivation of other crops such as maize. In Kapchorwa district where transportation infrastructure has improved, most farmers are giving up maize production in favour of potato farming.

In reviewing the sub-sector, attention was paid to identifying the strengths to rely on, weaknesses to overcome and opportunities to exploit as well as threats to be wary of, for improved performance of the potato sub-sector. These are summarized in the SWOT analysis table.

SWOT analysis of potato sub-sector

Strengths	Opportunities
• Modern tissue culture laboratory and aeroponics green house for seed production • Existence of potato processing standards to regulate quality of processed and traded potato products • A modern potato crisps processing plant in Kabale Town	• Input subsidies under NAADS programme • Production under irrigation in Kapchorwa using free gravity water provided by government • Versatile Victoria variety adaptable in grassland agro-ecological zones • Increasing urbanization and consumers preference for potato chips and crisps • Processing capacity building opportunities offered by UIRI
Weaknesses	**Threats**
• High price of inputs limiting the use of improved inputs • Adulterated inputs leading low factor productivity • Limited capacity of KAZARDI to produce higher volume of basic seed. • High use of locally saved seed • Poor and inadequate road infrastructure in highland areas leading to high transport costs and affecting access to markets • Limited access to business development services (e.g. credit, market information, storage etc.) by farmers, traders and small-scale processors -limiting use of improved technologies to increase in output • Limited processing and value addition • Unreliable electricity supply leading to production losses by medium-scale processors • Weak enforcement of potato processing standards • Weak or lack of institutional framework supporting potato value-chain development	• Unpredictable weather –climate change? • Diseases and pests • Non-tariff barriers including sanitary and phyto-sanitary requirements restricting potential exports •

The feasibility analysis of seed and ware potato export from Uganda to Kenya and Rwanda revealed that Uganda does not command the competitive advantage as well as has no capacity to sustainably supply a potential export market. Furthermore, the analysis showed that even a viable export market for Uganda's potato produce does not exist particularly in the East African region.

Analysis of South Africa potato export markets for possible lessons for Uganda's desire to export potatoes to countries beyond East Africa suggests that it is not economical unfeasible for Uganda export potato produce beyond the neighbouring countries as the crop is bulky and perishable on one hand and the country is landlocked and has poor transport infrastructure.

From the diagnostic and feasibility analyses of the potato sub-sector, some of the key conclusions and recommendations that emerge are:

Conclusion 1: The stagnant or declining potato production in Uganda is not good news at all amidst the rapidly increasing population, urbanization rate and per capita income growth. Population growth, urbanization and higher per capita income are all expected to increase the demand for food in general and potato produce and products in particular. It is therefore important and incumbent upon appropriate government institutions to implement innovative ways of rapidly increasing potato output and yield to much the anticipated growth demand for potatoes in Uganda in the near future.

Recommendation 1*: Since potato varieties such as Victoria adapt well in a range of agro-ecological zones, potato research and development institutions such as KAZRDI and NAADS should pattern up and explore options of promoting potato production in other areas other than highlands only.*

Conclusion 2: UNSPPA as a key institution in the promotion and development of the potato seed system in Uganda does not have the capacity to effectively take on this daunting task. The potato seed system risk remaining in the indeterminate state as it has been for the past years if this scenario is maintained.

Recommendation 2*: KAZARDI as a key institution in the seed potato research and development domain should initiate new partnerships with other farmer groups with sole purpose of promoting seed potato production and utilisation in potato farming in Uganda.*

Conclusion 3: At present as well as in the near future, Uganda has neither the capacity nor the competitive advantage to produce and sustainably supply a potential export market of seed and ware potatoes. In the economic sense, Uganda's potato can be graded as a non-tradable. Besides, an economically viable export market for seed and ware potatoes does not exist within East Africa at present.

Recommendation 3*: Institutions working in research and development domain of the potato sub-sector would benefit most if they focus their attention and resources on increasing productivity and developing potato products that satisfy the internal market. Additionally, focusing on potato value addition through processing products such as potato flour and starch is economically meaningful for export than focusing on export of bulky and perishable potato produce*

Conclusion 4: Potato processing especially crisps in Uganda has rapidly grown over the recent past but the processors hardly recognize and/or relate to each –leading to unhealthy competitive practices such as underweight packaging and mislabeling besides poor quality.

***Recommendation 4**: Individuals and companies in the business of potato processing need to initiate and establish an association to promote and regulate the activities of their business for the benefit of the producers and consumers of potato products as well as the economy.*

Conclusion 5: Quality standards for production and trade in various potato products in the East African Community have been ratified. These standards are not yet enforced for locally produced and traded potato products in Uganda. Lack of enforcement of quality standards undermines the capacity of local companies to produce for export.

***Recommendation5**: Government should start to enforce some minimum standards to ensure food safety. As a starting point, potato processors in Uganda should be encouraged by the country's standards enforcement agency (UNBS) to form an association which will work with UNBS to improve the hygiene and standards of processed potato products on the market.*

1.0 INTRODUCTION

1.1 Background

The potato is an important food security crop as well as cash crop in East Africa, most especially in the highland areas. Statistics indicate that potato productivity is declining (Figure 15 in the Appendix), yet the consumption growth rate of the crop -particularly in urban areas has surpassed production growth. This challenge calls for innovative ways to increase productivity. But, even with the apparently high demand for potatoes in urban areas, some farmers face difficulties in marketing their crop. To overcome some of the challenges in the potato sub-sector, a consortium of public and private sector institutions, spearheaded by the International Potato Centre (CIP) are implementing a project entitled "wealth creation through integrated development of the potato production and marketing in Kenya, Uganda and Ethiopia". The project is supported by the Common Fund for Commodities (CFC) and is implemented in 4 components, which are: (A) affordable seed potatoes, (B) improving smallholder productivity, (C) improvement of potato value-chain interaction, and (D) National potato sub-sector development and sharing of project lessons.

Component D of the project specifically seeks to: (i) develop the potato sub-sector development plan, and (ii) conduct feasibility studies for seed and ware potato export from Kenya, Uganda and Ethiopia. This report contributes to the implementation of this component by providing information on the current status of the Ugandan potato sub-sector in terms of stakeholders, production, utilisation and trade. This report also provides analysis and recommendations regarding the feasibility of exporting seed and ware potatoes from Uganda to potential export destinations.

1.2 Study objectives

The overall goal of this study was to examine the feasibility of export of Uganda's potato produce in addition to the review of the status of sub-subsector along the production to consumption value-chain. This report is expected to support the efforts of writing the sub-sector development strategy and investment plan. To this end, the following three specific objectives were the focus of the study:

a) Describe the current status of, opportunities and constraints in the potato sub-sector as well as highlight the future growth prospects of the sub-sector;

b) Examine the local and export market of Uganda's potato produce and products, with major focus on potato from south-western and eastern highlands agro-ecological zones; and

c) Examine the opportunities and constraints for increased exports of Uganda's seed and ware potato produce.

1.3 Data and Methods

1.3.1 Data

Primary data: Qualitative and quantitative primary data was collected on production, trade, and processing in highlands of south-western Uganda (Kabale and Kisoro district) and eastern Uganda (Mbale and Kapchwora district) and Kampala. The four districts in the highland agro-ecological zones were selected based on their level of potato production and trade (______, 2004) while Kampala was included in the study due to fact that it is the major trading, processing and consumption centre in potatoes in Uganda.

This study utilised the Rapid Rural Appraisal (RRA)[1] method and the market chain approach as complimentary techniques of generating qualitative and quantitative data from key informants. RRA is a more efficient and cost-effective way of learning about agricultural systems, particularly, on production, marketing and organization of the actors in the sub-sector than is possible by large-scale social surveys (Beebe, 1985). Using a checklist of questions, data was collected from farmers, traders, brokers and processors. For completeness and accuracy, however, data from farmers was triangulated with additional qualitative primary information and secondary data from officials from Ministry of Agriculture Animal Industry and Fisheries (MAAIF) headquarters, National Agricultural Advisory Services (NAADS), National Agricultural Research Organisation (NARO), Ministry of Tourism, Trade and Industry (MTTI), Uganda Bureau of Statistics (UBoS), Uganda Industrial Research Institute (UIRI), Uganda National Bureau of Standards (UNBS) and Uganda Revenue Authority. The list of some of the key informants who provided primary data is given in Table 22 in the Appendix. Table 1 gives a summary of the respondents by category.

Table 1. Summary of respondents

District	Farmers	Traders	Brokers	Processors	Gov't officials	Total
Kisoro	5	3	3		5	16
Kabale	5	2	2	1	5	15
Mbale	5	5		2	3	15
Kapchorwa	5	2			3	10
Kampala		6	3	5	10	24
Total	20	18	7	8	26	80

Source: Field survey, February 2011

The procedure of identifying and interviewing the respondents was top-down in sense that we started by first interviewing district officials, then Sub-county officials and finally farmers, traders and processors. District officials included mainly the district Production Officers and

[1] For further details about RRA, visit http://www.fao.org/docrep/W3241E/w3241e09.htm

NAADS Coordinators. Sub-county officials interviewed were the Sub-county Chief and/or Sub-county NAADS Coordinators.

In Kisoro, Kabale, Mbale and Kapchorwa districts, potato production is one of the priority enterprises under NAADS Programme. As such, identification of locations and the farmers to interview was guided mainly by NAADS coordinators based on the ranking of the area or farmer in terms of potato production. Based on this criterion, data was collected from areas and farmers considered as high, medium and low output producers of potatoes. Table 23 in the Appendix illustrates the casual ranking of sub-counties in descending order (high to low in terms of production), by district officials.

A checklist of questions developed by CIP-Nairobi in collaboration with CIP Uganda country office was used in the collection of the data from key informants. In general, the responses solicited from informants were for example -in the case of farmers; on production inputs, outputs and constraints and opportunities; market participation channels and constraints; varieties cultivated; etc.

Secondary data: For secondary data, various data and sources were accessed and used. These included:

(i) Uganda National Household Survey of 2005/6 (UNHS 2005/6) and Uganda Census of Agriculture of 2008/9 (UCA 2008/9), all collected by Uganda Bureau of Statistics (UBoS). UBoS is the only institution mandated to carryout and publish national statistics – be it census or national surveys. Data in the Statistical Abstracts also published by UBoS and is the data that is mostly published by FAO was consulted but its reliability was questionable (Table 24).

(ii) Market price information from FOODNET and Farmgain Africa databases. Farmgain Africa is a private sector organization that among other services monitors and reports on market prices trends of major crops in Uganda. Farmgain Africa is a successor of FOODNET that operated under the International Institute of Agriculture (IITA) in Uganda that among other activities monitored and reported on market prices trends of food crops.

(iii) Trade statistics from World Integrated Trade Solutions (WITS). WITS is a database of trade, tariffs and non-tariffs statistics managed by the World Bank and various International Organizations including United Nations Conference on Trade and Development (UNCTAD), International Trade Center (ITC), United Nations Statistical Division (UNSD) and World Trade Organization (WTO). For details, visit http://wits.worldbank.org/wits/

1.3.2 Analysis

This study followed a value-chain approach in the analysis of key issues in potato production, trade (internal and external), processing and utilisation. Descriptive analysis methods including frequency-tabulations, graphs, cross-tabulations, correlation analysis and gross-margin analysis were utilised. These methods were used mainly to answer objectives two and three of the study. Besides quantitative methods, qualitative narratives supported with photographic depictions of the current status and constraints of the stakeholders were used partly to answer objective one of the study. Objective three was answered through a value-chain analysis of the export chain.

Unlike other tuber crops such as cassava, potatoes are reproduced from other tubers –which are usually categorized as seed. In analysis of potato production therefore, a distinction is sometimes made between seed and ware/table potatoes. In Uganda, where farmers typically use part of their output as seed, the distinction between seed and ware potato production is vague. National statistics do not make the distinction between seed and ware potato output, but the WITS statistics do. Therefore, analysis on production did not make any distinction whether seed or ware potato. But the export and import trade analysis was disaggregated into seed are ware potatoes.

National potato production statistics reported in the statistical abstracts and also by United Nations Food and Agriculture Organization Statistical Database (FAOSTAT) are significantly different from those reported in the Uganda National Household Survey (UNHS) and Uganda Census of Agriculture (UCA) reports. Table 24 in Appendix depicts the magnitude of difference – which for example shows FAO/Statistical Abstract indicating that Uganda produced 670,000 tonnes (t) of potatoes compared to 154,388 reported in the UNHS/UCA reports. Though we may never be certain of the actual level of output, it is most likely that the statistical abstract/FAO data are highly exaggerated while UNHS and census data which sample the entire population is more accurate. For that matter, analysis of potato production in this report utilizes UNHS and UCA data as well as field survey data and not statistical abstract/FAOSTAT data.

1.4 Report outline

Section 1 of this report was the introduction, which has given the background, objectives and methodology of the study. The rest of the report is organized as follows. Section 2 outlines and explains key stakeholders in the potato sub-sector and the role they play as well as the challenges they face in potato value-chain. Section 3 gives a detailed analysis on potato production and productivity including the economics of production as well as the constraints that farmers face in potato farming. Section 4 gives an account of potato utilisation by product category at farm and non-farm level while section 5 gives a detailed analysis of the Uganda's internal and external trade position in potato produce and products. The feasibility of export of seed and ware potatoes to Kenya and Rwanda by individuals or firms from Uganda is analysed Section 6. Besides, Section 6 also examines potato products exports by South Africa and the possible lessons for Uganda The last section (Section 7) of the report gives the conclusion and recommendations after a summary of strengths, weaknesses, opportunities and threats (SWOT) observed in the sub-sector.

2.0 STAKEHOLDERS AND THEIR ROLE IN THE POTATO SUB-SECTOR

Key stakeholders in Uganda's potato sub-sector include producers, input traders, output traders, processors, ministries, departments and parastatal agencies (MDAs), international organizations, and consumers. The role played by each stakeholder in the potato sub-sector is briefly highlighted below.

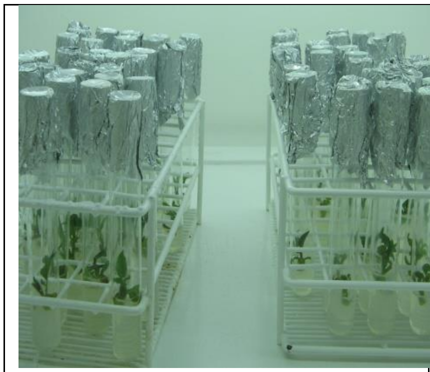
2.1 Ministries, departments and parastatal agencies (MDAs)

The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is the institution mandated to support, promote and guide the production of crops in Uganda. MAAIF is structured in a way that it has the headquarter and 7 semi-autonomous or parastatal agencies dealing in specific issues related to agriculture development such as research by the National Agricultural Research Organization (NARO), and extension services by the National Agricultural Advisory Services (NAADS). MAAIF headquarters is primarily responsible for the formulation and review of national policies, plans, legislation, and standards relating to the agricultural sector. The headquarters is structured into directorates, then departments and then units that are responsible for implementation of MAAIF headquarters' programmes and projects. Formulation, ownership and implementation of any crop sub-sector plan for example is the mandate of Directorate of Crop Resources (DCR). As such, the work of formulation of the potato sub-sector development strategy and investment plan falls under the authority of DCR.

National Agricultural Research Organization (NARO): MAAIF agency that is concerned with research and development work of crops is NARO. The day-to-day operations of NARO are through the National Agricultural Research Institutes (NARIs) and Zonal Agricultural Research and Development Institutes (ZARDIs). ZARDIs manage and carry out agricultural research for a specific agro-ecological zone. Figure 17 in the Appendix shows the 10 agro-ecological zones of Uganda. Potato research and development work is under the docket of Kachwekano ZARDI (KAZARDI) and to a limited extent Buginyanya ZARDI, which are found in the highland ranges agro-ecological zone.

KAZARDI was established in year 2000 with a research mandate on highland agricultural systems including potato. KAZARDI operates at three research centres, namely (i) Kachwekano research station, (ii) Kalengyere research station, and (iii) Bugongi research station. KARDI has established capacity to produce potato tissue culture, pre-basic and basic seed, which hitherto were obtained from Kenya Agricultural Research Institute or International Potato Center (CIP) in Kenya. Figure 1 shows pictures of some of the activities of KARDI regarding seed potato production. KAZARDI has a modern tissue culture laboratory and Aeroponics green-house at Kachwekano research station, capable of producing nucleus material and pre-basic seed all-year around. Pre-basic seed from Kachwekano research station is transferred to Kalengyere research station for production of basic seed.

Figure 1. Seed potato production at Kachwekano laboratory



A: Potato tissue culture for rapid seed multiplication

B: Pre-basic seed (mini tubers) production in Aeroponics green-house

C: Mini-tubers in Aeroponics

D: Potato germplasm under rapid multiplication

E: Pre-basic seed production under conventional method

F: Harvested mini-tubers from Aeroponics

Source: Field survey, February 2011.

While KARDI has established the capacity and facilities for seed potato production, the full potential of these resources appears not yet fully exploited as the Tissue Culture Laboratory and Aeroponics green house are recent additions to KAZARDI research infrastructure. At present, KARDI produces about 20 tonnes (t) per season (or 40 t per annum) of basic seed – which is equivalent to cultivated area of 2 acres (less than 1 hectare (ha)) at a yield rate of 10 t/acre. Yet KARDI has over 5 acres of potential land for potato seed production.

"Low demand for basic seed is one of the constraints for increased production," noted Dr. Imelda Kashaija, the Director of KARDI. The main buyers of KAZARDI basic seed are just about 35 farmers grouped under the association named –Uganda National Seed Potato Producers association (UNSPPA). "Farmers supported by NAADS would be potential buyers, but this market is not reliable," again noted the Director of KAZARDI. As such, KAZARDI has tailored its seed production capacity to only meet the demand by farmers under UNSPPA, who use 20 -30 t of basic seed per season.

On the issue of low demand for basic seed, Mr. Stephen Tindimubona, the chairman of UNSPPA however observed that the association has capacity to recruit more members to demand more basic seed provided the capacity of KAZARDI to produce more basic seed is increased. Given the conflicting views regarding the supply and demand of basic seed, it is important that both KAZARDI and UNSPPA work closely together to harmonize their potential supply and demand capacity for basic seed.

The dependence of KAZARDI on only a few farmers under UNSPPA to multiply and distribute potato seed in the country is not very good for rapid growth of the sector. It is important that other potential areas for seed production such as Mbale/Kapchorwa highlands should be earnestly explored to make potato seed market competitive.

Other MDAs. Besides MAAIF and its affiliate agencies that mainly focus on production, some MDAs that support the development of the potato sub-sector include Uganda Industrial Research Institute (UIRI) and Uganda National Bureau of Standards (UNBS).

UIRI is a parastatal institution under Ministry of Tourism Trade and Industry (MTTI) that is charged with promotion of industrial development in the country. UIRI is the brainchild behind the recently established potato processing plant in Kabale town. When fully operational, the plant is expected to produce potato crisps as well as frozen chips. At present however, the plant produces only crisps.

Tens of small-scale enterprises have ventured into processing, but they face a number of challenges including access to technology and quality assurance. It is not clear how UIRI is supporting these enterprises to improve their production processes other than UIRI engaging directly in potato processing –by establishing and operating a new processing facility that is already facing stiff competition in the market.

UNBS is mandated with development and enforcement of products standards in the country – from production, trade up to consumption levels. Recently, UNBS developed 4 product standards for potato processing in Uganda. These are:

i. Frozen Potatoes US 708/2009
ii. The Fried Potato Chips Standard US 702/2009
iii. Fresh. Potato US 705/2009
iv. The Potato Crisps Standard US 703/2009.

While UNBS has set standards for potato processing, all locally processed potato products currently on the market are not certified yet all imported potato products from Kenya and other countries are certified by the standards regulatory bodies in those countries. This suggests that potato products produced by the numerous small and medium scale processors in Uganda may not be conforming to UNBS standards. Also UNBS appears not to be stringent on standards enforcement as there is a significant variation in colour, size, taste, and packaging of locally produced potato crisps on the market.

2.2 International agencies

Some of the international agencies supporting the development of the potato sub-sector include the International potato centre (CIP) and the United States Agency for International Development (USAID). These organizations mainly support research work in seed production (Figure 2).

Figure 2. Signpost of international organizations supporting KAZARDI

Source: Field survey, February 2011.

2.3 Potato producers

Historically, potato farmers in Uganda were predominantly from the highlands of south-western Uganda (Kabale and Kisoro), eastern Uganda (Mbale and Kapchorwa) and Rwenzori, where temperatures are low (8 – 27°C), annual rainfall is usually more than 1,400 mm and the altitude ranges from 1,300-3,960 meters above sea level. But of recent, potato producers are also found in the savanna grasslands of western and central Uganda -because of the introduction of the versatile Victoria potato variety that is adaptable for production even in warm areas with at least an annual rainfall of 1,200 mm. Section 3 give more details on production by agro-ecological zones.

2.3.1 Seed potato producers

All potato producers use some form of seed, be it local or improved seed. In Uganda most potato producers use local seed saved from the previous season's production. A few farmers, mainly organized under UNSPPA are known to engage in multiplication and distribution of *clean*[2] seed. As mentioned before, UNSPPA farmers engaged in seed multiplication are about 35 and largely

[2] The level of cleanness (free of diseases and pests) of seed is not guaranteed as farmers do not follow specific protocols in seed production.

come from the highlands of Kabale district with a few members from Kisoro district. Seed potato production is discouraged in lowlands such as central and western Uganda savanna grasslands, even though such areas may favour ware potato cultivation.

UNSPPA has been in existence for over a decade, but membership has hardly increased. Instead, the association has shrunk in geographical representation away from Mbale, Kapchorwa and Nebbi districts, concentrating only in Kabale/Kisoro district(s).

At present UNSPPA uses 20-30 t of basic seed from KAZARDI, to produce 150 – 220 t of clean seed per season. The variety mostly multiplied is Victoria, which takes up 70 percent of the seed business. Other varieties multiplied on a small scale are Rutuku, NAKPOT 1&5, and KACHPOT 1 & 2.

Due to lack of the regulatory framework for seed potato certification, UNSPPA does not produce certified seed. Hence the potato seed system applies the "flush out" mechanism –whereby when basic seed gets out of KAZARDI to UNSPPA for seed multiplication, its quality is not guaranteed and hence KAZARDI does not encourage UNSPPA to the recycle such seed for reproduction. Since seed multiplied by farmers under UNSPPA does not go through the stringent certified seed production protocol, the country does not produce certified (quality declared) potato seed. This hampers any effort for formal export of seed potatoes from Uganda.

Even with the limited output of seed multiplied by UNSPPA, members of the association sometimes get challenges of selling their output due to the fact that most farmers use seed saved from the previous season's output. This is another challenge that limits increasing potato seed production by members of UNSPPA.

2.3.2 Ware potato producers

All potatoes produced at household level in Uganda can be regarded as ware potatoes –since the country does not have a specialized seed production system. Ware potatoes can be used for food or seed. It is ware potatoes used for food that are generally called ware or table potatoes.

The majority of farmers in the traditional potato cultivation areas (highlands) of Uganda grow the crop for subsistence and income. Average plots under potato production per household usually range from 0.25 – 0.5 acres due to land fragmentation arising partly from the high population density. Figure 3 is a picture of the typical plots under potato (in green colour) cultivation in Kisoro and Kabale districts. Plots in off-white/cream colour are for barley, a crop that of recent has overtaken/replaced sorghum cultivation mainly due to its advantage of early maturity. Barley is now the major crop planted for management of potato diseases and pests through for crop rotation.

Figure 3. Potato cultivation in Kisoro district.

Source: Field survey, February 2011.

Of recent, potato cultivation has been adopted by enterprising farmers in the lowland savanna grasslands of western and central Uganda, especially after the introduction of Victoria variety. Farmers in these areas mainly cultivate potatoes for income rather than subsistence. The average size of plots under potato production in these areas ranges from 0.5 -2 acres due to the relatively flat nature of land. One limitation of ware potatoes producers in lowland western and central Uganda though is that they mostly depend on locally saved for reproduction. Potato seed recycled for a long time is obviously susceptible to disease and loses vigour for higher yield.

Some enterprising farmers in Kapchorwa are growing some off-season potatoes under irrigation using piped water supplied by government from the gravity flow scheme. Mr. Chepsikor Peter, a farmer in Kapchesombe sub-county in particular was cultivating 2 - 3 acres of Victoria variety (Figure 4). The famer said the source of seed was from Buginyanya ZARDI and that he had purposely cultivated and timed the crop for sale as seed for the first season of 2011 that begins in mid-March or early April.

Figure 4. Potato cultivation under irrigation in Kapchorwa district.

Source: Field survey, February 2011.

2.4 Agro-input traders

Potato production particularly in tropical regions is highly affected by bacterial wilt and late blight diseases. As such, potato is one of the few crops with the highest intensity of chemical use (chemical fertilisers and fungicides) under smallholder production in Uganda. To this end, agricultural inputs traders are important stakeholders in promoting potato production, especially for commercial cultivation. Lack of accessible and affordable inputs affects the use of these inputs as well as output. For example, in Kisoro district, most farmers in Nyarusiza sub-county have resorted to using a fertiliser variety (NPK 17-17-17) smuggled from Rwanda (but originally imported from Tanzania) for which they consider as being less productive but cheaper (Ush 60,000 -70,000) compared to fertilisers that are accessible mainly in Kisoro town and are more expensive (e.g. 50 kg of NPK 17-17-17 costs Ush 100,000).

Thus as far as potato production and productivity is concerned, agro-input dealers play an important role but are less integrated in the value chain. On one hand, farmers often accuse traders of adulterating the chemicals and hiking prices while on the other the traders accuse farmers of incompetence in handling and proper application of the chemicals. It is important that institutions promoting potato production such as KAZARDI or NAADS bring the farmers and agro-inputs traders to interface -with purpose of increasing access to and effectiveness of chemical use in potato production.

2.5 Credit institutions

Potato production especially on a commercial basis is a fairly input-intensive and hence requires relatively high working capital. Although a number of financial institutions including microfinance institutions are established in the districts under study, these institutions rarely offer credit for agriculture especially to smallholder farmers. Farmer respondents in this study reported that they have never accessed agricultural credit from financial institutions although they are interested in obtaining agricultural credit. Some of the respondents however said they have ever obtained credit from friends and/or relatives for farming –though such credit is not readily available at the opportune time and in the desirable volume, they lamented.

Under the NAADS programme, there is the Integrated Support to Farmers' Groups (ISFG) programme that supports eligible farmers within NAADS Farmer Groups with technology inputs for their priority enterprises (_____, 2009). This is a form of input credit at community level, which if well managed with wide access could significantly reduce farmer constraints to improved technologies. NAADS programme coverage however is limited to few farmers in rural communities of Uganda and the ISFG programme in particular has not been very successful.

2.6 Potato traders

Traders play an important link between producers and consumers of produce. Potato traders include travelling traders, sedentary wholesale and retail traders and of recent –especially in metropolitan Kampala there are travelling (mobile) retailers who use push-carts to sell assorted foodstuffs including potatoes door-to-door.

In Mbale, most farmers of potatoes double as travelling traders of their crop (ware potatoes)- since the distance from the production area and Mbale town is less than 20 km. In the districts of Kapchorwa, Kabale and Kisoro where the main market is distant from the production area, ware potato traders (travelling traders) are usually few and from the urban centres of the particular district. In Kisoro district for example, travelling traders who take potatoes mainly to Kampala are very few. At times, travelling traders from Kampala and/or districts neighbouring the production area travel and buy potatoes from the areas of production.

Sedentary wholesale and retail traders mainly ply their business in food markets in urban areas. These traders usually operate in fixed locations and get supplies from travelling traders. Sedentary wholesale traders mainly sell to retailers who in turn sell to consumers. In Kampala, the major wholesale markets for potatoes are Owino market, Kalerwe market, and Nakawa market.

2.6 Brokers

Because of good information and networks of travelling traders from within the area of production, they play other roles including brokerage on behalf of traders outside the area of production. To fast-track the process of procurement of produce, travelling traders outside the production area (e.g. Kampala) usually provide cash advance to traders within the area of production to purchase and assemble the crop on a commission basis. In the wholesale markets of Kampala, there are also brokers who target travelling traders who are not experienced in the business. But this form of brokerage is on the decline as inexperienced travelling traders are usually accompanied with experienced colleagues.

2.7 Potato processors

Potato processing in Uganda is still at a basic level, focusing mainly on potato crisps and fried potato chips (*French fries)*. Though basic, surprisingly there are a sizeable number of small-scale processors of both crisps and fried potato chips. A rapid survey of crisps makers revealed that there over 20 small-scale home-based crisps makers -mostly located in Kampala. Only two crisps processors (Jubilee Agrofoods located in Kampala and another recently established plant in Kabale town) are medium-sized and use modern processing equipment. Figure 5 shows some of machines for making crisps in the Kabale crisps factory.

Figure 5. Potato crisps processing in factory in Kabale district

A: Potato crisps Slicer and Boiler

B: Packaging machine

C: Fermenting sliced potato (production loss) due to power cuts.

D: Sample of 150 gm packed crisps

Source: Field survey, February 2011.

In Kampala, perhaps the oldest and leading (in terms of market share) among small-scale home-based crisps processors is TomChris –a sole proprietor snacks company started in 1992 by Mr. Bukenya Thomas. The company processes about 8 bags of potatoes per day and employs about 25 people. Due to long experience in snacks processing, TomChris Company makes quality crisps in about three varieties for general and niche markets. For example, the company is the main supplier of crisps and other snacks to Entebbe Airport Cafeteria and Inflight Services Company besides supplying most supermarkets in Kampala metropolitan.

The upsurge of crisps processors is due to several factors including (i) simple production process and low working capital requirements, (ii) ready market -substitution of imported crisps mainly from Kenya, (iii) increased demand due to rapid urbanization, and (iv) weak or non-enforcement of laws on quality control.

While crisps processing is gaining momentum in Uganda with entry into business of medium sized enterprises, these companies face some challenges such as unstable power supply that leads to production losses as caption C, Figure 5 depicts. The other challenge faced by medium-sized enterprises is the lack of product quality enforcement by UNBS leading to stiff competition with lower quality products processed by back-yard small-scale processors on one hand and high quality imported products on the other.

In the case of fried potato chips makers, they are commonplace in urban areas in form of organized takeaway restaurants or open-air (road-side) eateries. Reasons for the upsurge in fried potato chips making in urban areas is also related to the (i) simple production process and low working capital requirements, (ii) ready market due to rapid urbanization, and (iv) weak enforcement of laws on food hygiene

No firms are processing other potato products such as frozen chips, and dehydrated potatoes products (flour, starch or canned potato). Based on 2004 market survey, Tesfaye et al. (2010) also found no firm processing frozen chips in Uganda at the time.

2.8 Potato consumers

Annual potato production in Uganda stands at about 155,000 t. About 50 percent of the output is consumed by the producers themselves and the other 50 percent is sold out. Of the 50 percent output sold out by farmers, approximately 5 percent is sold to fellow farmers for seed and 95 percent (75,000 t) is sold to traders who in turn sell to urban consumers and export market. Of the quantity sold to traders, 40 percent is consumed by urban households; 40 percent is used for making fried potato chips; 15 percent for making potato crisps; and 5 percent is exported.

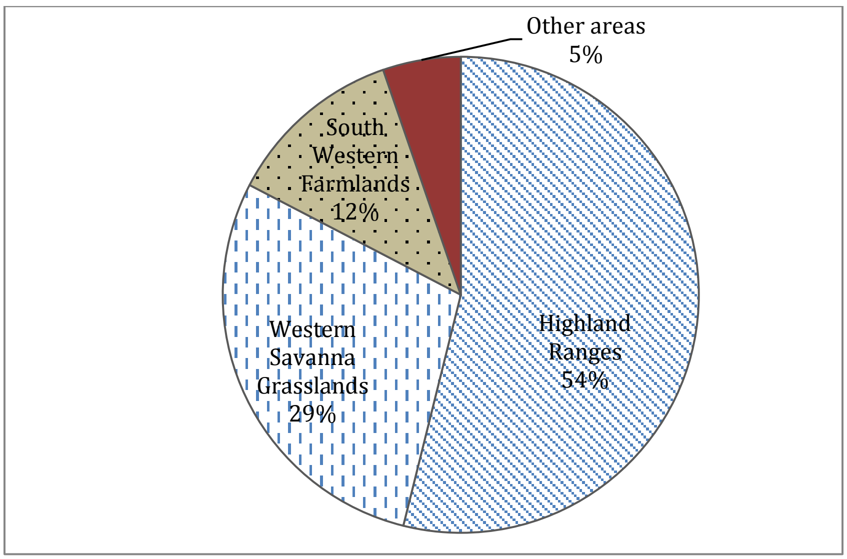
In households -either rural or urban, potatoes are consumed by all categories of household members (i.e. young or old; female or male). However, when it comes to consumption of potato snacks (chips and crisps) young people dominate. Some studies suggest that more females than men crave for potato snacks. But no study seems to have been undertaken in Uganda on potato snacks consumption habits by gender.

3.0 POTATO PRODUCTION

3.1 Agro-ecological production zones

Although potatoes can grow in various climates and soil types, in Uganda, the crop is mostly grown in the highland ranges (54%), followed by western savanna grasslands (29%) and south western farmlands (12%) (Figure 6). The map in Figure 16 shows the locations of these agro-ecological zones while the Table 20 gives the districts (as of 2004) that constitute these zones. Table 20 as well outlines the climatic and soil characteristics in these agro-ecological zones. The highland ranges, which include the regions of Kabale, Kisoro, northern Kanungu, northern Mbale, and southern Kapchowra -for example, are characterized with a high altitude, cool and humid climate, young volcanic soils, and highly fragmented land holdings.

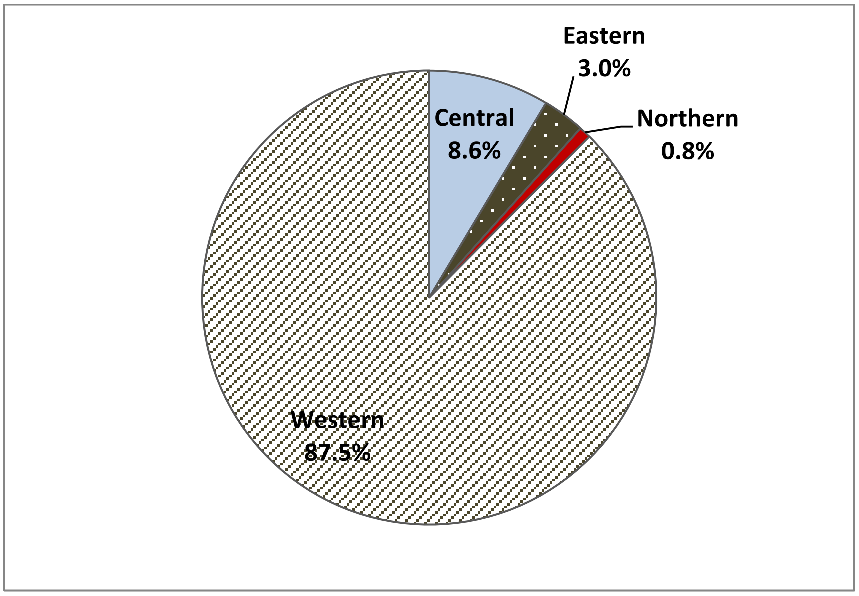
Figure 6. Potato agro-ecological production



Data source: UNHS 2005/6 (UBoS) and ________, 2004.

Western region produces almost 90 percent of all potatoes in Uganda, followed by central region (8%), eastern region (3%) and northern region produces the least amount of potatoes in Uganda (Figure 7).

Figure 7. Potato production by region

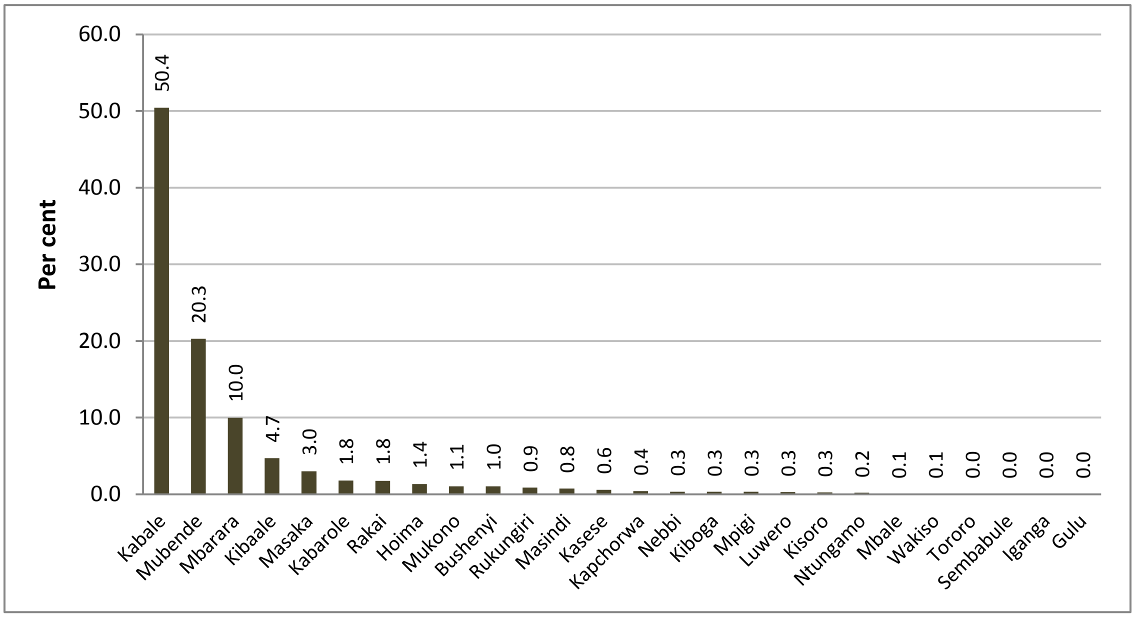


Data source: UCA 2010

Disaggregated by district, 2005/6 UHNS dataset indicates that Kabale accounts for about 50 percent (79,300 t) of Uganda's total potato production (Figure 8). Mubende district is the second most important producer with about 20 percent (31,900 t) of the potato crop. In the year 2000, however, Kabale district produced 57 percent of the national potato harvest while Mubende district was not even among the top 8 potato producing districts in Uganda (Ferris et al. 2002).

The other three prominent potato producing districts in Uganda -according to UNHS 2005/6 data are Mbarara, Kibaale and Masaka; which produced about 10.0, 4.7 and 3.0 percent of the crop respectively. Surprisingly, UNHS 2005/6 data indicates that districts such as Kisoro, Rukungiri and Mbale were not even among the top ten potato production areas of in Uganda in 2005/6, yet by 2000, these districts were among the top five producers. Overall, these results suggest that potato production which was until recently mainly concentrated in the highland ranges of Kigezi and Elgon, is now being adopted increasingly and rapidly in the western savanna grasslands. This finding is important to take note of, by entities such as KAZARDI working to increase potato production and productivity in Uganda.

Figure 8. Potato production (per cent) by district

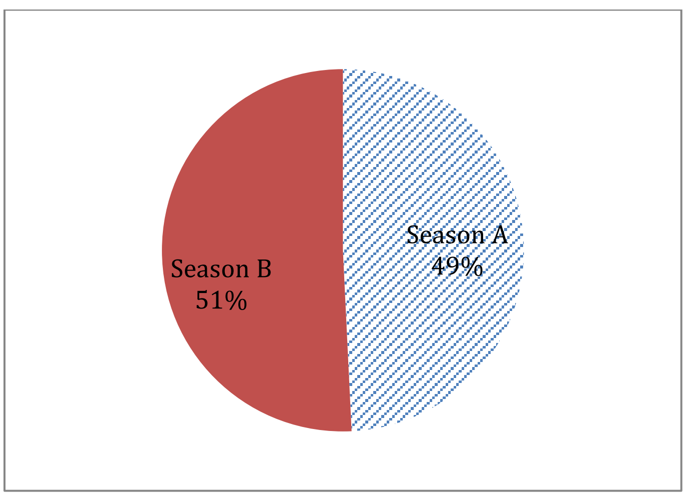


Data source: UNHS 2005/6

3.2 Seasonal production

Owing to the bimodal pattern of rainfall in potato production areas in Uganda, the country produces roughly an equal amount of potatoes in season A (March-July) as in season B (September –January), Figure 9.

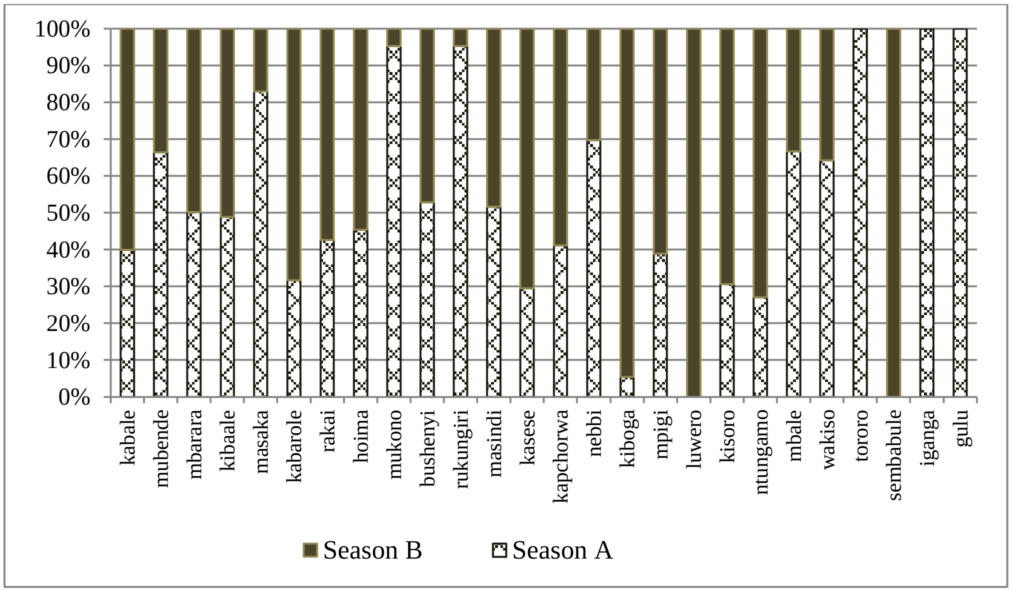
Figure 9. Potato production by season



Data source: UNHS 2005/6

At district level, the proportion of potato production by season is shown in Figure 10. The figure indicates that districts such as Kisoro, Kabale, Kabarole, Ntugamo, etc., which are found in southern and western Uganda produce the bulk of the crop in season B (September – January) during the long rainny season. Districts in central such as Luwero, Mpigi and Kiboga that also receive most of the rain in September -January are also observed to produce most potatoes in season B. In northern and eastern (except Kapchowra district) where potatoes are cultivated, most are produced in season A during the long rains of March –July.

