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Post-harvest losses in potato value chains in Kenya

Analysis and recommendations for reduction strategies

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Abbreviations

BMZ	German Federal Ministry for Economic Cooperation and Development
CIP	International Potato Center
DLS	Diffused light store
EUR	Euro
FAO	Food and Agriculture Organization
FPEAK	Fresh Produce Exporters Association of Kenya
FSP	Food Security Portal
GAP	Good agricultural practices
GFP	German Food Partnership
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GIZ PSDA	Private Sector Development in Agriculture Programme
Ha	Hectare
HCDA	Horticultural Crops Development Authority
ILO	International Labour Organization
KARI	Kenyan Agricultural Research Institute
KENFAP	Kenyan National Federation of Agricultural Producers
KENOPOFA	Kenya National Potato Farmers Association
KEPHIS	Kenya Plant Health Inspectorate Service
KES	Kenyan Shilling
KIRDI	Kenya Industrial Research and Development Institute
KFA	Kenya Farmers Association
KfW	KfW Entwicklungsbank
kg	Kilogram
MoALF	Ministry of Agriculture, Livestock and Fisheries
NPCK	National Potato Council of Kenya
PHL	Post-harvest loss
SNRD	Sector Network Rural Development

Currency exchange rate: EUR 1 = KES 118

Abstract

Potato is the second most important food crop in Kenya after maize and is mostly cultivated by smallholders. The Kenyan Government has recognised the critical role potatoes play in alleviating food shortages given that potato provides higher yields compared to maize and is less affected by climate change. The issue of food loss is a highly important factor in securing the stable production required to combat hunger and raise incomes. Food security is a priority area of German development policy. Therefore, the German Federal Ministry for Economic Cooperation and Development (BMZ) launched the special unit "One World – No Hunger" in order to intensify its dedication to alleviate hunger and malnutrition. This study, commissioned by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of BMZ, contributes to these efforts.

The survey on food loss in the potato sub-sector was completed by 247 potato farmers, more than 70 marketers (brokers, traders, retailers and supermarkets), 3 processors and 10 restaurants. The farmers interviewed were based in the main production areas and thus were more commercially oriented, and, although these farmers' yields come in above average, they are still low in comparison to yields projected by the Kenyan Agricultural Research Institute. The survey showed that up to 95 per cent of recorded damage and loss occurs at the production level and is caused in particular by inappropriate harvesting tools and an insufficiently trained workforce. With a market share of up to 80 per cent, the retail level is most affected by this, given that any resulting low-quality produce is then supplied to the markets. However, the absence of market signals stressing 'better prices for better quality tubers' contributes to the low performance in potato production.

The financial assessment of potato damage and loss along the value chain exposes the economic impact of this low performance in potato production. Per season, 19 per cent of produce is damaged or lost. Extrapolating these losses to the national production level, we can assume that 815,000 tonnes are damaged or lost each year, representing a value of around KES 12.9 billion (EUR 109 million).

This study on post-harvest losses of potato contributes to the efforts of the Kenyan Government and private sector to improve the development of the potato value chain. To strengthen market linkages in the potato value chain, it is necessary to stimulate and enhance cooperation and coordination between the different actors. The introduction of standardised bags along with per-weight payment and the expansion of contract farming present opportunities to support the market linkage of small-scale farmers. However, an important condition for cooperation is trust between the actors in the value chain.

Executive Summary

Every year, a significant proportion of food produced for human consumption is lost or wasted. Annual losses have been estimated at about 1.3 billion tonnes by the UN Food and Agriculture Organization (FAO 2011). In light of rising food prices, widespread food insecurity and growing pressure on natural resources, avoidable food loss and waste is not acceptable. The world's natural resources – such as its soil, water, fossil fuels and nutrients – are limited and must be used in a more efficient and responsible manner.

The term food wastage, as used by the FAO, encompasses both food loss and food waste. Wastage occurs along the entire food value chain and varies in extent depending on the produce and the region. In developing countries, food loss occurs mostly in the post-harvest stages, during marketing and processing.

This study focuses on food loss in the harvesting, processing and marketing stages. Its main aim is to improve data availability on food loss in an important food value chain in Kenya and to identify options for German Development Cooperation to engage in food loss reduction programmes.[1]

The scope of the study was to describe a typical value chain for potatoes (from harvest to retailer), providing quantitative and qualitative analysis of food loss, detect hot spots for loss, determining the causes of food loss, identifying important actors and partners in the private and public sectors and the research and donor communities, and examining the role of these actors in reducing food loss along value chain. Finally, it aimed to provide recommendations for reducing food loss at the operational and policy level, and for the future engagement of the German Federal Ministry for Economic Cooperation and Development (BMZ).

The survey was completed by 247 potato farmers, more than 70 marketers (brokers, traders, retailers and supermarkets), 3 processors and 22 restaurants. Field data have been supplemented with information available from public and private institutions in Kenya, and also with data from international sources. A verification workshop representing different actors and institutions in the subsector was held to discuss the results and elicit further thoughts regarding evaluation and reporting.

Potato is an important food crop in Kenya and is mostly cultivated by smallholders. Potatoes are mainly sold on the market as fresh produce and are then subsequently processed into different foodstuffs at the household or industrial level. Many factors contribute to the loss and damage of produce. At the production level, farmer practices engender heavy losses. Land preparation and soil management are poorly conducted, and pests and diseases are ineffectively controlled, leading to low yields. A recent survey showed that bacterial wilt was the most prevalent disease, affecting 77 per cent of potato farmers, followed by late blight (67 per cent) and viral diseases (12 per cent) (Kaguongo et al. 2014).

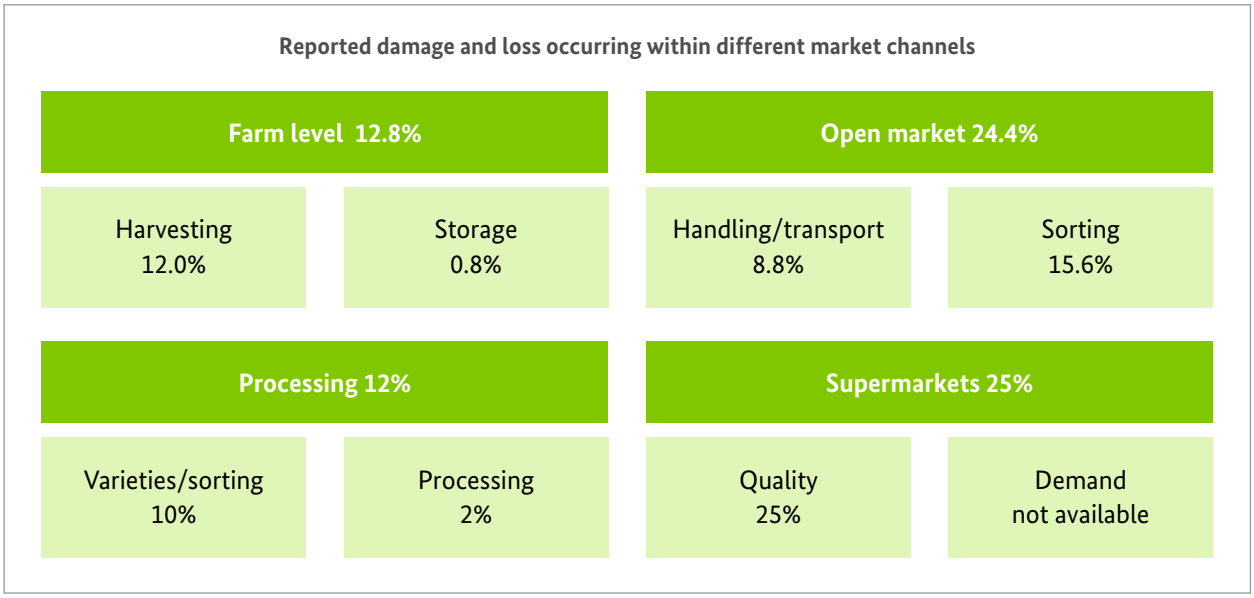
A shortage of clean seed is also contributing to this loss: available certified potato seed meets less than 5 per cent of the national demand for seed potato (Gildemacher et al. 2012). Added to this, there is a shortage of high-yielding varieties. The farmers interviewed are based in the main production areas and are thus more commercially oriented, achieving yields of 13.5 tonnes per hectare per season. These yields are above average (7-10 tonnes/ha) but are still low when compared to the 25-tonne yields often realised by professional farmers using certified seed and sound agricultural practices. However, the absence of market signals stressing 'better prices for better quality tubers' contributes to the low performance in potato production.

The survey showed that up to 95 per cent of recorded damage and loss occurs at the production level and is caused in particular by inappropriate harvesting tools and an insufficiently trained workforce. All produce earmarked for the fresh food market is packed in so-called extended bags, which farmers and brokers fill with unselected harvested potatoes – i.e. they include green, cut, bruised or rotten produce. Of the potatoes placed on the market, nearly a quarter are damaged or green. Almost all of these potatoes are eventually sold, but the quality issues mean prices must sometimes be lowered.

1 See also the GIZ publication 'Food Losses in Cassava and Maize Value Chains in Nigeria. Analysis and Recommendations for Reduction Strategies, 2013'.

The data on loss in the value chain shown in Figure 1 below describes the damage and loss reported at each stage in the chain (farmers, processors, marketers). The percentages are based on different produce quantities and are therefore not part of an overall total percentage. However, they do expose significant hot spots and challenges in terms of post-harvest losses. The retail level is most affected by the low quality of produce supplied to the markets. Losses reported by the processing industry and supermarkets run from 12 per cent to 25 per cent within sector businesses. However, given that their market share remains small (but growing), this damage and loss only contributes around 5 per cent to the overall damage and loss occurring along the value chain.

Figure 1: Synopsis of reported damage and loss occurring within different market channels of the potato value chain



The financial assessment of potato damage and loss along the value chain exposes the economic impact of this low performance in potato production. In each harvest season, 2,715 kg or 19 per cent of per-hectare production is damaged or lost, representing a loss of KES 42,824 (EUR 363) per hectare. Extrapolating these per-hectare losses to the national production level, we can assume that 815,000 tonnes of produce are damaged or lost each year, representing a value of around KES 12.9 billion (EUR 109 million).

The Kenyan Government has recognised potato's critical role in alleviating food shortages in the context of the decreasing production of maize and other staples (Mwaura 2009). The development of potato production could form part of the solution to overcome such shortages given that potatoes have higher yields compared to maize.[2] This being the case, improvements in the potato sub-sector will also benefit food security in the country.

This study on post-harvest losses of potato and its findings also intend to contribute to the development of the sub-sector by, in particular, supporting the Kenyan Government in its efforts to improve the development of the potato value chain. As such, Chapter 3 of this report sets out the challenges and options for delivering improvements along the ware potato value chain, summarised as follows:

2 FAO (2009) established the cereal and maize equivalents based on the calorie content of selected foods, which indicate that five units of potato can replace one unit of maize.

Seed improvements – new varieties and rapid multiplication

The limited availability and use of quality seed potato is a key barrier to increasing productivity in Kenya's potato sector. To improve certified seed potato supply, research institutes and the private sector have begun introducing an aeroponics technique in which mini-tubers are grown from in vitro plants in protected greenhouses. Furthermore, after a long period during which Kenya barred seed imports, the Kenyan Ministry of Agriculture, Livestock and Fisheries (MoALF) has begun cooperating with the Dutch Government and private companies on a fast-track system for rapidly multiplying certified seed.

A further challenge for seed potato production is the absence of a distribution system for certified seeds. Farmers seeking seed potatoes sometimes must travel more than 200 km to reach quality seed providers. Improving the seed potato distribution network is therefore of the utmost importance for reaching more farmers with certified seed.

Improved production and harvesting technologies

Soil fertility is one of the major problems in potato farming in Kenya. Fertiliser use in Kenya is low compared to the recommended rates of application and this results in the rapid decline of soil fertility. The biggest complaint farmers make is about increasing input costs and this factor results in the limited use of agro-inputs. About 38 per cent of farmers in Kenya stated that the costs of fertiliser, fungicide and employee wages have been rising and that this affects their incomes. Consequently, the lack of funds to buy inputs was reported as an important problem affecting potato production in Kenya (Kaguongo et al. 2008). This being the case, small-scale as well as larger-scale farmers should be supported in applying good agricultural practices to improve soil fertility, seed quality, fertilising and spraying.

On smallholdings, most work is performed manually, resulting in significant potato damage and loss. As the survey shows, damage caused by casual labour and harvesting tools represents 7.4 per cent of on-farm losses. An ongoing challenge for reducing damage is the presence of farms that are too small for mechanisation. As such, the size of potato production and harvesting machinery in Kenya should be geared towards local needs. Smallholders should also group together to share equipment and thereby generate economies of scale.

Improved post-harvest handling

The currently dominant potato variety is Shangi,[3] which has a short dormancy and begins sprouting after only five to six weeks. As such, it is not suitable for longer-term storage, neither as seed nor as ware potato. Improving seed and ware potato quality requires new varieties, which, in turn, requires improved on- and off-farm storage and storage technology. Diffused light stores (DLS) and improved traditional stores (with charcoal-coated walls) have proved to be useful low-cost storage alternatives, particularly for storing seed potatoes. However, to date, neither of these storage technologies is widely used in Kenya.

The Dutch study 'Value Chain of Seed and Ware Potatoes in Kenya' (Janssens et al. 2013) calculated that modern cooled storage facilities should have a minimum capacity of 100 tonnes to make investment worthwhile. Small-capacity storage facilities are relatively expensive and substantially raise investment and running cost per kg of seed potatoes. Consequently, professional modern storage is more attractive for the farmers, farmer groups or processors who store big quantities.

Improved packaging

The Kenyan Government and private sector sought to improve packaging by means of Legal Notice No 44 of 2005 and No 113 of 2008, which specify that potato must be marketed in standard bags of 110 kg. Besides the weight, the standard also defined the packaging material suitable for potatoes. The implementation of this law did not result in a real change, as it was not properly enforced. Recently the Government, National Potato Council of Kenya (NPCK) and county governments have started a new initiative to introduce maximum 50 kg bags in line with the requirements of the International Labour Organization (ILO).

As the survey results show, extended bags have severe impacts on the quality of potatoes marketed. This is because produce is paid for per bag rather than per kilogram and bag sizes vary, even within the same categories.

3 Shangi has also been called 'Zangi' or 'Cangi' in different publications.

As such, traders prefer to buy extended bags, as they are more profitable. This encourages farmers and brokers to pack all their potato stock regardless of its quality. In addition, the greater difficulty in handling the large bags and the material used to make them cause further damage.

Market signals rewarding quality are required to encourage farmers to deliver better production results. Therefore, implementing regulations on marketing standards would be a first step towards better quality and the fair payment of farmers. Firstly, having better bag material and a lower bag weight decreases spoilage and damage. Furthermore, a fixed bag weight would reduce the exploitation of farmers. Also, the content of a smaller bag can be better controlled, which helps improve the quality of produce supplied. To ensure the law is enforced, the process to improve packaging should involve brokers, local traders, wholesalers, retailers and the county authorities in order to reach an agreement supported by all actors along the value chain. Overall, standards and infrastructure should be established for and awareness raised about marketing potatoes by weight.

Improved conditions for the processing industry

Kenya has an expanding food processing industry, driven by its growing urban population, changing population structure, new eating habits and increasing tourism. The industry requires potato varieties with better processing qualities to replace the traditional varieties that are assusceptible to bacterial and viral diseases. Processors are calling for the production of suitable varieties to meet their needs for better-quality raw material for processing.

A further market signal could come from contract farming, which helps farmers to exit the vicious circle of insecure markets and exploitation through extended bags. Contract farming is a well-known arrangement for supplying the processing industry, but processors in Kenya face problems in their cooperations with farmers. As such, processors and farmers should be supported in developing stable business relationships to ensure the provision of suitable varieties, appropriate sorting and constant supply.

Human capacity development

There is a need to expand farmers' training on improved agronomic and management practices, with the support of extension services. Priority should be given to innovative approaches that enhance extension and farmer training, such as (i) the use of group approaches, (ii) farmer-led extension that involves, for example, farmer field schools operating demonstration plots, on-farm trials, etc., and (iii) the provision of communications technology (ICT) to support agricultural production (Nyagaka et al. 2009).

Besides farmers, those involved in trading stock also need comprehensive training to improve their post-harvest handling, storage, processing and marketing. Relevant training should be provided to operators in the wholesale and retail markets to improve their handling and storage of produce with a view to maintaining quality and reducing physical losses.

1 Introduction

1.1 Study objective

Potato[4] (commonly referred to as Irish potato) is the second most important food crop in Kenya after maize. Potato production in Kenya is expected to grow and could even take the number one spot as food crops like maize become affected by climate change, e.g. due to insufficient rainfall. Faced with droughts, farmers are being encouraged by the government to diversify their production. The Ministry of Agriculture reported that many farmers are opting to grow potato because it is fast-maturing compared to maize and can be used to bridge the gap during shortages of the staple grain. The number of farmers abandoning maize is not known but, according to the Ministry, the number of potato farmers has grown from 500,000 farmers in 2003 to 800,000 in 2011 (Thompson Reuters Foundation 2011).

In spite of this popularity, several studies have reported major constraints in potato production, such as diseases and pests mainly spread by diseased seed and the lack of crop rotation. Other problems are the climate (drought, heavy rains), the costs of inputs for smallholders, seed quality, soil quality and (post-)harvest losses.

The issue of food loss is a highly important factor in efforts to combat hunger and raise incomes. However, food loss also represents wasted production resources such as land, water, energy and inputs. These additional environmental impacts of food loss were not included in this study but were evaluated as part of the GIZ study on 'The Ecological Footprint of Cassava and Maize Post-Harvest Losses in Nigeria' (2013),[5] which showed that food loss has a significant impact on the environment.

The aim of this study is to improve the availability of data on food loss in the potato value chain in Kenya in order to identify options for the public and private sectors to engage in food loss reduction programmes.

The study will inform Kenyan partners, GIZ and the German Food Partnership on how to design appropriate measures and investments to reduce losses in the potato value chain and, in general, how to improve efficiency in value chains.

1.2 Concept of food loss

1.2.1 The study approach

Although ware potato is the focus of this study on post-harvest losses of potato (PHL study), aspects relating to seed potato use and production at the farm level were also taken into consideration.

This study looks at losses occurring at the pre-harvest, harvest, post-harvest and processing stages, as these are the most relevant in developing countries. Following the approach taken in the FAO study 'Global Food Losses and Food Waste (Gustavsson et al. 2011) five system boundaries are distinguished in the food supply chains of vegetable commodities. Food loss/waste should be estimated for each of these segments in the chains:

- **Pre-harvest**: practices affecting the quality of harvested potatoes.
- **Harvest**: losses due to mechanical damage during harvesting, as well as crops left in the field due to poor harvesting technologies.
- **Post-harvest handling and storage**, which includes losses during post-harvest crop sorting and losses during handling, storage and transportation between farms and distribution points including losses caused by packaging (extended bags).
- **Processing**, which includes losses due to spillage and degradation during industrial processing, such as: when crops being sorted are identified as unsuitable for processing; during washing, peeling, slicing and boiling; during process interruptions; or as a result of accidental spillage.

4 The relevance of potatoes (Solanum tuberosum) as a food crop is significant compared to sweet potatoes (Ipomoea batatas), which make up only around 20 per cent of potato production. In 2011, sweet potato cultivation occupied 33,000 hectares and provided a yield of 300,267 tonnes, valued at KES 3.6 billion (provisional data, HCDA 2012).

5 See also GIZ 2013b.

- **Distribution**, which includes losses and waste in the marketing system – for example, at wholesale markets, supermarkets, retailers and local markets.

- Unlike the FAO study, waste occurring during the **final consumption** stage was not factored into this GIZ PHL study.

1.2.2 Definition of loss and critical loss points

According to FAO, food loss refers to a decrease in edible food mass throughout the part of the supply chain that specifically provides edible food for human consumption. Therefore, food destined for human consumption that falls out of the human food chain is considered as food loss or waste. This approach distinguishes between 'planned' non-food uses and 'unplanned' non-food uses, with the latter being counted as loss. Food loss occurring at the end of the food chain (retail and final consumption) is called 'food waste' and is the result of retailer and consumer behaviour.

Losses include:

- **physical losses** – products that are not marketable/consumable, e.g. spoiled, rotten, damaged, green potatoes

- **financial losses** – lower prices paid due to insufficient quality or loss of value due to bad storage facilities

Critical loss points can occur all along the value chain (Table 1). Given that at certain points not all damaged produce is lost, specifications have been drawn up to distinguish between losses and other uses.

Financial losses due to low quality of potatoes is a challenge to retailers

Table 1: Critical loss points along the potato value chain

Stages	Critical loss points	Specifications of loss according to the PHL study
Production	Energy Audit Subsidy	Small potatoes are losses if they are not for used for home consumption or for seed.
	Capital Cost Subsidy	
Harvest	Planting and harvesting techniques that leave remnants on the fields (volunteer crops)	Volunteer crops (those left on the field and harvested early the following year) are lost if not used for home consumption.
	Harvesting tools cause damage	Damaged/cut potatoes: partly for home consumption, with the rest being losses.
	Harvest timing – premature harvesting (green potatoes) or harvesting in wet weather	Green potatoes are losses if they are not used for seed.
Packing	Quantity and quality of produce packed into extended bags	
	Size of extended bags	
	Material of extended bags	
Transpor-tation and handling	Weight of extended bags does not allow careful handling	
	Extended bags become heated (affecting sugar content)	
	Several stages of loading and unloading prior to reaching the end customer	
	Losses due to a lack of access roads or poor road conditions	
	Inadequate means of transport	
Storage	Lack of storage facilities or simple stores	
	Unsuitable varieties for storage	
	Stored products are immature, not disease-free	
Market conditions	Wet markets (dirt, contamination, weather)	Lower prices due to market oversupply/fluctuations are not losses.
		Losses caused by lack of sales are incorporated.
	Green potatoes due to sunlight and inadequate packaging material (nylon)	Reduction of prices due to low quality (green/cut potatoes) cause financial losses.
Processing	Wrong varieties for processing	
	Sorting and grading losses	Additional labour required to sort/cut potatoes causes financial losses.
	Forced to process by-products	Potato peel is not a loss.

2 Methodology

The chosen methodology was based on a five-step approach (details in Table 27, Annex 1) following that of the FAO (van Otterdijk 2012).

1. Screening of food losses including rapid appraisal.
2. Survey on food loss assessment.
3. Sampling including load-tracking assessment.
4. Data analysis, verification workshop and reporting.
5. Synthesis: recommendations and solution finding.

General data for the study were collected from published sources and through key informants, and specific data through questionnaires and group discussions.[6] Conducting a rapid appraisal to determine specific issues during the preparatory stage proved to be crucial for getting a better understanding of the context and for better preparing the survey.

Data was collected during the survey from the major participants along the value chain and on the major sources, causes and also quantities of loss and waste. A randomised survey was used so that statistically reliable quantitative data could be obtained on losses at the defined critical points. Multi-stage sampling was employed so that different regions and types of farmer, broker and trader were included in the survey. The survey results were discussed in a verification workshop, which provided further input to the reporting.

2.1 Sampling of counties and value chain actors

The farmer survey was conducted in four main potato-growing counties in Kenya, namely Bomet and Nakuru Counties in the Rift Valley area, Nyandarua County in Central Kenya and Meru County in Eastern Kenya (Figure 2). These four were purposively selected to provide a representative overview of potato production, post-harvest handling and marketing practices in the country. In Bomet and Nyandarua counties contract farming is already underway.

Bomet County was selected to gain an understanding of contract farming from farmers producing potatoes for processors. The production, marketing and handling practices of contract farmers are influenced by contractual arrangements. They plant varieties preferred by processors, allow the crop to fully mature before harvest and, in the main, pack potatoes in standard 110 kg bags.

Meru County farmers have secured a niche market, supplying potatoes to most of the markets in the drylands of northern Kenya, such as Marsabit. They also supply markets in Meru and Embu Counties. In Meru County, farmers grow potatoes off-season and use irrigation. Both irrigating and non-irrigating farmers allow the crop to fully mature before harvesting.

Nakuru County farmers mainly sell in large extended bags. Farmers are known not to wait until their crops are fully mature – traders ask farmers to harvest as soon as the crop flowers and farmers also like to harvest early when the prices are high.

Nyandarua County farmers grow potatoes in all sub-counties as their main crop. Contract farming was introduced in 2013 but is not progressing well. Nyandarua farmers also tend to harvest potatoes before they are fully mature to take advantage of high prices. Nyandarua and Nakuru Counties are two of the major sources of potatoes marketed in Nakuru, Nairobi and Mombasa.

Ware potato growers/farmers

All the major potato growing sub-counties in each of the four selected counties were included in the survey. Two sub-counties were selected in Bomet (Bomet Central and Bomet East), three in Nakuru (Molo, Kuresoi, Njoro), four in Nyandarua (Kinangop, Mirangine, Nyandarua North and Ol Kalou) and two in Meru (Buuri and Meru Central).

The sample size was calculated according to potato producing households and using information from the Seed Potato Sub-sector Master Plan for Kenya 2009-2014 (Kaguongo et al. 2010).