Figure 10. District level potato production by season



Data source: UBoS 2006, UNHS 2005/6

Though UNHS data lumps potato production in two seasons, field data from the highlands of Kabale, Kisoro, Mbale and Kapchorwa indicate that potato production in these areas is actually continuous throughout the year. In some cases, farmers especially in Kabale and Kisoro cultivate potatoes up to three times a year (Ferris et al., 2002). Commercially oriented farmers cultivate the crop throughout the year. For example, during the field survey (February 2011) for this report, in Nyarushiza sub-county in Kisoro district, we found that Mr. Mbonye Arsene -a prominent farmer and trader planted potatoes almost at a weekly interval. At the time of interview, he had planted over 3 acre of potatoes in a week and yet had up to 10 plots (about 7 acres) of cultivated potatoes with different periods of maturity. In Kapchorwa district, some farmers in Kapchesombe sub-county are taking advantage of the free gravity water to cultivate potatoes under irrigation.

3.3 Potato output and yield

National data for potato production and productivity indicates that the 2008/9 potato output in Uganda averaged 154,388 t, coming from an estimated cultivated area of 32,758 ha -which gives a yield of 4.7 t/ha (Tables 2, 3 & 4). National results indicate a slight reduction in potato output growth in 2008/9 compared to 2005/6 –although areas such as eastern and northern Uganda showed marked increase in output.

Table 2. Potato output (t)

Region	Year 2005/6	2008/9	Growth rate (%)
Central	42,700	13,290	-68.9
Eastern	771	4,624	499.9
Northern	618	1,311	112.0
Western	113,000	135,163	19.6
Uganda	157,000	154,388	-1.7

Source data: UNHS 2005/06 and UCA 2008/9

Whereas national potato production slightly decreased in 2008/9, Table 3 shows that yield has increased from an average of 3.7 t/ha to 4.7 t/ha over the period 2005/6 and 2008/9. Results suggest that near double increase in yields in northern region and 40 percent increase in western region greatly contributed to improvement in national potato yields over the period. Otherwise central Uganda registered a reduction in yields by over 30 percent.

Table 3. Potato yield (t/ha)

Region	Year 2005/6	2008/9	Growth rate (%)
Central	4.1	2.8	-31.7
Eastern	2.7	3.6	33.7
Northern	1.2	2.2	87.0
Western	3.7	5.2	41.1
Uganda	3.7	4.7	26.4

Source data: UNHS 2005/06 and UCA 2008/9

Increase in the area cultivated in eastern and northern Uganda appears to be the major factor that contributed to increased yield (Table 4). In western Uganda, increased use of improved inputs such as improved seed, fertiliser and fungicides is most likely factor in contributing to increased yields. Table 5 shows that farmers in south-western highlands (Kabale and Kisoro) used about twice more seed, fertiliser and fungicide than their counterparts in eastern highlands (Mbale and Kapchorwa); leading to yield in south-western highlands that is twice more than that in eastern highlands.

Table 4. Potato area cultivated (ha)

	2005/6	2008/9	Growth rate(%)
Central	10527	4799	-54.4
Eastern	283	1270	348.6
Northern	524	594	13.4
Western	30775	26095	-15.2
Uganda	42109	32758	-22.2

Source data: UNHS 2005/06 and UCA 2008/9.

Table 5. Input use rate among sample of farmers

Input use rate	Kabale	Kisoro	Kisoro	Mbale	Mbale	Kapchorwa	Kapchorwa
Approximate area (acres)	0.5	1.25	0.25	0.5	0.5	0.5	0.25
Seed (kg)	800	1600	25	300	400	500	100
Fertiliser (kg)	150	400	0	50	50	40	10
Fungicide (kg)	5	12	0	3	4	1	0
Seed rate (kg/acre)	1600	1280	100	600	800	1000	400
Fertiliser application rate (kg/acre)	300	320	0	100	100	80	40
Fungicide application rate (kg/acre)	10	9.6	0	6	8	2	0
Yield (t/ha)	29.7	27.7	3	11.9	12.4	9.9	6.90

Source: Authors calculations based on field survey data

A simple correlation matrix (Table 6) confirms that use of improved inputs –particularly fungicides and fertiliser is critical in increasing yield. Respondents during the field survey ranked bacterial wilt –which is controlled mainly by use of disease free seeds and crop rotation, as the number one constraint to increasing potato output and productivity.

Table 6. Simple pair-wise correlation matrix

	Yield	Seeding rate	Fertiliser appl. rate	Fungicide appl. rate
Yield	1.00			
Seeding rate	0.89	1.00		
fertiliser appl. rate	0.96	0.85	1.00	
Fungicide appl. rate	0.99	0.88	0.95	1.00

Source: Authors calculations based on field survey data

During the field survey, an inquiry was made about the seemingly rapid increase in the area cultivated in eastern Uganda on one hand and a reduction in area cultivated in western region on the other. In eastern Uganda –farmers particularly in Kapchorwa observed that many farmers have abandoned maize cultivation in favour of potatoes due to a number of factors including: (i) high yields from potato cultivation compared to maize, (ii) shorter maturity of potatoes and possibility of cultivating potatoes twice or more per year, (iii) ready market and better price of potatoes, and (iv) commercial farmers noted that due to physical characteristics (e.g. short and not coarse) of the potato crop it was much easier to produce potatoes under irrigation than maize.

In Kabale and Kisoro, though farmers were confident that potato output had increased in the recent years, they offered mixed views to the fact that area cultivated may have reduced. Farmers who supported the finding that area cultivated may have reduced noted that due to increased incidences of bacteria wilt disease especially among farmers cultivating Kinigi potato variety, some farmers have more often practiced crop rotation -planted gardens with other crops such as barley or beans than potatoes.

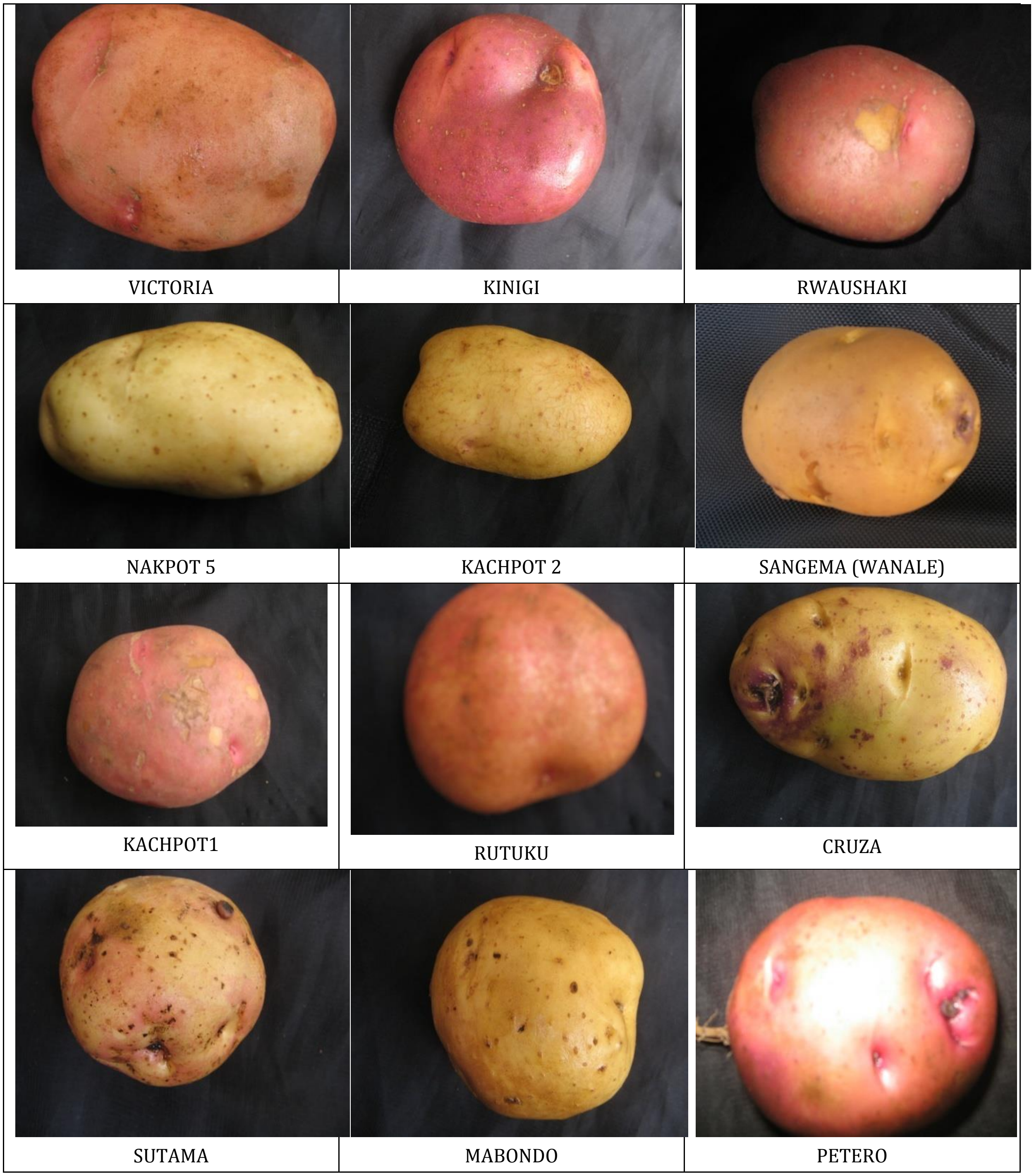
3.4 Potato varieties

There are over 15 potato varieties cultivated in Uganda. These include Victoria, Kinigi, Rwashaki, NAKPOT 1, NAKPOT 5, KACHPOT 1, KACHPOT 2, Cruza, Sangema, Rutuku, Rwangume, Sutama, Mabondo, Petero, Rwamakondo, Kimuli, Kisoro and Mbumba. Some of the varieties are shown in Figure 11. In the south-western highlands, Victoria variety was found to be most widely cultivated in Kabale while Kinigi was mostly cultivated in Kisoro. A recent study by Ssali and Kakuhenzire (2008) also reports similar results. Rwashaki and Rwangume are the two other major varieties cultivated in the south-western highlands. In eastern highlands, Sangema (popularly called Wanale) is the most widely cultivated variety, followed by Victoria.

Although farmers in Kabale, Kisoro, Mbale and Kapchorwa seem to cultivate different potatoes varieties, the underlying attributes of these varieties are almost similar. In terms of physical attributes, most of these varieties except Sangema have a purple skin colour; while in terms of cooking attributes, all these varieties are very good for making chips and even crisps. The cooking attributes in particular make these varieties more marketable.

A number of reasons have been advanced by farmers for cultivating particular varieties including access to and affordability of seed. Although Victoria and Kinigi almost have similar attributes, farmers in Kisoro for example said that they prefer the cultivation of Kinigi to Victoria because of the ease of access of seed within the area (among other farmers). One farmer in Kisoro had this to say "We have been informed that Victoria seeds give high yield and take a shorter time to sprout compared to Kinigi that take 4-5 months to sprout, but the seeds of Victoria are not available in this area. If I knew the farmers growing this variety I would buy some seed and try it out".

Figure 11. Potato varieties



Source: Field survey, February, 2011.

Farmers in eastern Uganda also expressed similar sentiments for cultivation of Sangema (Wanale) rather than Victoria. For example, a farmer in Wanale (Mbale district) said the following. "Victoria seed is rare and more expensive -a bag (100 kg) costs Ush 80,000 compared to *Maboni* (another local name for Sangema variety) that is readily available and costs Ush

40,000 -60,000 depending on the season." In Kapchorwa district, Victoria potato seed is also rare and more expensive than Sangema –as 100 kg bag of Victoria costs Ush 50,000 -60,000 compared to Sangema at Ush 30,000 -40,000.

Potato varieties such as Rutuku, NAKPOT 1 and NAKPOT 5 -which are very good varieties for chips and crisps have been in existence (released from research for adoption) for some time, but not much of these varieties are cultivated by farmers. KACHPOT 1 and KACHPOT 2 are recent varieties which have also not yet permeated well into the farming system. Sutama, Mabondo and Petero on the other hand are land races that are cultivated mainly for food security.

From the foregoing, it is clear that seed potato availability and affordability, irrespective of yield is cardinal in the farmer's ranking of the variety to cultivate. Yet in terms of research-based varietal development system, availability and affordability of the planting material is a vague attribute that is at most peripheral to issues such as yield, disease tolerance, starch content, skin and flesh colour, and size that are usually considered important and meaningful to research. This means that in promoting potato varieties, emphasis should initially focus on making quality seed available and affordable, if the varieties are to be rapidly and extensively adopted by farmers.

3.5 Gross margin analysis –ware potato production

The estimated difference between revenue and production costs –commonly referred to as gross profit or gross margin, in potato production in the highlands of south-western and eastern Uganda is presented in Tables 7 and 8. The analysis in Table 7 is based on data provided by two commercial farmers in Kisoro while Table 8 is based on a group interview of three farmers in Wanale sub-county. Overall, the results indicate that up to 51 percent of the revenue obtained by potato farmers in Mbale and Kapchorwa districts is gross profit. The proportion of gross profit in revenue for farmers in south-western highlands in general and Kisoro district in particular is at most 30 percent. The main reason for high difference in the ratio of gross profit to revenue obtained by farmers in eastern highlands compared to their counterparts in south-western highlands in potato cultivation is the lower intensity of improved inputs use (Table 5) and hence lower cost of production incurred by farmers in eastern compared to their counterparts in south-western highlands.

Table 7. Gross margin analysis of ware potato production in Kisoro and Mbale districts

	Kisoro districts			Mbale district		
Input	Quantity	cost/value	Proportion (%)	Quantity	cost/value	Proportion (%)
Land cultivated	1.25 acres	400,000	8.0	0.5 acres	Own land	
Seed	16 bags	2,880,000	57.5	4 bags	240,000	49.5
Fertiliser (NPK) bags	8 bags	800,000	16.0	1 bag	90,000	18.6
Fungicide (Mangozeb) kg	12 kg	120,000	2.4	4 kg	40000	8.2
Land preparation		240,000	4.8		30,000	6.2
Planting		100,000	2.0		15,000	3.1
weeding (weed & heaping)		220,000	4.4		30,000	6.2
fertiliser & pesticide application		50,000	1.0		family labour	
Theft guarding		20,000	0.4		-	
Harvesting		70,000	1.4		20,000	4.1
Transport garden to pack house	140 bags	70,000	1.4		family labour	
Packaging bags	140 bags	112,000	2.2	25 bags	20,000	4.1
Total costs		5,082,000	100		485,000	100
output and revenue	140 bags	7,000,000		25	1,000,000	
Gross profit		1,918,000	28.4		515,000	51.5
Gross profit per acre (approx.)		1,534,400			1,030,000	

Source: field survey, February 2011

Table 8. Gross margin analysis of average input and low input user farmers in Kapchorwa district

	Scenario A: Low input user farmer			Scenario B: Average input user farmer		
Input	Quantity	Cost/value	Proportion (%)	Quantity	Cost/value	Proportion (%)
Land cultivated	0.25 acre	own land		0.5 acres	own land	
Seed	1 bag	own seed		5 bags	200,000	51.3
Fertiliser	10 kg	18,000	81.8	40 kg	80,000	20.5
Fungicide		none		1 kg	50,000	12.8
Land clear (1st & 2nd plough)	family labour				20,000	5.1
Planting	family labour			family labour		
weeding (weed & heaping)	labour hire	4,000	18.2	Labour hire	40,000	10.3
Harvesting	family labour			family labour		
Transport garden -home	family labour			family labour		
Actual cost of inputs		22,000	100.0		390,000	100.0
Output & revenue	7 bags	280,000		20 bags	800,000	
Gross profit		258,000	92.1		410,000	51.3
Gross profit per acre (approx.)		1,000,000			800,000	

Source: field survey, February 2011

Although farmers in south-western highlands appear to obtain a lower proportion of revenue as gross profit compared to their counterparts in eastern highlands, in absolute terms however, they get higher gross profit due higher productivity arising from higher intensity of improved inputs use. Table 7 for example shows that farmers in Kisoro can obtain up to Ush 1.5 million per acre compared Ush 1 million per acre for farmers in Mbale or Kapchorwa.

Considering generally -from Tables 7 and 8, the gross profit obtained by farmers from potato cultivation is far much higher than that obtained from crops such as maize or beans. Based on 2005/6 UNHS data, Okoboi (2010) found that maize farmers in Uganda obtained an average gross profit of Ush 0.2 – 0.5 million per hectare or Ush 0.1 - 0.2 million per acre. This clearly suggests that potato cultivation is highly profitable and confirms the fact that potato cultivation is ranked as the number one commercial crop in the eastern and south-western highlands of Uganda. In the district of Kapchorwa where road infrastructure has improved, most of the farmers interviewed said that they have given up maize cultivation in favour of potato as a commercial crop.

Two cultivation scenarios of low and average input use, which are a common occurrence in smallholder farming are considered in Table 8. These scenarios are considered for Kapchorwa district only, but as mentioned above, they are prevalent in agriculture due to diversify socioeconomic characteristics of households (Tittonell, 2007). Scenario A is where the farmer typically depends on own family resources including land, labour and seed for production while Scenario B is where a relatively better-off farmer uses a reasonable amount of purchased inputs including seeds, fertilisers, fungicides and labour in production. In Scenario A, the farmer usually cultivates less area, uses local inputs –hence low cost of production and gets low output while in Scenario B, the farmer cultivates bigger area, uses more improved inputs –hence higher production cost and gets more output. In Scenario A, over 90 percent of the revenue is gross profit while in Scenario B; only 51 percent of revenue is gross profit. This is perhaps one of the main reasons why low input farming and recycling of seed is still dominant in smallholder farming.

Regarding the inputs and their cost, Tables 7 and 8 indicate that seed is perhaps the most important and expensive input in potato farming. Where no family labour is used in cultivation, the aggregate cost labour for land preparation, planting, weeding and harvesting is also a substantial proportion of the total cost of production. For farmers using fertiliser and fungicides, these inputs take about 20 percent of the production budget.

3.6 Gross margin analysis – seed potato production

Table 9 shows the costs of production and return obtained by an average potato seed producer under UNSPPA. The analysis is based on interview of two members of UNSPPA. The estimates indicates that in a season, a UNSPPA farmer earns as much as Ush 3.6 million per acre, which is about 2.2 times higher than the gross profit earned by a farmer in Kabale/Kisoro cultivating ware potatoes (Table 7). The main reason for the high return obtained by UNSPPA farmers is that basic seed provided by KAZARDI to UNSPPA farmers is at subsidized rate of Ush 65,000 – 105,000 per bag compared to the price (Ush 150,000 – 180,000 per 100kg bag) at which farmers in Kabale/Kisoro buy to buy local seed on the open market.

Table 9. Gross margin analysis of seed production by UNSPPA

Item	unit	unit cost	quantity	total
Seed	bag (100kg)	105,000	12	1,260,000
1st & 2nd land tilling labour	acre	300,000	1	300,000
Heaping labour	acre	150,000	1	150,000
Planting labour	bag (100kg)	10,000	12	120,000
Weeding labour	acre	100,000	1	100,000
Fertiliser	bag (50kg)	100,000	3	300,000
Fungicide	kg	15,000	5	75,000
Fungicide application labour	acre	10,000	1	10,000
Harvesting labour	bag (100kg)	1,000	70	70,000
Transport labour	bag (100kg)	6,000	70	420,000
Other costs	various	100,000	1	100,000
Total costs				2,905,000
Output	bag (100kg)		70	
Sale revenue	bag (100kg)	100,000	65	6,500,000
gross profit	acre			3,595,000

Source data: Field survey, February 2011.

From Table 9, it is clear that besides seed, farm labour hire for land tilling, planting, weeding, harvesting and transport is the second most significant input in potato cultivation. At the peak of cultivation, farm workers are scarce and expensive to hire –costing Ush 5,000 per man-day. To note also is that the transport cost from farm to home is high due the fact that the respondents observed that their gardens were a bit distant from home and the terrain of hills and valleys was very unfavourable –hence the high transport cost per bag. When the garden is near home, the respondents noted that the cost is about Ush 500 per bag.

3.8 Potato production constraints

The constraints mentioned by farmers as affecting their capacity to increase potato production include:

(i) High price of inputs. Fungicides and fertilisers were particularly ranked by most farmers as the number one constraint in their effort to increase potato output. The price of potato seed and farm labour was also reported to be expensive. The price of seed potato is reported to be twice as expensive as the price of ware potatoes. As such, farmers resort to saving part of the season's output for reproduction –leading to over recycling of seed and perpetuating of viral diseases and bacteria wilt.

Fake inputs yet sold expensively was another problem reported by farmers. In Kapchorwa farmers interviewed noted that fake fertilisers were a very big problem. In Kisoro, farmers who used NPK fertilisers from Rwanda observed that they were not as productive as fertilisers "from Uganda."

(ii) Low prices of output especially at harvest time. In Kapchorwa and Mbale for example, at harvest time, a bag (100 kg) of potatoes sells at Ush 10,000 -20,000. Traders offer low prices due to excess supply arising from concurrent harvest in Kapchorwa and Mbale, yet the only wholesale market for potatoes is Mbale town. A similar case is also reported by farmers in Kabale and Kisoro who say that at peak harvest, they sell a bag of potatoes at Ush 30,000 -40,000.

(iii) Rampant diseases and pests. Bacteria wilt is reported by all farmers as the most devastating they are wary of -the reason almost every farmer uses fungicides. For late blight, farmers noted that it can be serious during heavy rains but that it was not worse than bacteria wilt. For pests, farmers in Mbale reported that there are "tiny insects" – probably the Colorado potato beetles (*Leptinotarsa decemlineata*) or may be leafminer (*Liriomyza huidobrensis*). Research is required to ascertain the exact pest.

(iv) Unpredictable weather. "At times rainfall is much. In another season, it is little," the farmers complained. When rainfall is much, it causes the late blight disease from water mould – that requires heavy use of fungicides to contain. On the other hand, potato yield is highly affected by inadequate rainfall.

Table 10 shows farmer's rankings of the causes of pre-harvest potato losses. The results indicate that rainfall shortage, crop diseases and pests as the major causes.

Table 10. Pre-harvest crop loss

Cause of crop loss	Freq.	Per cent
Rain shortage	132	57.6
Crop disease	34	14.8
Insect damage	15	6.6
Animal damage	8	3.5
Floods	7	3.1
Theft	2	0.9
Other	31	13.5
Overall	229	100

Data source: UNHS 2005/06.

(v) Low soil fertility. All farmers interviewed in Kabale, Kisoro, Mbale and Kapchorwa observed that they have limited land leading to overuse and hence exhaustion of fertility. In Kapchorwa almost every farmer uses fertiliser (inorganic or organic) due to land overuse and exhaustion of fertility. Most farmers in Kabale, Kisoro and Mbale districts cultivating potatoes use fertilisers. In the highlands, land fallow is hardly practiced.

(vi) Limited land. Land fragmentation and lack of adequate land for expansion of farms is a common problem in the highland areas of Uganda. The problem of land shortage in Wanale sub-county in Mbale district and Kapchorwa district is acute due to the gazetting of some of the formerly cultivatable land into Mt. Elgon Forest Reserve. In Kisoro district, a large portion of land is rocky, with not fully withered rocks –rendering soil formation incomplete and unfit for cultivation. Besides, the highland regions of Uganda are the most densely populated.

(vii) Lack of storage. All farmers interviewed mentioned that they do not store ware potatoes to wait for a better price, though they would be happy to do that. Some farmers mentioned that the only way they store potatoes is to leave them in the soil especially in the dry season –otherwise they sprout if left in the soil in the wet season. In the case of seed storage, farmers revealed that they do not have a good storage system that can hasten or delay sprouting. Farmers mentioned that in most cases they spread their potato seed under the bed (for darkness) or the sitting room (for slight) if they want to hasten or delay sprouting.

4.0 POTATO UTILISATION

4.1 Farm-level consumption, seed and sale

About 51 percent (approximately 79,300 t) of total potato output in Uganda is sold by households for income, and the rest (77,700 t) retained for home utilisation as seed and food (Table 11). Based on the UNHS 2005/06 data, farmers in Central Uganda lead in potato commercialisation (61% of the output is sold) followed by farmers in western region (47%). The results indicate that farmers in eastern region sold only 14 per cent of their output sold.

Table 11. Potato utilisation at household level

Region	Consumption (t)	Sale (t)	Output (t)	Proportion (%) sold
Central	16,800	25,900	42,700	60.7
Eastern	665	106	771	13.7
Northern	399	219	618	35.5
Western	59,900	53,100	113,000	47.0
Total	77,700	79,300	157,000	50.5

Data source. UNHS 2005/06

The high proportion of potato output sold by farmers in central region most likely due to the consumption habits of people in central Uganda that are biased towards plantains than potato – hence cultivating potato more as a cash crop than food crop. The proximity of farmers in central Uganda to Kampala (major market of potatoes) as well as the good road network in central region also plays an important role in increasing potato demand and facilitating trade. For eastern Uganda, the low proportion of sales as of 2005/06 was most likely due to the poor road network connecting the production zones –particularly Kapchorwa district with Mbale town – which is the main market. However, with the upgrading of Mbale-Kapchorwa road to bitumen, transport between the two districts has significantly improved, thereby boosting household crop sales.

Of the portion of potatoes retained at the household, it is estimated that about 90 percent (70,000 t) is utilised as food, 8 percent (6,200 t) is used as seed for reproduction, and the remaining 2 percent (1,500 t) goes to waste or is fed to animals.

For the output that is sold out by farmers, about 5 percent (4,000 t) is estimated to be sold to other farmers as seed and rest (75,300 t) is sold to traders who in turn sell it in urban areas.

Whereas generally 5-10 percent of potato production is estimated to be recycled back into the production system as seed, the proportion of potato output that is retained as seed by smallholder farmers in Uganda can vary from zero to 50 percent –depending on the primary purpose for which the farmer cultivated the crop. Commercially-oriented farmers in Kabale and Kisoro for example tend to sell their entire crop output and later buy seed from other farmers.

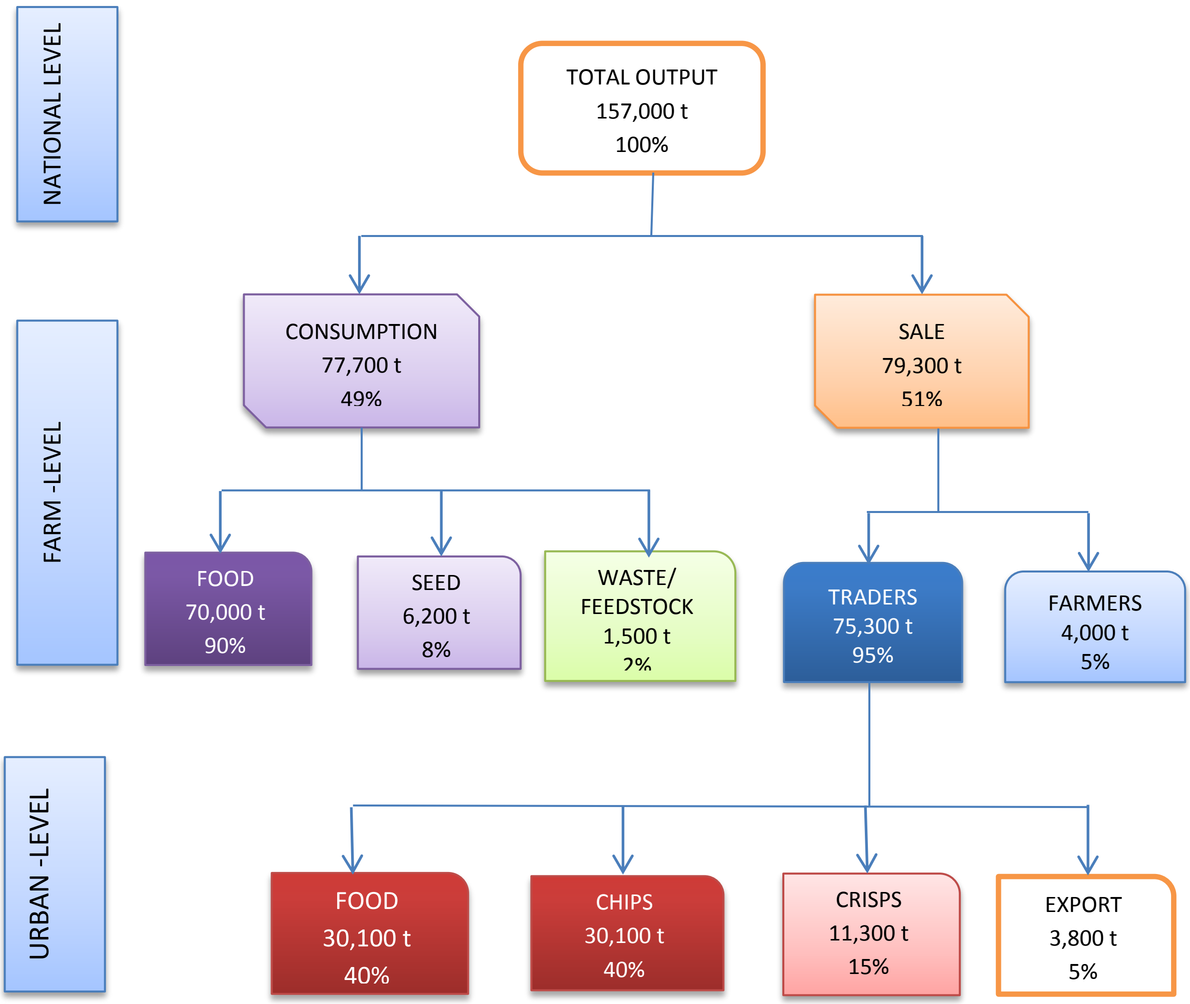
In Mbale, there are even cases where farmers sell the whole not-yet-harvested garden of potatoes to speculative traders –denying farmers any seed-retention plan. In the case of subsistence farmers, they always retain a reasonable portion of their crop output as seed. This is what one subsistence farmer (Mr. Yoweri Bipfakubaho) in Kisoro had to say: "Last season I planted one-half of a bag (about 50 kg) of seed I had retained from the previous harvest and obtained output of 3 bags. I ate most of it and sold one-half of a bag, but I am again keeping one-half of a bag (17% of output) as seed for this season".

At household level -in rural areas, potatoes are mainly eaten boiled. Potatoes are boiled together with other vegetables such as beans or beef (the mixture is locally called *Katogo*). Other forms of potato preparation at household level –especially in the rural areas, are rare.

4.2 Urban consumption, processing and export

Out of the 75,000 t of ware potatoes that are supplied to urban areas of Uganda, it is estimated that urban households consume up to 40 percent (30,000 t). Potato snacks business –particularly fried potato chips, use 35-40 percent (26,250 -30,000 t) of ware potatoes that are supplied to urban areas while crisps business uses about 10 -15 percent (7,500 -11,250 t). A small fraction -5 percent (3,750 t) is estimated to be exported to neigbouring countries particularly Southern Sudan and Rwanda. Uganda hardly exports processed potato products.

Figure 12. Potato utilisation flow diagram



Source data: Authors calculations based on UNHS 2005/06

5.0 POTATO TRADE

5.1 Internal trade

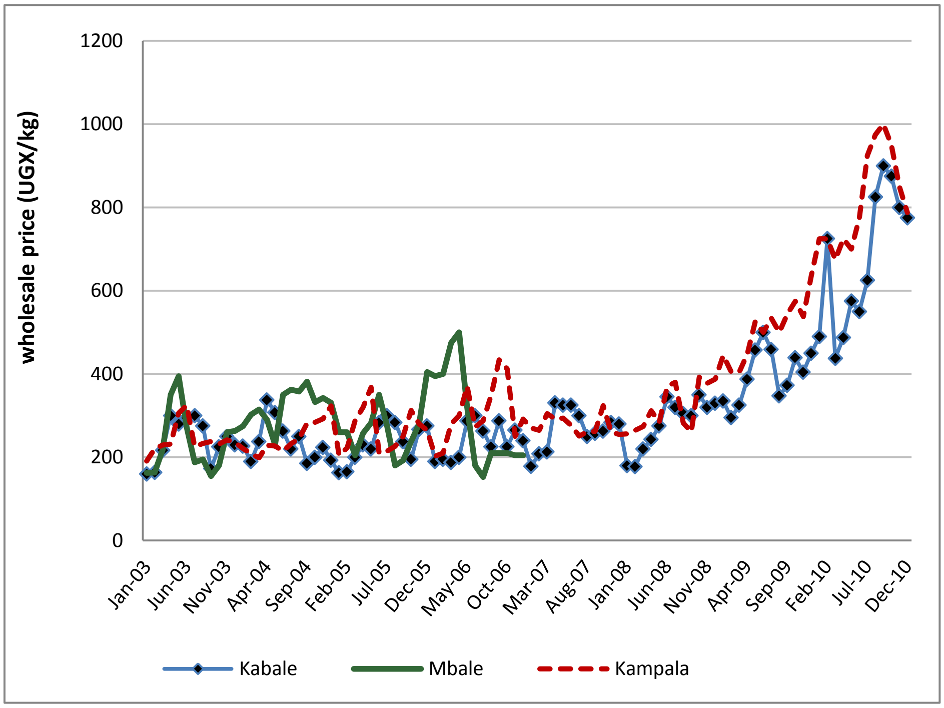
Though potatoes are produced in fewer areas in Uganda compared to other crops such as maize or beans, the crop is extensively traded in the country's urban areas. Potatoes produced in the districts of central, western, and south-western Uganda are sold mainly in Kampala markets of Owino, Nakawa and Kalerwe, which serve as wholesale markets for the hinterland districts and towns. The wholesale market for potatoes produced in Mbale and Kapchorwa is Mbale town, from where other towns such as Tororo, Soroti and Lira get supplies. Potatoes from Nebbi serve the urban areas such as Arua, Paidha and Gulu towns in the north-western region.

Participants in internal trade are mainly travelling traders, sedentary traders and consumers. Travelling traders are traders mainly from the area of production, the destination market or from districts that are neither the production area nor the wholesale market. In some cases, travelling traders are farmers who double as traders. Sedentary (sitting) traders are wholesale and retail traders with rented stalls in markets such as Nakawa. Sedentary wholesale traders mainly purchase their supplies from off the trucks of travelling traders while sedentary retail buy their supplies from wholesale traders within the market.

5.2 Price trends

Figure 13 shows the wholesale price trend of ware potatoes in the Kampala, Mbale and Kabale districts. The graphs show the wholesale price of potatoes in Kampala being consistently higher than in Kabale. Furthermore, the trend indicates that between 2003 and 2008, the wholesale price of ware potatoes ranged between Ush 200 and 450 per kg. However since 2009 to date, the wholesale price has spiraled, reaching Ush 1,000. The rapid increase in the wholesale price of ware potatoes follows the general trend in the rise of food prices in the Uganda as well as other countries. The rapid increase in the local price of food crops makes commodity trade within the country profitable, thereby minimizing nationals' interest in export trade.

Figure 13. Wholesale price of potatoes, 2003 - 2010



Source data: FOODNET and FarmGain Africa databases

5.3 Travelling traders' gross margin analysis.

Travelling traders are the major link between producers and retailers and ultimately consumers of commodities. In potato produce business, there are three categories of travelling traders, that is: (i) farmers who double as travelling traders, (ii) business persons from the district's urban centers who are dealers in produce, and (iii) business persons from other district's –mainly Kampala, who are dealers in produce. Table 12 gives the gross margin analysis based on the first two categories of travelling traders in Mbale and Kisoro districts.

Travelling traders from the area of production (case A, Table 12), buy directly from several farmers in the area after harvesting, carry and assemble produce alongside the road and repackage in bags –ready for transportation to the destination market. At the time of survey, the costs for the various marketing services and the price for output that prevailed are indicated in Table 12. The results show that when all the transactions costs are taken into account, travelling traders in Mbale obtained Ush 5,700 per bag while their counter parts from Kisoro obtained about Ush 6,000 per bag. This amount earned per bag is based on the assumption that travelling traders sell their produce in a single sale in one day. When travelling traders take more days -especially from south-western Uganda to Kampala to dispose their produce, they incur more costs on meals, lodging and fuel, which reduce on their gross profit.

Table 12. Gross margin analysis of travelling traders

	Case A: Travelling traders from area of production				
		Mbale district		Kisoro district	
	Item	Unit cost	cost for 25 bags	Unit cost	cost for 140 bags
A	Purchase cost per bag	40,000	1,000,000	50,000	7,000,000
B	Assembly costs per bag	1,300	32,500	1,500	210,000
C	Loading & offloading fee per bag	800	20,000	1,000	140,000
D	Transport per bag	1,500	37,500	8,000	1,120,000
E	Sub-county tax per truck		0	20,000	20,000
F	Market levy per bag	500	12,500	3,000	420,000
G	Other costs	5,000	5,000	50,000	50,000
H	Purchase & marketing costs		1,107,500		8,960,000
J	Wholesale price per bag	50,000	1,250,000	70,000	9,800,000
K	Gross profit		142,500		840,000
L	Gross profit per bag		5,700		6,000
	Case B: Farmers who double as travelling traders				
M	Total cost of production		485,000		5,012,000
N	Revenue	40,000	1,000,000	50,000	7,000,000
P	Gross profit at farm-level		515,000		1,988,000
Q	Gross income due to trade		657,500		2,828,000
R	Gross profit per acre due to trade		1,315,000		2,262,400

Source: Field survey, February 2011.

In Mbale, it is common for farmers from Wanale sub-county to double as travelling traders of their crops, as the distance between the sub-county and Mbale town is less than 20 km. In Kisoro, we interviewed a prominent farmer who doubles as trader as well as a broker of potatoes. Case B in Table 11, puts this phenomenon into context. Basically, the farmer who takes and sells his crop in the wholesale market such as Mbale town incurs similar marketing costs as the full-time produce businessman within the district (Case A). As such he earns the same gross profit shown in row K or an additional Ush 6,000 per bag (row L). When this gross profit is added to what the farmer earns at farm-level (row P) we obtain the gross income the farmer earns (row Q) when he doubles as a travelling trader of his own produce.

Standardizing the gross profit return per acre, the results show that potato farmers in Mbale who double as travelling traders earn up to Ush 1.32 million per acre. In Kisoro they earn up to Ush 2.26 million per acre. This clearly explains why most farmers –particularly male farmers from Wanale sub-county also operate as travelling traders of their own produce. This phenomenon of male farmers operating as travelling traders is also practiced by Kapchorwa farmers.

Although produce farmers in Mbale and other districts like to operate as travelling traders to enhance their return from farming, they are less likely to operate in groups to enhance their marketing capacity. This may be one area that needs to be explored to strengthen the farmer's integration into the market.

The other aspect of internal trade is retail trade, which brings the commodity close to the consumer. Two types of retailers are common especially in the metropolitan Kampala. These are sitting retailers and mobile retailers using push carts to sell potatoes. Mobile traders in Kampala and the surrounding urban centers have especially increased household access to and consumption of potatoes. This is because mobile retailers are flexible in the units of measurement and pricing of their wares.

5.4 Potato processor gross margin analysis

Table 13 gives an estimate of the gross margin of a crisps processor. The estimate is based on information provided by Mr. Bukenya of TomChris Company, a processor with 20 years' experience in crisps processing. The analysis indicates that crisps processing is a lucrative business. The processor earns up to Ush 65,000 as gross profit per 100kg bag of fresh potatoes. Company (TomChris) processes about 8 bags of potatoes per day. This implies that the company earns about Ush 525,000 for 8 bags of fresh potatoes they process per day. Though crisps processing is lucrative, the business has some challenges of quality assurance and competition and hence marketing especially for new entrants - according to Mr. Bukenya. The crisps market is awash with supply from numerous back-yard processors in Kampala and imports from Kenya supplied by Tropical Heat Company. Crisps imports from are certified for quality unlike crisps processed in Uganda, which possess a marketing challenge to Ugandan processors especially to up-scale supermarkets and consumers who are conscious of food hygiene. The other challenge for processors is adequate capital to enable continuous production and supply of crisps particularly to supermarkets -till payment is made at the end of the month, as is the case with most supply contracts.

Table 13. Gross margin analysis of crisps production by TomChris Company

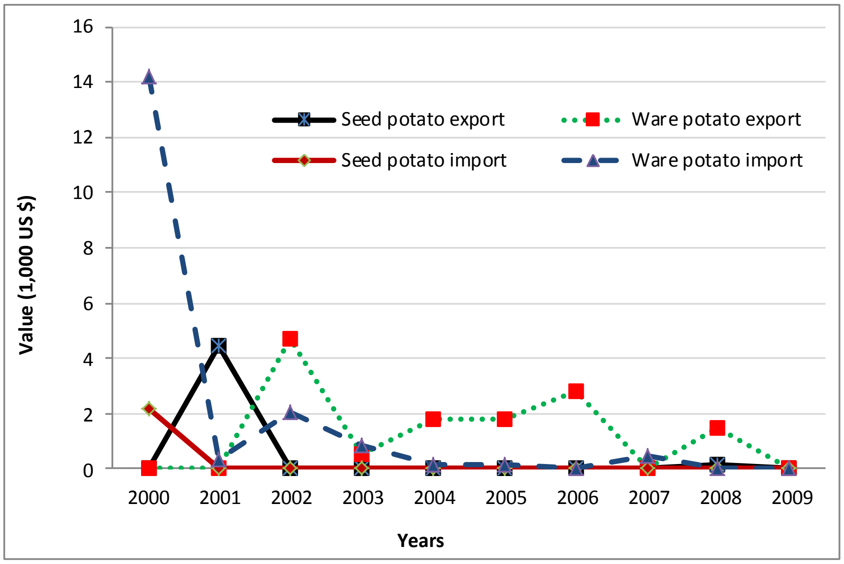
Production inputs	Units	Price/unit	Total
Fresh potatoes (Ush/100kg bag)	8	95,000	760,000
Loading cost(Ush/bag)	8	500	4,000
Transport -market to home/bakery (Ush)	1	25,000	25,000
Cooking oil -fresh -20kg (Ush)	5	85,000	425,000
Cooking oil -used from previous baking -20kg	3	65,000	195,000
Packaging polythene (Ush/kg)	1	8,000	8,000
labour peeling & packaging (Ush/person/week)	8	2,000	16,000
labour chipping and washing (Ush/person/week)	8	2,000	16,000
labour frying (Ush/person/week)	8	3,200	25,600
Wood cooking energy (Ush/day)	1	100,000	100,000
Water (Ush/Jerrycans/day)	50	100	5,000
Equipment (slicers, saucepans etc) depreciation (Ush/day)	1	2,000	2,000
Labels (Ush)	3057	10	30,570
Interest on loan (Ush)	1	2,000	2,000
Total cost for 8 bags (Ush)			1,614,170
Crisps processing conversion rates	Conversion rate (average)	Original quantity (kg)	Resultant quantity (kg/packets)
Fresh to peeled potato	0.75	800	600
Peeled to chipped potato	0.95	600	570
Chipped potato to crisps	0.35	570	200
Fresh crisps to 60gm packet crisps	0.065	200	3077
	Quantity	Unit price (Ush)	Revenue (Ush)
Revenue for 8 bags equivalent packets(Ush)	3,057	700	2,139,900
Gross profit for 8 bags (Ush)			525,730
Gross profit per 100kg bag equivalent packets (Ush)			65,716

Source: Field survey, February 2011.

5.4 Export and import trade

According to world trade statistics –which is a replica of Uganda Revenue Authority (URA) customs information, export and import of potatoes from and to Uganda is very low in volume and value. World trade statistics show that exports or imports of potatoes from/to Uganda hardly reach US$ 4,000 per annum (Figure 14). To note is that WITS database records only official statistics. Informal exports and imports that do not go through the customs are not captured. According to customs officials as well as residents along Uganda-Rwanda border, there is moderate seasonal informal trade in potatoes especially from Uganda to Rwanda. With the recent imposition of the food exportation ban in Rwanda, potato imports (either formal or informal) from Rwanda to Uganda are very low.

Figure 14. Value of Uganda potato exports and imports, 2000 -2009.



Source: WITS database, accessed January 2011.

The statistics show that over the past decade (2000 – 2009) seed potato exports have averaged only US$ 500 while seed imports have averaged a mere US$ 200. Ware potato exports have averaged US$ 1,300 and imports US$ 1,800. Noteworthy however is that seed potato exports were only recorded in the year 2001 while imports in 2000. The value of ware potato exports has remained somewhat stable though very low. Meanwhile ware potato imports that surged in early 2000 have since gone down to almost zero.

According to WITS statistics, the countries to which Uganda exported seed potatoes and the value of the exports over the past decade is shown in Table 14. As shown in the Table, the value of seed potato export flows between Uganda and her trade partners is very low and not steady. Data indicates for example, that Uganda exported perhaps the highest value (US$ 5,500) of seed potato consignment to the Democratic Republic of Congo in 2004, and since then has not had any formal exports.

Table 14. Uganda seed potato (HS Code 70110) exports; partner states and value (1000 $)

Partner name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Congo, Dem. Rep.	0	0	0	0	5.5	0	0	0	0	0	5.5
Netherlands	0	4.48	0	0	0.155	0	0	0	0	0	4.635
Sudan	0	0	0	0	0	0	0	0	0.077	0	0.077
United Kingdom	0	0	0	0	0	0	0	0	0.068	0	0.068
Total	0	4.48	0	0	5.655	0	0	0	0.145	0	10.28

Data source: WITS[3] database, accessed January 2011.

[3] The World Integrated Trade Solution (WITS) is a database of trade, tariffs and non-tariffs statistics managed by the World Bank. For details, http://wits.worldbank.org/wits/

The very low value of seed potato exports shown in Table 14, particularly to countries such as united Kingdom, Sudan, and Netherlands suggests that these exports were not be for commercial potato cultivation but other purposes such as research.

Table 15 shows the countries to which Uganda exported ware potatoes over past decade – according to WTO statistics. Similar to seed potato, the value of ware potato exports is low and the trade flow between Uganda and her partners is not steady. Perhaps export flows from Uganda to Kenya can be regarded as steady, but the annual value is peanuts. The year 2002 is when Uganda exported the highest value (US$ 4,700) of ware potatoes. Since then, the value of ware potato exports has continuously declined –at least according to WTO statistics.

Table 15. Uganda ware and other potato (HS Code 70190) exports; partner and value (1000 $)

Partner name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Congo, Dem. Rep.	0	0	2.076	0	0	0	0	0	0	0	2.076
Congo, Rep.	0	0	0	0	0	0	1.883	0	0	0	1.883
Denmark	0	0	0	0.034	0	0	0	0	0	0	0.034
Kenya	0	0	0	0	0	0.099	0.92	0	1.475	0	2.494
Netherlands	0	0	0	0.495	0	0	0	0	0	0	0.495
United Kingdom	0	0	2.61	0	0.309	1.678	0	0	0	0	4.597
United States	0	0	0.028	0	0	0	0	0	0	0	0.028
Total	0	0	4.714	0.529	0.309	1.777	2.803	0	1.475	0	11.607

Data source: WITS database, accessed January 2011.

The value of ware potato export flows from Uganda to United Kingdom were the highest, but occurred only between 2002 and 2005. Although a lot has been said to suggest that Ugandan traders export potatoes to Sudan (Southern), WITS statistics does not reflect this fact, at least up to the year 2009.

Turning to seed potato imports, Uganda imported the highest value of US$ 2,166 in the year 2000 (Table 15). Since then, less than US$ 200 of seed potato imports have been shipped into the country -and particularly since year 2006 no imports have been recorded. While Kenya is the country from which Uganda has consistently imported seed potatoes, the aggregate value is lower than the amount imported from Rwanda in the year 2000.

Table 16. Uganda seed potato (HS Code 70110) Imports; partner states and value (1000 $)

Partner name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Guinea	0	0.001	0	0	0	0	0	0	0	0	0.001
Iran, Islamic Re	0.414	0	0	0	0	0	0	0	0	0	0.414
Kenya	0.579	0	0.012	0	0.083	0.005	0	0	0	0	0.679
Qatar	0.228	0	0	0	0	0	0	0	0	0	0.228
Rwanda	0.945	0	0	0	0	0	0	0	0	0	0.945
South Africa	0	0	0	0	0.098	0	0	0	0	0	0.098
Total	2.166	0.001	0.012	0	0.181	0.005	0	0	0	0	2.365

Data source: WITS database, accessed January 2011.

Countries where Uganda imported ware potatoes and other potato products (e.g. crisps) over the past decade are almost the same as where seed potatoes were imported. Table 17 shows that Kenya has been the major source of imports of ware potatoes and products (particularly crisps) for Uganda. In the early 2000 when South African retail trade companies such as Shoprite and Game established in Uganda, some imports of ware potatoes come from South Africa. Since 2004, ware potato imports from South Africa ceased however. Imports from United Arab Emirates and United Kingdom are most likely to be dehydrated potato products such as potato flour and starch or its constituent products such as Pringles made from potato flour.

Table 17. Uganda ware and other potato (HS Code 70190) imports; partner and value (1000 $)

	Year										
Partner name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Kenya	13.56	0	1.965	0.346	0.322	0.127	0	0.37	0	0	16.69
Rwanda	0.662	0	0	0	0	0	0	0	0	0	0.662
South Africa	0	0.303	0	0.151	0	0	0	0	0	0	0.454
United Arab Emir	0	0	0	0.334	0	0	0	0.088	0	0	0.422
United Kingdom	0	0	0.056	0	0	0	0	0	0	0	0.056
Total	14.222	0.303	2.021	0.831	0.322	0.127	0	0.458	0	0	18.284

Data source: WITS database, accessed January 2011.

Besides the WITS statistics which relate to the official trade statistics collected by Uganda Revenue Authority, an attempt was made to obtain informal cross-border trade information on potatoes from the residents and traders at Bunagana Uganda-DR Congo border; Cyanika, Uganda-Rwanda border; Katuna, Uganda-Rwanda border; and Malaba, Uganda-Kenya border. Traders as well as residents in all these border locations talked of limited flows of potatoes from Uganda to the neighbouring countries and vise-versa. "I live and work at this border (Bunagana), but I have not witnessed any big business in potatoes" said Mr. Hashaka James –a prominent businessman at Bunagana border who also doubles as the Chairman of Kisoro NAADS Farmers' Fora. "The potatoes from DR Congo are cultivated by Ugandans who have acquired or rent land in Congo," added Mr. Hashaka.

At Cyanika border, we were informed that no potatoes come from Rwanda into Uganda. The URA official who did not disclose his name due to lack of authority to comment on cross-border trade said that there is a policy in Rwanda that bans exporting food from Rwanda to Uganda. One resident near Cyanika border said that it is Rwanda traders who come to Uganda to buy potatoes and no Ugandan traders go to Rwanda to bring potatoes. At Katuna border in Kabale district, residents say no some traders from Rwanda buy and take potatoes but none comes from Rwanda due to food export ban.

In Summary, Uganda's formal export trade in fresh potatoes and products is not that significant. Some informal exports to Rwanda exist but are not captured. The total value of seed and ware potato exports or imports for 10 years is about US$ 21,500 only. For seed potatoes, Uganda has been a net exporter while for ware potatoes and products; Uganda has been a net importer. Of recent, no major exports or imports of potatoes from/to Uganda has occurred. Unless there is a drastic supply-side intervention that leads to surplus household production, it is unlikely that Uganda potato exports are to increase in the short to medium term. But given the rapidly increasing urban population, it will not be surprising for potato imports to increase in Uganda.

6.0 ANALYSIS OF THE FEASIBILITY OF POTATO PRODUCE AND PRODUCTS EXPORT

6.1 Introduction

From the historical perspective, Uganda is not a major player in the potato export/import market (Section 5). The annual value of seed potato exports suggest that imports of potatoes from Uganda are most likely not for commercial transactions. Even annual exports of ware potatoes hardly reach US$ 2000, implying the exports may be for home consumption than business.

Low participation of Ugandan firms in the potato export market on one hand may imply lack of capacity –technical or otherwise of the firms to supply the market. On the other hand it may be due to lack of import demand from potential trade partners. Besides, it may be that the business does not make economic sense. What is the case for Uganda as far as potato produce and products export is concerned? This section (feasibility analysis) attempts to provide answer these issues. It demonstrates the technical and economic prospect of firms from Uganda exporting potato produce and products to other countries in east African region and beyond. Potato produce include seed potatoes and ware potatoes while potato products include frozen (chilled) potatoes, potato crisps, and dehydrated potato products such as flour and starch.

6.2 Technical feasibility.

Seed potato: Uganda has the technical capacity at KAZARDI to produce nucleus material, pre-basic seed (mini-tubers), and basic seed. But the quantities produced presently cannot even satisfy local demand. Due to lack of the regulatory framework, certified seed is not presently produced in Uganda.

Ware potato: potato cultivation in Uganda is on smallholder farms using simple technologies (hand-hoe, local seed, etc.) and depends entirely on rainfall. The crop is produced primarily for subsistence, with limited surplus for sale within the country. Consistent export market supply of potatoes would require cultivation under irrigation as it is for example in South Africa. But the technical as well as financial capacity of smallholder potato farmers in Uganda regarding the use of irrigation technology is very low. This implies that in the short to medium term, it is unlikely that farmers in Uganda will produce even a quarter of their output under irrigation to satisfy potential steady export demand.

Potato products (frozen, crisps and dehydrated products): At present, only crisps are produced in Uganda at a small-scale level using local technologies. Local production of crisps is mainly to substitute for imports, but the output does not even satisfy demand. Hence, Ugandan firms do not presently have the modern technologies to produce frozen potatoes, crisps or dehydrated products for export.

6.3 Economic Feasibility

For any business to remain in operation, the expected benefits should equal or exceed the expected costs. Table 18 gives the estimated costs and returns from exporting ware potatoes in Kenya (Nairobi) or Rwanda (Kigali) from key supply points in Uganda. The results indicate that only ware potato exports from Mbale to Nairobi may be economically rewarding. Ware potato exports from Kampala to Kigali would attract the highest loss due to the high cost of transport on one hand and the lower wholesale price of potatoes in Kigali on the other.

Table 18. Costs and benefits (US$) of ware potato export (100 kg bag)

Source market	Destination market	wholesale price(bag) source	Transport cost	other costs	Landed cost	Wholesale price (bag) - destination	Net benefit
Kampala	Nairobi	43	4	2	49	36.8	-12.2
Kampala	Kigali	43	4.3	2	49.3	25.2	-24.1
Mbale	Nairobi	25.8	3.5	1.8	31.1	36.8	5.7
Kabale/Kisoro	Kigali	25.8	2.5	1.8	30.1	25.2	-4.9

Exchange rate: US$1 = Ksh. 81.4, Ush 2330, RwF 594.3
Source: field survey, February 2011, www.exchange-rates.org

Transport cost. The cost of hiring a non-custom bonded 25 t truck returning to Kenya from Kampala or Mbale after delivering merchandise costs between Ush 75,000 - 85,000, depending on the location of the goods to transport and bargaining power. This translates to about US$ 4 per 100kg bag. The cost for hiring a similar truck from Uganda to Nairobi is slightly higher, ranging from US$ 4.5 – 5 per 100kg bag. From Kampala to Kigali, transport per 100kg bag is Ush 10,000 or US$ 4.3 while from Kabale and Kisoro to Kigali, transport per bag is Ush 5000 -6000 or US$ 2.5.

Under the transport cost column in Table 18, the value given is average and does not include other transport-related costs such as loading and off-loading –which are summed up under the column for other costs.

Other costs: Agricultural crops export business involves acquiring certificates such as: (i) Rules of origin certificate –issued by the National Chamber Commerce, Uganda Export Promotion Board or Uganda Revenue Authority, and (ii) Sanitary and phyto-sanitary inspection certificate issued by the Ministry of Agriculture Animal Industry and Fisheries (MAAIF). Each of these documents costs Ush 10,000 -20,000. Besides, there is transport cost to and from the offices where these documents issued. All this including the cost of loading and off-loading merchandise on the truck is averaged at US$ 2 per 100kg bag for Nairobi bound cargo.

Net benefit: Adding up the purchase price, transport cost and other costs gives the landed cost, which when subtracted from the wholesale price at the destination market gives the net return.

As shown in Table 18, export of potatoes from Kisoro/Kabale to Kigali is likely to lead to economic loss compared to selling potatoes in Kampala market which is much further from these production areas. The low wholesale price for potato exports in Kagali -which range from RwF 12000 -15000 (US$ 20.2 – 25.2) compared what traders get in Kampala markets (US$ 40 - 45) has driven away Ugandan exporters.

Even when export of potatoes from Mbale to Nairobi is likely to be profitable, at present there is no individual or firm is reported to be dealing in Mbale-Nairobi potato export business. Also, no individual or firm from Kenya is reported to be importing potatoes from Uganda –be it from Kampala or Mbale.

6.4 Potato imports by Kenya and Rwanda

Kenya and Rwanda as a potential export destination for Uganda's potatoes does not actually rely much on imports. Table 19 shows that Kenya hardly imports seed potatoes in general and from Uganda in particular. Table 20 also shows that while Kenya imports (officially) a small amount of ware potatoes, it does not import any from Uganda, including even in 2009 when the country imported the highest quantity of ware potatoes from Tanzania.

Table 19. Kenya seed potato (HS Code 70110) import, partner states and value (1000 US$)

Partner name	Yr-2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Italy	0	0	0	0	0	0	0.02	0	0	0	0.02
Switzerland	0	0	0	0	0	0.03	0	0	0	0	0.03
Tanzania	0	0	0	0	0	0	0	0	9.45	0	9.45
Uganda	0	0	0	0	0	3.42	0	0	0	0	3.42
Unspecified	0	0	0	0	0	0	0	0	0	0	0.06
Total	0	0	0	0	0	3.45	0	0	9.45	0	12.95

Data source: WITS database, accessed January 2011.

Table 20. Kenya ware and other potato products (HS 70110) imports; partner states and value (1000 US$)

Partner name	Yr-2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
China	0	0	0	0	0	0	0	0	0.16	4.77	4.93
Italy	0	0	0	0	0	0	0	0.05	0	0	0.05
South Africa	0	0	0	0	0	0	0	0	0	0.02	0.02
Tanzania	0	0	0	0	0.76	0	0	0	99.82	303.07	403.65
United Arab Emir	0	0	0	0	0	0	0	0.49	0	0.76	1.25
United Kingdom	0	0	0	0	0	0	2.04	0	0	6.65	8.68
United States	0.57	0	0	0	0	0	0	0	0	1.67	2.24
Unspecified	0.07	0	0	0.02	0	0	0	0	0	0	0.09
Total	0.64	0	0	0.02	0.76	0	2.04	0.54	99.98	316.94	420.91

Data source: WITS database, accessed January 2011.

Tables 21 and 22 show Rwanda imports of seed and ware potatoes respectively. The results indicate that every time Rwanda imports potatoes, Uganda is one of the major sources of seed as well as ware potatoes. For example, in the year 2009, Rwanda imported most of ware potatoes from Uganda. Though this data is not well reflected on the Uganda WITS database, it is a clear indication of the significance of Uganda potato produce in Rwanda imports.

Table 21. Rwanda seed potato (HS Code 70110) imports; partner states and value (1000 US$)

partner name	Yr-2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Belgium	0	16.07	0	0	0	0	0	1.90	0	0	17.97
Congo, Dem. Rep.	0	0	0	0	0	0	0	0	0	0.19	0.19
France	0	26.43	0	0	0	0	0	0	0	0	26.43
Italy	0	0	0	0	0	0	0.77	0	0	0	0.77
Kenya	0	0	0	0	0	0	0.21	0	0	5.23	5.43
South Africa	0	0.79	0	0	0	0	0.13	0	0	0	0.92
Tanzania	0	0	0	0	0	0	0	0	133.36	0	133.36
Uganda	0	0	0	0	0	0	18.55	0	65.58	9.97	94.09
United Kingdom	0	0	0	0	0	0	0	0	0	74.15	74.15
Total	0	43.29	0	0	0	0	19.65	1.90	198.94	89.53	353.31

Data source: WITS database accessed January 2011.

Table 22. Rwanda ware and other potato products (HS Code 70190); partner states and value (1000 US$)

Partner name	Yr-2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Burundi	0	0	0	0	0	0	0	0	0	0.50	0.50
Congo, Dem. Rep.	0	0	0	0	0	0	0.06	0	0	6.20	6.26
Finland	0	0	0	0	0	0	0	0	0	0.21	0.21
Gabon	0	0	0	0	0	0	0.14	0	0	0	0.14
Ghana	0	0	0	0	0	0	0.16	0	0	0	0.16
Sudan	0	0	0	0	0	0	0	0	0	0.32	0.32
Switzerland	0	0	0	0	0	0	0	0	0	1.27	1.27
Uganda	0	0	0	0	0	0	186.58	0	0	83.64	270.22
Total		0	0	0	0	0	186.93	0	0	92.14	279.08

Data source: WITS database, accessed January 2011.

Comparing results in Tables 13 and 14 for Uganda exports and results in Tables 19 -22, for Kenya and Rwanda imports, it is easy to notice slight differences in the value of declared exports vis-à-vis declared imports by trade partners. This is not an unusual occurrence in trade statistics -as some exporting countries may be lax with recording small volumes of exports yet the importing country records the transaction.

From the foregoing analysis, it is clear that the volume and value of seed and ware potato exports from Uganda to other countries is very low for the past decade. Registered exports from Uganda appear to be for personal use by travellers than for business. And this trend is likely to remain the same over the next decade. This particularly so for the following reasons:

(i) Uganda does not have the institutional framework to produce certified potato seed;

(ii) Current output of seed and ware potatoes barely meets the national demand. Besides, the rapid population growth and urbanization has created local demand;

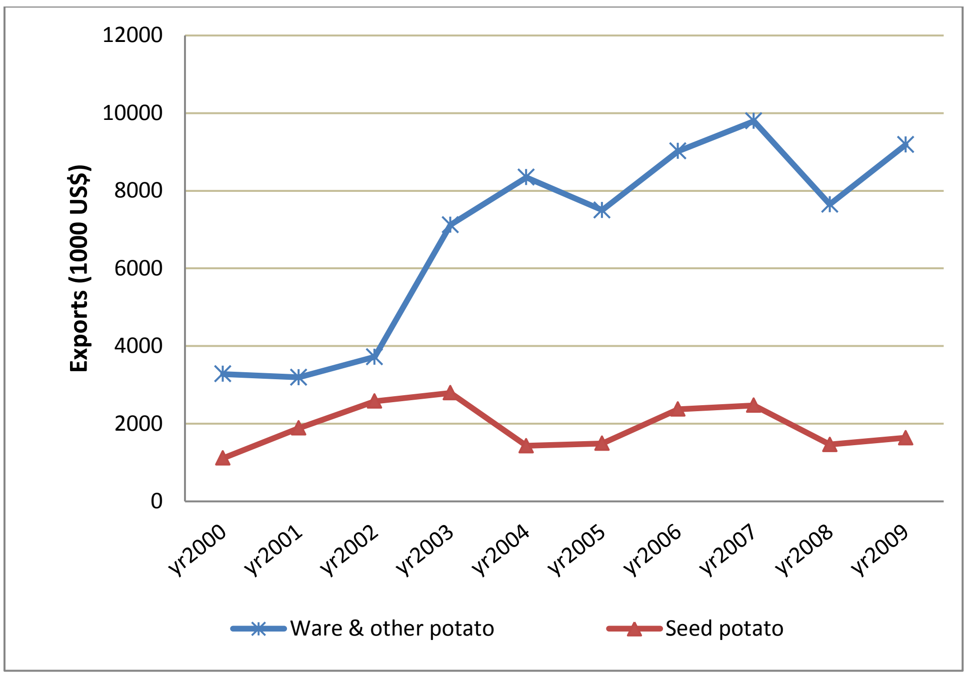
(iii) At present Ugandan ware potatoes are not competitive at all in other east African states such as Kenya and Rwanda that are potential export destinations.

(iv) Due to the bulkiness of potato produce, it is not cost effective to export potato produce beyond the countries surrounding Uganda.

6.5 Potato export by South Africa and lessons for Uganda

South Africa is the number two producer and exporter of potato produce and products in Africa after Egypt. South Africa produces about 2 million tonnes of potatoes per annum, two-thirds of which are produced under irrigation throughout the year. Figure 15, shows the trend in seed potato and ware and other potato exports. The trend indicates that annual potato produce and products exports from South Africa average US$ 10 million.

Figure 15. Trend and value of South Africa seed and ware potato exports (1000 US$)



Data source: WITS database, accessed January 2011

The list of countries to which South Africa exports potato produce and products and the value of exports is shown in Table 26 and 27 in the appendix. The lists suggest that South Africa has exported seed potatoes to over 50 countries while ware and processed potato to about 70 countries.

The top five export destination countries for South African potatoes are Angola, Mozambique, Zimbabwe, Mauritius and Zambia all found in the SADC region and neighbouring South Africa. This clearly suggests that bulkiness of the potato produce limits its export to distant countries.

For example, the statistics indicate that countries in the northern hemisphere including the East African states are least ranked export destination for South African potatoes.

The ranking and priority export market of South African potatoes provides important lessons for countries such as Uganda where some government officials may be floating the idea of exporting potatoes to countries other than those the country neighbours. The simple lesson is that it is economically unfeasible to export potatoes to countries such as Zambia, Djibouti or Northern Sudan considering that Uganda is landlocked and the transport system is poor.

Uganda has been able to export food to Southern Sudan because that part of Sudan is just coming out of a long civil war. With on-going recovery, Southern Sudan has greater potential to produce and even export to food into Uganda.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary

The focus of this report was mainly on two issues, namely (i) review of the current status of the potato sub-sector in terms of stakeholders, production, utilisation and trade; and (ii) assessment of the feasibility of exporting seed and ware potatoes from Uganda.

The potato is an important crop for food and income in Uganda. The potato sub-sector has a number of players including farmers, traders, processors, consumers, MDAs, international agencies. About 154 000 t of potatoes valued at approximately Ush 77 billion are produced annually. Much of the crop is consumed at farm-level and by households in urban areas and about a quarter of the output is processed into chips and crisps. A tiny amount of the crop is sometimes exported –as the exports are not regular or steady. At times, the country also imports a small amount of seed and ware potatoes. The main trade partners for exports and imports of seed and ware potatoes are Kenya and Rwanda. Countries where Uganda imports of potato products such as crisps are Kenya, Britain, United Arab Emirates and Malaysia.

Potato production in Uganda is not increasing as would be expected. For the past five years, output has remained the same or even declined, although yield seems to have increased as a result of increased use of improved inputs.

Potato cultivation is a very profitable venture, the gross margin analysis for seed potato as well as ware potato cultivation reveals. Seed potato farmers reap higher benefits due to their close working relationship with KAZARDI, from whom they purchase basic seed at a subsidized price. Although the inputs such as fertilisers and fungicides, used in potato cultivation are expensive, the high factor productivity of these inputs makes their use economically worthwhile. Other inputs that are critical and yet expensive in potato cultivation are seed and labour. In the highlands, traction power is of limited application thereby making human labour the only practical resource for tilling land and transporting produce.

The gross margin analysis for the travelling trader indicates that traders dealing in potato produce earn reasonably well from the trade. Farmers especially in Mbale district double as travelling traders to cut off middlemen and increase their income.

The feasibility analysis of seed and ware potato export from Uganda to Kenya and Rwanda revealed on one hand that Uganda does not have the capacity to sustainably supply a potential export market and on the other that actually an economically viable export market does not exist within East Africa. Even when the market existed such as Nairobi or Kigali, the analysis indicates that such an export would lead to economic loss rather than a profit.

In reviewing the sub-sector, attention was paid to identifying the strengths to rely on, weaknesses to overcome and opportunities to exploit as well as threats to be wary of, for improved performance of the potato sub-sector. These issues are summarized in the SWOT analysis table.

SWOT analysis of potato sub-sector

Strengths	**Opportunities**
• Modern tissue culture laboratory and aeroponics green house for seed production • Existence of potato processing standards to regulate quality of processed and traded potato products	• Input subsidies under NAADS programme • Production under irrigation in Kapchorwa using free gravity water provided by government • Versatile Victoria variety adaptable in grassland agro-ecological zones • Increasing urbanization and consumers preference for potato chips and crisps • Processing capacity building opportunities offered by UIRI
Weaknesses	**Threats**
• High price of inputs limiting the use of improved inputs • Adulterated inputs leading low factor productivity • Limited capacity of KAZARDI to produce higher volume of basic seed. • High use of locally saved seed • Poor and inadequate road infrastructure in highland areas leading to high transport costs and affecting access to markets • Limited access to business development services (e.g. credit, market information, storage etc.) by farmers, traders and small-scale processors -limiting use of improved technologies to increase in output • Limited processing and value addition • Unreliable electricity supply leading to production losses by medium-scale processors • Weak enforcement of potato processing standards • Weak or lack of institutional framework supporting potato value-chain development	• Unpredictable weather –climate change? • Diseases and pests • Non-tariff barriers including sanitary and phyto-sanitary requirements restricting potential exports •

7.2 Conclusions and recommendations

From the diagnostic and feasibility analyses of the potato sub-sector, some of the key conclusions and recommendations that emerge are:

Conclusion 1: The stagnant or declining potato production in Uganda is not good news at all amidst the rapidly increasing population, urbanization rate and per capita income growth. Population growth, urbanization and higher per capita income are all expected to increase the demand for food in general and potato produce and products in particular. It is therefore important and incumbent upon appropriate government institutions to implement innovative ways of rapidly increasing potato output and yield to much the anticipated growth demand for potatoes in Uganda in the near future.

***Recommendation 1**: Since potato varieties such as Victoria adapt well in a range of agro-ecological zones, potato research and development institutions such as KAZRDI and NAADS should pattern up and explore options of promoting potato production in other areas other than highlands only.*

Conclusion 2: UNSPPA as a key institution in the promotion and development of the potato seed system in Uganda does not have the capacity to effectively take on this daunting task. The potato seed system risk remaining in the indeterminate state as it has been for the past years if this scenario is maintained.

***Recommendation 2**: KAZARDI as a key institution in the seed potato research and development domain should initiate new partnerships with other farmer groups with sole purpose of promoting seed potato production and utilisation in potato farming in Uganda.*

Conclusion 3: At present as well as in the near future, Uganda has neither the capacity nor the competitive advantage to produce and sustainably supply a potential export market of seed and ware potatoes. In the economic sense, Uganda's potato can be graded as a non-tradable. Besides, an economically viable export market for seed and ware potatoes does not exist within East Africa at present.

***Recommendation 3**: Institutions working in research and development domain of the potato sub-sector would benefit most if they focus their attention and resources on increasing productivity and developing potato products that satisfy the internal market. Additionally, focusing on potato value addition through processing products such as potato flour and starch is economically meaningful for export than focusing on export of bulky and perishable potato produce*

Conclusion 4: Potato processing especially crisps in Uganda has rapidly grown over the recent past but the processors hardly recognize and/or relate to each –leading to unhealthy competitive practices such as underweight packaging and mislabeling besides poor quality.

***Recommendation 4**: Individuals and companies in the business of potato processing need to initiate and establish an association to promote and regulate the activities of their business for the benefit of the producers and consumers of potato products as well as the economy.*

Conclusion 5: Quality standards for production and trade in various potato products in the East African Community have been ratified. These standards are not yet enforced for locally produced and traded potato products in Uganda. Lack of enforcement of quality standards undermines the capacity of local companies to produce for export.

***Recommendation5**: Government should start to enforce some minimum standards.*

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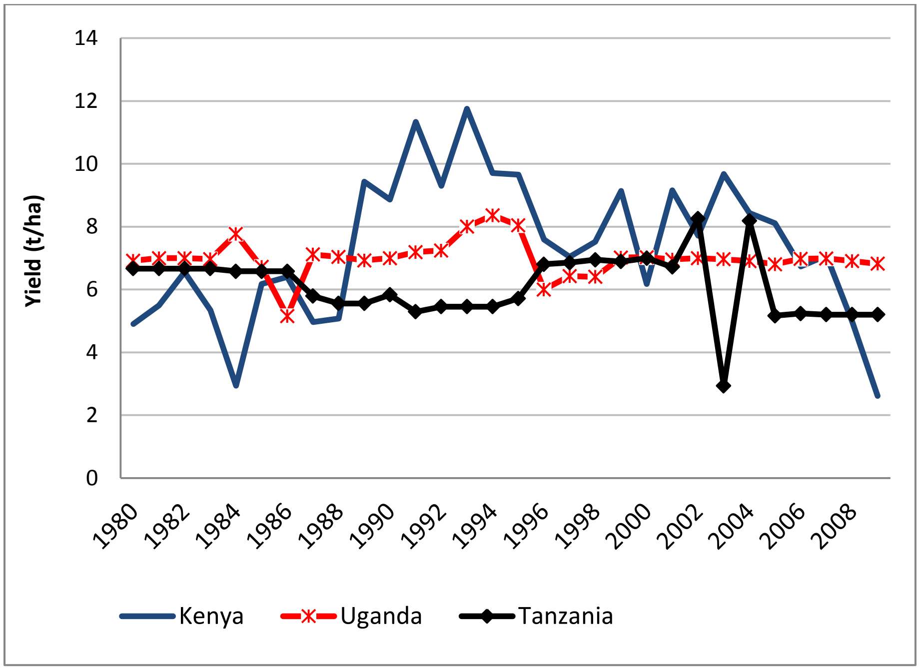
APPENDICIES

Figure 16. Potato yield in Kenya, Uganda and Tanzania, 1980-2009.



Data source: FAOSTAT accessed February 2011

Table 23. List of some of the key people interviewed during field survey

Name	Occupation	Location
Banda	NAADS Coordinator	Kisoro district, Tel: 0702-386284
James Hashaka	Chairman, NAADS Farmer Fora/ farmer	Kisoro district, Bunagana Town Board Tel: 0772-550407
Arsene Mbonye	Farmer/trader	Kisoro district, Nyarusiza sub-county, Tel: 0782-691079
David Kabuye	Farmer	Kisoro district, Nyakinama Sub-county, Tel: 0774-776299
Geoffrey Rugaragura	Trader	Kisoro district, Tel: 0774072225
Yoweri Bipfakubaho	Farmer	Kisoro district, Nyakinama Sub-county, Tel: 0783-147314
Name undisclosed: No authority to comment for URA	Officer, Uganda Revenue Authority (URA)	Cyanika, Kisoro district
	Farmer	Muko, Kabale
Stephen Tindimubona	Chairman, UNSPPA	Kabale district, Tel:
Charles Byarugaba	Chairperson, Nyabyumba farmers group	Kabale, Tel:0772-984619
Keith Aharinta and Evas	Laboratory technicians, Kalengyere Research Centre	Kabale
Dr. Imelda K	Director, KAZARDI	Kabale
	Manager, Potato & Bamboo factory	Kabale
Jowali Wanyiaye	NAADS Coordinator, Wanale sub-county	Wanale, Mbale Tel: 0782-607922
Nandudu Florence	Secretary Mudeso Farmers Group/ Farmer	Mbale district, Wanale sub-county
Sowali Mubajje	Farmer /travelling trader	Mbale district, Wanale sub-county
Abasa Gutaka	Farmer /travelling trader	Mbale district, Wanale sub-county
Godfrey Bugoli	Trader	Mbale Main Market
Francis Alinyo	District NAADS Coordinator	Kapchorwa , Tel: 0782-105282
James Laibich	NAADS Coordinator, Kapteret sub-county	Kapchorwa district 0782-930652
Joseph Munerya	Farmer	Kapchorwa district, Kapchesombe sub-county, Tel: 0782-903007
Peter Chepsikor	Farmer	Kapchorwa district, Kapchesombe sub-county, Tel: 0772-500836
Samuel Mwangusho	Farmer	Kacphorwa district, Kaptanya sub-county, Tel: 0773-149957
Cecilia	Crisps Processor	Kampala, Nakawa Division, Tel: 0777666603
Tom Chris	Crisps Processor	Kampala, Tel: 0772460793

Table 24. Casual ranking (descending order) of major potato production Sub-counties in study area

District	Sub-county
Kabale	Muko, Nyabyumba, Kalengyere
Kisoro	Nyarushiza, Muramba, Bukyimbiri, Kanaba, Murora, Nyakabande and Nyakinama
Mbale	Wanale, Bufumbo, Busano and Bukonde
Kapchorwa	Kaptanya, Tegeres Kapchesombe nad Kapteret

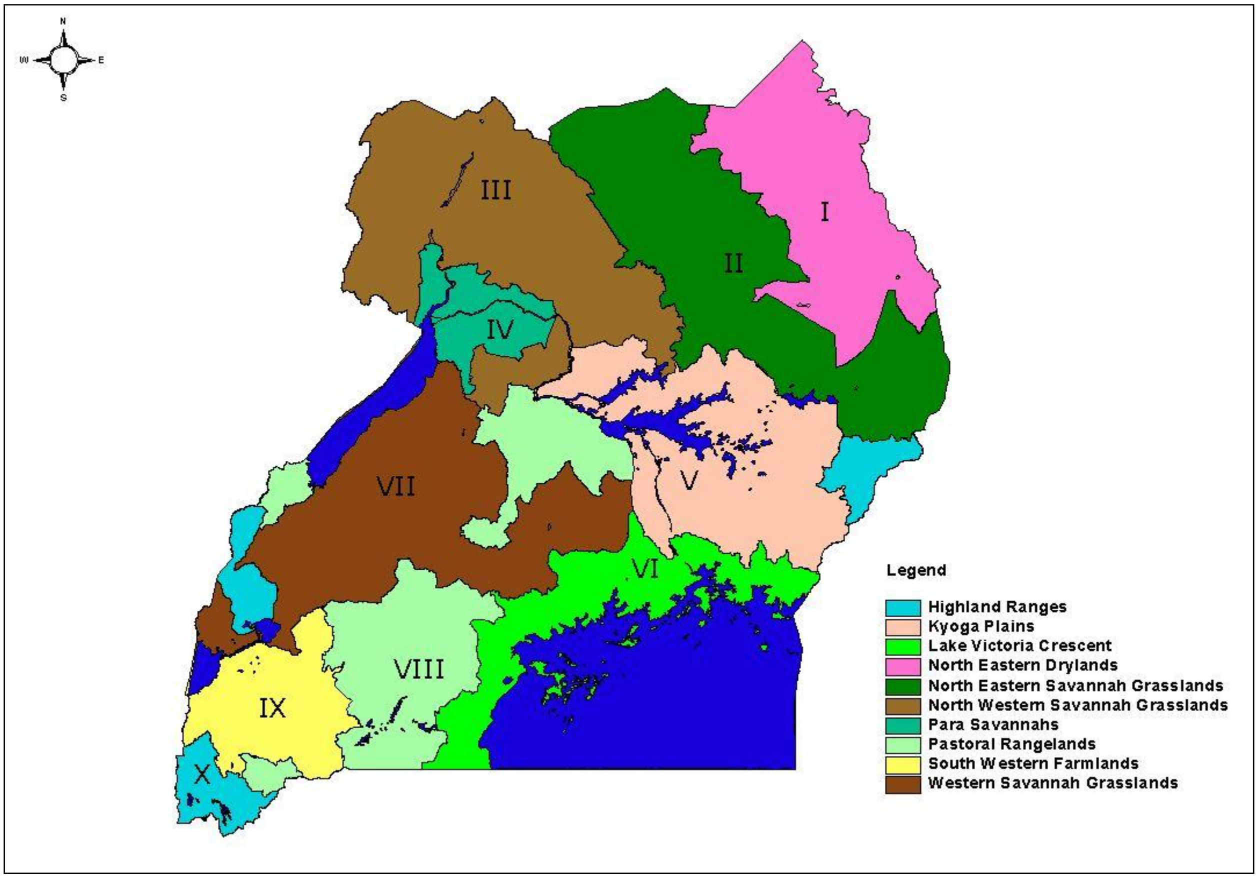
Source: Field survey, February 2011

Table 25: Magnitude of disparity in FAO/Statistical abstract and UNHS/Census data for potato production

	FAO/Statistical Abstract (2008)	UCA data (2008/2009)	magnitude of variation FAO: UCA data
Area cultivated (ha)	97,000	32,758	3.0
Output (t)	670,000	154,388	4.3
Yield (t/ha)	6.8	4.7	1.4

Source: FAOSTAT, accessed January 2010; UBoS Statistical Abstract, 2010; UBoS UCA 2011.