6 The questionnaires are attached in Annex 3.

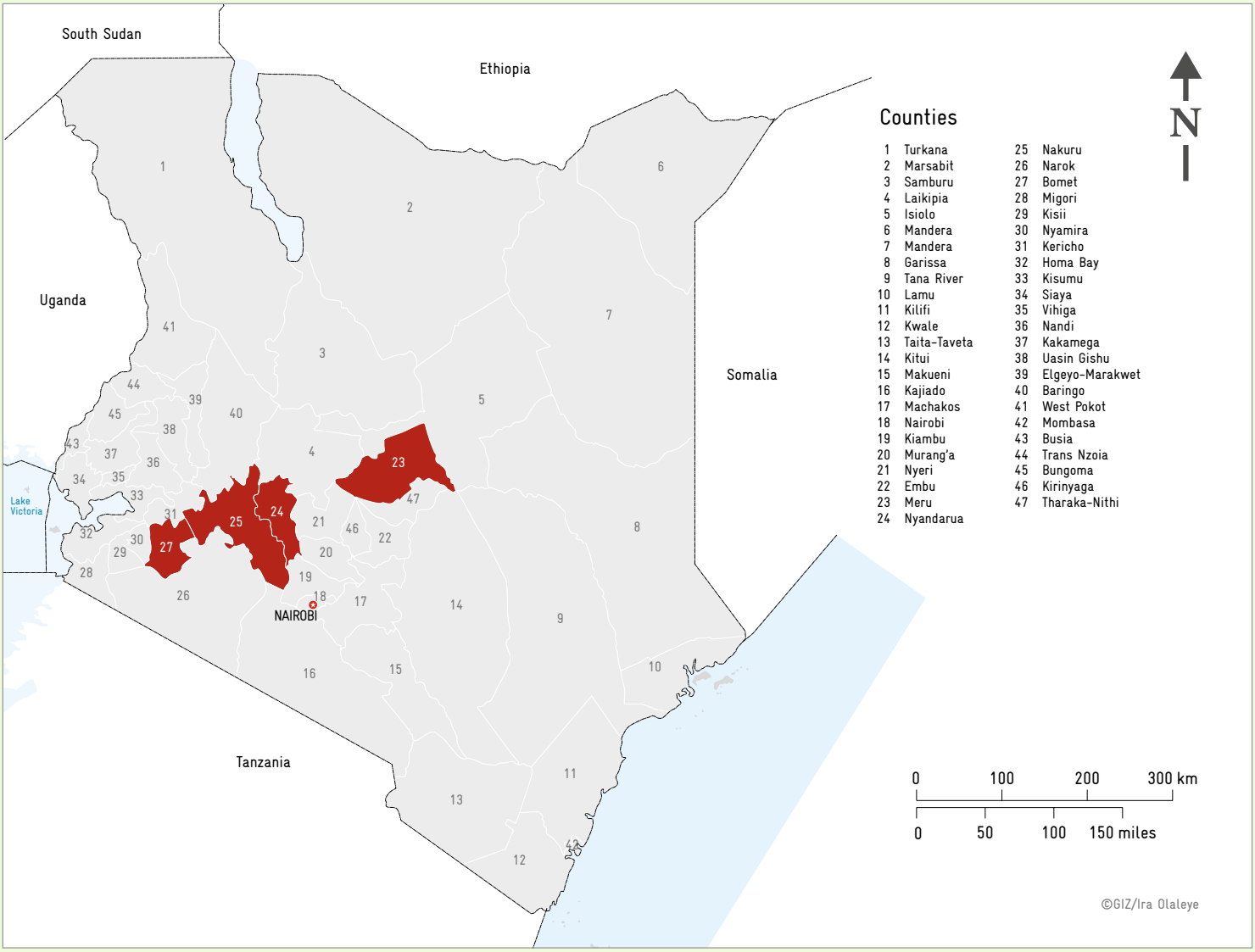


Figure 2: Map showing the four counties surveyed

To collect data from farmers, specific questionnaires were developed (Annex 3). The questionnaires were used as an interview guide for the trained enumerators tasked with collecting information from farmers. Using enumerators was important as some of the farmers were not able to read and therefore could not complete the questionnaires without assistance. A sample of 247 randomly selected farmers was interviewed.[7] The sample size was calculated according to the number of potato producing households in the four counties. In Bomet, 52 farms (39 individual farmers and 13 contracted farmers) were included; in Nakuru, 69 farms; in Nyandarua, 73 farms (60 individual potato farmers and 13 contracted farmers); and, in Meru, 53 farms were surveyed. The results in the tables and graphs summarised under 'all' show the weighted average of the counties.

7 A multi-stage sampling technique was adopted to select the farmers. In each of the counties, all the sub-counties that grow potatoes were listed and then a sample was selected at random. Once the sample of sub-counties was obtained, the wards in each sub-county were listed and a sample of these was then selected. From here, locations in the chosen wards were listed and a sample selected. In each location, the sub-locations were listed and a sample selected and in each sub-location administrative units were listed and a sample selected. From each unit, villages were listed and a sample selected, and then the farmers who grow and sell potatoes in each village were listed and a sample selected. On average, a sample of four farmers per village were interviewed. Farmers with contract farming arrangements were indicated in the questionnaires using the relevant respondent code.

Brokers

Brokers' characteristics are the same in each county in terms of how they operate, link up with traders and farmers, get paid for the work they do, and grade and package potatoes, and also in that they face the same challenges. On this basis, broker selection was purposive and, as they work in groups, it was decided to organise group discussions. Groups from the sub-counties with the highest potato production and marketing activities were selected (Table 3).

Table 2: Breakdown of farmer samples[8]

County	Sub-county	Villages surveyed	Number of farmers	County sample size
BOMET	Bomet Central	9	36	52
	Bomet East	4	16	
MERU	Meru Central	4	17	53
	Buuri	9	36	
NAKURU	Kuresoi	7	28	69
	Njoro	5	17	
	Molo	6	24	
NYANDARUA	Kinangop	6	24	73
	Mirangine	6	24	
	Nyandarua North	3	12	
	Ol Kalou	1	13	
		60	247	**247**

Table 3: Breakdown of samples of other value chain actors

County	Brokers Group	Wholesalers	Retailers	Supermarkets	Restaurants	Processors
BOMET	1	4	3		1	
MERU	1	4	3		1	
NAKURU	1	4	3	1	1	
NYANDARUA	1	4	3		1	1
MOMBASA		4	3		3	
NAIROBI		16	12	2	3	2
	4	**63**		**3**	**10**	**3**

8 See also Table 26 in Annex 1.

Wholesalers and retailers
Trader samples were selected at random. The potato traders present in each market were listed and three wholesalers and four retailers were randomly selected and interviewed. In Nairobi, four different market places were included: Wakulima, Gikomba, Kangemi and Githurai. A total of 63 traders were interviewed: 27 wholesalers, 27 retailers, and 9 traders who conducted both wholesale and retail operations.

Supermarkets
Supermarkets are mainly located in the major urban centres. In many supermarkets, purchasing is centralised and branches receive weekly goods deliveries. The pattern of purchasing agricultural produce is similar for most of the supermarkets, with produce being supplied centrally by a contracted supplier on a weekly basis. Purposive sampling was used to select the three major supermarket chains – Nakumatt, Uchumi and Tuskeys – for interviews with branch supervisors. Data were collected from one branch in Nairobi and one in Nakuru town.

Processors
Potato processors who make crisps and chips are few in Kenya. The main processors are the Nairobi-based companies Deepa Industries, Norda, Pioneer and Propack, and also Midlands, located in Nyandarua county. Purposive sampling was used to select three processors for interview.

Restaurants
Restaurants were sampled randomly from the high streets of selected towns.[9] One restaurant was interviewed in each main town of the four study counties; in Nairobi and Mombasa, the biggest potato markets in Kenya, three restaurants were selected in each city.

9 Sample selection involved picking one restaurant located in one of the three main streets of the principal towns of each of the four study counties. In Nairobi and Mombasa three restaurants were selected for each city.

2.2 Measurement

With regard to farm size and potato fields, the interview discussions with farmers were based on quarter acres (1,000 m^2) but that was later changed to one hectare (10,000 m^2). Since farmers use several plots on their farm for potatoes, they were asked to quantify according to the output of their largest potato plot under production. This approach meant farmers could provide more concrete answers but also carried the risk that they would overestimate output when converting the information to the farm scale. All data were finally converted into quantities per hectare.

Since different measures are used for business transactions across the surveyed counties, quantities and prices were difficult to standardise. Various measures for the so-called extended bags are currently in use, and all transactions are calculated in buckets/bags rather than by weight. The weight and content of extended bags are assessed according to the number of buckets required to fill a bag. An average bucket contains 17 kg of potatoes.

There are two key measurement terms associated with extended bags: *Kamba* determines the size of the bag's netting top section and *Kata* determines the additional pieces of cut bags used to extend a standard bag (Table 4). Traders also use different names for different sizes of bag – for example, *Gatabuko* corresponds with Kata 2 Kamba 4, or *Wa kaguku* or *Bomb* correspond with Kata 2 Kamba 5. *Mukurinu* describes the closed-bag packing method used, with bags ranging in size from 160 to 200 kg.

The observed weight per bag type varied by 7 to 10 kg (Table 5). The bag size keeps on changing from one season to another and from one locality to another depending on the buyer. Bags tend to be biggest at peak harvesting seasons and smallest when potatoes are in short supply. It should be noted that, because the survey was taken in the off-season period, the range of packaging types used in the market was fairly limited in many areas.

Three types of bag materials are used to pack and market potato, namely jute, sisal and nylon. Potatoes kept for longer than a week in nylon bags spoil.

Table 4: Traditional potato measures

Packaging types			
Non-extended bag	Bucket	Kamba 6 Kata 2[10]	Mukurinu
			

Table 5: Traditional measures and their metric conversions

Name of packaging	Size	Average weight
Bucket	1 bucket	17 kg
Non-extended bag	7 buckets	119 kg
Kata 2 Kamba 4	11 buckets	180-187 kg
Kata 2 Kamba 5	12 buckets	195-204 kg
Mukurinu	Different sizes	160-200 kg

2.3 Load tracking

Bag size, weight and material are expected to have a significant impact on produce quality and losses. To measure the impact of extended bags on the quality of the potatoes and, thus, on losses, three bags were traced along the supply chain.

Starting on a farm in Kanjuiri village in Ol Kalou Sub-County, Nyandarua County, the packing of bags was observed. Following this, packed bags were opened to analyse their content. The sorting was performed on the basis of selecting and weighing green, damaged/cut and rotten potatoes. Bucket-size samples were taken on the farm to determine the levels of quality and loss according to the above-mentioned definition.

The identified bags (of Kata 2 Kamba 5 size) were traced from their place of origin to their destination market in Nairobi. At the retail market level (the produce's final destination and location where bags are opened and re-packed), each of the bags were weighed and then opened and the various categories of potato in each bag were separated out and weighed. To get a broader understanding on the losses caused by the bags, interviews with retailers included questions related to seasonal effects.

10 *Kamba 6* is the size of the netting top section the bag. Kata 2 indicates the number of additional cut bag pieces used for the bag extension panels; in this case, it means two pieces of cut nylon bag are used with half a nylon bag for the top section.

3 Potato value chain in Kenya – survey results

3.1 Background

Potato is the second most important staple food in Kenya after maize. The most favourable climatic conditions for potato cultivation in Kenya are found in areas at altitudes between 1,500 and 3,000 metres above sea level, where the country's main staple food, maize, has no comparative advantage. At this altitude, potatoes grow faster than maize and produce more energy and protein per hectare per day. Potato production areas are found mainly in the highlands of the Central, Eastern and Rift Valley regions and on the slopes of Mount Kenya. Also, other regions like Mount Elgon (Bungoma County) in Western Kenya are prominent production areas (see Figure 2).

Potatoes are grown by up to 800,000 farmers, who are mainly smallholders.[11] It is estimated that 83 per cent of the land under potato cultivation belongs to smallholders dedicating 0.2 to 0.4 hectares to potato production, while approximately 17 per cent of potato plots belong to larger-scale farmers dedicating 2 to 10 hectares to the crop (Janssens et al. 2013). Average production in Kenya is estimated at 7 to 10 tonnes per hectare (Muthoni et al. 2011), compared to a global average yield of 17 tonnes per hectare (FAOSTAT 2011). Kenyan farmers achieve up to two harvests per year.

The total production area has increased in recent years and is estimated to have reached 150,000 to 160,000 hectares to date (Table 6).

11 The exact number is not known. 'The National Root and Tuber Crops Policy' published by the Ministry of Agriculture in 2010 estimates the number of farmers to be 790,000. In 2011, the Ministry reported 800,000 farmers.

Table 6: Main potato producing counties and the total area under potato production in Kenya

County	Area in ha	2010	2011	2012
Meru		17,463	12,500	18,092
Nyandarua		28,688	30,577	27,520
Nakuru		16,053	16,804	22,566
Bomet		2,900	3,680	2,987
Elgeyo Marakwet		8,311	15,097	20,992
Narok		6,836	7,808	6,292
Kiambu		11,271	10,092	18,769
Nyeri		8,067	6,404	7,821
Bungoma		5,113	6,051	5,321
Estimated total area under potato production				**150,000-160,000 ha**

Source: HCDA 2012, Kaguongo et al. 2013, and author's own estimations.

The common packing of potatoes in heavy bags causes damages

The ware potato value chain is structured rather simply (Figure 3) given that most of the potatoes marketed are bought and consumed as fresh produce by end-consumers. Farmers sell their produce mostly via brokers to local traders. Local traders take the produce to the wholesale markets where, again, brokers organise sales on behalf of the traders. Only farmers engaged in contract farming for the processing industry sell directly to their customers. Processing accounts for only around 9 per cent of marketed produce,[12] although a trend towards increasing demand for processed products has been observed.

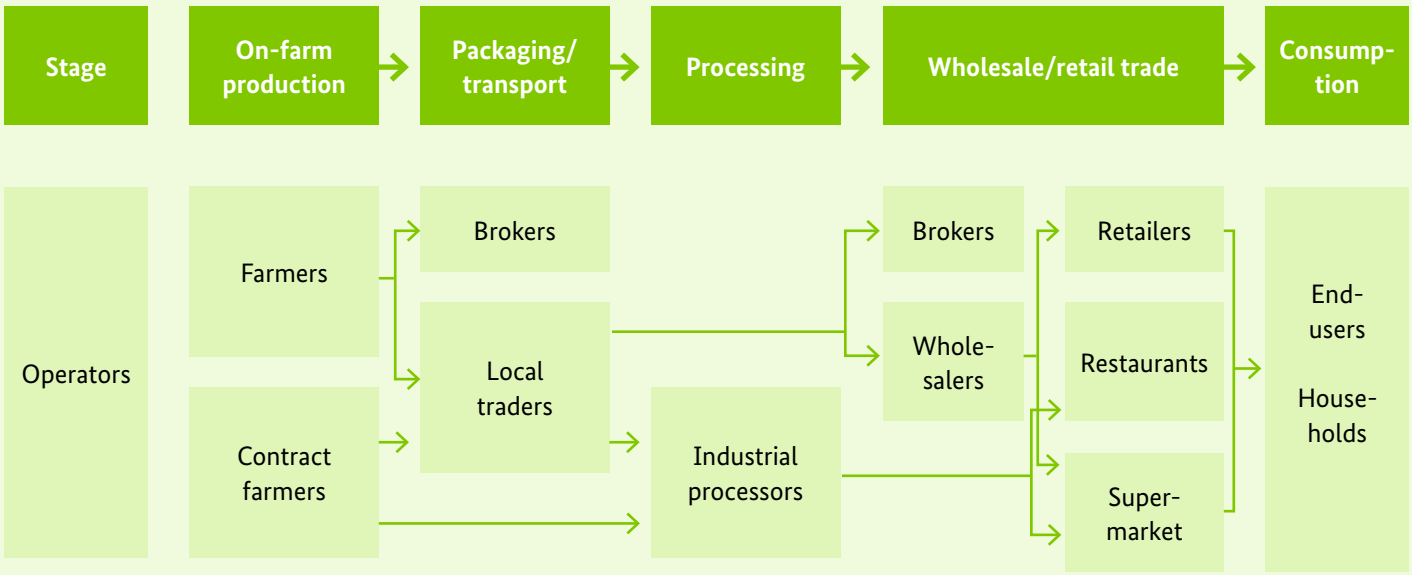
Average per capita consumption is estimated at 30 kg and is expected to rise due to increases in potato consumption by urban populations (FAO 2013) and rapid population growth. Present estimates indicate that around 1 to 1.5 million tonnes of potatoes are marketed in Kenya per season.[13] Currently, potatoes contribute over KES 40 billion or EUR 339 million (1 per cent) to the national economy (Kasina & Nderitu 2010). It therefore follows that potato is an important economic crop.

In addition to there being up to 800,000 potato farmers, another 2.5 million people work in the potato value chain (Kaguongo et al. 2013). Potato is ideal as a food security crop as it has a short season and provides food within just 2.5 to 3 months, especially when planting fast-maturing varieties. At the same time, farmers are assured of a harvest as the crop is drought resistant and will provide some produce, even with little rain.

12 According to NPCK estimates.

13 In 2012, Kenya had a population of 41 million and this is expected to rise to 50 million by 2020 (Zulu et al. 2012).

Figure 3: Ware Potato Value Chain



3.2 Potato production

3.2.1 Ware potato growers

The characteristics of the potato farmer sample (Table 28 in Annex 2) indicate the dominance of elder male farmers heading a family of five to six persons (68 per cent of the respondents were men, 32 per cent women). That said, the sub-sector is known for being gender-balanced. GIZ's PSDA[14] programme conducted labour studies in selected agriculture sub-sectors and the study on the potato sub-sector showed that women (49 per cent) and men (51 per cent) are nearly equally involved in the operations.[15] Some operations are heavy-duty in nature, meaning they are more likely to be performed by men (e.g., the handling of extended bags); conversely, women dominate the retail business.

The education levels of ware potato growers correspond with their age (Table 28 in Annex 2). Bomet County, where potato production often involves contract farming for processors, there are more young farmers. Farmers in this County also had the highest levels of literacy, with 73.1 per cent having completed secondary education and college. Compare this with Nakuru County, for example, where farmers had a low literacy level and only 49.3 per cent had completed secondary and college education. A comparison of male and female respondents showed higher illiteracy among women (10.3 per cent to 2.4 per cent of men) and consequently a lower education level (Table 29 in Annex 2).

Age and education is known to have an impact on openness to change and innovation and on the commercialisation of agricultural production. Farmers with higher levels of education tend to be more efficient in production. Better performance by more educated farmers may be attributed to the fact that education gives the farmers the ability to perceive, interpret and respond to

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

15 This runs in contrast to sweet potato production where, according to the GIZ PSDA study, women perform 75 per cent of the production activities.

new information and improved technology such as fertilisers, pesticides and planting materials much faster than their counterpartss (Nyagaka et al. 2009).

Land holdings and production methods

Smallholders with farm sizes averaging less than 2 hectares dominate the potato sub-sector in Kenya. Land ownership is predominantly freehold. The average farm size of surveyed potato farmers was 1.6 hectares (Table 7), while the average area of land given over to potato growing was 0.6 hectares, or 35.4 per cent of their overall farmland. Nyandarua County had the largest average land holding (1.9 hectares), with 0.7 hectares being dedicated to potato growing. Conversely, Bomet County had the smallest average land holding (1.4 hectares) and also the smallest area dedicated to potato growing (0.3 hectares).

Putting together a serious estimate of harvested and marketed potato in Kenya is difficult as data on production areas and yields are not systematically collected. Also, bag sizes used by traders vary from one area to another. MoALF and the Horticultural Crops Development Authority (HCDA) publish annual production data and, in 2012, HCDA calculated a production of 2.53 million tonnes on a 143,000-hectare area. The Kenyan Agricultural Research Institute (KARI) estimates smallholder yields to be in the region of 7 to 10 tonnes per hectare, equivalent to 1 to 1.5 million tonnes per season. The farmers interviewed for the study looking at main production areas harvest on average 13.5 tonnes per hectare per season, which is higher than the national average.

Most farmers produce two potato crops a year because of the bimodal rainfall in most potato growing areas. The long rainy season lasts from March/April to June/July, while the short rainy season lasts from October to December (Table 34 in Annex 2). Among the surveyed counties, only farmers from Meru (79.2 per cent) practise substantial off-season farming using irrigation, and these off-season crops secure higher prices (Table 7).

The majority of surveyed potato farmers (95.5 per cent) indicate that they practise crop rotation. However, the effectiveness of this crop rotation could not be determined as farmers did not report their rotation schedule. It is known that farmers rotate crops with, for example, maize, beans or cabbages; however, such rotations are not designed for the control of pests and diseases. CIP reported that 21 per cent of farmers grow potatoes continuously on the same plot and only one out of two farmers practises some form of rotation (Kaguongo et al. 2008).

Table 7: Land holdings and farming practices

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Potato yield (kg/ha)	13,243.8	11,888.6	14,950.3	13,629.4	13,551.6
Quantities eaten per farmer family (kg/ha)	1,295.6	2,032.7	1,326.8	1,041.8	1,394.9
Land holding in ha					
Total farm size	1.4	1.5	1.6	1.9	1.6
Land for potato production	0.3	0.4	0.7	0.7	0.6
Farming practices (%)					
Potato production irrigated	0.0	79.2	8.7	2.7	20.2
Farmer practising crop rotation	100	100	92.8	91.7	95.5

Kenya's soil-borne diseases,[16] limited pest management and low soil fertility mean current production practices are not sustainable. This situation is further aggravated by the remnants left in the field after harvest that produce so-called volunteer plants in the next season. Even though crops are rotated, the volunteer plants will carry diseases from one season into the next. The PHL survey showed that 97 per cent of interviewed farmers report leaving volunteer plants in the field, using them mostly for home consumption. The average quantities remaining in the field are estimated at 0.65 tonnes per hectare, Given surveyed farmers report an average yield of 13.5 tonnes per hectare, we can deduce that at least 5 per cent of the potato crop is left in the ground. A total of 53.2 per cent of farmers allow the volunteer plants to grow for home use, while others uproot the remnants (Table 37 in Annex 2).

Photograph 1: The Shangi potato variety

Farmers' seed system

More than 60 potato varieties are grown in Kenya, but relatively few are widely distributed. The dominance of certain varieties shifts over time. Today, Shangi[17] (a farmers' variety, shown in Photograph 1) and Tigoni (an officially released variety) are the main varieties because of market preferences (Table 45 in Annex 2). Shangi has a very short cooking time, saving energy and cutting costs, and so is preferred by low-income households. Although most varieties in Kenya have white skin, there is preference in some regions for red skin varieties.

Table 8: Potato varieties grown

Potato varieties grown in each county (% within the county)	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Shangi	30.8	49.1	98.5	100	74.0
Asante	0.0	79.2	5.9	6.8	20.7
Dutch Robjin	96.2	0.0	2.9	0.0	21.1
Tigoni	3.8	0.0	17.6	38.4	17.1
Sherekea	0.0	50.9	5.9	8.2	15.0
Kenya Karibu	7.7	0.0	14.7	23.3	12.6
Tigoni Red	0.0	52.8	0.0	0.0	11.4
Désirée	23.1	3.8	4.4	11	10.2

16 A recent survey showed that bacterial wilt was the most prevalent disease, affecting 77 per cent of potato farms, followed by late blight affecting 67 per cent and viral diseases affecting 12 per cent (Kaguongo et al. 2014). See also Janssens et al. 2013.

17 Shangi is also called 'Zangi' or 'Cangi' in other publications.

The farmer seed system currently dominates the subsector. Due to limited seed production, the lack of attractive varieties and an insufficient distribution network, certified seed[18] – including clean seed and positive selected seed – only meets around 5 per cent of the national demand for seed potato, according to NPCK. The limited availability and use of quality (and certified) seed potato is a key barrier to increasing productivity in Kenya's potato sector. Given farmers tend to practise short crop rotations, seed potato quality is an important factor in improving the sustainability of production. Clean seeds have the greatest impact on yields followed by irrigation, fungicides and fertilisers. However, clean seeds have the lowest adoption rate (Wang'ombe & van Dijk 2013). Of the farmers interviewed, most (77.7 per cent) used farmers' seed, with the main sources being their own harvest or seed from neighbouring farms (Table 33 in Annex 2). Only 6.9 per cent of farmers use certified seed purchased from certified seed suppliers (Graph 3 in the Annex 2).

Only 42 per cent of farmers renewed seed regularly (Graph 4 in Annex 2). The seed renewal rate was higher in Bomet and Meru where more than 60 per cent of farmers renewed seed after one to three seasons. Conversely, over 50 per cent of farmers in Nyandarua and Nakuru Counties never renewed their seed. Farmers from Meru and Bomet showed the highest rate of certified seed application (30 per cent). Note that in Bomet farmers are much more likely to be involved in producing for the processing industry and industrial clients generally provide the required seed material.

On-farm seed multiplication is further supported by varieties like Shangi; however, the variety is not certified and clean Shangi seed is not available. So, despite its advantages of higher yields and fast growth, the variety is easily affected by disease. Shangi germinates rapidly after harvest, meaning seed tubers can be planted out within just a few weeks. This short dormancy means the seed from one season can be planted in the next growing season. As ware potato, the variety is immediately sold after harvest, given it is not suitable for storage.

Harvesting practices

A total of 64 per cent of the farmers reported that they do not harvest potatoes when it is raining. However, those who do harvest during the rains experience damage and loss of up to 1,469 kg/ha, mostly caused by the potatoes rotting. When converted to the average of surveyed farmers, these losses stand at 344.2 kg/ha (Table 9). Farmers tend to harvest during the rains in order to reach the market early and fetch higher prices. Also, traders force farmers to harvest early. A comparison of farmers from Bomet and Nyandarua engaged in contract farming (Table 13) clearly indicates the impact of market forces on harvesting during the rains – e.g. contracted farmers from Bomet report 90 per cent less rain-induced damage than non-contracted farmers in the county. Still, weather conditions also play a role, such as when unexpected rains occur during a harvest. Annual rainfall patterns are becoming less easy to predict, with both drought and unseasonable rainfalls affecting production.

18 **Clean seed:** Multiplied at farm level, clean seed originates from certified or basic seed and its production follows guidelines laid down in farmer training programmes delivered by organisations like MoALF, KARI or GIZ. Most production guidelines used in the production of certified seed are also used to produce clean seed – the only difference is that the sample testing and supervision by KEPHIS is lacking. Negative selection is used to remove diseased and weak plants.
Positively selected seeds: Positively selected seeds are produced from ordinary or farmer-saved seeds through a process of selection undertaken by farmers who know how to select and manage good seed. However, Kenyan law stipulates that certified seed developed in accordance with strict production guidelines and inspected by the Kenya Plant Health Inspectorate Service (KEPHIS) are the only seeds that can be traded. All other seeds – including positively selected seeds, clean seeds and farmers' own seeds – are considered to be non-tradable by law (Kaguongo, W. et al. 2014).

Photograph 2: Fork jembe

Most small-scale farmers cannot afford motorised mechanisation (no cash to invest, farm acreage and plots are too small) and do most of their work manually (planting, fertilising, harvesting). The most commonly used tool for harvesting potatoes is the fork jembe (52.8 per cent), followed by oxen (23.2 per cent). However, the tools used varied from one county to another (Table 38 in Annex 2): in Bomet County, the majority (92.3 per cent) use oxen; Meru County was the only location where sticks were reported to be used (by 41.5 per cent); and, in Nyandarua, 97.2 per cent of farmers use a fork jembe.

The fork jembe is the main harvesting tool for farmers although most farmers (87.0 per cent) consider that the tool damages (cuts and bruises) potatoes during harvest. The damage caused by using fork jembes was estimated at 679 kg/ha. That said, other tools such as the hoe or stick damage crops even more.

Most farmers (85.4 per cent) used casual labour for harvesting potatoes and only 12.1 per cent also employ family members as part of their workforce (Table 38 in Annex 2). An important reason for this relates to how work is paid for: work provided by family members is usually not paid for and this makes them less willing to work on the family farm. Most farmers (80.8 per cent) considered harvesting operations to be the main cause of potato damage during harvest. The amount of damage caused by this type of labour was estimated at 488.2 kg/ha. However, as shown in Table 9, farmers experience most of their losses during production, e.g. through disease and other issues that are not reflected in this study.