Figure 17. Map of Uganda's agro-ecological zones



Source: ______, 2004. Zoning Report

Appendix 3. Climate and other characteristics in potato production zones

Zone	Districts	Climate	Other characteristics
VII	1. Hoima 2. Kiboga 3. Southern Luwero 4. Mubende 5. Kibaale 6. Kyenjojo 7. Kabarole 8. Kamwenge 9. Southern Kasese	• Average rainfall of 1,270 mm with high variability, from about 800 over eastern L. Albert parts to about 1400mm over the western parts. • Two rainy seasons, main season from August to November with peak in October and secondary season March to May with peak in April. Main, dry season from December to about mid March secondary dry season is June to July. Evaporation exceeds rainfall by a factor of up to 5 during the dry months. During the rainy months, rainfall is greater or equal to evaporation. • Temperature range from 15 – 30 °C • Altitude ranges from 621 – 1,585 m ASL	• Soils are generally good to moderate • Land available for agriculture and under utilized • Small to large scale farming but majority are smallholder • Out-grower systems existing • Infrastructure moderately developed • Land ownership disputes in some parts • Ongoing programmes include NAADS, DDSP, Fisheries Development Project
IX	1. Western Mbarara 2. Bushenyi 3. Northern Ntungamo 4. Rukungiri 5. Northern Kanungu	• Average rainfall range of 1,120 – 1,223 mm • High variability, lowest about 800 mm Kasese Rift Valley, highest over slopes of Rwenzori mountains, over 1500mm • Two rainy seasons, main season from August to November with peak in September to November and secondary season in March to May with peak in April. For Mubende and Luwero the main season is March to May with a peak in April and the Secondary season from October to December with a peak in November. • Evaporation exceeds rainfall by a factor of about 5 during the dry months from December to March. During the rainy months of March, and August to November rainfall exceeds evaporation. Main dry season is from December to late March, secondary dry season is June to August. • Temperature ranges from 12.5 – 30°C • Altitude ranges from 129 – 1,524 m ASL	• shortage of land and land fragmentation in some parts of the zone • Largely small to medium scale intensive farming • Potential for block farming e.g. in Kasese • Moderate literacy rate • Relatively well organised and moderately endowed • Infrastructure and marketing systems are fairly well developed • Farmers' entrepreneurial skills are well developed • Attitudes towards farming are good • Ongoing programmes include NAADS, Area-based Agricultural Programme, IFAD, FDP
X	1. Northern Mbale 2. Southern Sironko 3. Southern Kapchorwa 4. Southern Kanungu 5. Kabale 6. Kisoro 7. Northern Kasese 8. Southern Bundibugyo	• Rainfall usually more than 1400 mm • Two main rainy seasons from September to December for the Kabale, Kisoro and Kasese region • One long rainy season from March to October with peak in April and Secondary peak in August for Northern Mbale, Southern Sironko, Southern Kapchorwa • Temperature ranges from 7.5 – 27.5 °C • Altitude ranges from 1,299 – 3,962 m ASL	• Soils are mostly young volcanic and are rich in nutrients • Mountainous high altitude areas • Cultivated land is highly fragmented with small plots covering terraced hillsides • Infrastructure is poor largely due to the terrain • Entrepreneurial skills fairly developed • Stable geo-politically • Ongoing programmes include NAADS, Agro Forestry, African Highlands initiatives, AFRICARE, IUCN, CARE

Source: ______, 2004. Zoning Report

Table 26. South Africa seed potato export; partner and value (1000 US$)

Partner name	yr2000	yr2001	yr2002	yr2003	yr2004	yr2005	yr2006	yr2007	yr2008	yr2009
Angola	847.50	1473.20	1860.53	2491.10	885.65	749.79	1295.06	1326.85	565.03	184.34
Antigua and Barb	0	0	0	0	0	0	13.32	110.19	70.57	0
Argentina	0	0.12	0	0	0	0	0	0	0	0
Australia	42.57	4.63	14.81	6.68	0.22	3.15	1.69	0	0	8.28
Belgium	1.28	1.14	0	0	0	0	0	0	0	0
Benin	0	4.70	5.96	0	0	0	0	0	0	0
Brazil	0	0	0	0	0	0	30.84	0	0	0
Bunkers	0	0.01	0.03	0	3.43	48.43	69.62	76.61	112.46	159.71
Canada	0	0	0.28	0	0	0	0	0	0	0
Chile	0	0	0	8.88	0	0	0	0	0	0
China	0	0	0	0	0	0	0	0	10.96	0
Colombia	0	0	0	0	0	0	0	0.03	0	0
Congo, Dem. Rep.	7.51	2.32	0	2.21	1.36	23.14	1.23	14.47	33.88	82.14
Congo, Rep.	0	16.52	61.96	14.89	13.09	0	17.69	0	0	3.03
Cyprus	0	0	0	0	0	0	4.52	3.22	0	0
Denmark	0	0.72	0	0	0	0	0	0	0	0
Ethiopia(exclude	0	0	0	0	0	0	139.77	0	0	0
France	1.55	33.72	0	0	0.85	0	0	0	4.57	0
Gabon	0.00	0	0	28.19	0	0	0	0	0	0
Germany	5.81	0.01	0	0	0	0	0	0	0	0.04
Ghana	0	0	0	0	0	10.43	5.32	20.46	0	0
Hong Kong, China	0	7.05	0	0	0.01	0	0	0.00	20.23	18.52
India	0	0	0	0	0	0	0	3.46	0	0
Indonesia	1.30	0	0	0	0	0	0	0	0	0
Iran, Islamic Re	0	0	8.95	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	15.13	0	0	0
Japan	0	0	0	5.02	0	0.01	0.12	0	0	0
Kenya	0	0.48	0	0	0	0	0	0	0	0
Kuwait	0	0	4.48	0	0.00	0	0	0	0	0
Malawi	5.16	5.26	0.72	0	13.72	0	6.21	14.07	18.84	29.62
Malaysia	0	0	0	0	0	0	0	0	0	0.74
Mauritius	24.30	41.03	443.77	4.46	0.00	1.11	0	23.82	1.39	1.71
Mayotte	0	0	0	0	3.58	0	0	0	0	0
Mozambique	60.05	33.85	17.03	4.60	15.27	28.02	168.26	275.41	302.01	399.31
Netherlands	6.57	34.03	22.65	7.20	0.31	19.60	50.63	15.71	0.29	1.75
Netherlands Anti	0	5.34	0	0	0	0	0	0	0	0
New Zealand	0	0	0	0	0	0	0	0	0	9.28
Nigeria	0	0	1.66	0	0	0	0	0	3.39	1.86
Oman	0	0	4.69	0	0	0	0	0	0	0
Pakistan	0	0	0	0	0	0	0	0.13	0	1.15
Poland	0	0	0	0	0	0	0	86.41	0	0
Portugal	0	0	0.40	0	0	0	0	0.00	0	0
Saint Helena	9.66	13.82	24.81	68.80	64.90	65.82	48.19	51.92	38.32	13.98
Saudi Arabia	0	0	22.04	0.00	0	0	0	0	0	0
Seychelles	0	0	0	0.70	0.05	0	0.03	0	0	0
Singapore	0	0.01	0	0	0	0	0	0	0	0
Tanzania	6.22	0.71	0.46	0	0	0	0	0	0	0
Thailand	0	0	0	0	0.88	0	2.64	0	0	0
Uganda	0	0	0	0	0	0	0	0.01	0	0
United Arab Emir	0.21	0	0	0	0	0	0	0	0	0

United Kingdom	2.15	1.35	0	0	0.73	0	0	0	0.01	0
United States	1.40	16.72	6.38	18.38	3.71	2.99	10.39	0	3.22	0
Unspecified	0	0	0	0.22	0	0	0	0	0	0
Uruguay	0	0	0	0	0	0	0	0	13.53	0
Zambia	72.91	155.14	76.37	111.47	421.04	526.72	455.82	435.28	239.19	554.81
Zimbabwe	16.20	36.67	0.00	19.80	0.27	12.28	35.30	15.26	26.08	166.42
Total	1112.35	1888.54	2578.06	2792.58	1429.08	1491.49	2371.78	2473.49	1463.97	1636.68

Data source: WITS database, accessed January 2011

Table 27. South Africa ware and other potato export; partner and value (1000 US$)

Partner name	yr2000	yr2001	yr2002	yr2003	yr2004	yr2005	yr2006	yr2007	yr2008	yr2009
Andorra	0	0	0	0	0	0.32	0	0	0	0
Angola	1395.9	1700.9	1910.2	3891.2	5628.1	6163.5	5981.1	5026.3	1916.7	2176.2
Antarctica	0	0	0	0	0	0.05	0.1	6.49	0.31	0.52
Antigua and Barb	0	0	2.75	0	0	0	1.8	0	0	0
Barbados	0	0	0	0	0	0.02		0	0	0
Belgium	5.8	0	0.09	0	4.63	0		6.40	0	0
Benin	9.99	3.97	6.95	0	0	0.19		0	0	0
Bunkers	0	0.15	0.07	0	23.85	173.17	186.70	280.01	233.81	291.56
Burundi	0	0	0	0	0	0		0	0	0.006
Cameroon	0	0.058	0	0	0	0		0	0	0
Canada	0	0	0	0	0	0		0	1.99	0
Colombia	0	0	14.31	0	0	0	5	0	4.61	0
Comoros	1.87	0.267	0	0	0	0.10		0	0	0.03
Congo, Dem. Rep.	56.40	39.76	115.04	48.38	34.56	5.58	35.0	83.95	57.68	50.91
Congo, Rep.	0	3.27	17.07	19.11	25.41	15.08	16.8	165.86	153.35	238.54
Cote d'Ivoire	0	6.31	0	2.69	0	0.01	12.5	108.94	0	0
Cyprus	0	0	0	0	0	0		0.16	5.32	0
Equatorial Guine	0	0	0	0	0	0	12.88	0	0	0
Eritrea	0	0	0	0	0.016	0	0	0	0	0
Ethiopia(exclude	0	0	0.17	2.74	2.48	0	0	0	0	0
France	0	35.97	38.42	153.92	177.31	215.93	34.15	524.97	129.69	6.18
French Polynesia	0	0	0	0	0	0	0	5.049	0	0
Gabon	7.89	7.87	9.79	18.87	21.05	15.25	0.57	2.52	3.57	0.31
Gambia, The	0	0	0	0	0	0	0	8.59	0	0
Germany	0	0	0.019	0	0	0	0	0	101.54	0
Ghana	0.34	0.99	2.72	4.02	16.57	5.05	12.72	0.40	0.85	6.95
Greece	0.10	0.01	0	0	0	0	0	0	0	0
Guinea	0	0	0	0	0	0	0	0	0	29.03
Hong Kong, China	0	0	0.045	0	0.171	0.024	0	0	0.045	0
Indonesia	0	0	0	0	0	0	1.174	0	0	0
Japan	0	0	0	0	0	0.32	0.01	1.91	0	0
Kenya	0	0	0.014	0	0	0	0.16	0.22	0	0.01
Kuwait	0	0	0	0	0	0.001	0	0	0	0
Madagascar	0	0	0	0	0	0.005	0	0	0	0
Malawi	66.607	22.876	47.82	79.308	61.127	57.405	82.155	89.626	44.448	51.33
Malaysia	0.003	0	0	0	19.248	0	0	0	0	21.39
Maldives	0	0	0	0	0.144	0	0.176	0	0.596	0
Mali	0	0	0	0	0	1.53	0	0	0	0.01
Mauritius	658.17	539.85	556.33	1134.98	850.34	117.83	0.073	38.02	57.64	0.15

Mayotte	0	0	0	0	8.51	10.11	14.99	5.235	6.07	15.23
Morocco	0	0.352	0	0	0	0	0	0	0	0.48
Mozambique	944.0	588.0	732.1	1396.6	1078.5	79.1	2230.7	2954.4	4146.2	4347.56
Netherlands	0.01	14.48	109.02	129.79	204.85	184.84	154.96	52.92	0	0
Netherlands Anti	0	0	3.729	0	0	0	0	0	0	2.929
New Zealand	0.136	0	0	0	0	0	0	0	6.94	0
Nigeria	0.078	2.349	12.914	45.191	7.965	4.241	0	2.754	0.496	14.163
Northern Mariana	0	0	0	0	0	0	0	0	0	0.784
Panama	0	0	0	0	0	0.316	0.09	0.167	0.32	0.043
Papua New Guinea	0	0	0	0	0	0	0	43.163	14.196	11.417
Philippines	0	0	0	0	0	0.023	0	0	0	0
Portugal	0	0	0	0	0	0.071	0	0	0	0
Saint Helena	24.102	18.923	19.376	17.421	15.108	81.307	41.51	52.646	72.514	112.52
Sao Tome and Prin	0	0	0	0	0.117	0	0	0	0	0
Saudi Arabia	0	0	0	0	0	0	0	0	0.015	0
Senegal	0	0	4.054	0	0	0	0	14.975	0	0
Seychelles	5.583	0.203	1.536	1.629	9.388	0.51	22.666	0.287	7.174	9.059
Sierra Leone	0	0	0	0	0.106	0	0	0	0	0
Singapore	0	0	0	0	0	0	0	0.267	2.991	45.358
Switzerland	0	0	0	38.857	0	0	0	0	0	0
Tanzania	0.118	1.31	3.15	6.318	0	0	0.646	0	0.926	0.596
Togo	0	0	0	0	4.15	0	7.63	26.98	33.01	0
Uganda	0	0	0	0	0	0	0	0.03	0.01	0
United Arab Emir	0	0	0	0	0	0	0.594	0	6.31	0
United Kingdom	0.26	22.48	60.37	98.68	67.28	77.23	19.80	4.26	4.89	0
United States	0	0.07	0	0	0	0	0	0.022	0.97	0
Unspecified	0	0	0	8.29	0	0	0	0.041	0	0
Uruguay	0	0	0	0	0.073	0	0	0	0	0
Zambia	56.50	81.58	31.53	21.27	33.02	126.19	105.65	210.63	390.31	395.55
Zimbabwe	44.98	100.46	19.64	0	48.94	164.89	37.97	74.47	241.98	1354.91
Total	3278.74	3192.43	3719.20	7119.25	8343	7500.24	9021.24	9792.67	7647.44	9183.74

Data source: WITS database, accessed January 2011

Annex 2

A Roadmap for Revitalization of the Potato Sub-Sector in Kenya

A Roadmap for Revitalization of the Potato Sub-Sector in Kenya

Foreword

In the coming decades, a growing population will demand a greater quantity, variety and nutritional value of food than Kenya has ever produced before. It is projected that the country's population will reach over 60 million by 2030. Meeting this demand will require more than doubling of the food production, challenging a natural resource base that is already under significant strain. It will also require major increases in investment in agriculture under a backdrop of economic crisis, austerity measures and limited budgets.

The vision 2030 and Agriculture Sector Development Strategy (ASDS), Kenya's main policy documents on economic development and agriculture, recognize agriculture as one of the six key economic sectors expected to drive the country's economy to a projected 10 percent economic growth annually through promotion of an innovative, commercially-oriented and modern agriculture. The potato is one of the crops that can help to meet the country's aspirations but is beset by several challenges including i) low yields, high disease incidence, limited availability of desired varieties; ii) limited production, distribution and use of quality seeds; iii) fragmentation of actors and players with uncoordinated activities; and iv) low value addition and limited agribusiness activities.

Addressing these challenges effectively requires a new roadmap for revitalizing the potato subsector – one which leverages available resources to deliver economic growth and opportunity, improved food security and nutrition, and environmental sustainability through a re-invigorated potato sub-sector sector. Translating the road map for the potato subsector into action will be challenging, but feasible. It requires a substantially new approach in which actors in the potato subsector collaborate to develop new solutions and leverage investments for maximum impact. It will also require a change in mindset. Agriculture and indeed potato production needs to be viewed as a knowledge-based entrepreneurial activity. The youth in Kenya can no longer afford to see farming as a last-ditch effort when all other opportunities fall through. Potato production must be viewed as a profitable business opportunity for young entrepreneurs. Yet for that to happen, potato production must actually be a profitable and steady business opportunity for entrepreneurs.

This road map outlines how that can be achieved both strategically and operationally. The road map has the potential to deliver increased employment, expanded access to nutritious and affordable food, and sustainable resource use. The result can contribute towards the country's efforts of reinvigorating the economy, providing sustainable livelihoods for the many smallholder farmers and a resilient source of economic growth for potato growing counties in Kenya.

Progress towards the goals of this roadmap will be driven by: i) significant advances in productivity on smallholder farms and sustained productivity improvement on medium and large-scale farms ii) Increased value added on smallholder farms; and (iii) reduction of waste throughout the potato value chain. Monitoring the progress of the subsector towards the goals, will be essential to ensure implementation of the roadmap remains on course. Achieving the change required to realize the goals of the roadmap requires increased skills and investment in the potato subsector to improve potato productivity, sustainability and prosperity. Such transformative change can only be achieved through multi-stakeholder partnerships.

Stakeholders must adopt a ‘business unusual approach’ and ‘move out of their silos’, acting outside of traditional roles and structures and collaborating in innovative ways to achieve the transformation envisioned in this roadmap. Multi-stakeholder initiatives often operate from a jointly-created platform, e.g. a coordinating unit, which creates a neutral space in which to develop and enact the shared agenda. Such a structure engages leaders representing broader stakeholder networks whose support is essential to the initiative’s success. Partnerships can ensure progress by firmly anchoring their mission around shared goals, and focusing on collaboration and continuous dialogue to achieve practical progress towards those goals.

Kenya can be made more food-secure and with increased incomes through renewed investments in research and development of the potato subsector. Such investments will help to keep potato productivity increasing despite challenges from arising from resource constraints, pest and disease pressure, and the uncertainties of climate change. Without a sustained commitment, however, the country risks a future with food shortages and higher food prices.

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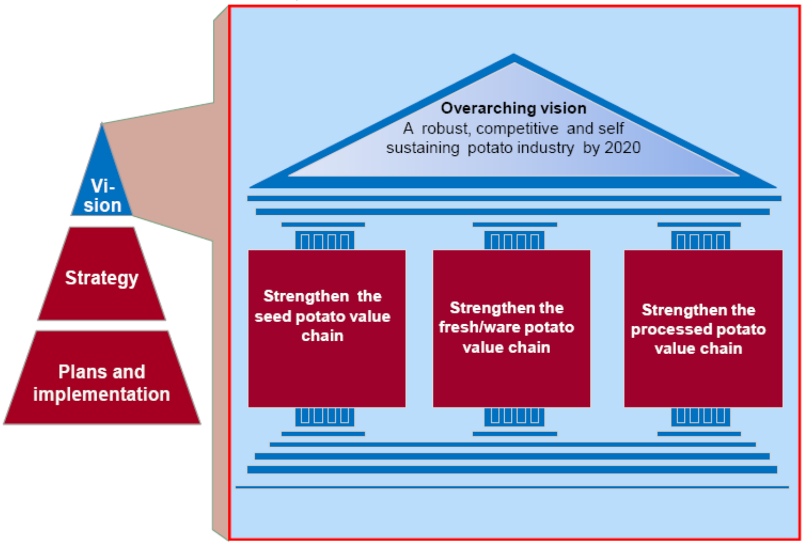
Overarching vision
A robust, competitive and self sustaining potato industry by 2020
Vi-sion
Strategy
Plans and implementation
Strengthen the seed potato value chain
Strengthen the fresh/ware potato value chain
Strengthen the processed potato value chain

Acronyms

ACTESA	Alliance for Commodity Trade in Eastern and Southern Africa
ADC	Agricultural Development Corporation
AFSTA	African Seed Testing Association
AGRA	Alliance for a Green revolution in Africa
ASARECA	Association of Strengthening Agricultural Research in Eastern and Central Africa
ASDS	Agricultural Sector Development Strategy
ATC	Agricultural Training Centre
BAF	Business Advocacy Fund
BS	Basic seed
BMZ	Federal Ministry of Economic Cooperation -Germany
BW	Bacterial wilt
CAADP	Comprehensive African Agricultural Development Program
CRS	Catholic Relief Services
CIP	International Potato Centre
DAO	District Agricultural Office
DUS	Distinct, Uniform and Stable
DLS	Diffused Light Store
EAC	East African Community
EASCOM	African and Eastern Africa Seed Committee
FAO	Food and Agriculture Organization
FIAN	FoodFirst Information and Action Network
FFS	Farmer Field School
FPS	Farmer Produced Seed
G0	Generation zero seed
G1	Generation one seed
G2	Generation two seed
G3	Generation three seed
GDP	Gross Domestic Product
GIS	Geographical information system
GIZ	Germany International Technical Corporation
GoK	Government of Kenya
GTIL	Genetics Technologies International Limited
GMPs	Good Manufacturing Practices
ICT	Information and Communication Technology
IFAD	International Fund for Agricultural Development
IDM	Integrated Disease Management
IPM	Integrated Pest Management
KFC	Kentucky Fried Chicken
KARI	Kenya Agricultural Research Institute
KENAPOFA	Kenya National potato Farmers Association
KENFAP	Kenya Federation of Agricultural Producers
KEPHIS	Kenya Plant Health Inspectorate Services
KFC	Kentucky Fried Chicken
Ksh	Kenya Shilling
MDGs	Millennium Development Goals
MoA	Ministry of Agriculture
NAAIAP	National Accelerated Agricultural Input Access Programme
NARL	National Agricultural Research Laboratories

NCST	National Council of Science and Technology
NDA	National Designated Authority
NEPAD	New Partnership for Africa's Development
NMK	Njaa Marufuku Kenya
NPCK	National Potato Council of Kenya
NPT	National Performance Trials
PLVY	Potato leaf roll virus
PPP	Public–Private Partnership
PMCA	Participatory Market Chain Approach
PS	Positive Selection
PSDA	Private Sector Development in Agriculture
PVY	Potato virus Y
PVY^{NTN}	Potato Virus Y NTN strain
QDS	Quality Declared Seed
SME	Small and Medium Scale Enterprise
t	Tonnes
TC	Tissue culture
ToT	Trainer of Trainers
USD	US Dollars
USAID	United States Agency for International Development
ZC	Zebra Chip

Executive summary

Potato is currently the second most food crop after maize and also an important cash crop. The crop makes significant contributions to economic growth. Because the crop is labour intensive, it generates employment in production, marketing and processing segments of the value chain. There are approximately 800,000 farmers involved in potato production while about 2.5 million people are employed in the potato industry as market agents, transporters, processors, vendors and exporters. Based on consumer prices, recent estimates place the value of the crop to more than Ksh. 46 billion.

The foregoing notwithstanding, the potato subsector has an unexploited potential that can make significant contributions to Kenya's development aspirations-particularly those related to food and nutrition security and economic development- as articulated in the country's two main policy documents-The Vision 2030 and the Agriculture Sector Development Strategy (ASDS).

The potato has many favourable attributes. The crop has wide acceptance in Kenya with many households depending on potato as primary or secondary sources of food and nutrition. Potatoes are highly nutritious. They are rich in protein, calcium, potassium, and vitamin C, and have an especially good amino acid balance. They are also high in fibre especially when the potatoes are served with their skins. Moreover, the potato is a highly productive crop. It produces more food per unit area and time than wheat, rice and maize. One of the crop's assets is its adaptability. It can be grown in a wide variety of farming systems. The crop has a short and highly flexible vegetative cycle, and is ready for harvesting within 100 days, fits well with double cropping and intercropping systems. In addition, potatoes are ecologically adaptable. They can be grown at almost any altitude or climate including the ASALs. The potato can also be grown as an off-season crop. Fresh potatoes have much to offer health conscious consumers. They are relatively low in calories, virtually free of fat and cholesterol.

Despite the investments made into the potato subsector the last several years, growth of the subsector has not been satisfactory. The subsector is currently characterised by: low commercialization, low average yields, uncompetitive, high wastage, low value addition with limited processing and limited agribusiness activities. There are very few contractual arrangements between producers and end users of potatoes e.g. processors, fast food restaurants or supermarkets.

Some of the challenges that still beset the subsector include: i) Inadequate use of certified seeds due to unavailability and high cost of seed; ii)Inadequate financial, technical and infrastructural capacity for potato seed production; iii) Fluctuations in weather conditions particularly rainfall leading to seasonal gluts and scarcities and at times crop failure; iv) Inadequate irrigation infrastructure and limited access to investment capital; v) Inadequate rotation in the seed and ware potato production areas leading to high occurrence of diseases and pests especially bacterial wilt and viral diseases; vi) Low adoption of technology (agronomy, pest and disease control, soil management as well as post harvest recommendations); vii) Poor farmer organisation in production and marketing; viii) Inadequate appropriate financial packages targeting potato production; ix) Low level of

public-private sector partnerships in research, extension and seed production, ware production and processing; x) A dominant informal potato seed sub-sector, largely controlled by unstructured systems that provide low quality seed; xi) Disharmony between the various statutes governing seed production and other subsidiary legislations that guide the potato industry; xii) Most of the seed multiplication of seed is done away far from most farmers hence constraints in accessing seed by farmers. The decentralized farmer based seed system has not picked up as fast as initially projected; Xiii) Inadequate resources such as extension personnel, funds and other facilitating factors; xiv) Low level of public-private sector partnerships in extension in potato production; xv) Weak linkages from research-extension-farmers-processors to consumers; xvi) Lack of environmentally friendly technologies in the potato industry; xvii) Exploitation of growers and consumers by middlemen (brokers and cartels) resulting in high transaction costs along the supply and demand chain largely due to lack of transparency. There is poor flow of market information; xviii) potato market instability as a result of supply fluctuations as associated with potato perishability; ixx) Poor enforcement of existing standards in ware potato production, grading, packaging, weighing, storage and transporting; xx) Limited export of potatoes and potato products; xxi) Processing is hindered by lack or unavailability of sufficient quantities of the preferred varieties; xxii) Inadequate product development (or value added products) and promotion; xxiii) Inadequate knowledge and investment capital in post-harvest handling and storage; xxiv) Poor road infrastructure and consequent high transportation costs; and xxv) poor communication networks between urban consumers and rural producers; xxvi) low availability and poor access to credit

In order to transform the potato subsector from subsistence to a vibrant, commercially oriented subsector, a new roadmap for– one which leverages available resources to deliver economic growth and opportunity, improved food security and nutrition, and environmental sustainability is required. This road map provides a guide as to the core investment areas of the potato subsector. The investment areas have been broadly grouped into three: i) the seed potato value chain ii) the ware potato value chain; and iii) the processed potato value chain.

The roadmap targets to increase yields by at least 20% to achieve three overarching objectives namely: a 15% increase in farm incomes, improved food security through a 10% increase in potato production, and more business opportunities for at least 10% of potato growing households.

It is estimated that investment required to further grow the subsector over the next five years is US $ 30 million.

CHAPTER 1. INTRODUCTION AND BACKGROUND

1.1 Importance of Agriculture in Kenya

Kenya's agricultural sector is the mainstay of the national economy and provides the basis for the development of the other sectors. Its direct contribution to the gross domestic product (GDP) is 26% while the indirect contribution, through linkages with agro-based and associated industries, is approximated to be 27%. Overall, the agricultural sector employs over 80% of the total labour force, generates 60% of foreign exchange earnings and provides 75% of industrial raw materials. About 80% of Kenya's population live in the rural areas with three quarters of them engaged in agricultural activities. The sector is dominated by smallholders who account for approximately 75% of the total output. Growth in the agricultural sector is closely linked to the overall economic growth in Kenya. It is estimated that a 1% increase in the sector results in a corresponding 1.6% GDP growth in the overall economy. Agriculture, therefore, remains the engine of the national economy and its performance impacts heavily on nearly all other sectors. By contributing raw materials to the manufacturing/industrial sector, the agricultural sector has a definite role in Kenya's progress towards becoming a newly industrialized country by 2030 as envisioned in Vision 2030-Kenya's long term economic blue print (GoK, 2007). Agriculture is not only important for development of the country but is also expected to deliver other regional and global commitments. Cross-country estimates show that GDP growth originating from agriculture is at least twice as effective in reducing poverty as GDP originating outside the sector.

For the agricultural sector to continue contributing significantly to the overall goal of economic growth, wealth creation, food security and poverty alleviation, smallholder agriculture must be transformed from subsistence to a commercial and profitable business enterprise. This is clearly articulated in the Agriculture Sector Development Strategy (ASDS) - the overall national policy document for the Agriculture sector ministries and all stakeholders in Agriculture in Kenya for the period 2010-2020 (GoK, 2010d). The ASDS envisions a food secure and prosperous nation by 2020 while its mission is 'innovative, commercially oriented and modern agriculture'.

The broad national objectives of the agricultural sector as articulated in various policy documents including the Agriculture Sector Development Strategy (ASDS) are to contribute towards: (i) attainment and maintenance of domestic supply of the main food items; (ii) production of raw materials for industries; (iii) creation of gainful employment and increase in incomes of those involved in production; and (iv) conservation of natural resources.

1.2 National Development Aspirations and Challenges in Agriculture

The Vision 2030-Kenya's blue print for economic development for the period 2008-2030 identifies agriculture as one of the six key economic sectors expected to drive the country's economy to a projected 10 percent economic growth annually through promotion of an innovative, commercially-oriented and modern agriculture.

The Kenya vision 2030 has identified four major challenges that are faced by the agricultural sector (Gok, 2007). These are: (i) Productivity levels for many crops are below potential and for some agricultural produce; yield and value have either remained constant or are on the decline. (ii) Land remains under-exploited for agricultural production both in the high and medium potential areas as well as in the arid and semi-arid lands (ASAL) areas. Moreover, much of the available cropland remains under-utilized with smallholders utilizing only 60 per cent of their crop land for agricultural production. (iii) The productivity of the agricultural sector is constrained by inefficiencies in the supply chain resulting from limited storage capacity, lack of post-harvest services, and poor access to input markets. (iv) Kenyan farmers mainly export semi-processed, low-value produce, which accounts for 91 % of total agriculture-related exports. The limited ability to add value to agricultural produce, coupled with high production costs makes Kenyan agricultural exports less competitive in global markets.

1.3 Agricultural Value Chains and Kenya's Development Agenda

Strong links to markets for poor rural producers are essential to increasing agricultural production, generating economic growth in rural areas and reducing hunger and poverty. Improving these links creates a virtuous circle by boosting productivity, increasing incomes and strengthening food security. Better access by small producers to domestic and international markets means that they can reliably sell more produce at higher prices. This in turn encourages farmers to invest in their own businesses and increase the quantity, quality and diversity of the goods they produce. The structural transformation of rural based economies into more urbanized societies has opened new market opportunities to participants in the potato value chain, to further increase incomes and create more employment in the sector.

Poor rural producers and their goods are connected to markets within larger agricultural value chains. Every product that is sold locally, nationally or internationally is part of a value chain. And every link of the chain has the potential to add value to the product. Value chains are a key framework for understanding how inputs and services are brought together and then used to grow, transform, or manufacture a product; how the product then moves physically from the producer to the customer; and how value increases along the way. The value chain perspective provides an important means to understand business-to-business relationships that connect the chain, mechanisms for increasing efficiency, and ways to enable businesses to increase productivity and add value. It also provides a reference point for improvements in supporting services and the business environment. It can contribute to pro-poor initiatives and better linking of small businesses with the market. Increasingly, the value chain approach is being used to guide and drive high-impact and sustainable initiatives focused on improving productivity, competitiveness, entrepreneurship, and the growth of small and medium enterprises (SMEs). Enhancing value chain competitiveness is increasingly recognized as an effective approach to generating growth and reducing the rural poverty prevalent in the country.

Participation of majority of potato farmers in the value chains in Kenya is currently limited to that of a primary producer and farmers therefore fail to draw significant benefits by integrating with markets. The factors which prevent potato farmers' entry into the value chains need to be identified. Information on such entry barriers could help in designing appropriate pro-poor value chains. Further, once information on associated risks to small producers who are part of a market-led value chain and proven examples of innovative risk mitigating measures have been identified, these would help in designing appropriate value chain development strategies.

1.4 Challenges facing Kenya

A key challenge facing the country is to ensure food security for present and future generations, while protecting the natural resource base. Kenya's population currently stands at about 40 million and is projected to reach approximately 50 million by the year 2020. Kenya largely remains a food deficit country even in a bumper harvest year with any discussion on Kenyan food security usually revolving around maize due to overwhelming dependence on maize as the key food staple, in spite of a structural deficit in production. Overall, vulnerability to food insecurity in the country is exacerbated by the absence of substantive diversification in food production and consumption. The annual consumption per capita of maize is estimated at 98 kg making overall demand about 40 million bags annually but annual production ranges between 25-40 million bags in a good year.

Food prices have generally been on the increase in Kenya in the recent past due to a combination of several factors including droughts, global price trends, and government policy. The recent high food and fuel prices are also challenging some of the macroeconomic fundamentals because they have translated into higher inflation—estimated at over 10 % over the last several years—and contributed to a sharp decline in the exchange rate. Diversifying the country's food base is therefore an important challenge facing the country particularly in view to its vulnerability to international food price shocks. Additionally, since average land size per household is shrinking rapidly due to high population coupled with subdivision of land, crops that give more food, more nutrition and more cash per unit of area and time like potato are gaining increasing importance in the quest to find solutions to Kenya's perennial food security problems.

1.5 Key characteristics of Potato

Potato is variously referred to as the Irish potato, English potato or round potato. Others names are viazi or viaza mviringo in *Kiswahili*. It is one of the crops that can help meet the country's Kenya's development targets because it has many favourable attributes. The crop has wide acceptance in Kenya with many households depending on potato as primary or secondary sources of food and nutrition.

Potatoes are highly nutritious. They are rich in protein, calcium, potassium, and vitamin C, and have an especially good amino acid balance. Potatoes are relatively low in calories, virtually free of fat and cholesterol. They are also high in fibre especially when the potatoes are served with their skins. Moreover, the potato is a highly productive crop. It produces more food per unit area and time than wheat, rice and maize (FAO, 2009). One of the crop's assets is its adaptability. It can be grown in a wide variety of farming systems. The crop has a short and highly flexible vegetative cycle, and is ready for harvesting within 100 days, fits well with double cropping and intercropping systems. In addition, potatoes are ecologically adaptable. They can be grown at almost any altitude or climate including the ASALs. The potato can also be grown as an off-season crop.

The potato is also insulated from international shocks. Unlike major cereal commodities, crop is thinly traded in global markets. Only a fraction of its total production enters foreign trade. Thus, potato prices in Kenya are determined by local demand and supply conditions, not the vagaries of international markets. In addition, since potato is absent in major international commodity exchanges, the crop is not at risk of the ill-effects of speculative activity. Potato is therefore, a highly dependable food security crop that can help ease future turmoil in world food supply and demand. The potato is a highly recommended, nutrient rich food security crop that can shield low income countries from the risks posed by rising international food prices, while at the same time providing a valuable source of income for farm households.

Other positive attributes of the potato include its:

- ability to grow in the high altitude areas where maize does not do well;
- ability to be profitably intercropped with many horticultural food crops.
- high production per unit of time, per unit of land and per unit of water (can have three crops per year)
- suitability for rotation with crops such as barley, maize and wheat;
- low requirements of fuel energy and short cooking time, and its convenience in processing it into chips and crisps that are popular with both rural and urban inhabitants;
- importance as a cash crop, for both local and export markets thus making a significant contributor to the country's economic growth;
- to generate employment in production, marketing and processing sectors
- Potential as an industrial crop in the manufacture of starch, bread, bar soap, alcohol and animal feeds.
- use as a major ingredient for weaning foods

1.6 Rationale for a potato sub-sector roadmap

Despite the enormous potential of the potato sub-sector to contribute to national development and the overall goal of the agricultural sector of a food secure and prosperous nation, the sub-sector has lagged behind and its growth has not matched expectations. Yields continue to be low with farmers getting very little returns on their investment. The subsector is not sufficiently commercialized and competitive enough to contribute towards moving the country to the next level of development. There is fragmentation of actors and players with uncoordinated activities. There is also low value addition and limited agribusiness activities in the potato subsector.

Although, the country has the potential to grow sufficient potatoes to feed itself and have surplus for exports, years of underinvestment in infrastructure, research innovation, and market development have hampered efforts to profitably cultivate the crop and develop a vibrant and self sustaining potato subsector. The country's overdependence on maize as the only staple food has not helped either. The many concerted efforts by the government, donors, and international and national development organizations have not yet led to sustainable potato productivity growth in the country. As a consequence potato production systems have remained subsistent-oriented, natural resource intensive and low input–output rain-fed systems.

There is a consensus that market-oriented development of smallholder agriculture and indeed potato production in Kenya can be a critical pathway out of food insecurity, poverty, and a powerful tool to stimulate rural and national economic growth. Improving the productivity of smallholder agriculture and by extension potato production will directly contribute to the realization of the MDGs (Millennium Development Goals). The Comprehensive Africa Agricultural Development Program (CAADP), under the New Partnership for Africa's Development (NEPAD) initiative, recognizes smallholder agriculture as the engine for economic growth in the continent.

Until now the subsector has not had a road map to guide its development in a structured manner and also to guide investment. This road map aims at unlocking the potential of the potato sub-sector and making the subsector a leader in contributing towards household food security and income generation.

1.7 The process of development of the roadmap

This road map was arrived at following a rigorous consultative process. During an inception workshop for an FAO supported study on 'A Policy Makers Guide to Crop Diversification: The case of potato in Kenya (Kaguongo *et al*., 2012) 'held on 4th April, 2012, problems affecting the potato subsector were outlined and discussed with stakeholders. Following this workshop, a comprehensive study was undertaken by a team of potato experts drawn from National Potato Council of Kenya, Kenya Agricultural Research Institute, Ministry of Agriculture and International Potato Centre. At a Potato Round Table meeting held on 25th June, 2012**,** policy makers and major stakeholders discussed the recommendations of the FAO study, deliberated on important issues of the subsector that could contribute to mapping out the way forward for potato industry. Interventions and actions plans necessary to unlock the potential of the subsector were discussed and agreed upon with stakeholders (NPCK, 2012). Based on the two workshops, desktop research and addition discussions with experts and stakeholders in the potato sector, a consensus document 'a road map for development of the potato sector' was arrived at.

CHAPTER 2. OVERVIEW OF THE POTATO SUBSECTOR

2.1 General

In Kenya, potato is the second most important food crop after maize. The crop is cultivated by 800,000 growers for food and income generation and it is worth KES 46 billion (USD 541 million) annually. Potato is labour-intensive and it generates employment in production, marketing and processing sectors. Because it is a major source of income in the production and consumption areas, potato is assuming increasing importance as a cash crop. Annually the country produces about 3 million tons of potatoes from 131,047 ha of land (GoK, 2011). These figures are much higher than the production figures cited by FAO (FAOSTAT, 2011). The potatoes produced are consumed and processed for use locally; with minimal imports and exports (Ng'ang'a and Wachira, 2012). Potato is thus a staple food and a cash crop for many rural and urban families. It is consumed mainly boiled (in stews), fried (as chips and crisps) or mashed (together with maize or/and beans and/or other vegetables). As a food crop, potato is an important source of carbohydrates, proteins, and vitamins; and plays a major role in food security. Potato plays an important role in national food and nutrition security, poverty alleviation, and income generation and provides employment in production to consumption continuum even though it faces many challenges.

Potatoes short cropping cycle, its high production per unit area and time, and it adaptability to climate change; make it the cash crop of choice for smallholders in densely populated areas of Kenya that are under siege from climate change. Potato has a huge potential to improve livelihoods; to be an important export earner (fresh and processed products); and for employment creation (on and off farm).

Potato is normally grown in areas that are above 1,500 metres above sea level in 2 season (or 3 seasons in a few areas) under rain-fed conditions in areas with rainfall of at least 1,000mm per year. These areas are on the slopes of Mt. Kenya (Meru, Embu, Kirinyaga, Laikipia counties); both sides of the Aberdare range (Nyeri, Kiambu, Nyandarua and Muranga counties); the Mau escarpment (Nakuru, Uasin Gishu, Bomet Counties), Tinderet and Nandi escarpment (Elgeyo Marakwet and Nandi counties) and Cherangani hills (Mt. Elgon county) (Gok, 2009). Small acreages are found in Kericho and Kisii counties and in isolated patches in Taita Tavetta County. Production is by numerous small scale producers with each growing less than 1 hectare of potatoes each season except in Narok (Kaguongo *et al*., 2009). Nearly all potatoes are grown in monoculture with production carried out using poor quality seeds, inappropriate production practices, inadequate disease management practices; unsuitable pre and post harvest practices; and with marketing practices that tend to be unfair (GoK, 2009). In the last 10 years yields have been decreasing (FAOSTAT, 2011); acreage expansion into the lowlands and drier areas has been minimal; and the value of the crop has stagnated.

Potato varieties grown vary according to time-period and location. Farmers grow over 60 informally and formally released potato varieties although only a few of these are widely distributed. Varieties, that were once popular in the 90's, like Nyayo, are now almost extinct while a variety like Zangi that did not feature in the 90's is now the dominant variety in many counties. A few varieties are dominant in certain areas and are relatively unknown in other locations. An example is Dutch Robijn that is common in Bomet and parts of Narok and Nakuru counties and is almost unheard of in other counties.

The potato subsector has two significant organizations that impact on growth and further development of the subsector.

a) **The National Potato Council of Kenya (NPCK)**: This is a member-based, non-profit organization consisting of diverse institutions from the public and private sector. Its mission is to coordinate and regulate potato sub-sector stakeholders towards development of greater potato industry profitability and the improvement of livelihoods. The organization is charged with the responsibility of facilitating better vertical and horizontal inter-relationships among stakeholders. It is further responsible for helping develop the sub-sector into a self-regulating and competitive industry through facilitating policy formulation and review as well as by encouraging better enforcement of existing regulations and standards. The organization is structured to promote greater synergies among a broad membership that includes researchers (KARI, CIP); academia (Universities); extensionists (MOA); farmers (KENAPOFA, KENFAP); seed producers (ADC, GTIL, Kisima farm); traders; processors; exporters; and regulatory agents (KEPHIS) and development partners (e.g. GIZ-PSDA, USAID).

b) **The Kenya National Potato Farmers' Association (KENAPOFA)**: This is a private sector initiative with the mission of ensuring that high quality services and products in the potato subsector are accessible to both local and international markets and to promote cohesive interaction and free flow of information amongst potato farmers.

2.2 Current status of the potato subsector

The potato subsector can be segmented into three distinct values chains based on the end market for potato. These are the i) seed potato value chain; ii) fresh/ware potato value chain; and iii) processed potato value chain

2.2.1 Seed potato value chain

Good quality seed is a prerequisite for improved potato productivity and needs to be grown specifically for this purpose. This implies use of healthy initial seed; land free from soil-borne diseases and special care being taken in the control of diseases and pests during the growing season. In formal seed system, the product should then be inspected by a certification agency (Kenya Plant Health Inspectorate Service-KEPHIS). However, in the vast majority of the cases, part of the ware crop, often the small tubers – are used as seed. Such seed is often of a poor quality resulting not only in poor yields but it may also transmit serious diseases such as bacterial wilt (*Ralstonia solanacearum*) which may render the soils unsuitable for future potato production.

The ideal quality seed potato value chain (Fig 1.), consists of linked actors who produce seed potato of different generations, starting with pathogen-free seed from a laboratory and end with use by ware producers. Seed should move from actor to actor across the chain, as the output of each generation of seed provides the input to the next, and money to purchase the seed moves in the opposite direction. A well-functioning value chain should show a high level of coordination as the supply of seed by each group of actors in the chain closely matches the requirements of the next group who uses it (CIP, 2011a).

Farmer seed: The quality of farmer seed is often questionable. There is little or no seed quality control, disease management is often inadequate and inappropriate, production practices are deficient, pre and post harvest practices are poor. Farmer seeds are not legally recognised as seed but they are used extensively by ware producers in all the potato producing counties.

Positively selected seed: This is seed used by approximately 1.5% of ware potato producers who have been trained in seed selection and management by MoA, KARI, GIZ, TOT or CIP to select the healthiest plants (from farmer seeds) for their own seed needs (Gildermacher *et al*., 2007). Positively selected seed is thus better than farmer seed but it is not legally recognised as potato seed.

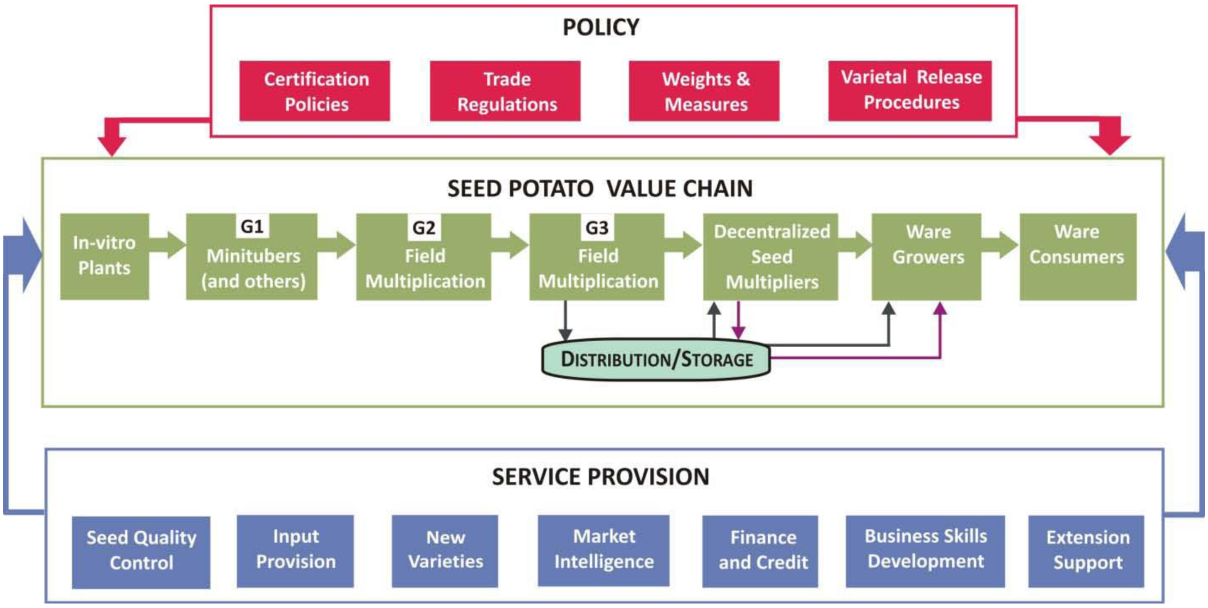

Figure 1: The seed potato value chain (CIP, 2011a)

Clean seed: This is seed whose origin is either certified seed or basic seeds and whose production follows laid down guidelines that the farmers have been trained in by MoA, KARI, GIZ, TOT. Clean seed differs from certified seed in that it is not inspected by KEPHIS and is thus not legally recognized by the law. It is not legal to trade in it but farmers trade in it anyway. It is used by only about 1.5% of ware producers.