Table 9: Farmers who experience losses during production and harvest

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Potato yield (kg/ha)	13,243.8	11,888.6	14,950.3	13,629.4	13,551.6
Farmers experiencing losses (%)	94.2	100.0	97.1	100.0	98.0
Stages at which losses occur (%)					
Production	77.6	81.1	74.6	55.6	71.0
Harvesting	53.1	56.6	44.8	45.8	49.4
Sales	28.6	39.6	26.9	36.1	32.8
Storage	8.2	15.1	10.4	15.3	12.4
Damage caused during harvest					
Harvesting in rain (kg/ha)	179.9	185.1	633.6	261.5	344.2
Harvesting tools (kg/ha)	430.3	525.1	759.2	528.7	568.2
Harvesting labour (kg/ha)	213.1	537.5	631.0	514.7	488.2

Post-harvesting practices

Most farmers reported sorting and grading potatoes at harvest. The majority of farmers (60.0 per cent) graded by size, with 85 per cent of their crop being either medium- or large-size potatoes (Table 10). Sorting and grading mainly involved separating out small potatoes for seed. After deducting potatoes for home use, medium and large tubers end up being bagged for sale along with cut, bruised and green tubers.

As there are usually only a few months between harvests, it is not common practice to store ware potatoes in Kenya, although smaller quantities may be stored on farms. Those operating modern storage facilities are the larger processors or larger producers of seed potato. The majority of the surveyed farmers (92.2 per cent) stored some potatoes after harvest, but most farmers (60.4 per cent) stored potato for seed (Table 11).

Table 10: Sorting and grading practices

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Farmers sorting and grading potatoes (%)	94.1	100	98.5	100	98.4
Stage of sorting and grading (%)					
During harvesting	85.4	94.3	86.4	90.1	89.1
Just before storing	10.4	5.7	10.6	4.2	7.6
When selling	4.2	0	3	5.6	3.4
Sorting and grading potatoes of each category obtained from a hectare (%)					
Small	11.0	8.4	9.5	6.2	8.4
Medium and large	85.1	84.3	81.5	86.3	84.9
Cut and bruised	3.7	5.3	7.5	4.9	5.2
Greening tubers	0.2	1.6	1.0	2.0	1.1
Off-type variety	0	0.4	0.5	0.6	0.4

Table 11: Potato storage practices

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Farmers who store potatoes (%)	94.1	96.2	91.0	88.9	92.2
Where the farmer stores potatoes (%)	n=51	n=48	n=61	n=64	n=224
Dark store	27.1	64.7	22.0	7.9	29.0
Store allowing light	47.9	15.7	22.8	49.2	35.7
Store with a wooden floor	18.8	2.0	15.3	20.6	14.5
Others	6.2	17.6	33.9	22.3	20.8
Why the farmer stores potatoes (%)					
To wait for better prices	9.1	55.1	1.7	10.9	18.0
Home consumption	2.3	30.6	16.7	32.8	21.7
For seed	88.6	14.3	81.7	56.2	60.4

A survey carried out as part of the Seed Potato Sub-sector Masterplan (Kaguongo et al. 2010) showed that although more than 90 per cent of interviewed farmers store seeds, only 4 per cent had been trained in seed storage and suitable technologies such as diffused light stores (DLS).[19]

Only 18 per cent of the farmers surveyed stored potatoes in order to wait for better market prices, although the majority of farmers (55.1 per cent) in Meru County stored stocks for reasons of price (Table 11). Farmers in Meru in particular set aside potatoes from rain-fed production to wait for better prices. Off-season production produced under irrigation secures high prices so, in the main, farmers sell directly after harvest. Meru farmers who stored potatoes reported, however, that this year's prices were not significantly higher – the difference being just KES 1.3 per kg. It is possible that, in other years, storing ware potatoes will prove more financially rewarding.

The majority of farmers (83.9 per cent) reported experiencing losses during potato storage, mainly caused by rotten potatoes (82.5 per cent) affected by disease or damage (Table 12). On average, 119 kg/ha (0.8 per cent of the production) were lost in storage. The highest such losses were reported in Meru where larger quantities of ware potatoes are stored.

Photograph 3: Seed potato storage - diffused light store

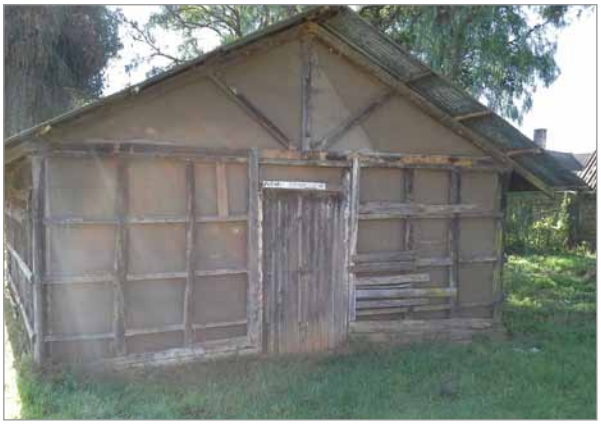


Table 12: Losses in storage

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Farmers experiencing losses (%)	80.4	84.3	84.2	85.7	83.9
Causes of damage during storage					
Pests and diseases (%)	40.5	10.5	10.4	9.3	16.4
Rotting (%)	59.5	84.2	89.6	90.7	82.5
Others (frost, rodents, etc.) (%)	32.7	5.7	24.6	50.0	29.7
Losses during storage (kg/ha)	122.8	414.0	105.6	62.6	119.0

19 In diffused light stores (DLS), seed tubers are stored on trays or racks and the stores are shaded and aerated. This type of store provides excellent conditions for seed tubers, but it is not widely used (Photograph 3).

When selling potatoes, bags were mainly packed by brokers (78 per cent) as the majority of farmers (67.6 per cent) sold their potatoes via brokers to local traders (Table 13). Farmers from Bomet selling their potatoes to processors (17.8 per cent) also take on the packing of their produce (19.6 per cent). In the 2013 season, Bomet farmers remained the only group in the survey cohort selling to the processing industry. Farmers from Nyandarua were contracted to produce for the processing industry but this arrangement did not work out and the produce was eventually sold to traders (see chapter 3.2.2).

Table 13: Farmers' transport and marketing practices

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Packers of bags for selling (%)					
Broker	49.0	88.7	76.8	91.8	78.0
Trader	27.5	7.5	11.6	0.0	10.6
Farmer	19.6	3.8	8.7	4.1	8.5
Workers	3.9	0.0	2.9	4.1	2.8
Consumer	3.8	0.0	1.4	0.0	1.2
To whom the farmer sells potatoes (%)					
Local trader	63.5	96.2	56.5	60.3	67.6
Wholesaler	3.8	15.4	40.6	37.0	26.3
Processor	17.8	0.0	0.0	0.0	

3.2.2 Comparison between contracted and non-contracted farmers

A comparison of ware potato growers operating as contract farmers in Bomet and Nyandarua County is set out in Table 14. As the results show, improved conditions under contract farming end up delivering better production performance, in particular when supported with the provision of inputs like fertiliser or seed. However, challenges are arising in the cooperations between farmers and processors, especially regarding fulfilment of the contract. The costs of the inputs provided are based on market prices but, sometimes, the pricing and quality of these inputs is questioned: farmers accuse processors of calculating higher than market prices or the quality of seed is called into question. In return, processors complain about farmers breaching their contracts despite the fact that they have provided them with inputs. Also, unmet quality standards are an issue needing discussion, given that farmers generally do not receive any training on improved agricultural practices.

Farmers from Bomet work closely with potato crisp manufacturers, hence the prevalence of the Dutch Robjin variety, which is preferred by the processing industry and grown by both contracted and non-contracted farmers in Bomet County. Non-contracted farmers in Bomet sell Dutch Robjin to the fresh produce markets as there is also demand for the variety in retail markets. A notable difference between the two kinds of farmer is that contracted farmers use certified seed more (23.1 per cent) than non-contracted farmers (10.3 per cent).

The quantities harvested per hectare were 14,945.9 kg for contracted farmers and 12,572.6 kg for non-contracted farmers, or 16 per cent less. The high yield for contracted farmers may be attributed to the use of high quality seed and improved production practices. The quantity of damaged potatoes per hectare for contracted farmers was 383 kg, whereas non-contracted farmers reported damages of 842 kg. Nevertheless, Bomet farmers' losses come in nearly 50 per cent lower than all other surveyed

farmers. The difference can be explained by the varieties selected (mainly Dutch Robjin) as well as the handling of produce. In all the categories of harvest-related damage, the quantities reported in Bomet were significantly lower than those of other counties (Table 9).

In Nyandarua, the quantity harvested per hectare was 16,877.6 kg for contracted farmers and 12,356.4 kg for non-contracted farmers. The high yield for contracted farmers may be attributed to better crop husbandry. However, different to the situation in Bomet, contracted farmers in Nyandarua had high quantities of damaged potatoes per hectare (1,618.8 kg/ha) in comparison to non-contracted farmers (1,202.4 kg/ha). It has been reported that the losses were the result of the contractor's strict sorting requirements. Farmers here are new to contract farming and do not have enough experience in reducing damage or unwanted potatoes. As such, they produced more waste compared to non-contracted farmers. The introduction of unfamiliar standards led to a high proportion of rejects by the contracting processor and so the farmers ended up selling the bulk of the harvest to traders.

Table 14: Contracted and non-contracted farmers in Bomet and Nyandarua Counties

	Bomet contracted n=13	**Bomet Non-contracted n=39**	**Nyandarua contracted n=13**	**Nyandarua Non-contracted n=60**
Main varieties grown (%)				
Shangi	15.4	35.9	100.0	100.0
Tigoni	0.0	5.1	100.0	26.2
Dutch Robjin	100.0	94.9	-	-
Kenya Karibu	-	-	75.0	13.1
Désirée	15.4	25.6	50.0	3.3
Type of seed used (%)				
Farmers' seed	61.5	71.4	88.3	91.8
Positively selected seed	15.4	17.9	0.0	3.3
'Clean' seed	0.0	0.0	8.3	4.9
Certified seed	23.1	10.3	8.3	0.0
Harvest				
Quantity harvested (kg/ha)	14,945.9	12,572.6	16,877.6	12,356.4
Quantity damaged (kg/ha)	383.1	842.3	1,618.8	1,202.4
by harvesting tool (kg/ha)	306.0	416.4	791.1	443.3
by harvesting in rain (kg/ha)	25.8	265.4	142.1	297.3
by harvest workforce (kg/ha)	51.3	160.5	685.6	461.8
Percentage of damaged harvested potatoes	**1.9**	**6.7**	**9.6**	**9.7**

3.3 Potato marketing

3.3.1 Brokers at the farm level

Brokers act as intermediaries between farmers and local traders and keep in close contact with farmers to stay abreast of the quantities and varieties they have available. Brokers work in groups and each group can deal with 30 to 70 farmers. Brokers get a fixed fee per bag from local traders.

Brokers tend always to be male as the work involves lots of heavy lifting. Brokers, contrary to the perception that they exploit farmers, work under very difficult conditions. They reported that lifting the heavy bags damages their health and that some have been injured when loading and offloading extended bags. It was observed that many of them appeared in poor health.

One of the challenges brokers come up against is the failure to implement standards in potato marketing. As intermediaries between farmers and traders, they have to convince farmers to accept extended bags for sale. Implementation of standard bags would facilitate their business operations. When brokers pack, they try to avoid including bad quality potatoes in the bags; however, they do not grade or buy potatoes by grade.

Photograph 4: Brokers on site filling extended bags

During the wet season, brokers organise tractors to transport potatoes from the field to the road. At other times, potatoes are transported using donkey or ox carts or loaded onto donkeys. Lorries/trucks or pickups are also used (Table 40 in Annex 2). Brokers normally load potatoes onto the truck. Depending on its size, a single bag is carried by three to six people or is loaded on the shoulders of one broker who subsequently throws the bag into a wheelbarrow.

Photograph 5: Loading and handling of extended bags at Nairobi's Wakulima Market

In rural areas, road infrastructure is very poor and brokers have difficulty transporting potatoes from farms. The poor roads cause delays in collecting purchased stocks, which can result in the potatoes going bad. This kind of loss is transferred to the brokers, as the trader may not take the spoilt stock. Brokers consider that the main damage to potatoes is caused by extended bag sizes but also acknowledge that delayed collection leads to damaged stock. Brokers estimate that in each 110 kg standard bag an average of 5 kg of stock will be damaged/lost.

3.3.2 Wholesale and retail trade

Distances from farms to sales points range from 15 km (i.e., a market local to producing areas) to up to 500 km (i.e., where Mombasa or Kampala is the furthest point). Traders buying in the surveyed counties come from Wakulima Market in Nairobi, Kongowea Market in Mombasa or Northern Tanzania. Wakulima Market in Nairobi is the largest terminal market and is estimated to handle over 50 per cent of all potatoes traded in Kenya.

From here, the produce is usually then distributed to other towns or markets or even to neighbouring countries. There is no storage at the wholesale level and the produce is distributed and sold within a short period. Traders selling at Wakulima in Nairobi cooperate with brokers based at the wholesale markets. The brokers wait for the trucks to arrive at the market and inform their customers about the expected load. All transactions are in the hands of the wholesale market brokers and, when a transaction is agreed, the trader is provided with a receipt of the purchased produce, quantities and price. Brokers at Wakulima Market earn commission of around KES 40-50 (EUR 0.35-0.40) on each bag.

Currently, the main wholesale market in Nairobi (photographs taken in December 2013) is highly congested and spills over into the surrounding areas, where conditions are very unhygienic. The same is true for other markets around the country, yet, in recent years, only a few market places have benefited from refurbishment.

Photograph 6: Conditions at Nairobi's Wakulima wholesale market

The majority of retailers interviewed (70.4 per cent) were female and the majority of wholesalers (77.8 per cent) were male. The findings also indicate that most respondents (63.5 per cent) had completed higher-level education at secondary school and college, with male traders having a slightly higher level of education than female traders (66.4 per cent to 59.2 per cent; Tables 30 and 31 in Annex 2).