Certified seed: This seed originates from either basic or certified seed, its production follows laid down guidelines (as stipulated in the Plant and varieties Act-Cap 326) and it is certified by an independent certifying organization (KEPHIS). It is the only type of potato seed that is officially authorized for use as seed and that can be legally traded. It is used by only about 1% of all ware potato producers. Certified seed are produced mainly by Agricultural Development Corporation (ADC) and very few private sector players (e.g. Kisima farm), with minimal amounts of seed produced by the MoA, Agricultural Training Centres (ATCs) individual farmers and farmer groups.

Basic seed: This is produced from breeder seed or it can be produced from pre-basic seed, which can be clearly traced to breeder seed. Pre-basic seed is multiplied twice in the field to produce basic seed. Basic seed is produced largely by the public sector (KARI-Tigoni) but recently there have been some quantities produced through aeroponics by several private sector companies and individuals in including ADC, Genetics Technologies International Limited (GTIL), Kisima farm and Mr. Mbugua's farm (2011b).

Seed policies: Policy's in potato seed are largely ignored as only certified seed (used by 1% of farmers) is legally recognized as seed and thus subject to policies. Certified seed is grown and packed according to set standards which KEPHIS ensures compliance with. Clean and positive seed should be grown according to established procedures that the farmers have been taught but they do so without independent verification. They are packed (material of package, size and weight etc) at each farmer's discretion. Farmer seed are grown and packaged according to individual farmer's knowledge, judgement, individual buyer needs and market requirements.

Current Sanitary and phytosanitary measures are considered inadequate by stakeholdedrs to ensure the protection of the industry from the possible introduction of new pests and diseases through imported seed and related products.

Service provision: Variety release: The 60 or more varieties grown in the country are either informally or formally released. -Formally released varieties (with legal recognition) have been characterized and tested in National Performance Trials (NPT's) for a minimum of 2 seasons and have been found to be Distinct, Uniform and Stable (DUS) by KEPHIS before being released due to their superior performance. These varieties usually come from potato breeders or are already varieties in other countries.

-Informally released varieties are varieties that have not gone through NPT's but are instead selected by farmers. Their source is thought to be potato breeding trials or ware potato imports or unlawful seed imports. Informal varieties are not recognized by law and their seed cannot be availed as certified or basic seed. There is no quality control of informally released varieties as their seeds spread informally amongst farmers with no official recognition, control or support.

Seed quality-: Seed quality prescribed in the seed and plant varieties act that sets guidelines for seed certification. These standards are the same for pre-basic, basic and certified seeds and these are administered, supervised and approved by the certification agency (KEPHIS). Clean seed quality is assured informally mainly through reputation especially with the extension officers.

2.2.2 Ware potato value chain

Globally, the main products in the fresh potato value chains include fresh potatoes, organic potatoes, pre-packed fresh potatoes, washed potatoes, baby potatoes. In Kenya, the ware value chain is largely dominated by trade in freshly harvested potatoes without any value addition. A few farmers sometimes wash potatoes prior to selling. A schematic representation of the fresh potato value chain is shown in figure 2.

Ware potatoes: Ware potatoes are produced using mainly human labour, with mechanization of land preparation done in only a few areas as smallholder potato farmers rarely own machinery. Production is controlled by the rainfall season with early harvesting of immature tubers starting 2 months after planting. Pre and post harvest management is poor and early harvest tubers tend to have a soft peeling skin that is easily damaged and the potato stores very poorly. Potatoes are generally are sold at harvest with storage for future

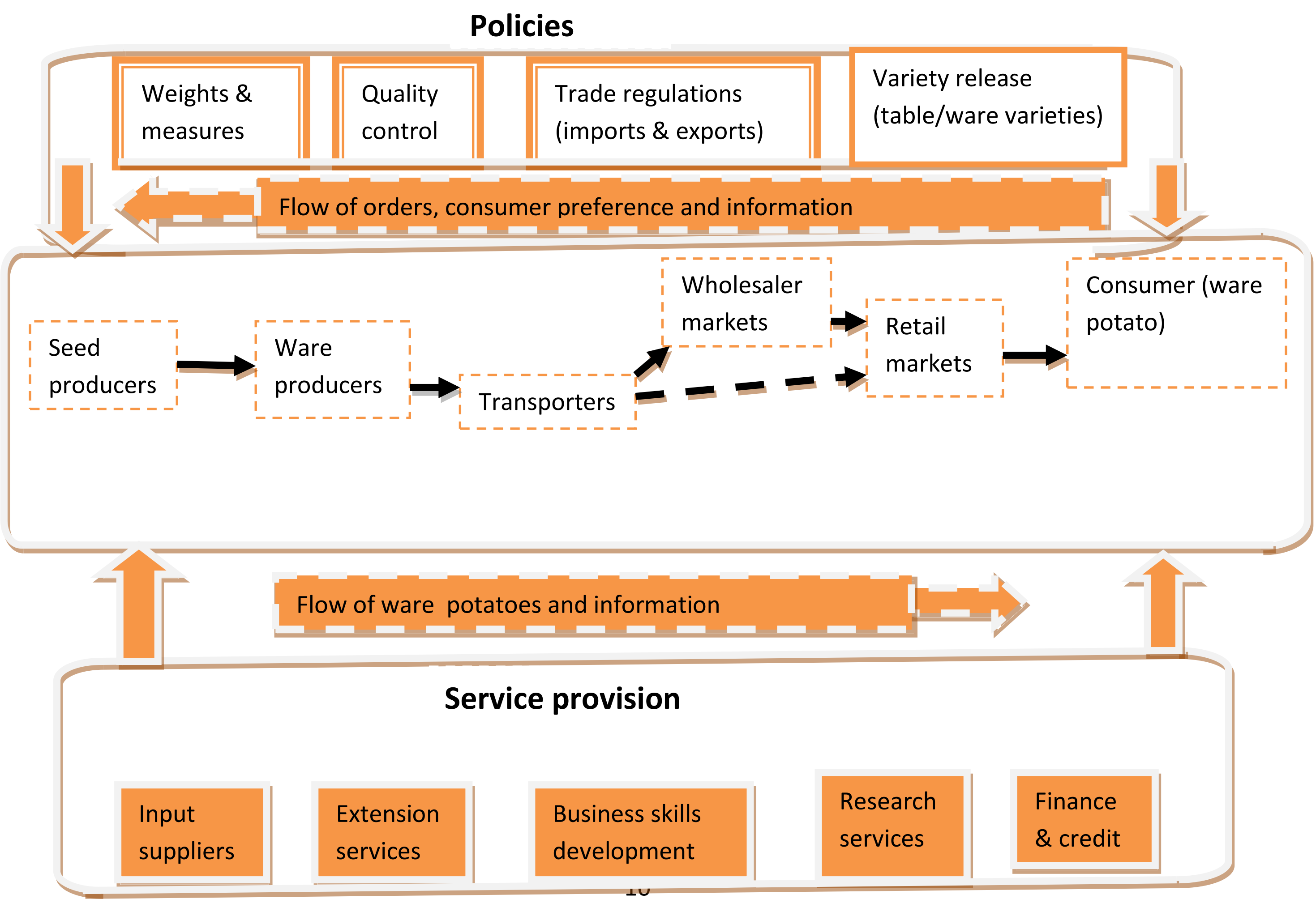

Figure 2.Ware Potato Value Chain

sales rarely done even though there are gluts and low prices at harvesting followed by scarcity and high prices a few months later (just before the next planting season).

Transporters: Potatoes are normally transported in lorry trucks of 7 ton capacity. Transporters include traders and brokers who play a key role in aggregating, packing and transporting potatoes from the production areas to the main urban markets in Nairobi, Mombasa, Kisumu and Nakuru. They tend to be men who sometime integrate forward and backward into the marketing of potatoes by performing more market functions in order to improve on their profit margins. Handcarts are also used.

Wholesale markets: Most potatoes are traded through wholesale markets in major towns such Kisumu, Nairobi, Nakuru and Mombasa. Potatoes are transported from the production areas and sold from the lorries in the various wholesale markets.

Retail markets: Ware potatoes are sold mainly in open air markets (found in most trading centres in the country) and in small neighbourhood shops or kiosks. Only 2% of all traded potato produce pass through supermarkets.

2.2.3 Policies:

Trade regulations (imports/exports):

Regional (East African Community) standards for fresh potatoes (ware potatoes) have been developed and should have been operationalized with the ongoing integration of the economies of the EAC countries. These should facilitate trade within the block as standards are harmonized.

Weight and measures: Legal notices no. 44 of 2005 and no. 113 of 2008 that control the size of traded ware potato bags to 110kgs have been largely disregarded with bag sizes getting as big as 260kgs in times of oversupply. The law also requires that potatoes be packed in sisal or jute bags that are well ventilated with netting at the top to allow for inspection of the produce. Contrary to the law potatoes tend to be packed in the cheaper, more readily available polythene bags but with netting at the top.

Variety release: Variety release has concentrated on availing varieties that are tolerant to diseases while also having acceptable cooking qualities.

Service provision

Extension services-

Potato extension services are provided mainly by government and they train farmers and farmer groups on all aspects of potato production. The ministry of Agriculture is limited by inadequate staff numbers; transfer of staff trained in potatoes and limited funding. Clean and positive seed production training has been done through the Ministry of Agriculture (MoA) in collaboration with partners in the potato industry. Formally released varieties that are approved by government are promoted for production by the extension services which have often tried to discourage the use of informally released varieties for production mainly because of the unavailability of these varieties as certified seeds. There is no significant private sector or civil society involvement in extension service delivery for potato. Some potato time bound projects also provide some extension to farmers within their projects. The linkages between research, extension and farmers are generally weak.

Research services-
Potato research is a public sector undertaking done at KARI-Tigoni in collaboration with the International Potato Centre (CIP), local universities, agro-chemical companies, processors, farmers and KEPHIS. KARI has the national mandate to carry out research on all aspects of potato and avail recommended breeders' seed to seed growers for further multiplication. In doing this, KARI follows the Agricultural Product Value Chain Approach to incorporate all the potato industry facets in research. KARI has potato research programs in agronomy, breeding, crop protection, food processing and post harvest technology, pest and disease control, seed research (including development of sustainable seed systems), socio-economics and Technology transfer. Bacterial wilt research is carried out at NARL due to the quarantine nature of KARI-Tigoni.

Finance and credit-
Potato farmers lack access to timely and reasonably priced financial resources thereby contributing to their exclusion from competitive markets. In the absence of financial resources, it is difficult for small holder potato farmers to meet the market demands. Typical loans from banks involve relatively high transaction costs on the part of both the lender and the borrower, and coupled with the climatic and market risks of the sector make such loans unattractive to the lenders and unavailable or unattractive to the smallholder potato farmers. Similarly, the typical short-term, relatively high-cost financing of most microfinance loan products are not well adapted to potato farmers. The government endeavours to support rural and agricultural financing and has rolled out several programmes to this end. Examples of such initiatives include collaborative efforts (like Njaa Marufuko). Farmers can also access farming bank loans (e.g. from Kenya commercial bank and Cooperative bank) or through microfinance institutions and the private sector.

Business development skills-: Provision of business development skills tailored for the potato subsector is generally lacking and impacts negatively on growth of the subsector. In the past there have been time-bound projects like KARI's ATIRI (Agricultural Technology and Information Response Initiative) program that provided business development skills to groups involved in seed and ware potato production as part of its many activities.

Input provision: Inputs such as chemicals, fertilizer etc are sourced from private stockists situated through most of the production areas. There have been initiatives to provide farmers with subsidized fertilizer through the Nation Cereals and Produce Board.

2.2.3 Processed potato value chain
The global processing industry usually sets strict requirements in the potato processing value chain because the industry is required to produce high-quality products on a cost effective basis in order to remain competitive. Consumers are the drivers of this given the

biosafety requirements set by customers globally. For the potato industry to be competitive, producers should be aware of consumer requirements and adhere to them for the products to be readily acceptable to them. For this reason, the global processing industry has strict criteria for product requirements like tuber length, colour, fat content and dry matter content so that the French fries, crisps, granules and flakes meet well-defined standards. Potatoes serving as raw material for the processing industry must meet a number of requirements regarding the following quality characteristics: i) size and shape of tubers; ii) injuries and defects; iii) dry matter content; and iv) colour and v) pesticide residue levels.
The quality of the processed products is influenced by various external factors including as climate, type of soil, variety, crop management, harvesting and storage. Growers can positively influence these factors in order to guarantee the continuous supply of well matured, high-quality raw material to the processing industry.

Globally, the main products in the processed potato value chain include crisps, frozen fries, french fries, chilled peeled potatoes, canned potatoes, diced potatoes, baby roasts and a variety of shaped potato products with child-appeal.

The processed potato value chain in Kenya is still not well developed.The most important products in the Kenyan processed potato value chain are crisps, frozen fries and fresh fries. On a fraction of all the potatoes grown are processed (Tsefaye *et al*., 2010). Potatoes are processed mainly into chips, crisps and used in different Indian snack foods (chevra, masala sticks etc). It is estimated that there are over 800 restaurants selling chips in Nairobi and over 40 local processors of crisps. It is further estimated that about 60-65% of the fresh potato supplied by urban traders in Kenya is processed in fast food outlets such as restaurants and street stalls. The processed potato value chain is present in figure 3.

Processed potatoes: A very small proportion of the potatoes are grown for processing. Like in ware potato crops, almost all the production is rainfed. Potatoes are generally sold at harvest with storage for future sales rarely done even though there are gluts and low prices at harvesting followed by scarcity and high prices a few months later (just before the next planting season).

Transporters: The transport of potatoes meant for processing is similar to that of ware potatoes. No refrigerated transport for potato exists. Actors in the transport of potato for processing are similar to those involved in ware potatoes.

Wholesale and retail markets: Some of the potatoes for processing are bought from whole sale and retail markets.

Markets for processed potato: Processed potatoes are sold mainly through supermarkets, small neighbourhood shops, kiosks and by hawkers who walk around with their products. The main outlet for French fries is the fast food industry. Some potato processors (e.g. Deepa industries, Norda, Chirag, Aphanars and others) engage with contract farmers. Some such as Kentucky Fried Chicken (KFC) have wanted to import potatoes. Others such as

Midlands company in Njabini supply pre-peeled potato to Nairobi for chip making. There is currently no association of potato processors.

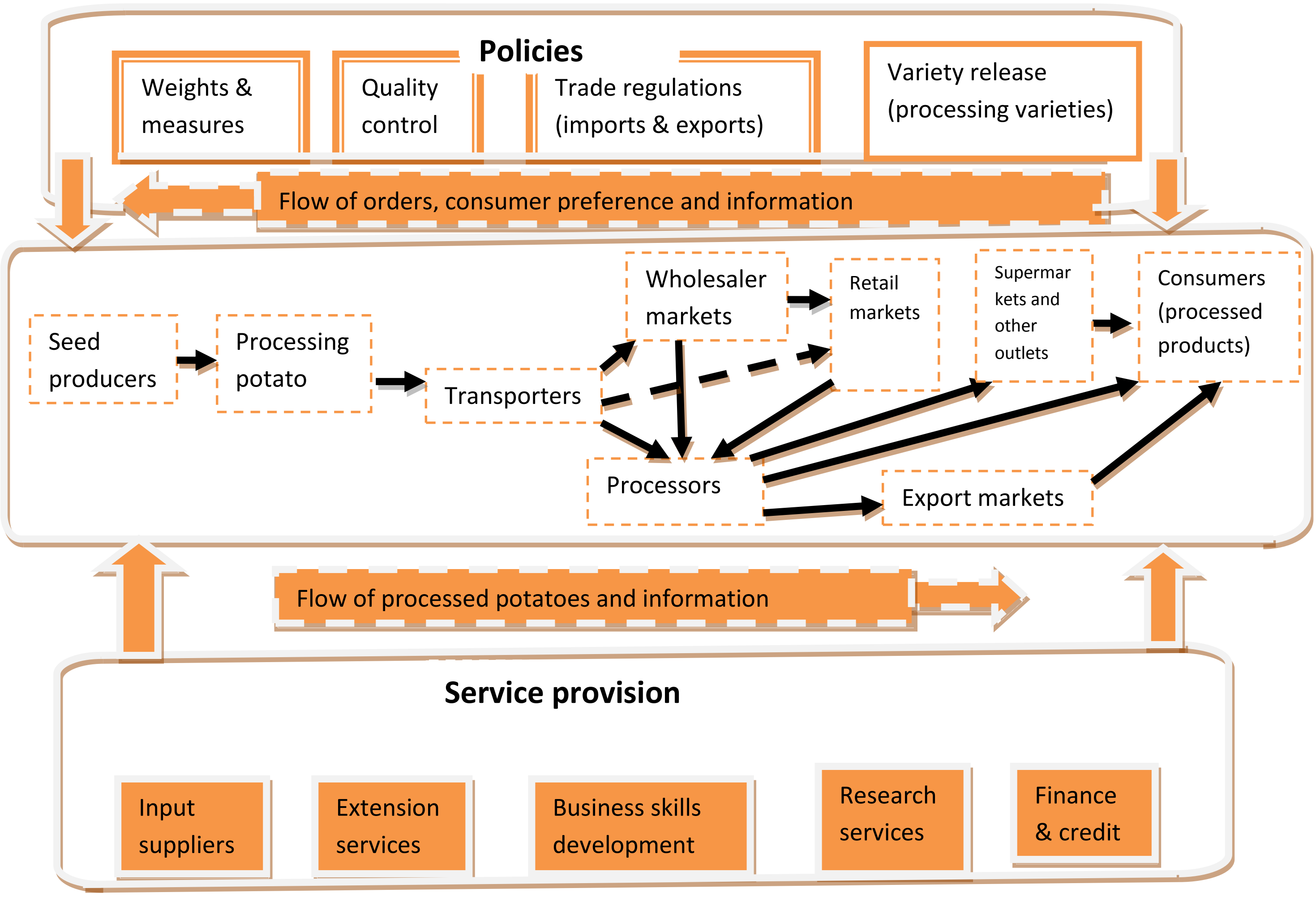

Figure 3. Processed Potato Value Chain

2.2.3 Policies:

Trade regulations (imports/exports):

Regional (East African Community) standards for processing of potatoes (into fried potato chips and frozen chips) and for fresh potatoes (ware potatoes) have been developed and should have been operationalized with the ongoing integration of the economies of the EAC countries. These should facilitate trade within the block as standards are harmonized.

Weight and measures: The issue for weights and measures are similar to those for the ware/fresh potato value chain discussed previously.

Variety release: Variety release has concentrated on availing varieties that are tolerant to diseases while also having acceptable cooking qualities. Variety release for specific processing traits has not been an overriding consideration of the program until now when 2 processing varieties are being evaluated in NPT's mainly for their processing qualities. Crisps processors have traditionally preferred Dutch Robijn potatoes from Bomet while frozen chips processors have preferred the Tigoni and Zangi varieties.

Service provision

The issues is service provision are similar to those in the ware potato value chain but with a focus on processing issues.

CHAPTER 3: CHALLENGES, CONSTRAINTS AND EMERGING THREATS

There are several challenges, constraints and emerging threats that have an impact on further growth and development of the potato subsector.

3.1 Challenges, constraints and emerging threats along the seed potato value chain

3.1.1 Inadequate production of starter seed

The low volumes of starter seed material that are currently being produced are a barrier to entrepreneurs who would want to venture into seed potato production. Limited access to starter material is therefore an obstacle to further growth of the seed potato value chain.

3.1.2 Inadequate capacity of seed potato production

Seed potato production is an expensive venture in terms of physical and human resource requirements. Currently, most of the seed potato is produced centrally by government agencies (ADC and KARI Tigoni) with limited private sector seed merchants. The vast majority of the technologies used in rapid pre-basic and basic seed potato production by these institutions are costly, inefficient and sometime skill intensive. This leads to low output thus high cost of production. This makes the little seed potato that is available expensive and out of reach for the majority of small scale farmers. Use of modern and validated technologies such as aeroponics (Otazu, 2010) and sand hydroponics is still low. Use of modern equipment and machinery in seed potato production is also low leading to inefficiency in operations. According to the National Potato Task Force Report (GOK, 2009), other facilities and equipment that are in short supply include i) support infrastructure such as irrigation, cold stores, tissue culture laboratories ii) land for breeding and basic seed multiplication; iii) Quality assurance laboratories including disease indexing. Technical personnel such as breeders, pathologists, engineers, farm managers, food technologist, agronomist and information technologists are also inadequate. Most small potato farmers have limited exposure to modern financial instruments. Currently, financial products and institutions are expanding rapidly and therefore deciding which services to choose and how to use them will become an increasing challenge. That challenge is especially great for customers who are poor and have limited experience in the formal financial sector. While money-management strategies can be innovative, the financial choices farmers make are defined by environments where informal financial practices are dominant and the consumer is often uncertain about commercial products and services. In increasingly complex and competitive financial markets, consumers with low levels of financial literacy lack the information and tools necessary to make informed decisions (Cohen, 2010)

3.1.3 Inadequate farmer knowledge on seed potato handling procedures

Expertise and skills are essential for profitable seed potato production. Unfortunately, majority of farmers have insufficient knowledge and skills regarding technical aspects of seed potato production. Such limitations negatively affect seed potato productivity. Many seed growers also do not know how to maintain seed quality up to the next planting season. This leads to poor quality seed tubers due to poor storage, inadequate control and management of pests and diseases.

3.1.4 Reliance on rain-fed agriculture for seed production

Climate change is real and will have will have adverse effects on agriculture in Kenya (Kabubo-Mariara and Karanja, 2007; FIAN, 2010) including potato production. Drought events associated with climate change and climate variability have become more pronounced in recent years. Since most of the seed production is currently done under rain fed conditions with little irrigation, there is a high risk of failure of seed crops in years when rains are sub-optimal. It is very probable that in certain potato growing regions aphids will occur in greater numbers and in different seasons than has been the case so far due to more favourable climatic conditions (Pliska, 2008). As virus vectors, aphids represent a significant threat particularly to seed production.

3.1.5 Inadequate capacity in research for development

The national potato research and development programme has limitations both in biophysical and socioeconomic issues related to seed potato production which the development and generation of innovations necessary for growth and development of the seed potato value chain. There are shortfalls in breeding and genetics; seed potato systems; potato husbandry and post-harvest technology, agronomic studies, and agricultural engineering.

3.1.6 Limited private sector involvement in seed production

The little involvement of the private sector in seed potato production has resulted in low production of seed and slow growth of the seed potato value chain with low productivity and low uptake of improved varieties.

3.1.7 Inadequate technical knowledge

The use of good quality seed is influenced by farmer's perception of the yield or quality advantages of good quality seed compared farmers' seeds, the price, prices of other inputs, relative price of crops, farmer's forecast of weather conditions, and the cost of distribution to retail outlets, Many potato farmers have inadequate knowledge on the use and performance of good quality seed. Their knowledge base is limited in with respect to production and marketing information. This affects their seed demand and use of seed access.

3.1.8 Pests and diseases

Viruses still pose the greatest disease threat to seed potato production due to the rejection of seed crops that a high level of infections more that the tolerance limits cause (Lung'aho *et al*., 2007). New strains of potato viruses e.g. PVY^{NTN} worldwide are particularly worrisome as they are more difficult to control leading to high rejection rates for seed crops. Although not yet been reported in Kenya, *Dickeya solani*, is a bacterial pathogen that has emerged as a major threat to potato production in Europe. The pathogen causes black-leg like symptoms, leaf wilts and tuber soft rots (Toth *et al.*, 2011). The disease has spread across Europe via trade in seed tubers and can cause economic losses. Because of recent developments in the potato sector where seed has been imported from Europe, the threat of disease is real. Bacterial wilt (BW) of potato caused by *Ralstonia solanacearum* also represents an important threat to seed potato production. Chemical control is not effective and management of the disease depends on the planting of BW-free seed in BW-free soil, the use of tolerant varieties, rotation with non-susceptible crops, and the application of sound sanitation and cultivation practices. However, scarcity of good quality seed coupled with inadequate rotations have resulted in the disease being endemic in the country (Kinyua *et al*., 2001, Otipa *et al*., 2003 and GoK, 2009). Climate change is also likely to result in increased incidence of the disease unless control measures are instituted. BW infected seed are should be discarded. Future export markets are likely to be affected if the disease is not eliminated. The disease therefore has serious economic consequences.

3.1.9 High start-up costs and low incentives for seed potato entrepreneurs

Seed potato production is a costly undertaking. The start-up capital and operating costs for facilities such as aeroponics, hydroponics, stores and equipment such as tractors is high and this may deter potential new entrants into the seed potato business. The limited incentives available for would-be entrepreneurs are another hindrance to entrepreneurs.

3.1.10 Poor linkages, collaboration and partnerships among stakeholders

Effective partnerships can help smallholder farmers in the seed potato value chain expand their operations cost-effectively and gain entry to otherwise inaccessible markets; encourage development of policies reflecting the needs of all stakeholders; provide access to knowledge, research and technology; encourage sharing of experiences; and improve access to financing. However, because the partnership, collaboration and linkages have are generally been weak, these benefits have only been marginally experienced by the seed potato value chains. Additionally, inadequate collaboration and consultation among stakeholders in the seed potato value chain has sometimes resulted in overlap and gaps in coverage of projects**.**

3.2 Challenges, constraints and emerging along threats fresh/ware potato value chain

3.2.1 Limited availability of high quality seed of desired varieties

Scarcity of good quality seed remains a major bottleneck to improved potato production, although demand is high (CIP, 2011a). Recent statics indicate that less than 2% of certified seed is available to farmers and this is very low compared to countries such as China, Argentina and Holland with availability ranging from 20 to over 90%. Although basic seed potato production increased from 9.6 tonnes in 2001 to 59.2 tonnes in 2008 while certified seed production increased from a mere 52.8 tonnes in 2000 to over 600 tonnes in 2010. This level of production is, however, far below the approximately 30,000 tonnes required annually to meet estimated national seed potato demand (Kaguongo *et al*., 2010). Inadequacy in quality seed supply lowers potato productivity thus making many potato enterprises to be unprofitable. Another consequence of poor quality seed is the spread of seed borne diseases such as *R. Solanacearum* which further complicates production of potatoes. Many would be potato growers are discouraged from venturing into potato production due to limited availability of good quality seed.

3.2.2 Inefficient markets and marketing

Potatoes are currently marketed through fragmented chains, characterized by many handlers, with hardly any cooperation, no integration, and limited standards and regulations (GoK, 2009). These inefficiencies result in high supply risks, high transaction costs, price fluctuations, quality losses and wastage. The smallholder potato producers are faced by enormous challenges in logistics of marketing, physical infrastructure, and market information. In addition to costs of various operational materials various agents are also paid fees without adding value to the marketing process. The marketing costs include: county council cess; open air market space rent; cost of empty bags; sewing sisal ropes; and labour wages for loaders and off-loaders.

3.2.3 Failure to enforce the potato regulatory policies

Although standards for production and marketing of potatoes have been set through Legal notice no. 44 of 2005 of Ministry of Agriculture, they have not been fully implemented (Nderitu, 2010). The marketing regulations require that potatoes be packaged in sisal or jute bags with a maximum weight of 110 kg. The bags should also be well ventilated at the top with netting to allow inspection of the produce by buyers and others. This regulation is reinforced by Legal notice no. 113 in form of Adaptive by-law of Ministry of Local government that state that no Local authority should allow sale of potatoes using extended bags in any urban, municipal or city market.

3.2.4 New and more aggressive strains of diseases and pests

Diseases that are likely to threaten ware potato production in the foreseeable future include late blight, bacterial wilt and leaf miners. Recent studies show that a new lineage of *Phytophthora infestans*, the causal organism for late blight (KE-1) is spreading rapidly around Eastern African countries including Kenya. The KE-1 lineage was first detected in 2007 in western Kenya (Pule *et al.*, 2013) and appears pose a more serious threat to the regions potato production than the US-1 lineage that has been common for the last century (Olanya *et al*., 2001). This new lineage may be responsible for the breakdown in late blight resistance for some of the varieties that have been released in the recent past. Just like is the seed potato value chain bacterial wilt infected tubers may rot are not marketable and results in serious economic losses. The potato leaf minor has recently been reported to be a problem in some potato growing regions. The pest can cause significant crop losses if not contained, thus affecting productivity of potato enterprises. Farmers interviewed indicated that the pest was not responding to some insecticides causing their yields to reduce significantly.

3.2.5 High post harvest losses

Post-harvest losses in potato production are huge. These losses are largely attributed poor agronomic practices coupled with inappropriate potato handling including poor storage. An estimated 40% of the national potato production never makes it to the consumer or arrives in poor condition. Beyond the threat to food security, post-harvest losses represent incomes that would otherwise have generated and used for productive purposes. Post-harvest losses are also a waste of valuable farming inputs, such as water, energy, land, labour, and capital. Given that many smallholders live on the margins of food insecurity, a reduction in potato losses could have an immediate and significant impact on their livelihoods.

3.2.6 Poor infrastructure

A major determinant of agricultural productivity growth is infrastructure. In addition to other factors such as human capital, credit markets, extension services, and technological research, the presence of reliable infrastructure increases both output per capita and output per unit of land. It is therefore a key contributor to productivity, mainly by reducing transaction costs in input and output markets, as well as better integrating markets within regions. Currently, most roads linking primary production and market centres with intermediate centres and the classified road network are generally in poor condition (GoK, 2009). Markets in major towns do not have appropriate structures to handle potatoes and are usually very unhygienic. Poor communication infrastructure (telephones, internet, e-commerce, etc.) in many of the production areas hinders collection and dissemination of market information. Such a scenarios pose are barriers to trade and not conducive for growth of the potato subsector and pose barriers for trade.

3.2.7 Exploitation by brokers and cartels

Brokering services can improve market efficiency by economizing on search effort (Gabre-Madhin, 2001); by developing expertise in gathering information on buyers and sellers and bringing them together to effect transactions, without having to put time and effort into managing the substantial price risk found in potato markets, an efficient and competitive set of brokers can match supply with demand at lower cost than if all sellers and buyers conduct their own search. However, in Kenya the performance of brokers in the potato subsector has not been satisfactory (GoK, 2009): many of the brokers often do not behave competitively, they may hinder the flow of information on supply and demand or on the commissions they are charging, or search costs may be low, suggesting little advantage from brokers. Both buyers and sellers may be prevented, by collusive behaviour among brokers and cartels, from conducting their own search and negotiating their own transactions. Such practices have led to exploitation of farmers resulting in low profitability. Market cartels distort prices and largely fleece both farmers and traders.

3.2.8 Rising production costs and falling incomes

Farmers have limited access to credit (GoK, 2009) but the price of fertilizers and pesticides continue to escalate as do the cost of fuel and transport. This makes production of the crop very costly. In real terms, adjusted for inflation, the price the farmer receives for the crops continue to fall. The consequence of uncertain or low prices is that farmers have neither the incentive nor resources to invest in replanting or purchasing production inputs necessary to produce high yields. If such a trend continues farmers and the youth may switch to more profitable ventures thus threatening future potato production.

3.2.9 Climate change

Climate change provides a threat of crop failure as a result of unpredictable rainfall patterns and more frequent and longer dry periods, which in turn are predicted to increase in number and spread of pests.

3.2.10 Declining soil fertility and poor soil health

Many potato growing areas are characterized by declining soil fertility (Muthoni and Nyamongo, 2009) and poor soil health. Unless the situation is corrected, sustainable potato production will not be possible.

3.3.11 Good arable land is becoming scarce

Urbanization and subdivision of land are reducing arable lands including that which can be profitably utilized for potato production. This may threaten future potato production as suitable land will be in short supply.

3.3.12 Limited agricultural extension services

Potato farmers require to be constantly provided with up-to-date and adequate information on all aspects of production, postharvest and marketing issues but access to extension services is limited because of the low level of outreach by public extension services. This is partly due to insufficient funds for operational costs, training, and capacity development, which limits their activities and continual development of the extension staff. The existing weak linkages and partnerships between extension services and other partners such as research and the private sector also which limits information flow resulting in knowledge gaps which contribute to yield gaps. Additionally, the optimal use of services and quality inputs which are essential- productivity enhancing tools is compromised because of limited agricultural extension services to potato farmers.

3.2.13 Low productivity and low farmer empowerment

Potato production is dominated by smallholder farmers who grow their crops individually. Such farmers have very little bargaining power when faced with a few large buyers who command enormous market power. In an evolving marketing system, characterized by stiff competition between different actors in the agricultural value chain to capture a larger margin of the value addition, such farmers stand to be the major losers. Too many farmers are neither productive nor profitable and tend to remain trapped in a cycle of subsistence because their yields are too low to generate marketable surpluses.

3.2.14 Development of sustainable linkages, collaboration and partnerships among stakeholders

The issues are similar to those identified in the seed potato value chain but with an emphasis on the ware/fresh potato value chain

3.3 Challenges, constraints and emerging threats along processed potato value chain

3.3.1 Low processing and limited value addition

Processing and value addition are important in determining the competitiveness of produce in markets. However, most of Kenya's potatoes are marketed mostly as freshly harvested tubers and largely consumed with minimal transformation limiting its value. This is partially because of lack of farmers' entrepreneurial skills. To diversify potato usage, it will require the chain players to adequately understand product development strategies to diversify potato usage. The limited ability to process and add value to potatoes can potentially make future exports less competitive in regional and global markets.

3.3.2 Inadequate processing varieties

The processing industry requires specific varieties. Such varieties have been specially developed for the processing industry's target markets and are usually are easy to process, and very tasty. Depending on the end product desired such varieties have specific shapes, dry matter contents, and other characteristics such susceptibility to enzymatic and after cooking darkening. Currently, there is a shortage of processing varieties with only the variety Dutch Robijn preferred for processing into crisps.

3.3.3 High investment costs, particularly large processing plants

Modern potato processing plants are costly to establish as they involve huge initial capital outlays yet access to affordable credit is limited. Existing processing facilities are situated in big towns near to the consumers.

3.3.4 Low local demand for processed products

The demand for processed products is currently small but in the foreseeable future, this demand is likely to increase due to urbanization, rising incomes, and a rising population of middle class and the youth.

3.3.5 Limited availability of high quality potatoes for processing

Most of the potato is harvested immature and this is not suitable for processing. This practice has made ware potato in this country to be less competitive leading to some importation of tubers for processing into fresh fries by some fast food outlets such as Kentucky Fried Chicken (KFC) from other countries. This deprives the potato value chain players of income and livelihood.

3.3.6 Seasonal prices fluctuations

Potato production is mainly undertaken under rainfed conditions characterized by periods of gluts immediately after harvest and shortages soon after with corresponding price fluctuations. This often leads to market failure.

3.3.7 Diseases

Zebra chip (ZC), a new and economically important disease of potato has been documented to occur in commercial potato fields in the United States, Mexico, Central America, and New Zealand (Munyaneza, 2012). Plant growth and yield are severely affected by the disease. Additionally, chips or fries processed from ZC-infected tubers exhibit dark stripes that become markedly more visible with frying, and hence are commercially unacceptable. The disease causes serious losses to the fresh market, table stock and export potato industry as well. ZC is transmitted by the potato psyllid. Although not documented in Kenya, the threat of the disease is real due to seed imports.

3.3.8 Poor market information

Many potato growers in the processed potato value chain just like in the fresh/ware potato value chain have a lack of understanding about quality requirements and lack of information about local prices changes and are frequently paid less than market prices by middlemen. Many farmers complain that brokers and traders and some of the processors under pay them. Failure to strictly adhere to contracts-where they exist- by both farmers and processors may threaten the growth of the processed potato value chain.

3.3.9 Imports of processed potato products from other countries

Although currently insignificant, continued imports of potato products from other countries may give local farmers unnecessary completion particularly if the imports are tariff-free and could threaten the survival of the nascent local processing industry.

3.3.10 Development of sustainable linkages, collaboration and partnerships among stakeholders

The issues are similar to those identified in the seed potato value chain but have an emphasis on the processed potato value chain.

CHAPTER 4: VISION, OBJECTIVES AND TARGETS

4.1 Vision of the roadmap

The overarching vision of the road map is a robust, competitive and self sustaining potato subsector by 2020. An overview of the roadmap is presented in figure 4.

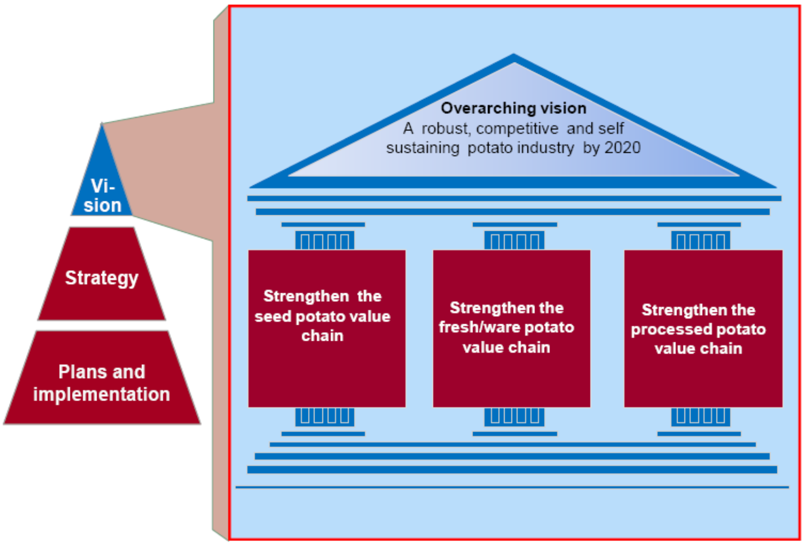

Figure 4. Overview of the roadmap to revitalize the potato subsector

4.2 Objective of the roadmap

The overall objective of this roadmap is to transform the potato sub-sector from subsistence to a vibrant and commercially oriented subsector. The roadmap aims at stimulating an annual production growth rate of the potato subsector of about 10% in the next 5-10 years. The focus areas and approaches proposed in this roadmap are consistent with the major policy documents and recent reports on the potato subsector. These include: i)–Kenya Vision 2030 (GoK, 2007)- with the country's current development blue print; ii) Agriculture Development strategy (ASDS) (Gok, 2010d) the overall agricultural sector policy document; iii) the draft root and tuber crops policy (GoK, 2010a), iv) the draft potato strategy (GoK, 2010b); v) the seed potato master plan (Kaguongo *et al*., 2010); vi) the Potato taskforce report (Gok, 2009); vii) KARI's analysis of the potato value chain; vii) A policy makers' guide to crop diversification in Kenya: The case of potato in Kenya (Kaguongo *et al*., 2012); and viii) KARI strategic plan (2009-2014).

4.3 Strategic objectives: The 8 strategic objectives that have been identified to transform the potato sub-sector are:

i) Creating an enabling environment for development of the potato subsector

ii) Increasing potato productivity and outputs

iii) Promoting market access and product development
iv) Enhancing accessibility of affordable inputs and credit to potato farmers
v) Promote sustainable land use and environmental conservation
vi) Enhance institutional efficiency and effectiveness in implementation and service delivery

4.4 Targets of the roadmap

The targets of the road are presented according to the three priority value chains

4.4.1 Seed potato value chain

i) To upgrade the seed potato value chain (through development businesses) and build capacity to continuously improve seed provision
ii) To increase availability of high-quality seed potatoes from the current less than 1% to 10% promote improved seed potato management
iii) To enable the private sector to assume a leading role in seed production and distribution without excluding the public sector
iv) To strengthen the capacity for research and innovation systems to improve seed management and variety development
v) To enable farmers to effectively manage their seed quality to improve potato productivity and make more food available
vi) To harmonize policies leading to cross-border trade in seed potato and exchange of varieties
vii) To accelerate the availability, dissemination and adoption of new varieties
viii) To create sustainable linkages between seed and the fresh potato value chains

4.4.2 Fresh potato value chain

i) To upgrade the fresh potato value chain (through development businesses) and build capacity to continuously improve availability of fresh potato
ii) Increase potato yields from less than 10 t ha-1 to at least 15 t ha-1
iii) Increase the per capita consumption of potato from 29.6 Kg ha^{-1} to 40 Kg ha^{-1}.
iv) improve the demand for fresh potatoes, improve the competitiveness
v) To strengthen the capacity for research and innovation systems to improve productivity of the fresh potato value chain
vi) To enable farmers to effectively manage their ware potato crops to improve potato productivity, quality of fresh potatoes and make more food available
vii) To harmonize policies leading to cross-border trade in ware potato
viii) To accelerate the availability, dissemination and adoption of new varieties suited for the fresh potato market
ix) To create sustainable linkages between seed, fresh and processed potato value chains

4.4.3 Processing potato value chain

i) To upgrade the processed potato value chain (through development businesses) and build capacity to continuously improve quality and availability of processed potato
ii) Increase the proportional of ware potatoes that are processed products from the current 5% to 20%

iii) To increase the types of processed potato products in the subsector
iv) improve the demand for processed potatoes, improve the competitiveness of processed potatoes
v) To strengthen the capacity for research and innovation systems to improve productivity of the processed potato value chain
vi) To enable farmers to effectively manage their processed crops to the quantity and quality of processed potatoes
vii) To harmonize policies leading to regional trade in processed potato
viii) To accelerate the availability, dissemination and adoption of new varieties suited for the processed potato market
ix) To create sustainable linkages between seed, fresh and processed potato value chains

A summary of the current status of the potato subsector and the desired status that can be attained by implementing roadmap is presented in figure 5.