Wholesalers travel more than 300 km to transport potatoes from the main production areas to the main markets. Larger trucks are used to transport goods to urban centres. Retailers mostly buy at the wholesale market or at retail markets with an attached wholesale section and these outlets are used by both retailers and wholesalers because most of the markets have sections catering to both sectors. Wakulima Market in Nairobi also includes a retail section located in the old covered-market building (Table 42 in Annex 2).

The packaging bought also depends on the season and availability of produce. A total of 25 per cent of wholesalers bought standard bags with a Mukurinu closure. These are normally cheaper because the bag is totally closed up, meaning the content is not visible (Table 43 in Annex 2). Nylon bags are most commonly purchased and their average weight totals 173 kg. Nylon bags are cheap and strong enough to carry larger quantities compared to jute bags (Table 44 in Annex 2).

Table 15: Potato traders repacking bags

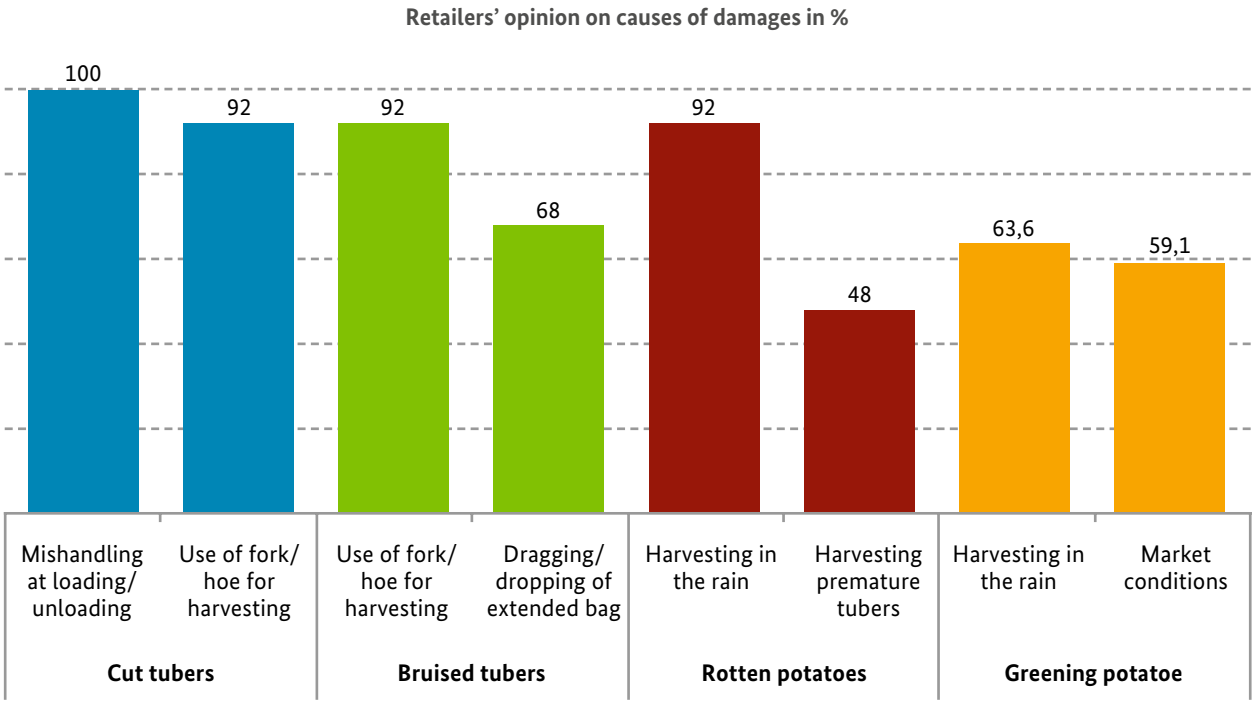
	Retailer n=27	Wholesaler n=27	Both retail/ wholesale n=9	All n=63
Traders expecting/experiencing damages				
from the farm (%)	100.0	76.0	88.9	88.5
from transportation (%)	59.3	60.0	22.2	54.1
from market conditions (%)	96.3	100.0	100.0	98.4
Traders opening bags and repacking (%)	96.2	59.1	77.8	78.9
Main reasons for repacking (%)				
When there is visible damage	61.5	13.6	0.0	33.3
When potato greening is visible	29.2	15.4	14.3	22.7
To create into smaller units for sale	95.8	84.6	85.7	90.9

Photograph 7: Retailer selling out of an opened extended bag

Observations at retail and wholesale markets showed that potato bags are not usually opened until the bags reach the final customer: the retailer. In all, 59 per cent of the interviewed wholesalers reported opening the bags, but mainly to break the stock up into smaller quantities (Table 15). Bad quality is not considered an important enough issue for wholesalers to open bags, although they do expect damage from transportation and market conditions or even from farms packing bad quality stock in the bags.

Since the sorting and grading of harvested potato tubers, undertaken by farmers and brokers, is an activity that neither party takes seriously, the damage occurring to stock at the farm level is then transferred to retailers. It is retailers who eventually open the bags and must deal with the quality of stock they contain. After opening the bags, retailers sort the potatoes and any smaller or cut potatoes are then offered to buyers at reduced prices. Retailers consider that, along with the mishandling of extended bags, harvesting methods have a significant impact on potato quality (Graph 1).

Graph 1: Causes of damages at retail level



Opening bags for the load tracking undertaken as part of the survey indicated that damaged, green, diseased and/or infested potatoes are put into bags destined for various markets. Bags opened on farms for the load tracking exercise contained 31 kg of damaged stock in a 198.6 kg bag, with cut potatoes being the most prevalent form of damage. There were also up to 5.5 kg of green potatoes per bag. When the bags were subsequently opened in the Nairobi market the quantity of damaged stock had risen to 17.5 kg (Table 16), also mainly of cut potatoes. It is expected that this increase in cut potatoes is caused by transport impacts.

Table 16: Results of bag tracking in kg

Place	Type of bag	Weight per bag	Cut	Green	Rotten	Total kg losses per bag
Tracking from Nyandarua to Nairobi						
Nyandarua – farm level	Kata 2 Kamba 5	198.6	23	5.5	2.5	**31**
Nairobi – retail market	Kata 2 Kamba 5	196.5	36	10	2.5	**48.5**

Photograph 8: Potato sample from load tracking

In the off-season, cut/damaged potatoes (called *makombola*) are still sold on the market; however, in high season there is less demand for cheap potatoes as prices are lower. The price of cut/damaged tubers is half the price of good tubers – e.g., 1 kg of good-quality tubers is sold at KES 30 (EUR 0.25) whereas 1 kg of makombola sells at KES 15 (EUR 0.12).

Table 17 below shows, however, that it is difficult to generalise about damage being caused by packaging, transportation and bag handling. During the survey, further bags were opened at retail markets and it became obvious that the quality of potato bags opened in the markets of Mombasa and Nairobi differs significantly. It was reported that bags destined for Mombasa are more carefully packed than those going to Nairobi because of the long distance involved in transporting goods to Mombasa. Cut potatoes, which can still be sold at the Nairobi

Table 17: Results of opening bags at different markets

Place	Type of bag	Weight per bag in kg	Cut in kg	Green in kg	Rotten in kg	Total kg losses per bag
Mombasa retail market	Kata 2 Kamba 4	187	11	0	0.5	**12**
	Mukurinu	171	15	0.75	1.5	**17.3**
	Kata 2 Kamba 5	198.5	17	1	1	**19**
Nairobi retail market	Kata 2 Kamba 4	185	33	33	1	**66**
	Mukurinu	174	53	5	0	**59**
	Kata 2 Kamba 5	205	31	1	1	**33**

market, might be rotten before they reach the market in Mombasa. A further reason might be that there is increased quality awareness among customers involved in the tourism sector around Mombasa.

3.3.3 Supermarkets

Supermarkets in Kenya come in various sizes: some are quite small and independently owned whereas others are national or multinational retail chains. The large supermarket chains like Nakumatt, Uchumi and Tuskeys are expanding with branches in all of Kenya's larger cities.

The average quantity of potatoes sold per week in each supermarket branch is estimated at 120 kg. Supermarkets are not a popular source of fresh potatoes because consumers prefer to buy from open-air markets where they are cheaper and fresher. Supermarkets' share of potato sales is estimated at just 1 per cent.[20]

Contracted traders supply the large supermarket chains with fresh potatoes on a weekly basis. The potatoes are brought to the central distribution centre for onward distribution to branches nationwide. Supermarkets handle their own transportation to branches, using crates and refrigerated trucks to prevent any losses during transport. Supermarkets buy graded potatoes and will buy-in big tubers and baby potatoes according to consumer demand. The potatoes are supplied already sorted and any defective potatoes found in the consignment delivered are returned to the supplier – this includes green, damaged or rotten tubers. However, returns are minimal as it is expected that the supplies will meet the standards laid down by the supermarket management.

Purchase prices are more or less stable at all times due to the contractual arrangements in place, averaging KES 4,000 (EUR 34) for a 110 kg standard bag (EUR 0.31 per kg). The price is relatively high due to the higher quality of potatoes supplied. Supermarkets are the only buyer at the retail level that reward quality supply. Supermarkets do not experience seasonal fluctuations because supply and demand is almost constant. Supermarkets sell fresh potatoes, frozen chips and potato crisps. Potatoes in supermarkets are sold by the kilogram. The sales price of a kilogram varies according to the variety and supermarket, but average prices range from KES 30-80 (EUR 0.25-0.68) per kg.

Supermarkets do not store potatoes, so storage losses are not a factor in their case. Losses do occur, however, in shop displays through rotting, greening and weight loss from shrinking and sprouting. Shangi, the most common variety, is known for weight loss and sprouting and Tigoni quickly turns green on the shelves. The losses are estimated at up to 25 per cent of the produce traded. As such, supermarkets are keen to procure high-quality potatoes with a long shelf life. However, part of the reported losses could also be attributed to a lack of demand/sales in the supermarkets because consumers prefer to purchase potatoes at fresh produce markets.

3.3.4 Restaurants

Restaurants are major outlets for the potatoes consumed in Kenya's main urban centres. Many of them specialise in chips, a popular dish with the urban population, especially young people. Restaurants use potatoes to make *chips banjia* (spiced slices of potatoes) and mash-based dishes that use potato on its own or mixed with other ingredients. An increase in fast food restaurants coupled with the arrival of international fast-food restaurants chains like Kentucky Fried Chicken (KFC), Chicken Inn and others indicates that the demand for potatoes for processing is increasing.

The majority of the 22 restaurants surveyed (68.2 per cent) source their potatoes from various markets and suppliers, mostly from wholesale and retail markets. The main suppliers are wholesalers (54.5 per cent) but contracted local traders also deliver direct to restaurants (Table 18). Chips were the most common product sold by the restaurants interviewed (90.9 per cent), followed by potato stew and *kienyeji* (a mashed vegetable dish that is also called *mukimo*). Chips are prepared manually rather than being purchased ready-made.

20 NPCK puts forward an estimate of a 1 per cent market share. Hoeffler and Maingi (2006), on the other hand, reported a 2 per cent market share.

Table 18: Characteristics of restaurants (multiple choice)

Restaurants purchases	In %
Where restaurants buy potatoes (%)	
Open market	68.2
Direct from farms	27.3
Delivered to the premises	45.5
From whom restaurants buy potatoes (%)	
Wholesalers	54.5
Retailers	22.7
Contracted trader	45.5
Farmers	22.7
Main potato products sold by the restaurant (%)	
Potato stew/food	77.3
Chips	90.9
Kienyeji (Mukimo)	31.8
How restaurants prepare potatoes prior to cooking (%)	
Peeling by hand/machine	90.9
Shredding by hand/machine	68.2

Most restaurants (90 per cent) stated that they bought graded/sorted potatoes by size (small, medium, large). The preferred variety is Shangi due to its taste and availability (Table 48 in Annex 2). On average, restaurants store potatoes for three days, meaning that restaurants are supplied with potatoes two to three times a week. Restaurants did not report on losses occurring when purchasing and processing potatoes, other than that lost through peeling, which is not categorised as loss.

3.4 Potato processing

The local fresh potato markets, including supermarkets and retail shops, are the main destinations for produce. According to NPCK estimations, only about 9 per cent of produce goes into potato processing (Table 19). Although, in future, a significant increase in demand for processed products is expected, particularly for French fry and potato crisp processing. Local and international fast-food restaurant chains are reported to be increasing their branch networks in Kenya.

Table 19: Market shares of different market channels in the potato value chain

End use		Estimated current
Local market		80%
Supermarkets		1%
Restaurants/institutions		10%
Processing		9%
	French fries	5%
	Crisps and other snacks	3%
	Starch/potato flour/flakes	1%

Source: author's own estimations.

Kenya has an expanding food processing industry, driven by its growing urban population, changing population structure, new eating habits and increased tourism. Three processing companies located in Nairobi and Nyandarua County were interviewed. Two of the processors make potato crisps while the other processes ready-to-cook fresh chips, *banjia* and ready-to-cook peeled whole potatoes.

The most popular processing variety for crisps is Dutch Robjin, grown by farmers in Bomet who are contracted to supply the potatoes. Processors are also get their supplies from contracted traders who collect potatoes from farmers. Processors complain that contract farming faces many challenges and concerted efforts are required to improve the contract agreements. A particular, complaint processors report is that farmers breach their contracts even though they have been provided with inputs. Brokers are accused of encouraging farmers to break their agreements by paying them a few KES more than the contract price.

Processing companies buy and process 5 to 15 tonnes of potatoes a week. Of the potatoes supplied, 3-5 per cent are damaged, immature or rotten. These are considered as rejects and are removed and returned to the supplier, who then discards them. Processors have problems getting the right size potatoes for their processing machines: 1 per cent of the potatoes supplied by contractors are undersize and must be removed and discarded, and 4-7 per cent are oversize and cannot be fed through the processing machines. To treat oversize produce, companies employ extra personnel to halve the potatoes so they fit into the processing machines.

Some processors do not have a potato store, so they experience supply shortages in March/April and November/December. Processors operating cold storage facilities store stock for up to four months in 25 kg wooden and plastic crates, which are more suitable for storage. Little is lost during storage and using crates also helps to minimise damage and rotting during transportation and storage.

An estimated 1 per cent of each batch of potato crisps will turn brown during frying and must be removed and discarded. Another 1 per cent can end up broken and so are discarded or used as an ingredient in other snacks.

The Kenyan potato processing industry is expected to increase substantially

4 Analysis of food losses and options for food loss reduction

4.1 Assessment of quantitative and financial losses in the potato value chain

Critical loss points and quantitative assessment

All reported forms of damage and loss occurring along the value chain are listed in the following table. However, it is not possible to calculate totals for the reported losses because the relevance of each market channel differs in terms of potato sales.

The results of this study show rough loss data but do not consider the economics of these losses. In reality, it is not feasible to achieve zero losses and a certain level of losses must be accepted, depending on market prices and existing infrastructure. Actual losses for farmers, processors and marketers are therefore smaller than estimated in this study.

Table 20: Synopsis of reported damage/loss along the value chain

VC function	Critical loss points		Average losses	Average damages	Remarks
Harvesting	Left in the field		2.1%		Average yield of 14.2 tonnes/ha (including stock set aside for home use)
	Harvesting tool			4.0%	
	Harvesting in the rain			2.8%	
	Casual labour			3.4%	
Storage	Storage losses		0,8%		
Broker	Sorting by brokers			5%	Per standard bag of 110 kg
Transport/ packaging				6.5% cut 2.3% green	Per extended bag
Wholesaler/ retailer		Market share 80%	1.3% rotten	11.6% cut 2.8% green	Per extended bag
Supermarket	Display shelves	Market share 1%	25%		Per consignment
Restaurants		Market share 10%			No losses reported
Processing	Quality checking of supplies	Market share 9%	3-5% rejects, 1% undersized		Per consignment
				5% over-sized	Extra cutting that requires employing extra staff
	Processing			2%	Burned, broken

Loss and damage reported at the farm level in the survey are summarised in Table 21. All quantities shown represent the overall average for surveyed farms in one season. Potatoes left in the field (volunteer plants) amount to about 650.1 kg per hectare and are added to the harvested potatoes. Since around 53 per cent of these volunteer stocks are later used for home consumption, only 47 per cent (304.2 kg) of these potatoes are ultimately lost.

Table 21: Production and loss/damage at the farm level

Production and loss at the farm level per ha	All farmers interviewed	As a %
Production and losses per ha per season		
Yields in kg per ha	13,551.6	
Left in field after second gathering (kg)	650.1	
Total production plus produce left in field (kg)	**14,201.7**	
Loss/damage at the farm level		
Losses from produce being left in the field (kg)	304.2	2.2%
Damage caused by harvesting in the rain (kg)	344.2	2.4%
Damage caused by harvesting tools (kg)	568.2	4.0%
Damage caused by labour (kg)	488.2	3.4%
Losses during storage (kg)	119.0	0.8%
Total damage and losses at the farm level (kg)	**1,823.9**	
Percentage damaged/lost at the farm level		**12.8%**

With regard to the other listed forms of damage/loss, it is difficult to define the real losses at the farm level because, as Table 22 shows, large quantities of damaged potatoes still leave the farm and are sold on to traders and retailers. In this context, 12.8 per cent of potatoes produced can be classified as lost or damaged. Harvesting tools caused the highest amount of damage on farms, followed by harvesting labour and harvesting during the rain.[21] Losses occurring during the storage of seed potatoes are of minor importance.

The difference between the percentage of damage and loss found at the farm gate (15.6 per cent) and at the retail point (24.4. per cent) (Table 22) can be attributed to bag handling, packaging and transportation. Because they are so heavy, large bags are dragged and dropped. This results in splitting and bruising tubers, which eventually rot. Also, because of the packing methods used, potatoes can be exposed to sunlight, which turns them green.

21 The figures used here for the quantities of stock damaged through harvesting in the rain represent the average levels of damage expected on farms overall.

Table 22: Weight and losses at the trader level in kg and % per bag

Weights and losses at the trader level	Weight (kg)	Per cent (%)
Weight of the bag	198.6	
Cut and bruised when buying at the farm gate	23	11.6
Greening tubers at the point of purchase	5.5	2.8
Rotten tubers at the point of purchase	2.5	1.3
Loss/damage at the farm gate	**31 kg**	**15.6%**
Cut and bruised at the retail point	36	18.1
Greening tubers at the retail point	10	5.0
Rotten tubers at the retail point	2.5	1.3
Total damage/loss at the retail point	**48.5 kg**	**24.4%**
Percentage change in damage during transportation		13
Percentage change in greening during transportation		4.5
Percentage change in rotten tubers during transportation		0.0
Total damage/loss during transportation		**17.5 kg**

Load tracking, where bags were opened at the farm gate and then at the retail level, showed that the underlying cause of damage/loss recorded at the retail level is due to the treatment of produce on farms. This being the case, it is possible to attribute around 95 per cent of damage/loss to problems occurring on farms (with three quarters of this damage being caused by harvesting tools and labour), along with a small share of post-harvest losses at the farm level (2.9 per cent). Furthermore, most loss/damage recorded by supermarkets or processors is rooted in issues occurring at the production level, such as diseased potatoes, inappropriate varieties, the lack of sorting and grading, etc.

Around 30 per cent of harvested potatoes remain on the farm for home consumption, for use as seed potato, or due to on-farm loss (3 per cent). That said, during the off-season when the survey was conducted, nearly all retail potatoes reaching the markets were sold, though often at lower prices. Of the 71 per cent of potatoes marketed, 16 per cent were damaged or lost[22] (Graph 2). Therefore, retailers in particular (and, ultimately, consumers) are left with potatoes that are perhaps cheaper but that are ultimately low-quality.

Financial assessment

The financial assessment of the damage and loss of potatoes along the value chain, as described in Table 24, shows the economic impact of low performance in potato production. Per season, 2,760 kg or 19.4 per cent of production per hectare is damaged or lost, resulting in a loss of value of KES 42,824 (EUR 363) per hectare. Extrapolating these losses per hectare to the level of national yearly production (two seasons) on 150,000 hectares, we can assume that 815,000 tonnes are damaged or lost, with a value of about KES 12.9 billion (EUR 109 million). As outlined, most of this loss could be prevented with better agricultural practices and careful handling.

To quantify the financial losses, prices at each level of the value chain were collected (Table 23). The average farm-gate price in October during the survey was KES 13.2 per kg and the recorded retail market sale price was KES 30 per kg. Consumer prices at supermarkets were significantly higher reaching up to KES 80 per kg.

22 Marketed produce includes supplies to supermarkets and the processing industry.

Graph 2: Use and quality of potatoes

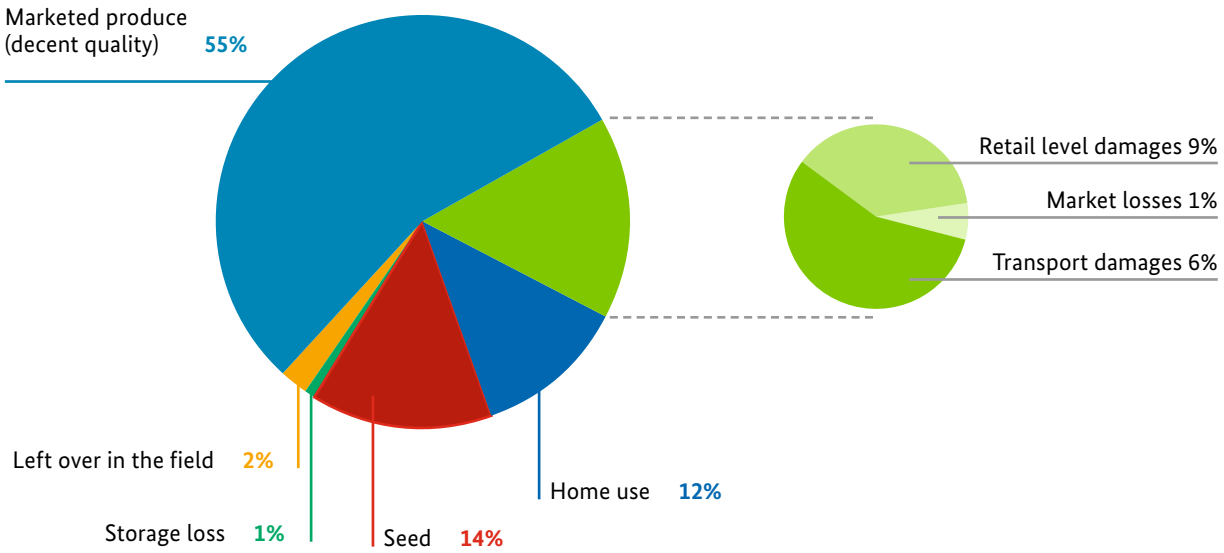


Table 23: Average potato purchase prices in October/November 2013

Value chain	October/November 2013	Remarks
Farm gate: farmer	9-19 KES/kg	
	13.2 KES/kg	PHL survey data
Farm gate: broker	11.8 KES/kg	Information from brokers on farm gate prices
Wholesalers	18.7 KES/kg	Information from brokers
	10.0-21.4 KES/kg	15.6%
	14.4 KES/kg	Survey data
Processing	20.0 KES/kg	Information from processors[23]
Supermarkets	36.4 KES/kg	
Retailers	13.3-26.6 KES/kg	PHL survey data
	16.5 KES/kg	Average price paid by retailers
Restaurant	26.8 KES/kg	
Consumer	30-80 KES/kg	KES 30 at retail markets and up to KES 80 in supermarkets

23 http://www.hortinews.co.ke/article.php?id=593 (20th February 2013).

The prices collected at each stage form the basis for subsequent calculations. The average farm-gate price is KES 13.2 (EUR 0.11), the average consumer price is calculated as KES 30 per kg (EUR 0.25) and the consumer price at supermarkets is based on an average of KES 50 per kg (EUR 0.42). Losses at the processing level are calculated using purchase prices of KES 20 per kg (EUR 0.17) – the additional costs of extra labour employed to cut oversize tubers are not included due to the lack of cost prices. The losses are calculated according to the market share of the different actors in the value chain. The total quantities are estimated based on a production area of 150,000 hectares per season (losses per hectare) and do not take into consideration the share of larger-scale farms that produce under better conditions.

Table 24: Financial calculation of damage and loss occurring along the ware potato value chain

Food loss according to production per ha	Produced and marketed produce	Quantity damaged in tonnes	Quantity lost	Cost of losses per kg	Value of losses per ha
On-farm production	14,202 kg				
Harvested	13,552 kg				
Left in field	650 kg				
On-farm consumption	-1,395 kg				
Left in field for home use	-346 kg				
Potatoes for seed[24]	-2,000 kg				
Losses in storage			-119 kg	KES 13	KES 1,547
Losses left over in the field			-304 kg	KES 13	KES 3,952
Marketed produce	10,038 kg				
Retail market (90%)[25]	9,034 kg				
Transport/packaging damage (50% lower retail price)			-795 kg	KES 15	KES 11,925
Losses			-117 kg (rotten)	KES 30	KES 3,510
Damages (50% lower retail price)		-1,292 kg		KES 15	KES 19,380
Supermarkets (1%)	100 kg				
Losses			-25 kg	KES 50	KES 1,250
Processing (9%)	903 kg				
Loss			-63 kg	KES 20	KES 1,260
Damage (extra costs for cutting)		-45 kg		not available	not available
Value of losses per ha in one season					**KES 42,824 EUR 363**
Value of losses per year (two seasons) for a total production area of 150,000 ha					**KES 12,850 billion EUR 109 million**

24 Estimated on basis of Nyagaka 2009.

25 The retail market share totals up to 90 per cent when adding the 10 per cent market share for restaurants and purchasing at retail markets.

4.2 Challenges and options for food loss reduction

The Kenyan Government has recognised the critical role potato plays in alleviating food shortages in the context of the decreasing production of maize and other staples (Mwaura 2009). The development of potato production could form part of the solution for tackling food shortages given that potato has higher yields compared to maize.[26] As such, improvements in the potato sub-sector will also benefit food security in the country. Due to the increasing importance of the potato crop, a number of initiatives to improve performance in the potato sub-sector are now in place. Several international donor projects and local and international NGOs are working in cooperation with CIP and Kenyan institutions like KARI and NPCK on the different challenges arising along the value chain.

It is intended that the findings of this study on post-harvest losses of potato will also contribute to the development of the sub-sector and, in particular, will serve to support the Kenyan Government in its efforts to improve the development of the potato value chain.

Although the study focuses on post-harvest losses, the results indicate that a very high level of loss-causing factors occur at the production level, because potato production practices in Kenya remain suboptimal. The problems identified as occurring on farms require capacity building and investment in order to change production patterns and improve harvesting techniques and on-farm infrastructure.

Therefore, to make significant change happen, market signals involving better prices for better quality[27] are required to stimulate farmers' interest in better production results. A starting point for improvements could be the introduction of standardised bags, allowing better handling and the fair payment of farmers. A further market signal could come from contract farming, which helps farmers to exit the vicious circle of insecure markets and exploitation through extended bags. As the case of the contract farmers in Nyandarua shows, capacity building of farmers – especially with the support of extension services – is key for delivering on-farm improvements.