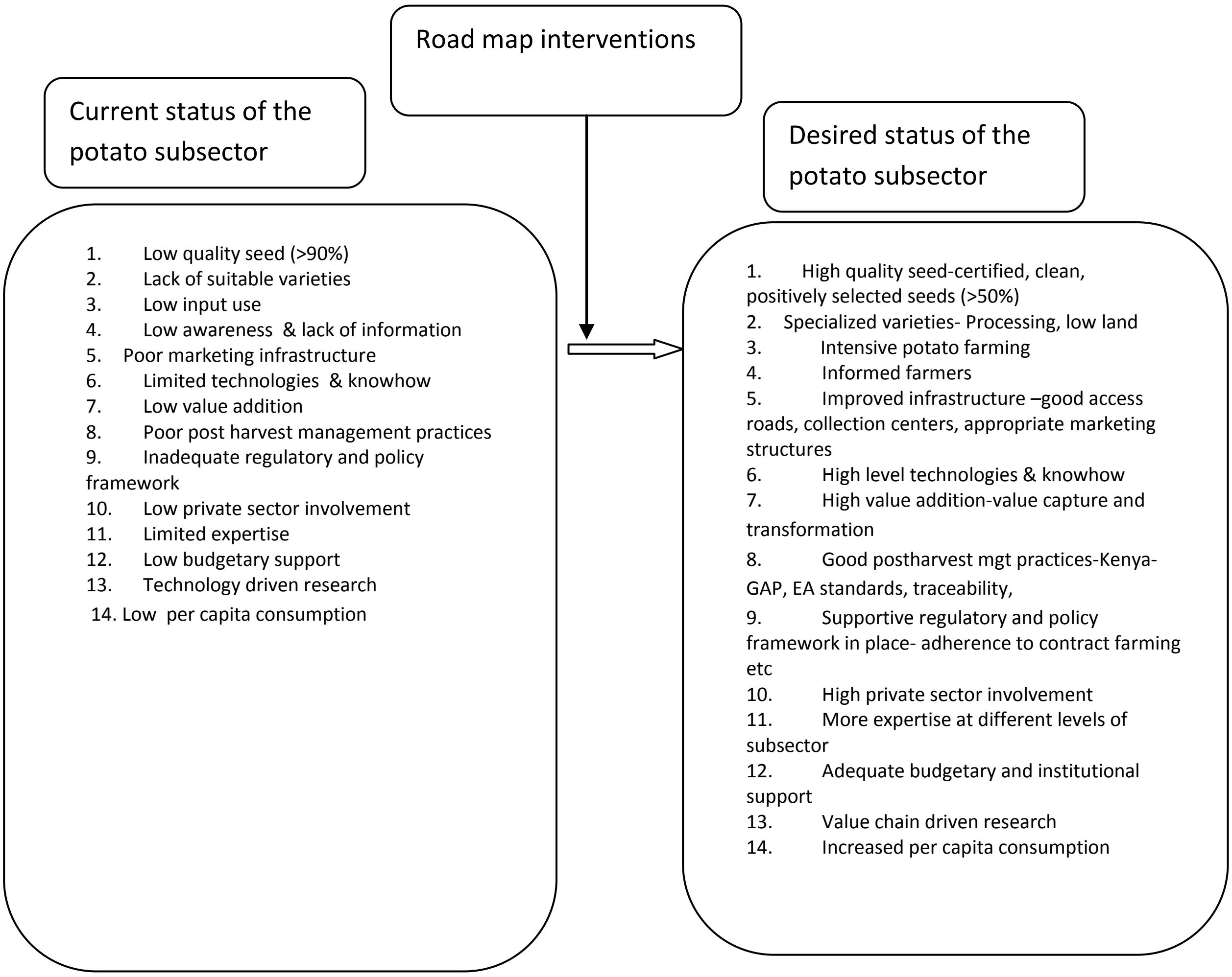

Figure 5. Summary of current status and desired status of the potato subsector

CHAPTER 5. CORE INVESTMENT AREAS

Three areas have been prioritised as being are key investment areas that will spur the growth and development of the potato subsector. The investments are specifically targeted at strengthening the three most important potato value chains namely: i) the Seed potato value chain ii) the Fresh potato value chain, and iii) the processed potato value chain. The strategies identified to strengthen each of the three value chains are briefly described in the following sections.

5.1 Strengthening the seed potato value chain

5.1.1 Develop plans for sustainable seed business development. A description of the actors in the quality seed value chain, both existing and potential, and the status of seed production technology should be undertaken. Following which an analysis of the profitability of different seed enterprises and strengths, weaknesses, opportunities, and threats (SWOT) analysis of the seed potato value chain should be undertaken. Best practice shows that the analysis should be carried out with the actors themselves, particularly those in the private sector, and should take into consideration both minituber production and onward specialized multiplication.

The national seed potato business plan should build on the strengths and opportunities identified in the SWOT analysis. The plans are expected to validate the targets for production of different seed categories along the seed potato value chain, analyze the existing capacity of seed potato businesses, and provide estimates of the capacity that is needed to achieve the targets. The types and size of investments that are needed to close the gap should be identified taking cognisance of lessons learned in previous projects.

5.1.2 Improve infrastructure and capacity for quality seed production. Improving infrastructure and capacity for high-quality seed production is both resource- and knowledge intensive. It requires investments in infrastructure, technical inputs, and other factors. The initial investment in constructing new RMTs and other types of infrastructure is risky because of the uncertainty about market size and farmers' lack of knowledge about RMTs. Part of this investment cost should be covered as an incentive for existing and upcoming entrepreneurs to participate in RMTs and related activities. In addition to strengthening existing TC labs already engaged in in-vitro production (public and private), new private TC facilities should be identified to deliver on the projected targets. There is need to identify entrepreneurs who can customize the TC technology for small and medium enterprises (SMEs) to suit local conditions without compromising product quality.

In order to reach the targets for G4 seed, considerable investments in minituber production systems are required. The involvement of selected private companies is necessary as to respond to the unmet demand for G3 seed potato. This will include providing technical backstopping in production and development of business plans for most appropriate and cost-effective RMTs (e.g., aeroponics, rooted stem cuttings, improved conventional systems) and field multiplication. Because aeroponic systems are very sensitive to high temperatures and the fact that yield of at least 20–25 minitubers/plant is needed to recover costs of an aeroponics system (Labarta and Mulwa, 2011), the location of the units and expertise of prospective minituber tuber growers are critical determinants of their profitability. High temperatures at lower altitudes are known to negatively affect production thereby reducing profitability.

To expand G2 and G3 seed production it will be necessary to identify suitable locations and operators for specialized field multiplication in suitable areas (low aphid pressure and free of bacterial wilt) with adequate land to conduct a proper rotation scheme. The SMEs, with the support of the national potato program, are most likely the best ones to implement this type of seed production. The seed production should be done by trained private seed potato producers with a backup production by the national potato programme at KARI. Some large cereal farm operations in the highlands are already engaged in seed production in the country, considering it as an additional business and good rotation for cereals.

5.1.3 Improve seed distribution: A network of decentralized seed producers needs to be established in order to make seed readily available in the immediate localities of growers. This network will need strong linkages and coordination with the specialized seed producers (G2 and G3) to source their seed where the logistics of seed movement will be facilitated—for instance, by the county or district extension offices and/or traders.

Agro-input dealers must also be involved in seed potato trade, which is currently not the case. Since seed potatoes are bulky and perishable, improved storage facilities will be required. Innovative approaches such as the use of smaller seed bags and having larger agro-input companies, who regularly supply their network of smaller local agro-input dealers, distribute seed appears to be feasible alternative with great promise.

Different innovative seed and variety diffusion strategies should be explored to diffuse clean seed to small private multipliers and ware potato growers. Possibilities include voucher schemes, seed banks (based on commodity loan systems), seed fairs, input loans (e.g. through Equity Bank and Kenyan Women Finance Trust, etc), and input insurance systems (e.g., Kilimo Salama by the Syngenta Foundation for Sustainable Agriculture). Another promising approach, developed by Catholic Relief Services, involves the distribution of subsidized vouchers that are redeemable for a preset period for a fixed amount of seed from local seed multipliers (Remington *et al*. 2002). It is worth noting that for majority of farmers in Kenya, potato is a significant cash crop for smallholders and subsidized voucher schemes may not be necessary to ensure uptake of quality seed.

Linking seed growers to ware potato and processing potato growers could also help in making the seed enterprises profitable. Establishing linkages between formal and existing informal seed distribution channels currently selling seed potato of unknown sources and qualities will help to increase the uptake of good quality seed. In this regard, traders dealing with informal seed should be identified and linked to trained local multipliers.

Seed should be marketed, partly through awareness and demand creation campaigns, as described below, and through direct marketing such as the setting up of simple seed directories that list trained seed suppliers in the county.

5.1.4 Develop capacity of decentralized seed producers with a focus on empowering women

Producing quality seed requires a range of skills at various levels, from planning and management of seed production through skilled farm operations. Improving entrepreneurs and farmers' skills and knowledge in seed storage, seed quality management, and accessing new varieties could do much to enhance uptake and spread of new varieties and improved practices. Seed production should be viewed as a business rather than a technical or development activity if it is to succeed. Consequently, the need for business and entrepreneurial skills, and not just technical skills must be emphasized from the outset of any seed initiative.

Private seed potato producers (individuals, groups, associations) will need to be identified and trained for decentralized multiplication using G3 seed. Training of small private seed multipliers ideally starts through identification of suitable candidates, profiled as having a minimum of 4 ha of suitable land or having the capacity to rent land (for rotation purposes), and identified by local extension services as being leading or entrepreneurial growers. It is especially important to empower female farmers as seed producers, as they are predominately engaged in potato production in Kenya, and experiences from previous projects have shown that women are excellent multipliers (USAID, 2010). The number of trained seed growers should be rationalized according to the number of ware potato growers per district so that a decentralized network of seed multipliers can be established across all districts and thus reduce the distance travelled by potential seed purchasers.

The activities to ensure a sustainable onward decentralized seed multiplication could involve the identification and massive training and backstopping of "secondary" seed producers, linked to specialized seed producers by, for example, contracted out-grower schemes and development of marketing and business plans. Similarly, training of field multipliers within the seed potato production chain would lower costs and thereby increase profitability. Improved capacity to multiply seed by commercial multipliers would also improve sustainability of the enterprise by reducing the risk of seed loss (or rejection) due to pests and diseases.

5.1.5 Improve capacity for seed quality control: It will be necessary to complement efforts to increase the capacity of the national potato program and plant health inspectorate services to enable them to monitor and backstop seed production through i) advocacy and piloting of farmer/community-based quality standards, practicing self certification and labelling (QDS), with limited regulatory oversight; ii) training of community-based or grower association-based inspectors to support QDS; and iii) improved and easy-to-use low-cost disease detection methods.

5.1.6 Improve technology for seed multiplication: To strengthen the seed potato value chain, a continuous functional research support system for the seed sector is necessary. The improvement of in-vitro and minituber production systems will provide more efficient methods and reduce the risk that could be associated with using the technologies. Research on field multiplication at the farm level should concentrate on development of best agronomic measures like improvements in plant nutrition and disease control. Research should also be conducted on development and shifts in the occurrence and severity of the major seed-borne diseases. As a consequence of climate change, late blight and bacterial wilt are expected to expand into areas that have previously been fairly free of the diseases; and aphid populations are likely to increase in certain regions, in different seasons, and move to higher altitudes with more favourable climatic conditions for their development.

The research system can contribute to further development of minituber production by investigating new technologies for multiplication, well suited to conditions in the respective growing regions (e.g., by fine-tuning aeroponics to specific varieties, and managing diseases in aeroponics systems). Degeneration trials will help determine the number of acceptable generations under field conditions.

Decentralized seed potato multipliers can be further supported by testing alternative quality control systems, standards, and easy, low-cost disease detection techniques and effective approaches such as the branding of quality seed. This could be combined with testing options for on-farm seed maintenance.

5.1.7 Increase demand for improved seed and market-preferred varieties

The advantages of high-quality seed should be further developed through approaches such as: I) establishing plots comparing quality seed with farmer-saved seed, distribution and/or sale of quality seed to farmers in small quantities (5–25 kg); and ii) the use of different media channels.

Because specific strategies to be used depend on the local context, seed entrepreneurs must stay abreast of market-preferred varieties and have the resources and knowledge needed to produce high-quality seed of those varieties. Communication and feedback mechanisms need to be developed and maintained to ensure that relevant value chain actors are aware of what the market is responding to and its needs.

Through demonstration plots, farmers will be shown and feedback gathered on new potato varieties with value added traits (e.g., disease resistance, shorter growing season, or heat or drought tolerance) that could enter the quality seed production system. Many farmers do not have access to new, late blight-resistant varieties because the formal seed system produces only a tiny fraction of the seed planted. Other traits of value include virus and drought resistance, variation in maturation and dormancy periods (for more flexible planning), improved nutritional characteristics, and greater yield stability. These, combined with desirable processing qualities, reflect the needs of a fast-growing potato-processing industry and expanding urban market in the country.

The registration and cleaning of farmer- and market-preferred unregistered, introduced varieties (e.g., escapes from the variety testing and release process) should be supported to increase the range of varieties available through the regulated seed system. These activities will generate increased demand for seed as market-demanded new varieties enter the quality seed production system.

The development of sustainable strategies for managing and delivering source seed—including contracting for sale of pre-basic seed—by the national agricultural research system (NARS) can stimulate commercial seed production and farmer-to-farmer diffusion of new improved varieties and additional benefits to farmers. Communication to develop demand for new varieties, combined with strengthening local seed systems, can stimulate the exchange of seed by farmers and the emergence of formal seed potato enterprises.

5.1.8 Improve use of certified seed. Productive, profitable seed system performance relies on the skills and capacities of farmers to benefit from high quality seed. A commercial seed potato sector can only grow in response to the demands of a skilled and discriminating farming population (Tripp, 2003). Farmer training will help farmers get the best out of their clean seed. For example, if farmers understand that virus diseases are transmitted by aphids, and that aphids acquire virus from other sources, they can readily see the value of removing virus-infected *Solanum* weeds from hedge rows.

Farmers can also avoid planting clean seed in soil infested with bacterial wilt if they understand the contamination routes of this disease. Linkages should be established with initiatives to promote access to and better use of fertilizer, as clean seed is highly responsive to increased input use. New approaches to extension such as, farmer-to-farmer, private local extension services, and contract farming with extension components should also be piloted.

5.1.9 Improve seed management of farmers who cannot access certified seed

Existing farmer-training networks need to be strengthened in order to enhance farmers' capacity to extend the quality of their seed. Training materials are already available that could help facilitators train farmers to maintain seed quality through practices such as PS, on-farm sanitation, rotation, and proper seed storage. However, for farmers to effectively perform PS they need to understand that degeneration is associated with diseases symptoms, and they need to accurately identify diseases in the field to effectively select the disease-free plants. Farmers must learn to protect their investment in seed by slowing down degeneration and thus reaping additional benefits over several seasons from the high-quality seed they purchase. The aim is to implement massive training of a large number of farmers in on-farm seed maintenance and on-farm saved-seed quality improvement.

5.1.10 Improve farmer seed storage

Appropriate seed storage is an important pre-condition the profitability of seed enterprises. Poorly stored seed will produce lower yields and lead to more pest and disease problems. The DLS can be built by farmers themselves from locally available materials, with technical backstopping by researchers or extension staff. As the seed potato value chain matures and the adoption of DLS expands, trained small private seed multipliers or community-based seed multipliers should also be involved in DLS construction.

Seed storage warehouses also help solve a major problem for farmers—namely, not having enough reliable, healthy seed available when it is most needed for planting. When professionally designed and built to store high-quality seed, these facilities could meet the sanitary and phytosanitary conditions and requirements needed to add value to certified and QDS planting material. Farmer-owned seed cooperatives are another way to increase seed storage capacity, promote trust among seed value chain actors, and provide a good "incubator" for learning essential business management skills on a small scale.

5.1.11 Improve trust and communication and stimulate joint innovation

A lack of trust and communication between actors often short-circuit innovation in value chains. To develop a viable seed potato value chain, linkages between service providers, basic-seed producers, decentralized seed multipliers, and ware producers need to be improved. The Participatory Market Chain Approach (PMCA) (Devaux *et al.*, 2009; Horton *et al.*, 2009) could be a good starting point. The PMCA brings together small farmers, market actors, and service providers for an intense process of facilitated interaction.

The PMCA approach uses a flexible, three-stage participatory process over 9–18 months to improve communication, build trust, and facilitate collaboration among participants so that they can jointly identify, analyze, and exploit new market opportunities. This approach builds trust among seed potato value chain actors, enhances communication, and promotes joint innovation around new market opportunities in the value chain (Bernet *et al.*, 2006). PMCA will require investment in training process facilitators and organizing thematic group meetings around new business opportunities (e.g., decentralized seed production and seed distribution by agro-input dealers) to build product concepts and gauge market potential). It also will stimulate joint innovation required to meet the quality parameters associated with each market opportunity.

5.1.12 Creation of platforms of seed potato actors

Farmers should have access to sufficient information and training so that seed multiplication and business development create a profitable alternative for those located in appropriate environments (Tripp, 2001). To overcome the lack of information flow about seed business, seed potato stakeholder platforms should be formed with appropriate linkages to the wider potato value chain at each location. For example, the National Potato Council of Kenya shows how the private sector—from seed producers, farmers' organizations, processors, NARS, and the Ministry of Agriculture—engages in active communication and develops strong linkages in the whole potato sub-sector.

Functional platforms will facilitate the flow of technical and market-related information for the seed business. Major gaps in the information pipeline and stakeholder decision support concern (i) demand versus supply of quality seed; (ii) guarantee and traceability of seed quality, and (iii) new trends in terms of varieties and production technologies. Principles of agile and user-friendly information systems can be better exploited for the benefit of seed businesses.

A virtual market place for seed tuber supply and demand should be created with information about sources (companies), volumes, conditions, and the like. Market information can be connected to social media and mobile networks to keep subscribers updated. For example, having a seed directory with information about seed availability (where, how much of which variety, and when) and variety descriptions would facilitate business. This seed directory could be made available to extension officers, farmers, and seed traders via SMS mobile phone information system and the Internet. A database of growers and farms involved could be built and maintained to monitor progress; dynamic maps of seed production regions could be produced through the use of GIS tools. Moreover, the platforms provide stakeholders with relevant information about such topics as agronomy, postharvest physiology and management, market development, and credit sources. Once stakeholders agree to form platforms to pursue seed-related business opportunities, they are strengthened to interact with business development service providers that can help them access services like finance (credit) and complementary inputs, among others

5.1.13 Improve capacity of potato players countrywide

Major gaps in seed sector capacity building include: (i) technological innovation (production, storage, variety portfolios) and (ii) business management (marketing, labelling, positioning). Skills, knowledge, and replicable knowledge do exist in some parts of the country but need to be scaled up so that widespread benefits and economies of scale can be achieved for the country's emerging seed potato sector.

Underscoring virtually every activity proposed in the Roadmap and its potential for success is the pivotal role of building capacity through training and information sharing. Capacity building with key partners in the country should be targeted to take adequate stock of how many value chain actors—from aeroponics production to farmer seed maintenance—can be reached at the lowest possible transaction cost. Specialized capacity-building modules, incorporating new curricula and learning tools, need to be developed for trainers, producers, and businesses in the country. Four candidate capacity-building modules that have proved effective in other seed potato projects are recommended. These are:

i) "**Seed-entrepreneurs' business schools**," drawing on "farmer business schools" that have been successfully applied in Asia, can be used to train decentralized seed multipliers as a key group of actors. The country wide implementation of the training of trainers for seed entrepreneurs' business schools will ensure consistency in content and methodology, and be more cost effective.

ii) **Exchange visits** help promote and foster successful seed production operations at different points along the value chain concerned with multiplication (in vitro, minituber, field multiplication).
iii) **Short training events** (two to five days), organized nationally on specific technical or methodological topics, and should be provided by subject matter specialists. Examples of seed topics that can be covered include concepts of quality, planning, production plans, and technical aspects of seed production and storage.
iv) **On-the-job training** can be provided by specialists to emerging seed businesses through technical and methodological backstopping. Once key stakeholders have been introduced to basic concepts of the potato-seed business and some have agreed to a formal partnership arrangement, specific actions should be taken to strengthen certain capabilities according to local contexts.

5.1.14 Share best practices and technology for seed production and distribution

Sharing best practices and technology for seed production and distribution among different potato growing regions and eastern Africa countries will be essential to ensure progress towards sustainable seed systems. This exchange will facilitate information access and knowledge building on previous experiences, avoiding making similar mistakes, improving efficiencies, and using best practices whenever appropriate. Communities of practices can be organized on key topics within countries (e.g., on aeroponics and farmer seed maintenance).

5.1.15 Monitor tuber-borne pests and pathogens with user-friendly decision support tools

Surveys should be conducted to evaluate the status of seed-based pests and diseases as a precondition for the safe movement of seed, leading to the identification of “clean” areas suitable for seed production and monitoring systems. In other countries such as Chile, Argentina, and India, information on disease and pest pressure allows public and private institutions to identify “seed potato production zones”. In such countries, “clean” geographical areas are supported with investment and (regional) regulation to set up specialized spaces for seed production accompanied by certification and labelling schemes that recognize the origin.

Ensuring the phytosanitary status of seed is an important component of seed production and is crucial for countrywide, regional and international exchange of seed. No such common database exists in the country and, in fact, very few studies have been done on tuber-borne diseases in the country. Thus, while seed systems aim at managing tuber-borne diseases, the full extent of such diseases in the country and the region is not known. To this end, a national and possibly regional database of tuber-borne pests and pathogens of potato should be built in order to provide decision support tools to policy makers involved in quarantine-related issues.

To manage quarantine risks, public and private sector partners should commit to improving the knowledge base on plant health and develop functioning integrated quality assurance systems for the seed potato sector in the country and the eastern Africa region. Research on plant health; promotion of appropriate technologies, best practices, capacities, and policies for avoidance and detection; communication; and institution strengthening constitute an integrated strategy to prevent the spread and introduction of plant pests and pathogens.

Cross-border trade, however, will require very stringent quality assurance and norms must be standardized across the Eastern Africa region. These norms should be based on sound scientific knowledge of the risks of quarantine pests and diseases currently not present in the region or limited to specific locations.

5.1.16 Conduct market opportunity studies for regional trade in seed potato

Market opportunity and relative cost of production studies need to be conducted to identify possibilities for expanded trade in high-quality seed potato nationally and within the eastern African region, building on studies in Kenya (Labarta and Mulwa, 2011). The studies should focus on: (i) relative costs of production and favorable conditions (e.g., low virus vector pressure, sufficient land for multiplication, and capacities for seed production across the countries where trade could occur) and (ii) transport and transaction costs to identify market niches in the countries that could be served by a lower cost and more efficient producer of clean seed in another country.

Trade of quality seed can be of comparative advantage for potato farmers in the nation and region (e.g., seed can be produced cheaper in other regions/countries) and, as in Rwanda, land for multiplication is limited). These two factors can make quality seed more affordable for farmers and create lucrative business opportunities for seed producers in the region. The creation of reliable access to larger, more predictable markets will create incentives for investments in more efficient seed production and seed trade, which eventually increases supply and choice of quality seed to farmers at a reasonable price. Furthermore, investments in regionally managed alliances of public and private partners can help open up those markets.

5.1.17 Contribute to harmonization of regulations for cross-border trade, seed quality, and quarantine with the region

The harmonization of phytosanitary standards is a prerequisite for cross-border trade. The goal of harmonized standards is to facilitate movement and fair trade and to eliminate technical barriers to trade in seed potato planting materials. This initiative would improve producers’ profitability and encourage production of high-quality seeds and planting materials and protect consumers’ interest. To achieve this goal, the standard should address requirements and certification for varietal identity and purity, genealogy and traceability, diseases and pests, external quality and physiology, and sizing and labelling.

A draft for the harmonization of seed quality standard for the East African Community (EAC) was recently developed. The process of formulation and mobilization of stakeholders to review the standard in national and regional fora is ongoing. Beyond supporting this harmonization of EAC seed potato standards, a Roadmap project should engage actively in plans for policy dialogue and advocacy beyond the EAC member states, to address policy and regulatory issues that affect the distribution and sale of planting material for potatoes and other vegetatively propagated crops to improve domestic and foreign investment by expanding markets beyond national borders.

The dialogue between scientists and policy makers is a crucial aspect for harmonization and regulatory change. The sharing of current relevant knowledge to inform policy is facilitated by documenting the gains to liberalized or harmonized trade, quantifying the economic costs and gains, and informing decision makers through policy briefs and engagement in policy dialogue. KEPHIS National seed services should be encouraged to share information about seed supply and demand, promoting and monitoring truth-in-labelling, and training to improve the quality of seed production.

Transfer, acquisition, and dissemination of seed are highly dependent on safe movement of planting materials and the need to avoid introduction or dissemination of devastating plant pests and diseases from one country to another. In eastern Africa this is governed by plant protection and quarantine regulations and procedures, which are not harmonized yet and consequently hinder cross-border movement of seed potatoes in the region. Therefore, efforts have to be taken in account to support, for instance, the existing ASARECA harmonization initiative.

5.1.18 Establishment of strategic reserves of seed potatoes

There will be need to explore the possibility of establishment of ‘strategic reserves’ of seed potatoes by promoting use of and cold storage and/or improved storage facilities particularly the diffused light stores made from locally available materials. *In vitro* conservation of plantlets will also ensure that are there sufficient stocks of ‘nuclear seed stocks’ of priority varieties readily available for further multiplication whenever the need arises.

5.2 Strengthening the fresh potato value chain

5.2.1 Promote potato as an important food and cash crop with potential to contribute to country’s development aspirations. The potato is a nutrient-rich food security crop that can shield low the country from the risks posed by rising international food prices, while at the same time providing a valuable source of income for farm households. Increasing production and consumption of potato can reduce food insecurity. However, to do so first requires creating a favourable environment within which the fresh potato value chain can operate efficiently. This entails finding solutions that reduce constraints, create opportunities, improve productivity and reduce risks in the farming systems on which the most vulnerable depend. Potato has also not received sufficient attention policies for food crops despite its importance as a staple food and its potential contribution to combating hunger and poverty. There is a need for policy-makers to realize the importance of potato, *vis-à-vis* other crops, for food security and poverty alleviation. Increased production of potatoes can help save foreign exchange by reducing food imports. Policy needs to consider mechanisms that protect the unique role that smallholders play in the fresh potato value chain.

5.2.2 Engaging policymakers in preparing potato development plans and policies that encourage potato production and consumption

In order for potato to play its rightful role in the country's development agenda, policy-makers need a thorough understanding of the nature and functioning of potato value chains. This will require that the policy-makers be kept up to date on ongoing developments in the potato value chains and on the implementable research that can enhance chain performance. It also requires that those responsible for both policy formulation and implementation work together in developing effective potato development plans and policies.

5.2.3 Promote availability of, accessibility and use of production inputs

Inputs such as seed and fertilizer, and services such as credit, extension, research and information need to be available and accessible of if efficient performance of the fresh potato value chain is to be realized. Lack of good quality, clean seed is the most limiting element of the potato value chain and the main reason for poor productivity in the Kenya. The availability and accessibility of good quality clean seed has potential to increase yields significantly.

5.2.4 Develop plans for sustainable fresh /ware potato business development

An in-depth description of the actors—existing and potential—in the ware potato value chain and the status of ware potato production technology needs to be undertaken. This should be followed by an analysis of the profitability of different ware potato enterprises and strengths, weaknesses, opportunities, and threats (SWOT) analysis of the fresh potato value chain. The analysis should be carried out with the actors themselves, particularly those in the private sector. The national fresh potato business plans will build on the strengths and opportunities described in the SWOT. The plans will validate the targets for production of ware along the fresh potato value chain, analyze the existing capacity of ware potato businesses, and provide estimates of the capacity that would be needed to reach these targets. The plans should identify the types and size of investment that would be needed to close the gap.

5.2.5 Improve infrastructure and capacity for ware potato production and distribution

Improving infrastructure and capacity for high-quality ware potato is resource- and knowledge intensive. It will require investments in infrastructure, technical inputs, and other factors. To expand ware potato production it will be necessary to identify suitable locations and operators for specialized fresh/ware multiplication in suitable areas (low lands and arid and semi-arid areas) with enough land to conduct a proper rotation scheme. This should be done by trained ware potato producers. In some cases this may require development of irrigated production as a strategy of the enterprises becoming over dependent on rain-fed agriculture. Promotion of private and public sector investments in collection centres and warehouse receipting systems will be necessary so as to: i) even out supply of ware potatoes over the year; ii) encourage farmers to store (receipting system); iii) add value through storage (time utility) and iv) reduce volatility of ware potato prices over the seasons.

5.2.6 Improve ware potato distribution

A network of decentralized ware producers will need to be established in order to make ware potato available locally in all consumption regions. This network needs strong linkages and coordination with the specialized seed producers to source their seed where the logistics of seed movement will be facilitated—for instance, by the district extension offices and/or traders. They also need strong links with markets for fresh potatoes. However, potatoes are bulky and improved storage facilities will be required.

5.2.7 Promote Good Agricultural Practices (GAPS) and traceability systems

Good Agricultural Practices (GAPs) and traceability systems for potatoes should be developed for the country. GAP is a basic system to assure food safety on farm while traceability is an indispensable system to communicate information on food safety to both traders and consumers. The traceability system, therefore, serves as a pipeline of information. Combining these two systems is the only way to establish a food safety chain that can supply safe foods with confidence. For the potato subsector, GAP principles imply that potato production: i) takes place in an economically efficient way; ii) contributes to food security by providing quantity and nutritional quality for a balanced food supply; iii) along with post-harvest handling and processing, ensures a safe food supply to consumers; iv) conserves the natural resource base; v) does not lead to emissions that endanger the environment and biodiversity; vi) enhances potato biodiversity and ensures a sufficient genetic base for varietal adaptation and resistance; vii) supports viable farming enterprises and contributes to livelihoods; viii) meets the cultural and social needs of society.

5.2.8 Safeguard farmers' health, safety and welfare: The health, safety and welfare of farmers and consumers are important components in strengthening the fresh potato value chains. There is need to reduce risks associated with the use of pesticides, tools and machinery, and to ensure that potatoes for the fresh potato value chain are produced and handled in a manner that does not harm the environment and the health, and safety of farmers and consumers. Areas of focus could include: i) Creating awareness of food safety and environmental issues; ii) training farmers in the efficient and safe use of pesticides, fertilizers, tools and machinery; iii) Development of partnerships between farmers groups and public sector and development organizations to address health and safety issues; iv) Creating services that collect pesticide packing material and unused redundant stocks for centrally organized destruction; v) Informing farmers about proper pesticide labelling and the designation of containers used to mix pesticides, and the use of properly functioning protective equipment and clothing; vi) Establishing a list of chemicals that are generally safe for potatoes and a "black list" of chemicals that are dangerous and are forbidden; vii) setting maximum residue levels for agrochemicals that are permitted for potato production in the country; viii) Organizing farmers groups in cooperatives to promote their interests and call for positive marketing regulations, lower duties and taxes on imported tools and equipment, and better access to credit to improve their self-reliance and welfare.

5.2.9 Research for development: Further growth of the fresh potato value chain requires increases in the productivity, profitability and sustainability of potato based farming systems. This will necessitate a new and vigorous research. Emphasis should be placed on: i) investing in laboratories for the diagnosis of potato diseases, for measuring mineral concentrations in soils, and manure and fertilizers, and for determining the residue levels of pesticides; ii) the potential effects of climate change pose a threat to the levels and stability of potato yields. Heat and drought resistance should be considered in breeding programmes along with other key traits such as late-blight resistance, virus resistance, earliness and culinary qualities. The research system should provide a broader range of genetic material that meets site specific criteria, is adaptable to changing environments, and meets new demands from fresh potato markets including organic potatoes; iii) the potato subsector faces a growing challenge from more aggressive strains of the disease late blight but the country has a limited capacity to control the disease through fungicide application. Continued research on resistance breeding and integrated management strategies is therefore essential. Support is needed for scaling up existing LB control technologies and methodologies; iii) given the current state of knowledge, it is unlikely that resistance to latent bacterial wilt infection will become available through conventional breeding in the foreseeable future. Consequently, research on integrated management to control bacterial wilt should focus on designing improved detection technologies, developing recommendations that farmers are willing and able to adopt, and exploring options for suppressing the disease through improved soil fertility and health management (e.g. sanitation measures and clean seed). Participatory approaches to farmer empowerment and learning, such as Farmers' Field Schools (FFS) for IPM and IDM, are required in order to reach a significant number of potato growers; iv) The development of conservation agriculture technologies and practices for potato-based systems presents opportunities for both public and private sector research and requires research support. v) Consumer surveys to identify growing market segments and types of fresh potato products likely to be in demand in the near future are also needed. vi) Surveys to determine the most critical problems affecting players along the fresh potato value chain are also required.

5.2.10 Package available technology into usable information and formats for use by producers and extension agents. A more enabling environment for potato production in the country can be created through the further uptake of affordable technology. The research system has demonstrated that yields in excess of 40 tonnes ha^{-1} can be attained in the country. Progressive farmers easily obtain yields that exceed over 20 t ha^{-1}. There is therefore, need for farmers to adopt such technologies to bolster yields from the current national average yields of < 10 t ha^{-1}. Accordingly, programmes need to be put in place to inform potato producers about existing technologies and how their use can contribute to enabling environments and improve performance. This will require keeping extension services up to date with the latest technological developments and applications in the fresh potato value chain as well as the most appropriate media through which information can be disseminated to farmers. Embracing of e-extension may help relieve some of the constraints faced by extension officers in service delivery.

5.2.11 Intensify scaling up and scaling out of developed technologies: The performance of the fresh potato value chain is strongly influenced by technologies associated with production, processing and distribution operations. Although the technology for potato production exists, there is a significant gap between actual and potential performance resulting in low average yields. While continued technological research is still needed, it is imperative that existing technologies be scaled up and scaled out to ensure better accessibility and application for farmers. As part of the scaling-up process, proven technology needs to be adapted to local conditions to maximize the potential gains. Such activities should be undertaken in association with the various value chain actors – researchers, producers, the private sector and consumers – to ensure that all their needs taken into account. As part of the scaling-out process, the availability and application of existing technologies need to be communicated to all farmers as discussed above.

5.2.12 Promote public policies and private sector initiatives that reduce the risk of potato farming: Risk is a major constraint to potato production in Kenya. Accordingly, development of risk reduction strategies will provide significant scope to create a more favourable enabling environment for potato production. There are many forms of risk and each form requires the adoption of a different risk reduction strategy, which can be provided by either the public or private sector or by forging partnerships. For example, production risk can be mitigated through crop insurance , the adoption of technologies (e.g. use of robust varieties and disease-resistant varieties), the promotion of irrigated production and associated equipment in drought-prone areas, adoption of contour farming in areas prone to soil erosion, etc. Risks associated with postharvest losses can be mitigated through the construction of storage facilities and processing capacities, while price and market risk can be mitigated through vertical integration and forward contracts.

5.2.13 Promote the development and use of robust varieties that will perform reasonable well under adverse conditions and over successive years. Climate change is real and its effects are being felt all over the world. Risk-averse smallholder farmers tend to prefer technologies that reduce production risk. However, some of the high-yielding potato varieties show relatively high yield variation when subjected to adverse conditions. Considerable scope therefore exists to further the development of 'climate smart' or robust potato varieties that consistently do well under the marginal conditions faced by many smallholder farmers as drought, disease and low fertility. Development of such robust varieties takes into account not only yield maximization but also qualities that increase the ability of potatoes to contribute to food security and poverty alleviation Use of modern biotechnologies in would speed –up the development of such varieties.

Organize smallholders into producer organizations in order to reduce transaction costs, add value through grading, selection and storage, and gain bargaining power. The structure of the market at each stage of the value chain has a large impact on the chain's overall performance as well as the performance of the individual chain actors. Organizing smallholders into larger producer groups can benefit the entire value chain. Collective organization and post-harvest strategies, such as storage, can significantly increase the bargaining power of producers while reducing transaction costs, thus benefiting the entire chain. Furthermore, marketability can be improved by pooling production, enabling farmers to create larger potato batches for sale that that have been graded and selected specifically for the target market. Establishment of collection centres and warehouse receipting systems will also go a long way in addressing market challenges such as fluctuating supply and prices throughout the year. In order to remove the market cartels operating at major wholesale markets, registration of marketing agents/agencies directly linked to the farmers should be undertaken.

5.2.14 Linking producer groups with markets, including wholesalers and retailers
Linking producers and producer groups directly with other value chain participants, such as wholesalers and retailers, will enable smallholders to meet the specific demands of the value chain, thereby adding value and boosting incomes. Promoting an understanding of the market and the demands of the value chain to smallholders will ensure the right product, in terms of variety, grading and packaging, is delivered to the right place at the right time.

5.2.15 Promote the availability of market information through media and other channels. Kenyan potato producers generally have insufficient knowledge of the fresh potato market to help their decisions on when and where to sell their potatoes. Increasing their understanding of the market and the demands of the value chain necessitates better provision of market information and greater transparency along the chain. Application of modern ICT applications (M-agriculture, e- extension etc), guided by business logic, can several interventions in the supply chain including: reduction of costs of coordination (collection of production, distribution of inputs, and so on); increased transparency in decision making between partners; reduction of transaction costs; dissemination of market demand and price information; dissemination of weather, pest, and risk-management information; dissemination of best practices to meet quality and certification standards; collection management data from the field; and ensuring traceability. ICTs can also be used in extension in what is commonly known as e-extension or m-agriculture.

5.2.16 Provide business development services to producers and producer associations as a complement to technical training. Effective management at every stage along the value chain is necessary if individuals are to allocate resources efficiently, respond to consumer needs and adapt to market changes. Effective business administration is often overlooked at the individual level in favour of more technical approaches to further increasing production. This will need to be remedied if the fresh potato value chain is to be strengthened.

5.2.17 Improve consumer demand for fresh/ware potatoes. There have been very few efforts on promotion and marketing of fresh potatoes in the country. No consumer research has been conducted, although it is believed that consumer knowledge of potatoes (varieties and uses) is poor. Opportunities exist to increase demand for fresh potatoes in: promotion, packaging, niche varieties, taste, education, alternative uses and consistency in product quality. Increases in per capita consumption of potatoes can be in achieved through various marketing processes, such as blanket generic marketing. Some of the ways to increase value in fresh potatoes include inserting recipe cards, nutritional information, or sachets of sauce or herbs in fresh potato packs. Also provision of advice of what variety is suited for various cooking purposes. Customers may in the future be offered full traceability for their fresh potatoes. There is also a clear opportunity for greater market segmentation within the fresh market.

5.2.18 Explore potential for exporting potatoes: Kenya´s total potato imports and exports are negligible (Ng'ang'a and Kaguongo, 2012). Some informal, unrecorded trade takes place with Tanzania and Uganda, e.g. potatoes are sent from the growing areas around Arusha to Nairobi, and from production zones in Kenya across the border to Mwanza in Tanzania. These shipments are private-sector driven and largely reflect regional/ seasonal production patterns and trucking access to different markets on either side of the border. There is potential for increasing exports of fresh potato beyond the very modest volumes that have been shipped to date. Any export efforts geared towards ware potatoes should focus first on stabilizing supplies and improving the quality of the tubers available within the country as part of a more long-term process to make them more competitive in potential export markets.

5.2.19 Packaging: Packaging of fresh potatoes is rather undeveloped. Small quantities of fresh potatoes are packaged and sold in net bags in some markets and supermarkets. Some retailers sell their potatoes in polythene bags (usually 1-2 kg). Packaging of ware potatoes in paper bags is currently not done. There is there potential to expand the packaging industry and increase the value of potato.

5.2.20 Avail credit and financial services: Financing is a major driver of transformation of the potato subsector, yet it is in short supply. Potato growers have in general been unable to access credit facilities. This credit constraint has limited their ability to produce potatoes optimally. There is need to increase greater access to affordable credit and financial services by potato farmers. There is also need to build a package of instruments – grants, guarantees, patient capital and commercial money combined – to finance the capital costs associated with transformation of the potato subsector. The various instruments identified should be mutually enabling, for example, using crop insurance or financial guarantees as collateral to get banks to lend money, or using donor funding and patient capital to co-invest with private investors to improve a project's access to capital through public private partnerships.

5.2.21 Coordination of stakeholders in the fresh potato value chain. Chain coordination harmonizes the physical, financial and information flows along the value chain and can facilitate performance. However, coordination among farmers to facilitate activities along the fresh potato value chain is still not sufficiently developed and needs strengthening. Organizations such as the National Potato Council of Kenya (NPCK) and Kenya National Potato Farmers' Association (KENAPOFA) to help improve the flow of information among players in the fresh potato value chain.

5.2.22 Inadequate policies and limited enforcement of existing policies

Implementation of existing potatoes policies and legal framework is inadequate due to unclear responsibilities of implementing agencies. For instance, the implementation of Legal Notices No. 44 and 113 is hampered by an unclear implementation strategy between the Ministry of Agriculture, Provincial Administration and the Ministry of Local Government. Extended bags (130-260 kg) still end up in markets. There is need to continuously review and update existing potato standards for both local and export markets. There is need to review and enforce legal and regulatory frameworks such as legal notice N0. 44 and 113 and any other legislation that affects the fresh potato value chain.

5.2.23 Improvement of market infrastructure.

Markets are in a pathetic state and need to be improved.

5.3 Strengthening the processed potato value chain

5.3.1 Develop plans for sustainable processed potato business development

An in-depth description of the actors—existing and potential—in the processed potato value chain and the status of processed potato production technology needs to be undertaken. This should be followed by an analysis of the profitability of different processed potato enterprises and strengths, weaknesses, opportunities, and threats (SWOT) analysis of the processed potato value chain. The analysis should be carried out with the actors themselves, particularly those in the private sector. The national processed potato business plans will build on the strengths and opportunities described in the SWOT. The plans will validate the targets for production of processed potatoes along the processed potato value chain, analyze the existing capacity of processed potato businesses, and provide estimates of the capacity that would be needed to reach these targets. The plans should identify the types and size of investment that would be needed to close the gap.

5.3.2 Promote Good Manufacturing Practices (GMPs)

Good Manufacturing Practices (GMP) should be developed for the potato processing industry. GMP compliance assures sanitary and processing requirements applicable to all food processing establishments are met. The GMP is a set of regulations, codes and guidelines that control the operational conditions within food establishment allowing for the production of safe food.

5.3.3 Research for development: Further research is required to: i) develop best practices for growing potatoes for the processing industry ii) conduct consumer surveys to identify growing market segments and types of processed potato products likely to be in demand in the near future are also needed. iii) conduct surveys to determine the most critical problems affecting players along the processed potato value chain are also required. iv) reduce polyacrylamide levels in fried potato products.

5.3.4 Package available technology into usable information and formats for use by producers and extension agents. A more enabling environment for potato production in the country can be created through the further uptake of affordable technology. The research system has proved that yields in excess of 40 tonnes ha^{-1} can be attained in the country. Progressive farmers easily obtain yields that exceed over 20 t ha^{-1}. There is therefore, need for farmers to adopt such technologies to bolster yields from the current national average yields of < 10 t ha^{-1}. Accordingly, programmes need to be put in place to inform potato producers about existing technologies and how their use can contribute to enabling environments and improve performance. This will require keeping extension services up to date with the latest technological developments and applications in the fresh potato value chain as well as the most appropriate media through which information can be disseminated to farmers.

5.3.5 Promote public policies and private sector initiatives that reduce the risk of potato farming: The strategy to be adopted is similar to those proposed for the ware/fresh potato value chain but with emphasis on the processed potato value chain

5.3.6 Promote the development and use of varieties suited for processing. Currently, there are very few varieties suited for the processing industry and processors continue to demand for the 'correct' varieties. Considerable scope therefore exists to further the development of potato varieties that are suitable for the processing industry.

5.3.7 Linking producer groups with markets, including wholesalers and retailers

Linking producers and producer groups directly with processors will enable smallholders to meet the specific demands of the processed potato value chain, thereby adding value and boosting incomes. Promoting an understanding of the market and the demands of the processed potato value chain to smallholders will ensure the right product, in terms of variety, grading, quality and packaging is delivered.

5.3.8 Provision of business development services to producers and producer associations as a complement to technical training. Effective management at every stage along the value chain is necessary if individuals are to allocate resources efficiently, respond to consumer needs and adapt to market changes. Effective business administration is often overlooked at the individual level in favour of more technical approaches to further increasing production. This will need to be remedied if the processed potato value chain is to be strengthened.

5.3.9 Improve consumer demand for processed potato products. There have been very few efforts on promotion and marketing of processed potato products in the country. No consumer research has been conducted. Opportunities exist to increase demand for processed potatoes in: promotion, packaging, niche varieties, taste, education, alternative uses and consistency in product quality.

5.3.10 Export potential for processed potatoes: Kenya´s total exports for processed potato products are negligible. There is potential for increasing exports of processed potato beyond the very modest volumes that have been shipped to date. Strategies need to put in place to aggressively find markets for processed potato products beyond the domestic front.

5.3.11 Packaging: Packaging of processed potatoes is rather undeveloped. Most of the cottage processing industries have poor packaging There is there potential to expand the packaging industry and increase the value of processed potato.

5.3.12 Coordination of stakeholders in the processed potato value chain. Just like in the fresh potato value chain, chain coordination harmonizes the physical, financial and information flows along the value chain and can facilitate performance. However, coordination among farmers to facilitate activities along the processed potato value chain is still not sufficiently developed and needs strengthening. Organizations such as the National Potato Council of Kenya (NPCK) and Kenya National Potato Farmers' Association (KENAPOFA) to help improve the flow of information among players in the processed potato value chain.

5.3.13 Inadequate policies. Finalization of local and regional standards (e.g. the EAC standards) for crisps and other processed products will go a long way to strengthening the value chain.

5.3.14 Contract farming arrangements.
A contract farming approach could help farmers access high-value markets linked to seed (and other input) provision by the processor on a loan basis to ensure a regular supply of the desired processing characteristics (e.g., the right variety, potatoes of appropriate age and qualities). This approach has already proved effective in some of the projects that have recently been implemented in the country.

5.3.15 Finance and credit. The approach to be used will be similar as for the fresh/ware potato value chain.

CHAPTER 7. BUILDING PARTNERSHIPS

Partnerships remain a key component of delivering the potato road map. Both national and regional partnerships will be developed into to make the potato industry more sustainable. Partnership among research-oriented partners will also be promoted in order to find solutions to specific technical bottlenecks that reduce the efficiency and profitability of the potato businesses.

7.1 Partnerships and Actors

At the National level, partnerships between the public sector and key private sector actors and parastatals will serve as basic drivers to commercialize the seed potato subsector, while partnerships between the NARS and The International Potato Centre will be useful in development and release improved potato varieties, production of nuclear seed, and in building capacity. The Ministry of Agriculture (MoA) is expected to provide leadership in dissemination of technologies, farmer training, and also to play a seed quality regulatory function that will enhance regional seed and germplasm exchange. Partnerships with institutions of higher learning will enhance training and capacity of researchers. Strategic partnership will also be forged with input and output traders, transporters, and processors.

The Kenya Plant Health Inspectorate Service (KEPHIS), is expected to support the seed companies in seed potato certification and quality control, particularly with a view to promoting seed potato export trade.

Partnerships with policy organizations and other stakeholders to develop seed potato quality standards that will reflect the reality for national and regional seed potato exchange. The concept of quality declared seed (QDS), developed by FAO and CIP (Fajardo *et al.*, 2010), will be employed to enhance national seed exchange, where quality standards will be less stringent, to help promote production and utilization of quality seed

Partnerships with processors, supermarkets and other outlets for processing and consumption potatoes will also be strengthened.

At the regional level, partnerships will be forged with the different programs of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA), the Common Market for Eastern and Southern Africa (COMESA), the African Seed Trade Association (AFSTA), and Eastern Africa Seed Committee (EASCOM) to develop a favourable policy for seed potato and enhance its quality, strengthen seed potato associations at regional and national levels, and promote regional trade for seed potato and other potato products by avoiding tariff and non-tariff barriers. Partnerships will also be forged with the Alliance for Green Revolution in Africa (AGRA) to train breeders, seed specialists, and agronomists. Collaborations with regional programs such as the SSA-Challenge Program will enhance spill over to other countries. Partnering with the private companies that produce and distribute quality potato planting stocks will be given special attention. Collaboration with this network of partners, coupled with favourable regional trade, can help break the seed potato bottleneck in the entire region. It will lead to increased contribution of the potato subsector to achieving the 6% economic growth target set by the New Partnership for Africa's Development (NEPAD) by 2015 and the Millennium Development Goals.

7.2 Mapping Current and Potential Partners

There are several strategic partners related to regulatory function, technical and methodological backstopping (Table1). These include the MoA to help in seed policy issues, variety release, seed certification, dissemination of technologies and training; NARS to develop and promote technologies, produce breeders seed, conserve germplasm/varieties, conduct quality control and seed certification, enhance capacity building for researchers and other stakeholders; and NGOs that will bring special skills to help in the dissemination of technologies. In addition to strategic partners, there are primary partners, including those who will benefit from the improved potato seed business, such as selected farmers' associations, seed traders, transporters, microfinance organizations, universities, and decision makers in charge of development investments. There are also a number of secondary partners who will benefit from the project but may not necessarily involve in the project directly unless otherwise deemed necessary in the course of project implementation.

Regionally, partnerships will be forged with strategic partners (Table 2), including ASARECA, AGRA, AFSTA, EASCOM, and ACTESA to develop a favourable policy and regulatory environment for seed potato promotion; enhanced seed quality; local, national, and regional trade; and networking among others. Partnerships will also be forged with organizations with experience in the promotion of seed of vegetatively propagated crops, such NGOs with a wide regional presence; will enable widespread dissemination of quality seed potato of the improved varieties using mechanisms such as the voucher approach as a model.

Effective regional partnerships coupled with a favourable policy, especially in the areas of regional seed potato trade and standards, can be successfully break the seed potato bottleneck in a progressive manner in the entire region while at the same time strengthening the entire potato value chain.

Table 1 National partners, their roles, and endowments

Partner Organizations	Roles	Partner Endowments
Ministry of Agriculture (MoA)1	Policy development and implementation • Extension services and technology transfer • Variety release and seed certification • Training of staff and farmers	Active seed certification service • Presence of seed and potato policy • A functional national potato council • Agricultural extension manpower
Kenya Agricultural Research Institute (KARI)1	Technology development and • dissemination Production of breeders' seed • Variety maintenance • Capacity building	Research laboratories Trained manpower • Access to public resources • Potato germplasm
Kenya Plant Health Inspectorate Service (KEPHIS)[1]	• Variety testing (NPT & DUS) • Granting of plant breeder's rights • Seed certification and inspection of seed potatoes for export and import • Phytosanitary and quarantine	• Tissue culture and pathology laboratories • Trained manpower • Government recognition and support as certifying institute
Agricultural Development Corporation (ADC)[1] Universities and Colleges of Agriculture[2] National Council of Science and Technology (NCST)[1]	Certified seed production Capacity building Research grants	• Resources, including staff, land, aeroponics • Trained personnel • Laboratories
Private Genetic Technologies International Limited (GTIL)[1]	• Commercial production of invitro plantlets and minitubers	• Tissue culture laboratory • Aeroponics and conventional greenhouses • Private financial resources • Seed market strategies
Commercial farms[1] (Kisima, Milwar, Suera, Kagia, Kinyua Mbijiwe)	• Production and sale of minitubers, basic and certified seed	• Resources (cash, land, personnel) • Facilities (lab. aeroponics) • Experience in commercial seed production
Agrochemical Association of Kenya (AAK)[2]	Quality control and training on safe use • Supply of agrochemical and may be seed potato distribution	Inputs, knowledge
Farmer Organizations National Potato Council of Kenya[1]	Promote and regulate the potato industry	• Public and donor funds • Trained manpower
Kenya National Federation of Producers (KENFAP)[2]	Advocacy	Recognition and trained staff
Potato processors[2]	Supply certified seed to contract Farmers	• Cash, market
NGOs FIPS-Africa[1]	Seed potato distribution	Proven small pack farm input market mode
Farm Concern International[2]	• Linking farmers to market	• Commercial village model in a group • Proven experience in commercial village model • Experience and knowledge
Donors and Financial Partners (potential partners) Syngenta Foundation[2]	• Donor and capacity building • Seed potato insurance	Funds, experience in seed Insurance
Equity Bank[3]	Credit facilities and training on financial management	Cash, knowledge
Packaging industry[2]	Supply of seed packaging materials	Supplies
USAID Feed the Future (USAID-FTF)[2]	Donor	

[1]Strategic partner; [2]Primary partner; [3]Secondary partner

Table 2 Regional Partners, their roles, and endowments

Partner Organizations	Roles	Partner Endowments
ASARECA1	Extension and service provision • Agricultural education and training • Empowerment of farmers' organizations and other appropriate bodies • Focuses on increased productivity, food security, increased income, and poverty alleviation • Potato policies and standards	• Active in 10 countries in SSA • Access to funds • Recognition • Legal entity • Link to appropriate bodies
AFSTA1	• Promote the use of improved quality seed • Strengthen communication with African seed industries • Facilitate establishment of national seed trade associations in Africa • Promote activities that lead to regulatory harmonization throughout Africa to facilitate movement of seed	Access to funds • Expertise in seed harmonization • Link to appropriate bodies
ACTESA/ COMESA1	Increase the commercial integration of small farmers into national, regional, and international markets • Accelerate the implementation of regional initiatives in agriculture, trade, and investment • Improve competitiveness and integration of staple foods markets in the region through improved microand macro-economic policies	Recognized and influential body • Powers to regulate regional trade • Links to heads of states and other organizations
AGRA1	• Has integrated programs in seeds, soils, market access, policy and partnerships, and innovative finance work to trigger comprehensive changes across the agricultural system • Strengthen agricultural education and extension • Address the issue of efficient water management, and strive to involve and train youth • Promotes training of professionals to improve the critical mass	• Access to funds • Links to other organizations • Interest in building up resources, including human and natural
EAC/EASCOM1	• Harmonization of seed certification • Seed standards • Regional seed trade	Access to funds • Links to other organizations • Recognized body
International NGO **CRS**[1]	Interest in increasing productivity, food security ● Dissemination of technologies	● Presence in several countries ● Voucher model of seed distribution ● Available personnel and experience ● Links to other organizations Access to funds
Program **SSA Challenge Program**[2]	Involved in seed potato production ● Tackle regional food security and poverty reduction Issues	Access to funds ● Regional experience ● Link to NARS

[1]Strategic partner; [2]Primary partner.

CHAPTER 7. MONITORING AND EVALUATION

Successful transformation of the potato subsector will require a deliberate and adequately resourced approach to designing, managing and monitoring implementation of activities to drive change at scale. It will require the institutionalization of the partnerships through a formal organization and governance setup to orchestrate change and monitor progress, either through explicit empowerment of existing actors or establishment of a delivery unit. This delivery mechanism is one of the cornerstones required to facilitate revitalization of the potato sub-sector.

Adequate resources are required to drive operational development and deployment of initiatives until they achieve a self-sustaining momentum. Without the right mix of people, skills and funding, and a structure that gives and clarifies the authority to manage, the envisaged transformation of the potato subsector is unlikely to be achieved. To ensure mutual accountability, all stakeholders should agree on transparently monitoring and regular reporting of progress to the head of government through some kind of coordinating platform.

The level of institutionalization and resourcing can vary, tailored to the specific facets of the a transformation. Several options exist (WEF, 2012).: It may be possible to create a stand-alone “delivery” or “transformation” units reporting directly to the change leader (e.g., Agriculture secretary or principal secretary (currently PS) that have strong amounts of authority and staff to quickly troubleshoot and execute on all aspects of the transformation. Another alternative is to create a “lean-and-mean” coordinating steering committee that provides a regular forum for all stakeholders to meet and track roll out. It may be prudent to set up a transformational unit or an overarching programme management office to monitor progress and adjust plans without taking a direct role in implementation.

The design of the ‘delivery unit’ will ultimately need to incorporate targeted capacity building to ensure the critical mass to implement projects. Considerations may include: evaluating the country’s past and present performance and its capacity for delivering large transformations; establishing an appropriate organizational set-up to drive and monitor performance; and building an irreversible results-oriented culture, continually building system capacity and communicating the delivery message so that all stakeholders are aware of what is expected of them and why they are doing it.

CHAPTER 8: ESTIMATED COSTS

The roadmap requires an estimated USD 30 million dollars to implement over the next five years (Table 3). The investment will benefit different actors and productive enterprises along the three potato value chains namely: the seed potato value chains, the fresh potato value chain and the processed potato value chain.

Table 3: Estimated investment cost for the various value chains (KSHs)

Value chain	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Seed potato value chain	3,500,000	3,500,000	3,500,000	2,000,000	2,000,000	14,500,000
Fresh potato value chain	1,500,000	1,500,000	1,500,000	2,000,000	1,500,000	8,000,000
Processed potato value chain	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	7,500,000
Total	**6,500,000**	**6,500,000**	**6,500,000**	**5,500,000**	**5,000,000**	**30,000,000**

I USD= 85 KSHs

Funding mechanisms

There is need to need to invest some "seed money" (risk investment) for competitive grants to conduct demand-driven research on problems that limit the profitability of the potato value chain, but prioritizing the participation of partners from different sectors of the potato value chain. Such funds could be administered by potato value chain platforms at the national or county level. These platforms involve stakeholders from the entire potato value chain who will participate in the identification of researchable areas. The ultimate objective is to conduct demand driven research that is aimed at strengthening the potato value chain.

In addition, mechanism of internal funding to eventually make research or other potato-related services more sustainable will be explored. These mechanisms could be linked to small tariffs (levies) or taxes on seed, ware potatoes or processed potato products sold.

A specific fund could also be established to provide microcredit for farmer organizations or other private groups interested in potato businesses. Such credit would of course, depend upon the approval of sound business plans. Monitoring of partnership formation and function in order to extract lessons and best practices will be an important element of the roadmap. Such lessons will be useful informing potato related or other vegetatively propagated crop interventions in other countries.

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Annex 3

Report 1: Ethiopia Potato Impact Study

Report 2: POTATO IMPACT STUDY Uganda

CFC potato report, 2012

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1 Introduction

1.1 Background information

Improvement of the potato production system in developing countries can be a pathway out of poverty. This is specifically true for Sub Saharan Africa, where potatoes are an important cash crop. The potato is an outstanding smallholder farmer crop. It has a short cropping cycle, a large per area production, and can fulfill both household food requirements as well as generate income. Potatoes marketing systems, although often not perfect, are in place and sufficiently functioning in Sub Saharan Africa to assure smallholder farmers gain income to support their livelihood. Potatoes are a crop where almost all produce is made use of. The low quality potatoes can be consumed in the household, while the better part of the harvest is marketed. Potatoes have a short cropping cycle, and can give income in a period of just four months. Because of this, and increasing demand from urban consumers the potato is potentially the smallholder cash crop of the future for the densely populated East and Central African highlands.

Apart from providing cash income for poor farmers, potato production can also play a major role in improving food security. In Kenya potato is the second most important food crop after maize, while in Ethiopia potato production could fill a gap in food supply during the ‘hungry months’ of October to December before the grain crops are being harvested. In the very densely populated highlands of South Western Uganda potato production is key to supporting the income and food security of the rural population, similar to Rwanda, Burundi and North-Eastern Congo. Furthermore, potatoes can provide a cheap but nutritionally rich staple food required in the fast growing cities of Sub Saharan Africa, contributing significant amounts of protein, zinc and iron to the diet.

Potato farmers face various constraints which include lack of and unavailability of quality potato seed and diseases such as Late Blight and Bacterial Wilt (BW). Diseases and poor seed quality are intertwined such that frequent recycling of seeds leads to build up of disease leading to disease multiplication (Wang’ombe 2008). Some diseases such as BW are both soil and seed borne which spreads rapidly through seed recycling. Soil infertility is also a major constraint which is closely related to poor management. Most farmers also lack proper storage facilities (Diffuse Light Storage) for both ware potato and seed. Storage determines the shelf life of potato and also the sprouting of seed potato.

Marketing challenges encountered by potato producers are price instability and poor prices.

CFC project sought to address such constraints faced by potato producers in Ethiopia. Farmers were trained on proper potato management which included improvement in soil fertility, production of quality seed potato, seed selection, use of improved seeds, disease management, proper potato storage, linking farmers to markets and credit institutions among others.

1.2 Project Goal

The main goal of this CFC project was to improve the livelihoods of smallholder potato producers in Ethiopia, through integrated development of the seed and ware potato production and marketing chain

Smallholder potato farmers in Ethiopia were to improve their livelihoods through development of the potato sector. Using an integrated approach the CFC project, tackled the different imperfections in the potato sector simultaneously to allow for rapid development of the potato sector. Through the intervention of this project, the following hypotheses were to be achieved:

1. Increased potato productivity due to introduction of new technologies
2. Productivity improvement due to improved knowledge on crop husbandry and access to high quality seed
3. Increased income as a result of improved marketing systems through contract farming

1.3 Goal of the impact assessment survey

The general objective of the impact assessment survey was to measure various impacts that could be attributed to the implementation of the CFC project in Ethiopia. The specific objectives were to:

- Quantify the returns to investment for ware farmers investing in quality seed
- Assess the effect of the use of clean seed and seed management training on productivity and potato derived incomes for both ware and seed potato farmers
- Assess the degree of use of quality potato seed in the intervention areas
- To assess the multiplier effect of the project interventions in the intervention geographical areas

- To assess the degree of direct marketing and future potential of such arrangements between farmers and other value chain agents

2 Methods

2.1 Study Design and Data Sources

To achieve the above objectives, the study utilized three key sources of data; mainly the baseline, impact assessment survey and focus group data from the farmer trainers (TOTs) and potato processors. 'Before and after' study design were employed in the analysis whereby farmer and farm situations before the project implementation as captured in the baseline survey were compared to the current situations. As such, efforts were made to interview the same farmers in the impact survey as those interviewed in the baseline survey.

Data from the baseline survey was used for comparison with the current situation and included; farmed areas, acreages under both ware and seed potato, the types of seed used, seed varieties, sources of seed, seed prices, input use, quantity of output realized, quantity of output sold, output buyers, and the prevailing market prices.

Using a semi-structured questionnaire, the impact survey collected data on various variables which included: land ownership, the types of farmers, land areas farmed, seed sources, types of seed, seed varieties used now, seed prices, inputs used, outputs realized, output sold, output buyers, marketed produce prices, level of direct marketing, and contractual agreements between farmers and processors or retailers.

2.2 Data analysis

The study employed the use of descriptive statistics and gross margin analysis to characterize productivity and incomes realized from potato farming. Since the study focused on the information of a smaller sample, extrapolations of computed parameters were done to inform on the situation in the whole areas of intervention.

2.3 Sampling

In Ethiopia, CFC project was implemented in West Shoa and Gurage zones. A sample of 200 farmers was targeted for the impact study in both districts. This was proportionately distributed across seed and ware potato trained farmers, as the first basis of stratification. Subsequent strata were drawn from the administrative units down from the zone to the peasant association level. Stepwise proportionate stratified random sampling was employed in Ethiopia to get the 200 units of study. Questionnaires were administered at the household level.

2.4 Data Collection, Entry and Analysis

The data required was gathered from in-depth interviews (household survey). The enumerators were properly trained and supervised during data collection to ensure the accuracy of the data collected. The interviews and discussions were conducted in the local.

Data collection took place for a period of six days in each zone. In each district, a total of eight enumerators were used for the data collection exercise. During the entire data collection period, quality assurance was maintained by constantly supervising the enumerators in the field. Completed questionnaires were thoroughly checked for inconsistencies and errors during the evening hours by the monitoring team and necessary adjustments made before embarking on data collection for the following day.

Data entry clerks were recruited through a competitive process through an oral interview and they were well versed with MS Office computer packages which was a major requirement. They were properly trained on data entry skills using CSPro program. During data entry, there was constant backstopping by the monitoring and evaluation team to ensure minimum errors. Further, the study used double data entry method that validated the data at the entry stage. After all the data had been entered, data cleaning was properly done led by the monitoring and evaluation team to ensure maximum quality assurance.

Data was analyzed using SPSS program and the final results presented using narration and tables where applicable. The analysis was done using descriptive methods i.e. percentages and means, cross tabulations and regression methods.

3 Results and discussions

3.1 Socio-demographic Background

The studies showed that majority (87%) of those interviewed were married and lived with their spouses contributing. About 92% of the participant farmers interviewed were males, while in the control group 93% were males. The average age was 43 and 46 years among the participants and non participants respectively. The average years of education were 3.7 years for the participants and 3.9 years for the non participants.

The mean number of people per household in Ethiopia was 6.06 persons per household with an average of 7.2 and 5.7 persons for Oromiya and SNNPR regions respectively. The mean person per household in Ethiopia during the baseline survey was 6.01.

About 43% of all the household members were engaged in farming as the main economic activity. About 52% were school going children. Only 2% were earning salaries from employment. Most of the household heads (95%) were engaged in farming to generate income. Only 2% earned salaries from employment while about 2% were off farm casual labourers. The people who were employed reduced from 3.4% during baseline survey to 2 % during the impact assessment report.

Table 1: Main occupation of the household head

	Baseline time (%)	End of project survey (%)
Farming	91.6	95.0
Salaried employment	3.4	2.0
Casual labourer (off farm)	0.8	1.5
School going	0.3	0.5
Business	2.9	0.5
Other	0.5	0.5
	100	100

There were significant differences in livestock values with the participants having livestock valued ETB11263 more than the non participants (Table 2). There are also significant differences in the farm size with the participants having 0.05 more hectares compared to the non participants.

About 87% of CFC participants used improved seeds while only 46% of the non participants used improved seeds. This difference is significant at 1%. The participants were also able to store their seeds for a period of 5 months compared to the control group who could store for only 3 months. The recycling period was also significantly shorter for the participants compared to the non participants. However, the control farmers received higher price for potato (ETB5) compared to the participants (ETB4).

Table 2: Descriptive statistics of participants and non participants

Variable	Participants	Non participants	Mean difference	Sig.
Gender(1=male,0=female)	0.92	0.93	-0.017	0.645
Age (years)	43.34	46.01	-2.67	0.125
Education(years)	3.71	3.86	0.570	0.272
Off farm income(1=yes,0=no)	0.03	0.03	-0.01	0.832
Annual income(ETB)	4766	4085	681	0.589
Asset value(ETB)	74383	47584	26799	0.141
Livestock value(ETB)	21365	10101	11263	0.000***
Farm size(Hectares)	0.18	0.13	0.05	0.022**
Group membership(1=yes,0=no)	0.74	0.34	0.40	0.000***
Seed type(1=improved,0=local)	0.87	0.46	0.43	0.000***
Seed storage(months)	5.18	3.87	1.32	0.000***
Seasons seed is recycled	2.96	3.87	-0.91	0.042**
Price received last year (ETB/kg)	4.04	5.19	-1.15	0.000***

*** Significant at 2%, ** significant at 5%, * significant at 10%

3.2 Income generation crops

During the Meher season, majority of farmers depend on potato as a source of income. About 42% of the participants and 35% of the non participants depend on potato for income. The % has increased compared to 20% who depended on potatoes for income during the baseline survey. Other important crops during Meher season are barley, wheat, peas and vegetables.

Table 3: Income generation crops in Meher season

	Baseline (%)	End of project (%)	
	Participants (n=374)	Participants (n=147)	Non participants (n=54)
Potato	20.6	41.5	35.2
Maize	1.9	3.4	1.9
Cabbages/kales/spinach	8.3	6.1	0.5
Peas	7.2	8.2	3.7
Beans	6.7	7.5	3.7
Wheat	11.8	6.8	18.5
Barley	17.4	15.6	25.9
Other	32	10.9	9.3

3.3 Land ownership

The average land owned was 1.2 ha. Majority of farmers own land with titles. About 85% and 91% of the CFC participants and control group respectively owned land with title deeds. Other land ownership regimes in the area were renting and sharecropping (Table 4).

Table 4: Land ownership

	Participants (n=106) %	Non participants (n=88) %
Owned with certificate	84.9	90.9
Owned without certificate	1.9	1.1
Rented	4.7	6.8
Owned	6.6	1.1
Sharecropping	1.9	0.0

3.4 Household main dwelling house conditions, water and energy sources

About 58% of the participants (n=105) and 76% of the control group (n=89) lived in thatched houses. However, the number of participants who lived in iron sheets' houses was almost double the control group with 42% and 24% respectively.

Most the houses of both the participants and control group were mud houses with about 85% of each. Less than a quarter of the interviewed farmers lived in bricks/stone or plastered houses. The floor was mainly of earth with 96% for both participants and non participants.

About 93% of the CFC participants and 97% of the control group used pit latrines. However, there are still some who use bushes.

The most common sources of water were piped water within the compound (29%) and streams (25%) among the CFC participants (Table 5).. Other sources include protected and unprotected springs, wells and piped water outside the main house. Among the control group, about 30% used stream water, 24% piped water within the compound and 18 unprotected springs.

The main cooking fuel among both categories of farmers was firewood at 99% for both participants and non participants. About 91% of both the participants and non participants used tin lamps for lighting. A few farmers used electricity as their main source of light. Other types of lighting in the area are pressure lamps and lanterns.

Table 5: Main water source

	Participants (n=105) %	Non participants (n=91) %
Pond/water dams	1.0	2.2
Stream	24.8	29.2
Spring (protected)	21.0	18.0
Spring (unprotected)	12.4	13.5
Well	6.7	3.4
Piped (compound)	28.6	23.6
Piped (outside)	3.8	6.7
Other	1.9	3.4

3.5 Seed

Seed type

About 89% of the CFC participants used improved seeds with only 46% of the control adopting improved potato varieties. The remaining 11% and 54% used local seed among participants and non participants respectively (Table 6).

Table 6: Seed type used by participants and non participants

	Participants (n=106)	**Non participants (n=89)**
Improved	88.7	46.1
Local	11.3	53.9

Varieties planted

In 2009, the most popular varieties among the CFC participants were Keydinch (21%), Red potato (19%), Aba Minemene (13%) and Keyi. Other varieties that were grown include French potato, Forengy and Shashamane (Table 7). In the year 2012, the CFC participants mainly grew Gudene (43%) and Jalene (30%). About 15% grew Guasa. However, about 43% of the non participants grew local potato varieties. About 24% and 17% planted Jalene and Gudene respectively. CFC encouraged potato farmers to grow the improved varieties.

Table 7: Varieties grown (%)

Variety name	**Baseline participants (n=195)**	**Terminal participants (n=106)**	**Terminal non participants (n=89)**
Jalene	1.0	30.2	23.6
Gudene	1.0	42.5	16.9
Guasa	2.1	15.1	6.7
Local varieties		**11.3**	**42.7**
Keydinch	20.5		
Red potato	19.0		
Astech	0.5		
Keyi	10.8		
Nazerate	1.0		
Asefu	0.5		
Alazert	0.5		
Aba Minemene	13.3		
French potato	2.1		
Shashamane	2.1		
Forengy	3.1		
Chimdi	17.4		
Forenge Denche	2.1		
Other		0.9	10.1

In the year 2012, the CFC participants mainly grew Gudene (43%) and Jalene (30%). About 15% grew Guasa. However, about 43% of the non participants grew local potato varieties. About 24% and 17% planted Jalene and Gudene respectively. CFC encouraged potato farmers to grow the improved varieties. The project had an impact on the type of potato varieties grown as indicated by a high number of participants planting improved varieties compared to the non participants (Table 8).

Table 8: Varieties grown by participation and acreage in 2012

Farmer category	**Variety name**	**Mean(acres)**	**Std. dev**	**Sum(acres)**
Participants	Jalene (31)	0.17	0.13	5.20
	Gudene(42)	0.34	0.24	14.14
	Guasa(28)	0.35	0.30	9.92
Non participants	Jalene(19)	0.28	0.12	5.33
	Gudene(14)	0.31	0.19	4.37
	Gera(38)	0.57	0.48	21.50
	Guasa(6)	0.36	0.16	2.14
	Local(11)	0.92	0.45	10.09

Number in bracket ( ) is the number of farmers growing the variety

Guasa had the highest mean acreage of 0.35 acres, followed by Gudene with a mean of 0.34 acres and finally Jalene with a mean of 0.17 acres among the participant farmers. Gudene leads the total acreage with 14 acres, followed by Guasa and finally Jalene.

In the control group, the local variety occupied most land with an average 0.92 acres, followed by Gera with 0.57 acres, Guasa with 0.36 acres, Gudene with 0.31 acres and finally Jalene with 0.28 acres. Gera occupied a total of 21 acres which is the highest, followed by, local varieties with 10 acres.

Ware and seed production speciality

In 2009, about 85% of the CFC participants specialized in both ware and seed production while 12% specialized in ware production alone. Only about 3% produced seed. The situation changed in 2012 with 83% producing both seed and ware and 17% engaged in ware alone (Table 9).

Table 9: Speciality of farmers

	Baseline participants (n=107) %	Terminal participants (n=90) %
Ware	12.1	16.7
Seed	2.8	
Ware and seed (seed)	85.0	83.3

Soil fertility and farm management practices

About 43% and 52% of the participants reported that their soils were of good and medium fertility. However, only 13% of the non participants reported good soil fertility (Table 10). Most of the potato fields were of gentle and medium slopes as shown below (Table 11).

Table 10: Soil fertility

	% Participants (n=106)	% Non participants (n=88)
Good	42.5	12.5
Medium	51.9	76.1
Poor	5.7	11.4

Table 11: Slope

	% Participants (n=104)	% Non participants (n=89)
Gentle slope	33.7	16.9
Medium slope	59.6	78.7
Steep	6.7	4.5

The most common soil and water conservation practice in the study areas were terraces with about 91% and 97% of the participants and non participants respectively practicing it (Table 5.3).

Other soil and water conservation practices are grass strips at 9.2% and 1.3% among participants and non participants respectively. About 1.3% of non participants also practiced mulching.

More of the participants (68%) left crop residues in the field to enhance soil fertility compared to the non participants (53%).

Most farmers depended on rain for potato cultivation. About 99% of both the participants and the non participants practiced rain-fed agriculture in potato fields.

The most common land preparation method among the CFC participants was use of oxen (55%) with 45% using manual labour. However, most of the non participants (76%) used manual labour for field preparation with only 23% using oxen.

3.6 Markets

The participant farmers were far from quality seed market compared to the control group with a mean difference of 0.23km which is significant at 1%. They are also far from the nearest extension service (Table 12). However, the participants were closer to tarmac roads with a mean difference of about 18km.

Table 12: Distance to input market and extension providers

	Participants	**Non participants**	**Mean difference**	**Sig.**
Distance to fertilizer market(km)	2.23	2.50	-0.26	0.313
Distance to quality seed market(km)	0.63	0.39	0.23	0.001***
Distance to nearest extension service(km)	1.29	1.01	0.28	0.024**
Distance of homestead to nearest farm produce market(km)	4.95	4.97	-0.02	0.963
Distance to potato market(km)	4.78	5.26	-0.48	0.262
Distance of homestead to nearest all weather road(km)	0.39	0.40	-0.01	0.917
Distance of homestead to nearest tarmac road(km)	54.15	71.80	-17.65	0.000***

*** Significant at 2%, ** significant at 5%, * significant at 10%

3.7 Potato production constraints

Farmers were asked to state their condition on the various potato production constraints compared to four years ago. About 97% of the CFC participants reported that there was improvement on timely availability of improved seeds. About 92% of the same category of farmers reported that there was improvement on prices of improved quality seeds and that they were better off compared to four years ago. 84% reported that there was improvement on getting the appropriate types, quantity and quality of seeds as well as availability of credit to purchase inputs. However, about 94% reported that fertilizer prices were worse compared to four years ago. There were also improvements on access to market and information (95%), reasonable prices for potato (97%), pests (81%) and diseases (81%).

Table 13: Potato production constraints compared to 4 years ago

	Participants (n=107)			Non participants (n=88)		
Constraint	**Better**	**Worse**	**Same**	**Better**	**Worse**	**Same**
Timely availability of improved seeds	97.2	1.9	0.9	90.1	1.1	8.8
Prices of improved quality seeds	91.6	5.6	2.8	87.9	5.5	6.6
Get the appropriate type of seeds	83.2	4.7	12.1	84.1	2.8	13.1
Get required quantity of seeds	84.1	2.8	13.1	90.1	4.4	5.5
Get required quality of seeds	84.1	3.7	12.1	89.1	3.7	12.1
Availability of credit for input acquisition	84.1	13.1	2.8	80.2	8.8	11.0
Timely availability of fertilizer	83.2	15.0	1.9	95.6	2.2	2.2
Price of fertilizer	2.8	94.4	2.8	3.3	92.3	4.4
Access to market and information	95.3	3.7	0.9	89.0	3.3	7.7
Reasonable prices for potato produce	97.2	0.0	2.8	93.4	2.2	4.4
Pests	81.3	3.7	15.0	78.9	4.4	16.7
Diseases	81.3	4.7	14.0	78.9	3.3	17.8
Soil fertility	62.6	7.5	29.9	57.1	8.8	34.1
Land shortage	9.3	76.9	13.9	4.4	87.9	7.7

About 63% reported improvement in soil fertility with 30% stating that the soil fertility has remained the same over the four years. About 77% reported that land shortage had worsened compared to four years ago.

It is evident that CFC had impacted positively on improving the various constraints faced by potato producers. Most farmers reported improvement in the various constraints except for high fertilizer prices and land shortage.

Seed source

In 2009, about 38% of participant farmers planted seeds from their own harvest. About 25% got their seeds from untrained farmers within their locations. Other bought seeds from the open market, traders and untrained farmers outside their locations (Table 14). However, in 2012, about 61% of the participants bought seeds from qualified seed multipliers. 29% planted own seeds that were positively selected. Among the control group, about 29% bought seeds from qualified seed multipliers. About 32% planted seeds that were not positively selected.

Table 14: Seed source

Seed sources	Baseline participants (n=197) %	Terminal participants (n=106) %	Terminal non participants (n=89) %
Own harvest	37.6		
Untrained farmers within location	24.9		
Untrained farmers outside location	5.6		
Trained farmer within the location	5.1		
Trained farmer outside the location	1.5		
Trader	8.1		
Open market	15.2		
Ministry of Agriculture/EIAR	2.0		
Specialized producer(HARC)		2.8	2.2
Qualified seed multiplier		61.3	29.2
Own (positively selected)		29.2	21.3
Own (not positively selected)		4.7	31.5
Neighbour		1.9	15.7

CFC had an impact among the participants as indicated by the shift of type of seeds planted from planting seeds from their harvests to planting seeds from qualified seed multipliers and seeds that are positively selected. The number of participant farmers who planted seeds from qualified seed multipliers and positively selected seeds is also higher compared to those in the control group.

Storage

Proper storage of potato ensures a longer potato shelf life. At the start of the CFC project in 2009, most farmers (23%) covered their potato seeds in the field. About 18% left their seeds uncovered in the house. Others stored their seeds in dark stores (15%), dark space in the house (12%), covering them in the house and use of granaries (15%). Only about 5% used DLS. However, in 2012, about 34% of the participants stored their potato in DLS. About 26% left their potato uncovered in the house (Table 15).

CFC had an impact on the participants evidenced by a large number of the participants (34%) using DLS compared to the non participants (12%). Using DLS prolongs the shelf life of seed potato.

Table 15: Seed potato storage

	Baseline participants (n=227) %	Terminal participants (n=97) %	Terminal **non** participants (n=81) %
Dark store	14.5	1.0	6.2
Store allowing light	4.4	8.2	9.9
Dark space in the ground		19.6	1.2
Uncovered in the house	17.6	25.8	18.5
Covered in the house	10.6	2.1	37.0
Diffuse light store (DLS)	5.3	34.0	12.3
Leave in the ground		9.3	13.6
Covered in the field	22.5		
In hole in ground	3.1		1.2
Dark space in the house	12.3		
Granary	5.3		
On shelves	0.4		
Kote/local seed bed	1.8		
Shelf in the house	0.4		

Storage to ensure appropriate sprouting

In 2009, about 43% of the participants stored their potato seeds in warm places to ensure appropriate sprouting. About 16% waited while 13% used bags. Other measures taken to ensure sprouting were use of chemicals, covering seeds with straw, applying ash and covering in the soil. However, in 2012, about 15% of the CFC participants stored their seeds in DLS (owned and group) to ensure appropriate sprouting. Majority (51%) still wait until the seeds sprout. Others put the seeds in warm places, covering with straw and use of bags (Table 16).

Table 16: Measures to ensure appropriate sprouting of seeds

	Baseline participants (n=209)	Terminal participants (n=105)	Terminal **non** participants (n=91)
Use a pit	2.4		1.1
Put in bags	13.4	7.6	4.4
Wait	15.8	51.4	49.5
Put in a warm place	42.6	15.2	20.9
Use chemicals	0.5	1.0	2.2
Cover with straw	1.9	9.5	9.9
Put DLS (own)		10.5	6.6
Put in DLS (group)		4.8	2.2
I don’t plant sprouted tubers	2.4		
Put in beds	1.9		
Apply ash	0.5		
Put in sun	1.0		
Covered in soil in field	0.5		
Kote	1.0		
Other		0.0	3.3

Diseases incidences and intensity

Late blight was the most important disease reported by both the participants (95%) and the non participants (88%). Bacterial wilt was reported by only 6% of the participants and 13% of the control group (Table 17).

Table 17: Disease incidences

	Participants		Non participants	
	Frequency	Percent	Frequency	Percent
Bacterial wilt	5	5.5	4	12.5
Late blight	86	94.5	28	87.5

About 64% of the participants and 56% of the non participants reported low disease intensity in their potato fields. However, 14% of the participants reported very high disease intensity compared to 9% of the non participants (Table 18).

Table 18: Disease intensity

	Participants		Non participants	
	Frequency	Percent	Frequency	Percent
Very high	13	14.3	3	9.4
Moderate	20	22.0	11	34.4
Low	58	63.7	18	56.3

3.8 Potato Productivity

The productivity of the participant farmers is higher (4709kg/acre) compared to the non participants (4000g/acre). The revenue gained by the non participants is however higher compared to the participants but they have higher variable costs. The participants therefore have a higher gross margin compared to the control group. However, the control group still sold their potatoes at an average price of ETB2.33/kg compared to the CFC participants who sell at ETB2.18/kg. The cost of production was lower for the CFC participants at ETB2.5/kg compared to ETB2.8/kg for the control group.

The cost of production was higher among the control group at ETB2.8/kg of potato compared to the CFC participants who incurred ETB2.5/kg of potato produced. However, the non participants fetched better prices for their outputs compared to the participants.

The seed rate has increased from 358kg/acre in 2009 to 722kg/acre in 2012 (Table 20). The participants also have a higher seed rate compared to the non participants. However, the control group used more fertilizer and fungicides per unit of land compared to the project participants. The control group applied an average of 169kg/acre of fertilizer. Fungicides use has increased from 0.25 kg or litres/acre to 0.75kg or litres/acre in 2012. The fungicides rates are also higher for the CFC.

The fungicides rates are also higher for the CFC participants with a mean of 0.75kg or litres/acre compared to 0.64k g or litres/acre for the control group. CFC had an impact on input usage especially increase in the seed rate and fungicides. It has also impacted positively on fertilizer use but the control group still use more fertiliser.

Table 19: Potato productivity for the participants and non participants

	Participants (n=101)	Non participants (n=88)
Cost/acre (ETB)		
Seed	2478	6223
Fertilizer	1160	2109
Fungicides	168	275
Labour	3994	7788
Total Variable Costs	7475	14490
Output (kg)	4709	4000
Revenue	19128	19690
Gross margin	11653	5200
Cost/kg	2.5	2.8
Price/kg	2.18	2.33
Benefit Cost Ratio	1.4	0.66

Table 20: Input use per acre

	Participants 2009	Participants 2012	Non participants 2012
Seed rate (kg)	358	722	655
Fertilizer (kg)	35	118	169
Fungicides (kg/litres)	0.25	0.75	0.64

3.9 Marketing

In 2009, most farmers (62%) sold their potato at the village market. About 33% sold in the district/capital markets. In 2012, about 55% of the project participants sold potatoes directly to consumers while 32% sold to NGOs. Most of the project participants (58%) sold their potato to NGOs while 27% sold to government organizations

Table 21: Ware potato buyer

Buyer	Baseline participants (n=87) %	Terminal participants (n=60) %	Terminal non participants (n=26)%
Village market	62.1		
District/capital market	33.3		
Middlemen at farm gate	1.1		
Farmer cooperatives/groups	1.1		
Big trader		3.3	7.7
Consumers/farmers directly		55.0	7.7
NGOs		31.7	57.7
Government organizations		10.0	26.9

Table 22: Convenience to sell potato compared to four years ago

	% Participants (n=100)	% Non participants (n=80)
More convenient	91.0	76.3
The same	9.0	22.5
Less convenient	0.0	1.3

One of the objectives of CFC was to link farmers to markets. Majority (91%) of the participant farmers reported that it was more convenient to sell potatoes compared to four years ago. About 76% of the control group reported that it was more convenient to sell potatoes compared to 4 years ago while 23% reported that the situation has remained the same (Table 22).

It is evident that the CFC project had an impact in potato marketing as indicated by most participating farmers selling their potato more conveniently. This is contrary to about 23% of the non participants who reported that the marketing condition has remained the same. However, none of the farmers had a contractual obligation with the buyers.

3.10 Access to extension services and training on potato production

About 93% and 78% of the participants and non participants received extension services in the 2011/2012 cropping year. However, about 94% of the participants received training on potato production in the last 4 years compared to 57% of the non participants.

Table 23: Frequencies of farmers who received extension and training on potato production

		% Participants (n=108)	% Non participants(n=91)
Received extension	Yes	92.6	78.0
	No	7.4	22.0
Training on potato production in the last four years	Yes	94.4	57.1
	No	5.6	42.9

About 88% of the participants and 84% of the non participants received extension on potato production. The other crop whose extension services were sought on is maize (Table 24).

Table 24: Enterprises for which extension was received

	Participants (n=113) %	Non participants(n=75) %
Potato	87.6	84.0
Maize	12.4	16.0

About 93% of CFC participants were aware of DLS compared to 80% of the control group. More of the participants (96%) were trained on DLS compared to 69% of the non participants (Table 25). On ownership of DLS, about 29% of the participants had DLS, while only 15% of the control group owned DLS.

Potato and seeds stored in DLS stay for longer duration compared to other methods of storage. DLS also ensures appropriate sprouting of seeds and selling of potato later when the market prices are better. CFC had an impact in the intervention area as indicated by the high level of awareness, training and ownership of DLS among the participants compared to the control group.

Table 25: Knowledge and training on DLS

		Participants (n=108) %	Non participants(n=91) %
Awareness on DLS	Yes	92.6	80.2
	No	7.4	19.8
Training on DLS	Yes	96.0	68.5
	No	4.0	31.5

Most farmers received extension from research centres with 92% for the participants and 63% for the control group (Table 26). Other extension providers in the study areas are the Ministry of Agriculture and private companies.

Table 26: Extension providers

	Participants		Non participants	
Mode	N	%	N	%
MOA	46	7.6	97	32.9
Research centres(HARC)	521	92.3	186	63.1
Private companies	1	0.2	12	4.1
Total	608	100	295	100

The most common training method among the participants was group training (74%). This was followed by open field days (24%) and individual training (Table 27). Among the control group, about 74% received extension through group training, 14% through open field days while about 10% were trained individually.

Table 27: Mode of training

	Participants		Non participants	
Mode	N	%	N	%
Open field days	145	23.5	43	14.3
Group training	452	74.3	222	73.8
Individual training	7	1.2	30	10.0
Other	6	1.0	6	2.0
Total	608	100	301	100

Impact of training on yield

The trainings received by the participants on potato production, pests, and diseases and marketing had an impact on the participant farmers as shown by about 70% indicating that the trainings had a high impact on yield (Table 28). About 27% of the same farmers reported moderate impact as a result of the trainings. On the other hand, about 60% of the control group reported high impact on yield as a result of training with about 35% reporting moderate impact.

Table 28: Impact of training on yield

	Participants		Non participants	
	N	%	N	%
High impact	427	70.2	175	59.3
Moderate impact	164	27.0	102	34.6
Low impact	12	2.0	6	2.0
No difference	5	0.8	12	4.1
Total	608	100	295	100

Reasons for not seeking extension

For those participant farmers who did not seek extension in the cropping year 2011/2012, about 50% reported that they did not need any extension (Table 29). About 33% reported that there were no extension providers nearby while 17% did not have the time for extension. However, among the control group, about 33% reported lack of time and money as the reasons why they did not seek for extension services. About 17% reported that there were no extension providers nearby or did not need any extension.

Table 29: Reasons for not seeking extension

	% Participants (n=12)	% Non participants(n=24)
No extension provider nearby	33.3	16.7
Lack of time	16.7	33.3
Lack of money	0.0	33.3
Didn’t need any	50.0	16.7

3.11 Credit linkage and access

CFC aimed at linking farmers to formal credit providers who issue credit at relatively lower interest rates compared to the informal sources.

Among those who responded to credit access question, 90% and 78% of the participants and non participants received credit respectively. The CFC participants received a mean credit of ETB899 while the control group received ETB463 with 13% and 15% monthly interest rates respectively.

Table 30: Credit access

	% Participants (n=19)	**% Non participants (n=9)**
Yes	89.5	77.8
No	10.5	22.2

The main source of credit was the saving cooperatives (Table 31). About 82% of the participants all the non participants received credit from saving cooperatives. The other main credit source was the input sellers.

Table 31: Source of credit

	% Participants (n=17)	% Non participants (n=8)
Saving cooperatives	82.4	100.0
Input seller	5.9	
other	11.8	

About 60% of the credit received by the CFC participants was used to purchase agricultural inputs while 26% was used in other business related activities. On the other hand, about 44% of the credit among the control group was channelled to business related activities with 33% being used to purchase agricultural inputs. About 22% of the credit was used for household consumption.

Table 32: Reasons for credit

	% Participants (n=19)	% Non participants (n=9)
Agricultural inputs	57.9	33.3
Business related	26.3	44.4
School fees	5.3	
Household consumption	5.3	22.2
Others	5.3	

3.12 Group membership

About 74 percent of the CFC participants were members of a group compared to only 34% of the control group. Participant farmers were equally almost equally distributed among the seed groups (51%) and seed/ware group (49%). However, most of the control farmers were in seed groups (61%) while 39% were in seed/ware group.

Table 33: Type of group

	% Participants (n=108)	% Non participants(n=91)
Seed group	50.6	61.3
Seed/ware group	49.4	38.7

4 References

Wang'ombe, J.G. (2008). The potato value chain in Kenya and Uganda. Maastricht school of management

POTATO IMPACT STUDY Uganda

CFC potato report, 2012

Contents

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1 Introduction

Potatoes are mainly grown for food security and local market and therefore a main source of incomes in areas where they are grown. In Uganda, most of the potatoes are grown in the highlands like Kabale and Kisoro districts. Potato farmers face various constraints which include lack of quality potato seed and various diseases such as Late Blight and Bacterial Wilt (BW). Diseases and poor seed quality are intertwined such that frequent recycling of seeds leads to build up of disease leading to disease multiplication (Wang'ombe 2008). Some diseases such as BW are both soil and seed borne which spreads rapidly through seed recycling. Soil infertility is also a major constraint which is closely related to poor management. Most farmers also lack proper storage facilities (Diffuse Light Storage) for ware and seed potato. Storage determines the shelf life of potato and also the sprouting of seed potato. Most farmers are also conservative in using the traditional varieties such as Kimuli and Bumbamagara. Marketing challenges encountered by potato producers are price instability and poor prices.

CFC project sought to address such constraints faced by potato producers in Uganda. Farmers were trained on proper potato management which included improvement in soil fertility, production of quality seed potato, seed selection, use of improved seeds, disease management, proper potato storage, linking farmers to markets and credit institutions among others.

1.2 Project Goal

The main goal of this CFC project was to improve the livelihoods of smallholder potato producers in Uganda, through integrated development of the seed and ware potato production and marketing chain

Smallholder potato farmers in Uganda were to improve their livelihoods through development of the potato sector. Using an integrated approach the CFC project, tackled the different imperfections in the potato sector simultaneously to allow for rapid development of the potato sector. Through the intervention of this project, the following hypotheses were to be achieved:

1. Increased potato productivity due to introduction of new technologies
2. Productivity improvement due to improved knowledge on crop husbandry and access to high quality seed
3. Increased income as a result of improved marketing systems through contract farming

1.3 Goal of the impact assessment survey

The general objective of the impact assessment survey was to measure various impacts that could be attributed to the implementation of the CFC project in Uganda. The specific objectives were to:

- Quantify the returns to investment for ware farmers investing in quality seed

- Assess the effect of the use of clean seed and seed management training on productivity and potato derived incomes for both ware and seed potato farmers
- Assess the degree of use of quality potato seed in the intervention areas
- To assess the multiplier effect of the project interventions in the intervention geographical areas
- To assess the degree of direct marketing and future potential of such arrangements between farmers and other value chain agents

2 Methods

2.1 Study Design and Data Sources

To achieve the above objectives, the study utilized three key sources of data; mainly the baseline, impact assessment survey and focus group data from the farmer trainers (TOTs) and potato processors. 'Before and after' study design were employed in the analysis whereby farmer and farm situations before the project implementation as captured in the baseline survey were compared to the current situations. As such, efforts were made to interview the same farmers in the impact survey as those interviewed in the baseline survey.

Data from the baseline survey was used for comparison with the current situation and included; farmed areas, acreages under both ware and seed potato, the types of seed used, seed varieties, sources of seed, seed prices, input use, quantity of output realized, quantity of output sold, output buyers, and the prevailing market prices.

Using a semi-structured questionnaire, the impact survey collected data on various variables which included: land ownership, the types of farmers, land areas farmed, seed sources, types of seed, seed varieties used now, seed prices, inputs used, outputs realized, output sold, output buyers, marketed produce prices, level of direct marketing, and contractual agreements between farmers and processors or retailers.

2.2 Sampling

In Uganda, the project was implemented in Kabale and Kanugu districts. A total of 200 farmers were targeted for interviews in the impact study. Stepwise proportionate stratified random sampling was also employed to choose the units across the strata. The sample contained only the participating farmers. Since seed and ware potato farmers were drawn from different groups in Uganda, the first level of stratification was either seed or ware farmers. Administrative units were used to form the subsequent strata up to the group level. The questionnaire was administered at the household level.

2.3 Data Collection, Entry and Analysis

The data required was gathered from in-depth interviews (household survey). The enumerators were properly trained and supervised during data collection to ensure the accuracy of the data collected. The interviews and discussions were conducted in the local language.

Data collection took place for a period of six days in each district, a total of eight enumerators were used for the data collection exercise. During the entire data collection period, quality assurance was maintained by constantly supervising the enumerators in the field. Completed questionnaires were thoroughly checked for inconsistencies and errors during the evening hours by the monitoring team and necessary adjustments made before embarking on data collection for the following day.

Data entry clerks were recruited through a competitive process through an oral interview and they were well versed with MS Office computer packages which was a major requirement. They were properly trained on data entry skills using CSPro program. During data entry, there was constant backstopping by the monitoring and evaluation team to ensure minimum errors. Further, the study used double data entry method that validated the data at the entry stage. After all the data had been entered, data cleaning was properly done led by the monitoring and evaluation team to ensure maximum quality assurance.

Data was analyzed using SPSS program and the final results presented using narration and tables where applicable. The analysis was done using descriptive methods i.e. percentages and means, cross tabulations and regression methods.

The study employed the use of descriptive statistics and gross margin analysis to characterize productivity and incomes realized from potato farming. Since the study focused on the information of a smaller sample, extrapolations of computed parameters were done to inform on the situation in the whole areas of intervention.

3 Results and discussions

3.1 Socio-demographic Background

During the baseline survey of 2009; 153 farmers were interviewed in Uganda. However, during the impact survey a total of 200 farmers were interviewed in 2012, of which 101 being farmers were participated in the CFC project while 99 were non participants. Some respondents (91) interviewed were from Kabale district while 109 were from Kanugu district. Among the participants, 41.6% practiced ware production, 8.9% seed production while 49.5% grew both ware and seed potatoes.

About 52% of the household members were male. About 79% of the respondents were married with single spouses while about 15% were single. The polygamously married respondents were 4% with about 2% being single. Majority of household members were school going children at 54%.

The main occupation of the respondents was farming (71%). About 9% were employed. Most farmers own land without certificates (72%) for the participants and 71% for the control group. However, more participating farmers have titles to their lands (18%) compared to the control group (9%) as shown in Table 1.

Table 1: Land ownership

Land ownership	% Participants (n=101)	% Non participants (n=99)
Owned land with certificate	17.8	9.1
Owned land without certificate	72.3	70.7
Rented land	3.0	7.1
Owned by parent	6.9	13.1

Among the respondents, male farmers were the majority with 85% in the participants' category and 84% in the non participants. There were significant ($P<0.05$) differences in farm size, seeking extension advice, distance to training centres, credit access, knowledge and ownership of Diffuse light stores and group memberships between the CFC participants and non participants (Table 2). Farmers who participated in the project received more extension advice compared to the non participants. Majority (82%) of the participants had knowledge on diffuse light stores compared to 48% of the non participants who were aware of diffuse light stores. About 18% of the participating farmers owned diffuse light stores compared to 6% of the non participants who owned them. Group membership was also higher in the participating farmers compared to the non participants. In general, 34% of the participants planted improved varieties compared to only 13% for the non participants.

Table 2: Descriptive statistics of participants and non participants in Uganda (2012)

Variable	Participants	Non participants	Mean difference	Sig.
Gender(1=male,0=female)	0.85	0.84	0.012	0.025**
Age (years)	48.28	49.20	-0.923	0.622
Education(years)	7.08	6.19	0.894	0.565
Off farm income(1=yes,0=no)	0.16	0.17	-0.012	0.809
Farming last 2 seasons(1=yes,0=no)	0.90	0.91	-0.012	0.816
Annual income(UGS)	1,840,738	1,214,323	626415	0.030**
Farm size(acres)	0.32	0.27	0.05	0.019**
Actively seek extension(1=yes,0=no)	0.67	0.35	0.23	0.000***
Received extension(1=yes,0=no)	1.06	1.32	-0.253	0.000***
Training on potato prodn(1=yes,0=no)	0.97	0.71	0.260	0.000
Number of times trained	3.92	3.01	0.901	0.666
Distance to training centre(km)	3.62	1.97	1.648	0.037**
Knowledge on DLS(1=yes,0=no)	0.82	0.48	0.341	0.000***
Trained on DLS(1=yes,0=no)	0.82	0.48	0.341	0.000***
Own DLS(1=yes,0=no)	0.18	0.06	0.124	0.006***
Group membership(1=yes,0=no)	0.92	0.78	0.135	0.006***
Seed type(1=improved,0=local)	0.34	0.13	0.211	0.000***
Seed storage(months)	2.25	2.20	0.052	0.532

*** Significant at 2%, ** significant at 5%, * significant at 10%

Farmers who participated in the CFC project had higher assets value compared to the control group. This was the case for total livestock value as well as household income as shown in Table 3. The CFC project participants had approximately 30% more in household asset and livestock value as compared to the non participants.

Table 3: Household income, assets and livestock value among potato farmers in Uganda (2012)

	Farmer category	Mean (UGS)	Std.dev
Household assets	Participants	10,280,660	15929357
	Non participants	7,788,334	27444297
Livestock value	Participants	2,126,366	304381
	Non participants	1,193,061	169404
Household income	Participants	2,630,053	3663767
	Non participants	2,127,782	2848709

3.4 Household main dwelling house conditions, water and energy sources

Most households were living in houses with iron sheets roof. About 96% (n=109) of the participating farmers were living in houses roofed with iron sheets while only 3% were in thatched houses. For the non participants, about 90% (n=99) lived in iron sheets roofed houses with 9% living in thatched houses. Only 1% in both groups had other types of roofing types e.g tiles.

More than half the participant interviewed had houses whose walls were plastered or made of bricks or stones, with only 38% living in mud houses. This is contrary to the non participants whom the majority (58%) lived in mud houses and only 7% in brick/stone houses.

Most of the main houses' floors were of earth. About 64% and 77% of the participants and non participants respectively had earth floor houses. About 36% of the participants had cemented their floors with 23% of the non participant group having also cemented their floor. Most households (99%) interviewed had built in their homes and used pit latrines.

Most CFC participants sourced their water from wells (40%). About 17% used roof catchments and 11% using piped water outside the house. However, most of the control group (53%) used bore hole water, 16% using water from protected streams (Table 4).

Table 4: Main water source among farmers in Uganda (2012)

	% Participants (n=101)	% Non participants (n=99)
Pond/water dams	7.0	3.0
Stream	3.0	4.0
Spring (protected)	15.8	16.2
Well	39.6	3.0
Borehole	11.9	52.5
Piped (compound)	1.0	1.0
Piped (outside)	10.9	6.1
Roof catchments	16.8	5.1

The main cooking fuel for both categories of farmers (98%) was firewood. Charcoal was used by only 2% of the participants and 1% of the non participants. The main type of lighting was tin lamp with 60% and 67% of the participants and non participants using it. The second main source of lighting was lantern. However, very few farmers used electricity (Table 5).

Table 5: Main type of lighting

	Participants (n=101) %	Non participants (n=99) %
Electricity	2.0	1.0
Tin lamp	60.4	66.7
Lantern	28.7	29.3
Solar power	7.9	2.0
Other	1.0	1.0

3.5 Potato Seed

Seed type

Comparing the adoption of improved varieties, 34% of participating farmers were using improved seed varieties compared to 17% of the non participating farmers. However, most of the farmers still plant the local potato varieties comprising of 66% of farmers in the project and 83% of those not in the project.

Table 6: Seed type

	Participants	**Non participants**
Improved	34.3	17.0
Local	65.7	83.0

Varieties planted

Rwangume is the most grown variety with 63% of all the interviewed farmers planting it. It is followed by Victoria at 21%. Chinig is the third at 10%. Considering participation in the CFC project, 56% of farmers in the project planted Rwangume while 34% planted Victoria. The number of farmers who participated in the CFC project and plant Victoria has declined since 2009 from 44% to 34%. For the non participants, 70% planted Rwangume, 15% Chinig and 9% Victoria (Table 7).

Table 7: varieties grown

Variety name	**Baseline participants (%) (n=155)**	**Terminal participants (%) (n=101)**	**Terminal non participants (%) (n=99)**
Victoria	43.9	33.7	9.1
Bumbamagara	2.6	1.0	2.0
Cruza	0.6	0.0	
Rwashakye	1.3	2.0	
Chinig	5.2	5.0	15.2
Rwangume	43.9	56.4	69.7
Kimuli	2.6	2.0	3.0
Rusina/Rutuku			1.0

Victoria and Rwangume were the most grown varieties in 2009 by farmers who participated in the CFC project. Other varieties included Bumbamagara, Chinig, Kimuli, Cruza and Rwashakye. Rwangume had the highest acreage (56 acres), followed by Victoria with 47 acres (Table 8).

Table 8: Varieties grown by participation and acreage in 2009

Farmer category	Variety name	Mean(acres)	Std. dev	Sum(acres)
Participants	Victoria (67)	0.71	0.68	47.80
	Rwangume (67)	0.83	0.75	56.05
	Bumbamagara (3)	0.58	0.38	1.75
	Chinig (5)	0.90	0.22	4.50
	Kimuli(5)	0.63	0.49	3.18
	Cruza/Rwashakye(5)	0.42	0.25	2.09
Non participants	Victoria (45)	0.79	1.47	35.62
	Rwangume (91)	0.57	0.63	51.44
	Bumbamagara (8)	0.55	0.32	4.36
	Chinig (13)	0.51	0.41	6.61

Number in bracket ( ) is the number of farmers growing the variety

Table 9: Varieties grown by participation and acreage in 2012

Farmer category	Variety name	Mean(acres)	Std. dev	Sum(acres)
Participants	Victoria(34)	0.45	0.31	15.2
	Rwangume(57)	0.63	0.79	36.2
Non participants	Victoria(9)	0.45	0.48	4.0
	Chinig(15)	0.36	0.17	5.4
	Rwangume(69)	0.33	0.30	23.0
Both	Victoria(43)	0.45	0.35	19.2
	Chinig(20)	0.41	0.27	8.2
	Rwangume(126)	0.45	0.59	59.2
	Kimuli(5)	0.23	0.05	1.13
	Bumbamagara, Rwashakye(5)	0.39	0.33	1.3

Number in bracket ( ) is the number of farmers growing the variety

Considering the total acreage under each variety among the farmers who participated in the CFC project, Rwagume was the most grown with 57 farmers with a mean of 0.25ha (0.63 acres) and a total of 15ha (36 acres) as shown in Table 9. Victoria was planted by 34 farmers with a mean of 0.45 acres and a sum of 15 acres. However, the mean acreage has declined since 2009 for both Victoria and Rwangume from 0.7and 0.8 acres to 0.5 and 0.6 acres respectively in 2012.

Among the non participants, Rwagume still led with 69 farmers planting it with a mean of 0.33 acres and a sum of 23 acres. Chinig is the second most popular among these farmers followed by Victoria. Considering both categories of farmers, Rwangume leads with a total acreage of 59 acres, followed by Victoria and Chinig respectively.

During the baseline survey, about 92% of the farmers grew ware with only 8% involved in seed production. In 2012, the number of farmers specializing in seed production increased to about 18%.

Table 10: Potatoes grown by farmers in Uganda (2012)

	% Baseline participants (n=155)	% Terminal participants (n=101)
Ware	91.6	80.2
Seed	8.4	17.8
Both	0.0	2.0

3.6 Soil fertility and input use

Fertilizer use was very low in both categories of farmers at a mean of 0.41kg/ha or 1kg per acre as shown in Table 11. Very few farmers applied fertilizer which could be due to the fact that about and 97% of the farmers reported that the fertility of their land was medium or good as shown in Table 11. Most famers indicated that the fertility of their soils was medium (62%). About 36% reported that their soil fertility was good. Only about 3% reported poor soil fertility. This explains the low use of fertilizer.

Table 11: Fertilizer and fungicide use

Input	Farmer category	Mean	Std. dev
Fertilizer (kg)	Participants	1.09	5.00
	Non participants	1.08	8.02
Fungicide (kg/litres)	Participants	1.27	1.23
	Non participants	0.24	0.17

Fungicide use was high among the participants of the CFC project compared to the non participants. The project encouraged the use of farm inputs and this could be attributed to the high fungicide usage among the participants with a mean of 1.27kg or litres compared to 0.24 kg or litres among the non participants.

Table 12: Distance to input market and extension providers by potato farmers in Uganda (2012)

	Participants	Non participants	Mean difference	Sig.
Distance to fertilizer market(km)	18.47	16.48	1.98	0.296
Distance to quality seed market(km)	3.88	4.90	-1.01	0.048**
Distance to nearest extension service(km)	5.04	5.76	-0.72	0.244
Distance to nearest farm produce market(km)	4.88	5.55	-0.67	0.273
Distance to potato market(km)	4.88	5.58	-0.70	0.253
Distance to nearest all weather road(km)	1.64	1.37	0.27	0.264
Distance of homestead to nearest tarmac road(km)	20.57	22.47	-1.90	0.420

Famers in the CFC project travel long distances to fertilizer market (18km) compared to the control group (16km). However, the distance to quality seed potato market is shorter for the participant farmers (3.9 km) compared to the control group (4.9km) and is significant at 5%. The CFC project participant farmers also travel shorter distances to farm produce market and potato markets. They are also closer to the tarmac road with a difference of about 2km. The intervention of CFC project on production of quality seeds has made the seeds available to farmers through a reduction in distance to seed source.

3.7 Potato production constraints

Seed availability

On the potato production constraints, about 68% of the farmers reported that timely availability of improved seeds had improved and that they were better off. However, about 24% reported that the situation was the way it was four years ago. About 61% reported that prices of improved quality seeds had improved implying reduced prices. On access to market and information, about 74% were better off with 19% indicating that the situation had not changed. Most farmers (74%) indicated that they received reasonable prices for potato. However, 37% and 32% reported that they were better off with pests and diseases among participants and non participants respectively. About 44% and 30% were worse off in terms of diseases and pests respectively. The CFC project had impacts in improving the availability of improved seeds, reduction in quality seed prices, access to market information and better prices for potatoes. However, only about a third of the farmers were better off in combating potato diseases and pests with the rest remaining in the same condition or even worse off.

Table 13: Potato production constraints compared to 4 years ago

Description of constraints (n=101)	Better off %	Worse off %	About the same %
Timely availability of improved seeds	68.3	7.9	23.8
Prices of improved quality seeds)	61.4	18.8	19.4
Access to market and information	74.3	6.9	18.8
Reasonable potato prices	74.3	8.9	16.8
Pests	36.6	29.7	33.7
Diseases	31.7	43.6	24.8

Seed source

In 2009, most farmers planted seeds from their own harvest (35%) as shown in Table 14. About 21% got seeds from untrained relatives within their locations; while 11% and 12% of farmers during this period bought seeds from trained farmers outside their locations and private companies respectively.

In 2012, about 29% of the farmers who participated in the project bought seeds from specialized producers while 19% bought from qualified seed multipliers. About 39% got seeds from their neighbours while 13% bought from the open market.

On the other hand, 9% and 18% of the non participant farmers bought seeds from specialized producers and qualified seed multipliers respectively. About 56% bought seeds from their neighbours while 23% bought from open market.

The project had an impact on the type of seed planted. The number of participating farmers who bought seeds from specialized producers and qualified seed multiplier is higher compared to their counterparts who did not participate in the project. Also among the participants, the number of those who planted bought from neighbours and open market is lower compared to those who did not participate in the project.

Table 14: Seed source

	% Baseline participants (n=155)	% Terminal participants (n=101)	% Terminal non participants (n=98)
Own harvest	34.8		
Untrained relative within location	21.3		
Untrained neighbour outside location	5.2		
Untrained relative outside the location	11.0		
Untrained farmer outside the location	2.6		
Trained farmer outside the location	11.0		
Trader	0.6		
Private company	12.3		
ADC	1.3		
Specialized producer		28.7	9.1
Qualified seed multiplier		18.8	18.2
Own (not positively selected)			1.0
Neighbour		38.6	55.6
Open market		12.9	23.2
Others			2.0

Storage

The most common seed potato storage among the participant farmers is covering the seeds in the house with the number increasing from 23% in 2009 to about 33% in 2012. The participant farmers also shifted away from storing in dark space in the ground indicated by a drop in the practice from 23% in 2009 to 1% in 2012. However, more farmers who participated in the CFC project have adopted the use of Diffuse Light Stores as shown by the increase in the number from 11% in 2009 to about 19% in 2012. The percentage of farmers using DLS is higher among the participants (19%) compared to the non participants (7%).

Most farmers in the control group left their seeds uncovered in the house (42%), followed by storing in dark stores (19%) and covering them in the house (18%).

Table 15: Seed potato storage

	% Baseline participants (n=26)	%Terminal participants (n=101)	%Terminal non participants (n=99)
Dark store	19.2	13.9	19.2
Store allowing light	3.8	10.9	7.1
Dark space in the ground	23.1	1.0	4.0
Uncovered in the house	19.2	21.8	42.4
Covered in the house	23.1	32.7	18.2
Diffuse light store	11.5	18.8	7.1
Leave in the ground			2.0
Other	0.0	1.0	0.0

Storage to ensure appropriate sprouting

Potato productivity is depended on seed storage and farmers have adopted ways to ensure proper sprouting of seeds. Most farmers prefer waiting until the seeds sprout in both categories of farmers although the number has declined among the participants from 40% to 31%. About 25% of the participants covered their seeds with straw. The use of DLS has been adopted by the participant farmers with about 20% using either their own DLS or the ones owned by groups. This number is higher compared to the control group (10%) who use DLS. Some farmers used different measures to ensure appropriate sprouting of seeds. The methods include spreading seeds on the ground, floor, heaping and spreading them on leaves.

It is evident that farmers who participated in the project gained knowledge of proper seed storage as indicated by a high percentage (about 20% in total) who use DLS compared to those who never participated (about 10%).

Table 16: Measures to ensure appropriate sprouting of seeds

	Baseline participants (n=25)	Terminal participants (n=101)	Terminal non participants (n=99)
Use a pit	4.0		2.0
Put in bags	20.0	11.9	13.1
Wait	40.0	30.7	38.4
Put in a warm place	28.0		
Use chemicals	8.0	1.0	1.0
Cover with straw		24.8	18.2
Put DLS (own)		15.8	7.1
Put in DLS (group)		4.0	3.0
Put in a warm place		4.0	2.0
Other		7.9	15.2

Diseases incidences and intensity

The most important disease in potato production in Kabale and Kanugu districts in Uganda is bacterial wilt followed by late blight and then leaf roll. About 79% of the participating farmers reported bacterial wilt in their potato fields, 10% reported late blight while 7% reported leaf roll (Table 17).

The non participant farmers reported 79%, 14% and 2% cases of bacterial wilt, late blight and leaf roll respectively. Diseases in these areas did not discriminate against any category of farmers, either participants or non participants. This means that the diseases mentioned are still a constraint to potato production.

Table 17: Disease incidences

	Participants		Non participants	
	Frequency	Percent	Frequency	Percent
Bacterial wilt	241	78.8	198	78.9
Late blight	31	10.1	36	14.3
Leaf roll	21	6.9	6	2.4
Others	13	4.2	11	4.4
Total	306	100.0	251	100

Disease intensity

For the various diseases mentioned by farmers, about 16% of the project participants reported that the intensity was very high; while 36% and 49% reported the respective disease incidences as moderate and low respectively. On the other hand, 21%, 26% and 53% of the non participants reported very high, moderate and low intensities respectively (Table 18).

Table 18: Disease intensity

	Participants		Non participants	
	Frequency	Percent	Frequency	Percent
Very high	26	15.9	29	21.2
Moderate	58	35.4	36	26.3
Low	80	48.8	72	52.6
Total	164	100.0	137	100.0

3.8 Productivity

The productivity of the farmers who participated in the CFC project has increased from 2775kg/acre in 2009 to 3881kg/acre in 2012 for ware. This resulted to an increase in revenues from UGS1,133,778 to UGS 1,684,305 per acre of ware. Seed production had higher returns in 2009 but with a slightly lower production of 2144kg/acre although the selling price was more than double ware price (Table 19).

Comparing the participants and non participants, productivity was higher among the participating farmers with a mean of 3881kg/acre. The non participants had a productivity of 2523kg/acre. Ware was produced at a cost of UGS320/kg with a selling price of UGS363/kg. However, seed production cost was lower at UGS272/kg with a high selling price of UGS771/kg.

Table 19: Potato Productivity for farmers in Uganda for the period 2009 and 2012

	Baseline participants		Terminal participants	Terminal non participants
	Ware (n=123)	Seed (n=12)	Ware (n=101)	Ware (n=99)
Cost/acre	UGS	UGS	UGS	UGS
Seed	362306	296314	615927	549420
Fertilizer	10832	48356	102607	32260
Fungicides	20128	39468	63351	88410
Labour	152867	102051	624347	329906
Total Variable Costs	**558241**	**486189**	**1212605**	**693765**
Output (kg)	2775	2144	3881	2523
Revenue	**1133778**	**1684305**	**2125897**	**1602845**
Gross margin	**575537**	**1198116**	**913292**	**909080**
Cost/kg	320	272	480	510
Price/kg	363	771	594	648
Benefit Cost Ratio	**0.93**	**3.11**	**1.71**	**1.41**

The participants produced their potatoes cheaply at a cost of UGS480/kg compared to UGS510/kg for the control group. This is attributed to the increased productivity per ha of land. However, the control group sold their potatoes at a higher price of UGS648/kg compared to UGS594/kg for the participants.

Seeds from open market among the project participants had the highest yield of 5977kg/acre followed by seeds from specialized producers with 5472kg/acre. A seed from qualified seed multipliers was third with a mean yield of 4219kg/acres then finally those bought from neighbours. However, the mean acreage of seeds from qualified seed multipliers was highest (0.32 acres), followed by specialized producers and neighbours with means of 0.29acres each. Seeds from the open market recorded the least mean acreage of 0.28 acres (Table 20).

Specialized producers' seeds were the most expensive with a mean buying price of UGS2009/kg, followed by seeds from neighbours (UGS1711). The cheapest seeds were from the open market with a mean price of UGS1227/kg. The output from seeds bought from specialized producers recorded the highest selling price of UGS827/kg, followed by output from qualified seed multipliers at UGS485/kg. Those who planted seeds from the open market and neighbours sold their output at the lowest prices of UGS146 and UGS 122 respectively.

Table 20: Area planted, yield, seed price from different seed sources among the participants

Seed source	Area planted (acre)		Yield per acre		Seed buying price UGS/kg		Selling price UGS/kg	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Specialized producer(20)	0.29	0.10	5472	6358	2009	1282	703	827
Qualified multiplier(11)	0.32	0.15	4219	4430	1262	699	708	485
Neighbor(46)	0.29	0.13	3681	3385	1711	1047	520	122
Open market(18)	0.28	0.13	5977	9407	1227	599	557	146

Table 21: Area planted, yield, seed price from different seed sources among the non participants

Seed source	Acres planted		Yield per acre		Seed buying price UGS/kg		Selling price UGS/kg	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Specialized producer(18)	0.33	0.14	1852	1536	1644	547	731	947
Qualified multiplier(11)	0.26	0.19	3261	4616	1195	651	487	96
Neighbor(48)	0.29	0.17	3817	5941	1336	892	677	837
Open market(18)	0.30	0.14	1747	1987	1261	1011	608	226

Table 22: Area planted, yield, seed price and output selling price from different seed sources for all farmers

Seed source	Acres planted		Yield per acre		Seed buying price UGS/kg		Selling price UGS/kg	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Specialized producer(38)	0.31	0.12	3757	5020	1923	1154	716	874
Qualified multiplier(28)	0.29	0.14	3843	4443	1252	682	620	393
Neighbor(94)	0.29	0.15	3750	4836	1489	970	600	606
Open market(39)	0.29	0.13	3729	6769	1249	875	581	182

Among the control group, seeds from specialized producers recorded the highest mean acreage of 0.33, followed by open market, neighbours and qualified seed multipliers with 0.30, 0.29 and 0.26 acres respectively among non participants. However, the highest yield was from seeds bought from neighbours with a mean yield of 3817kg/acre (Table 21). The second highest yields from this group of farmers was from seeds from qualified seed multipliers (3261kg/acre), then specialized producers (1852kg/acres) and finally open market (1747kg/acre).

Specialized producers' seeds were the most expensive at UGS1644/kg, followed by neighbours, open market and finally qualified seed multipliers. Outputs from seeds from specialized producers fetched the highest selling price of UGS731/kg, followed by neighbor, open market and finally qualified seed multipliers among the non participants.

Considering all the respondents interviewed, seeds from specialized producers were leading in acreage at a mean of 0.31acres (Table 22). Seeds from other sources occupied a mean of 0.29acres though with different frequencies. Seeds from qualified seed multipliers had the highest yield of 3843kg/acre, followed by specialized producers (3757kg/acre), neighbor and finally open market with 3729kg/acre.

The most expensive seeds were from specialized producers at UGS1923/kg, followed by seeds from neighbours (UGS1489/kg), then seeds from qualified seed multipliers. Seeds from the open market were the cheapest at UGS1249/kg. On the output price, those from specialized producers fetched the highest market price of UGS874/kg. Output from seeds from open market fetched the lowest market price of UGS182/kg.

It is evident that investment in high quality seeds results to increase in potato productivity. Seeds from specialized producers and qualified seed multipliers generally have high productivity. The output from these seeds also fetches higher market prices compared to other source

3.9 Marketing

In 2009, most farmers sold their potato to village market (41%) and middlemen at the farm gate (30%). One of the objectives of CFC was to link farmers to markets (Table 23). This is evident as indicated by a high number of farmers selling their potato to big traders (37%). However, none of the interviewed farmers sold to processors. For the non participating farmers, about 31% sold to the big traders, 28% to retailers and 18% to consumers directly. From the market point of view, there were no major disparities on the type and number of buyers for both groups. None of the farmers from both groups had a contractual agreement with buyers. Only one farmer had direct sales.

Table 23: Ware potato market channels

Buyer	Baseline participants (n=155) %	Terminal participants (n=101) %	Terminal non participants (n=99)%
Village market	41.2		
District/capital market	12.5		
Middlemen at farm gate	30.1		
NGOs	0.7		
Farmers' cooperatives/groups	5.9		
Private trader	6.6		
No one	2.9	10.9	20.2
Retailer		37.6	28.3
Big trader		36.6	31.3
Consumers/farmers directly		14.9	18.2
NGOs			1.0
Processor			1.0

3.10 Access to extension services

Extension services and training on potato production

The number of farmers who received extension services among the participant farmers (67%) was almost double the control group (35%). A very high number of the participating farmers (98) received training on potato production in the last four years compared to 72% in the control group (Table 24). Potato was the crop which most farmers sought extension on at 98% and 96% among the participants and non participants respectively. Extension on maize crop was low at about 2% in both categories of farmers (Table 25).

Table 24: Farmers who received extension and training on potato production in Uganda (2012)

Service received	Response	Participants (n=101) %	Non participants(n=96) %
Received extension	Yes	67.0	34.7
	No	33.0	65.3
Training on potato production	Yes	98.0	71.7
	No	2.0	28.3

Table 25: Enterprises for which extension was received among potato farmers in Uganda (2012)

Crops	% Participants (n=94)	% Non participants(n=68)
Potato	98.0	95.6
Maize	2.0	1.5
Other crops	0.0	2.9

Extension providers

About 47% of the participants were got extension services from research centres such as KAZARDI. About 28% received extension services from the Ministry of Agriculture (Table 26). Those who received extension services from fellow trained farmers were about 22%. For the non participants, a majority of about 42% received extension services from Ministry of Agriculture and research centres. About 35% received extension services from Research centres and 18% from fellow trained farmers. However, the penetration of private companies in provision of extension services was quite low with only 2% among the non participants and 0.3% among the farmers who participated in the project.

Table 26: Extension providers in Uganda (2012)

Extension providers	Participants		Non participants	
	N	%	N	%
MOA	337	28.2	309	42.2
Research centres(KAZARDI)	565	47.3	254	34.7
Private companies	4	0.3	15	2.0
Development partners	30	2.5	16	2.2
Fellow trained farmers	259	21.7	132	18.0
Others			6	0.8

Mode of training

The most common mode of training was group training. About 51% of the farmers in the CFC project received their training through group training. About 37% received training through open field days while about 11% through individual training (Table 27). Training through trade fairs and exhibitions was low in both categories of farmers. About 58% of farmers who did not participate in the project received their training through group training, 30% through open field days and 11% through individual training.

Table 27: Mode of extension or training

Mode of extension	Participants		Non participants	
	N	%	N	%
Trade fairs and exhibitions	15	1.3	7	1.0
Open field days	418	36.7	211	30.4
Group training	577	50.7	400	57.7
Individual training	129	11.3	75	10.8

Impact of training on yield

Most farmers reported that the trainings they received had high impacts on potato yields. Majority (67%) of the participant farmers reported high impact on yield, 26% moderate yield and 7% low impact. For the non participants, 52% reported high impact, 41% moderate impact and 7% low impact as shown in Table 28. Farmers in the CFC project were trained on potato production which impacted positively on the potato yields.

Table 28: Impact of training on yield

Impact of training on yield	Participants		Non participants	
	N	%	N	%
High impact	380	66.7	211	51.6
Moderate impact	150	26.3	169	41.3
Low impact	140	7.0	28	6.8
No difference	1	0.2	1	0.2

Reasons for not seeking extension

Some farmers did not seek any extension services. Various reasons were given for not seeking extension. About 31% said they lacked money and time and 13% did not need any extension among the participating farmers. For the non participants, 39% reported that there were no extension providers nearby, 25% lacked money while 23% lacked time as shown in Table 29.

Table 29: Reasons for not seeking extension by potato farmers in Uganda (2012)

	Participants (n=32)	Non participants(n=64)
	%	%
None	3.1	1.6
No extension provider nearby	21.9	39.1
Lack of time	31.3	23.4
Lack of money	31.3	25.0
Didn't need any	12.5	9.4
Other	0.0	1.6

3.11 Credit linkage among potato farmers

CFC aimed at linking small scale farmer to formal credit sources with lower interest charges. The mean credit received by CFC participant farmers averaged UGS434609 with a maximum of UGS3,000,000. The mean interest rate was 6.4% with a minimum of 1% and a maximum of 40% per month.

Credit sources and access

For the farmers who needed credit (64) and who participated in the CFC project all reported receiving credit. Majority (73%) of the non participating group also received credit.

The commonest credit provider in the study regions were Saving cooperatives. About 64% of the CFC project participants received credit saving cooperatives. About 13% received credit from banks while 18% received credit from other sources such as ROSCAS, VLSA and ASCAS. On the other hand, 55% of the non participants received credit from saving cooperatives with 10% from banks and 31% from the other sources mentioned above.

Table 30: Source of credit

Sources of credit	% Participants (n=64)	% Non participants (n=72)
Bank	12.5	9.9
Saving cooperatives	64.1	54.9
Neighbour	4.7	1.4
Input seller		1.4
other	18.8	31.0

About 49% of the farmers who participated in the CFC project and received credit used the money to purchase agricultural inputs. More than halve the credit was however diverted to other uses such as business (11%), paying school fees (22%) and household consumption (9%). The same applies to the non participants with only 43% of the credit used to purchase agricultural inputs. The other uses of credit were to buy land, construction of buildings, buying livestock and medical care (Table 31).

Table 31: Reasons for credit

Reasons for credit	% Participants (n=64)	% Non participants (n=72)
Agricultural inputs	48.4	43.1
Business related	10.9	8.3
School fees	21.9	30.6
Household consumption	9.4	9.7
Others	9.4	8.3

3.12 Group membership

Most farmers interviewed were members of various groups. About 91% of the participants belonged to various groups while 78% of the control group were also members of various groups.

About 48% of the participating farmers were in various potato seed groups; 47% were in ware group while 5% were in both ware and seed groups. For the non participants, about 78% were in seed groups while 22% were in ware groups.

4 References

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