Below, the challenges to and options for improving the performance of the ware potato sub-sector along its value chain are outlined and serve to contribute towards the development of the sub-sector. As outlined in the World Resource Institute's working paper (Lipinski et al. 2013), it is important to note that technical solutions, for example, can only be effective when deployed in close coordination with other parts of the value chain. For example, improved on-farm storage will not ultimately lead to reductions in food loss if market prices do not provide profit gains from storage. Therefore, progress in reducing food loss and waste will require an integrated value-chain approach.

4.2.1 Seed improvements

New varieties and rapid multiplication

Seed potato research is dominated by KARI-Tigoni (National Potato Research Centre) and supported by the International Potato Center (CIP). Along with being the main bodies involved in potato research in the country, these two organisations constitute the major sources of breeding materials and pre-basic seed potatoes. Until 2008, the only source of mini-tubers in Kenya was a conventional soil-based production system at KARI-Tigoni. In 2008, aeroponics technology for mini-tuber production was introduced in order to speed up the distribution of newly released varieties to farmers.

Due to Kenya's very strict quarantine regulations, importing high-quality seed potatoes has been difficult and, over the past 30 years, no certified seed potatoes have been imported. However, after a long period during which Kenya barred seed imports, the Kenyan Ministry of Agriculture, Livestock and Fisheries has begun cooperating with the Dutch Government and private companies on a fast-track system for the rapid multiplication of certified seed. After agreement between the Kenyan and Dutch phytosanitary authorities was reached, Dutch seed potatoes of the Désirée variety (a variety registered in Kenya) were imported.

26 FAO (2009) established cereal and maize equivalents based on the calorie content of selected foods, which indicate that five units of potato can replace one unit of maize.

27 Farmers cited market demand and pricing as important challenges (Table 47 in Annex 2).

The limited availability and use of quality seed potato is a key barrier to increasing productivity in Kenya's potato sector. As such, seed potatoes need to be made available and affordable for small-scale growers. A survey conducted as part of a study on the 'Value of seed potatoes from four systems in Kenya' (Kaguongo et al. 2014) showed that farmers were aware of the importance of using high-quality seed and were willing to pay higher prices for quality. On average, farmers were willing to pay 190 per cent of the price of farmer seed for certified seed and 170 per cent of the price of farmer seed for clean seed. This indicates that farmers recognise the importance of good quality seed in potato production and are willing to pay a premium price for quality.

Improved distribution network

The major weakness in seed potato production is the absence of a distribution system for certified seed output. Farmers wishing to buy seed potatoes must travel to, for example, KARI centres, which are sometimes located more than 200 km away. Improving the seed potato distribution network is therefore of the utmost importance if more farmers are to have access to certified seed.

4.2.2 Improved production and harvesting technologies

Improved soil fertility, soil analysis and crop husbandry

Soil fertility is one of the major problems for potato farming in Kenya. The poor yields that farmers achieve are directly linked to the poor state of their soils and a lack of crop rotation. Although interviewed farmers reported that they carry out crop rotation, the frequency of their rotations is low. According to CIP (Kaguongo et al. 2008), 21 per cent of farmers indicate that they grow potatoes in the same plot continuously, with another 24 per cent indicating that they grow potatoes in the same plot in three out of every four seasons. Only 55 per cent of farmers practice some form of regular rotation, with at least two out of every four seasons being given over to crops other than potato.

Fertiliser use in Kenya is low compared to the recommended rates of application, which results in the rapid decline of soil fertility. The biggest complaint farmers make is about increasing input costs and this factor results in the limited use of agro-inputs. About 38 per cent of farmers in Kenya stated that the costs of fertiliser, fungicide and employee wages have been rising and that this affects their incomes. Consequently, the lack of funds to buy inputs was reported as the second most important problem affecting potato production in Kenya (Kaguongo et al. 2008). In short, plant diseases and access to inputs and seed are the major challenges farmers face in their production activities (Table 32 in Annex 2).

The situation is further aggravated by the fact that remnant tubers remain in the soil after harvest and produce volunteer plants in the next crop. Farmers reported up to 304 kg/ha remain in the field and these allow diseases to carry over from one season to the next.

KARI[28] performed a cost-benefit analysis on different seed types under current and target conditions which showed that, although yields from certified seeds were the highest (12.7 tonnes/ha), they still fell well short of the expected yields of 25 tonnes/ha envisaged by KARI-Tigoni. Although seed quality is important in determining yields, other factors like management practices, disease prevalence and control methods play equally important roles.

Therefore, both small-scale and larger-scale farmers should be supported in developing good agricultural practices to improve soil fertility, seed quality, fertilising and spraying. At present, NPCK and CIP are working on guidelines for good agricultural practices (GAP) in the potato sub-sector in cooperation with Kenya-GAP, a GLOBALGAP-benchmarked GAP initiative in Kenya for fruit, vegetables and flowers (Muthoni et al. 2013).

28 Kenya GAP is a trademark is registered to the Fresh Produce Exporters Association of Kenya (FPEAK). Kenya GAP is a quality assurance scheme based on: the principles of good agricultural practice, hazard analysis critical control point principles for food handling and marketing, local regulations, and ILO conventions ratified by the Government of Kenya.

Adequate harvesting tools
The level of mechanisation on medium-size and large-scale farms is medium to low and machinery is often fairly old. On smallholdings, most work is performed manually, which results in significant damage to and losses of potatoes. As the survey shows, damage caused by casual labour and harvesting tools like the *fork jembe* equals 7.3 per cent of on-farm losses.

An ongoing challenge for reducing damage is the presence of farms that are too small for mechanisation. Therefore, the size of machinery supplied for potato production in Kenya should be tailored to local needs and take into account the workforce involved in harvesting. Smallholders should also group together to share equipment and thereby generate economies of scale.

4.2.3 Improved post-harvest handling

Traditional storage alternatives
A major challenge in improving the on- and off-farm use of storage and storage technology is the improvement of seed and ware potato varieties and quality. Diffused light stores (DLS) and improved traditional stores (with charcoal-coated walls) have proved to be useful low-cost storage alternatives, in particular for storing seed potatoes. However, neither of these storage technologies is widely used in Kenya because the provision of information and training on these technologies is limited. A further aspect limiting the use of and investment in storage is the current preference for growing Shangi potatoes, which are not suitable for storage.

KARI recently conducted an on-farm storage trial in Nyandarua County using seed tubers of eight officially recognised Kenyan potato varieties as well as farmers' preferred variety, Shangi. The seeds were stored for up to eight months under DLS conditions in low-cost structures to test the feasibility of prolonged seed storage on farms.

The results of this study have shown that it is feasible to store healthy seed tubers of currently available potato varieties in Kenya on farms and at low cost. Varieties selected for long-term storage should have a long dormancy and be in high demand, either for the market (such as the Kenya Mpya) or for processing (such as the Dutch Robjin or Désirée). The unofficial variety, Shangi, which is the most popular on the market, showed poor levels of storability but could be planted two to three months after harvest. That said, KARI still favours the Shangi variety due to its short dormancy periods. According to KARI, the variety Shangi should be officially recognised as a quick sprouting variety, which is a good characteristic for complementing on-farm storage and mitigating climate change.

Cold storage for seed potatoes
According to the Dutch study 'Value chain of seed and ware potatoes in Kenya' (Janssens et al. 2013), modern cooled storage facilities should have a minimum capacity of 100 tonnes, given that costs decrease the more storage capacity is increased. The costs of storing seed potato long term are calculated to be EUR 0.33 per kg in a 100-tonne store and drop to EUR 0.13 per kg in a 400-tonne store. Investments required per tonne are rather high for storage capacities of 400 tonnes or less. Thus, small cold storage facilities are relatively expensive and will substantially raise seed prices. Consequently, professional modern storage is more attractive for farmers, farmer groups or processors who store big quantities.

Improved packaging
Sorting and grading of potatoes is not performed in earnest because the fresh produce market currently fails to reward good quality. The market offers no price incentives for quality potatoes – potatoes are traded on a per-bag basis with no price differential for mature, large tubers. Farmers are, therefore, not motivated to grade potatoes or to pack well-matured potatoes.

The Kenyan Government attempted to improve packaging in 2005 and again in 2008. Legal Notice No 113 of 2008 and No 44 of 2005 specified that potato must be marketed in a standard 110 kg bag. However, the implementation of this law did not effect real change as it was not properly enforced. Recently, the Government, NPCK and counties have kick-started a new initiative to introduce a maximum 50 kg bag in line with the requirements of the International Labour Organisation (ILO).

A study conducted by KARI in 2009/2010 (Kasina & Ndritu 2010) analysing the low levels of adoption of the 2008 Legal Notice showed that 92 per cent of interviewed traders were aware of the new potato packaging regulations, though only 16 per cent implemented them. Lack of enforcement and the absence of additional benefits/incentives are the main reasons traders fail to comply with the regulation. Traders reported good profits from trading with extended-size bags (with 53 per cent gains) compared with standard bags (with 44 per cent gains). The key challenge for implementing the regulations is market competition (24 per cent), since demand for extended bags among retailers remains high. The reason extended bags are popular is that using a fixed bag size and weight results in sales being charged according to weight. The advantage of using extended bags is, conversely, the vague definition of bag sizes that can be used to exploit farmers. Damage/losses are costed in and mean lower prices for traders. Therefore, traders offering standard-size bags fear losing out to competitors offering extended ones. Among the farmers interviewed, 97 per cent were aware of the new regulations but competition (63 per cent) and the lack of enforcement by Government agencies (27 per cent) were cited as barriers to implementation.

As the survey shows, extended bags have a severe impact on the quality of produce marketed. The fact that payments for large volumes are inadequate encourages farmers (and brokers) to pack all potato stocks regardless of their quality. Furthermore, the packaging material and difficulty in handling the large bags cause additional losses. An agreement on smaller bag sizes would be a first step towards better quality and would send an important market signal to farmers.

To ensure the law is enforced, any process to improve packaging should involve brokers, local traders, wholesalers, retailers and local authorities so that the resulting agreement is supported by all actors along the value chain.[29] In general, standards should be established for general measurement according to weight.

29 Extended bags are also commonly used for other commodities. Therefore, legal notices should not be limited to potatoes.

Market infrastructure

The major markets for potatoes are in large urban areas like Nairobi, Mombasa, Nakuru and Kisumu. The Wakulima Market in Nairobi is the largest terminal market handling over 50 per cent of all potatoes traded in urban markets. However, the 2.4-hectare market can no longer cope with supply and demand. This situation has resulted in high levels of congestion and market activities spilling over into surrounding areas where conditions are very unhygienic. The physical improvement of Nairobi Market is decades overdue but the efforts of the international donor community to convince the Government and Nairobi City Council to set up a new wholesale market outside the city centre have so far failed. The same applies for other marketplaces in the country and only a few market sites have been refurbished in recent years.

Improving the marketing system, and in particular market infrastructure, would help to reduce losses as it is reasonable to assume that modern infrastructure would also have an impact on quality awareness.

4.2.4 Improved conditions for the processing industry

Varieties

Kenya has an expanding food processing industry, driven by its growing urban population, changing population structure, new eating habits and increased tourism. The industry requires potato varieties with better processing qualities (for example, Dutch Robjin, which is suitable for crisps) to replace the traditional varieties that are susceptible to bacterial and viral diseases. Processors are calling for suitable varieties that meet their needs for better-quality raw material for processing. There is a need for a concerted effort from all stakeholders to introduce new processing varieties in the country in order to improve the competitiveness of the industry.

Furthermore, processors should be supported in developing stable business relationships with farmers to ensure the provision of suitable varieties, appropriate sorting and constant supply. The production of properly sorted suitable varieties would, in particular, have a notable impact on reducing losses and, hence, on the competitiveness of the industry.

Contract farming

Contract farming is already a well-known arrangement in Kenya. However, problems are arising in the cooperations between the potato processing industry and ware potato farmers. Farmers surveyed in Nyandarua had had their contract with the processing industry terminated because of issues arising from the strict sorting standards and they ended up selling the bulk of their stock to local traders. Processors cooperating with farmers in Bomet encountered problems with side-selling and also terminated their agreement. Conversely, farmers complain about the high price or low quality of supplied inputs. The potato processing industry is still in its infancy and this is also true of the partnerships being developed between potato farmers and the industry.

Contract farming is a business model for the interface between farm supply and industrial procurement, linking the buyer's strategy with the suppliers' farming systems. It can be an appropriate tool for promoting inclusive business models, giving small-scale farmers an opportunity to join in the venture, an equal voice in contract negotiations, a fair reward and a reasonable approach to risk sharing.

Contract farming is primarily characterised by the interdependency of the contracting parties and the risks involved should the contract farming arrangement not be appropriate for ensuring either partner fulfils their obligations. Default risks are high on both sides and are frequently reasons for failure, as outlined above. Therefore, sound planning, appropriate skills and adequate approaches are key to the success and sustainability of contract farming schemes. With its recently published Contract Farming Handbook (Will 2013), GIZ provides practical guidance to practitioners on the business model required to deliver innovation at the interface between farm supply and firm procurement. A train-the-trainer curriculum has been developed and a first round of courses has been delivered in Zimbabwe, Kenya and Thailand. In addition, projects in Eastern and Western Africa are currently adapting the training course to meet the needs of different target groups (e.g., Farmer Business Schools). Teams of local and international business advisors are available for assisting companies and farmers to set up contract farming schemes using GIZ's business model approach.

4.2.5 Capacity building and agricultural finance

Human capacity development

The level of education of farmers, number of extension visits and access to credit are significant variables for improving the level of economic efficiency in potato production. It is, therefore, necessary to expand farmer training in improved agronomic and management practices, with the support of extension services. Priority should be given to innovative approaches that enhance extension and farmer training, such as: (i) the use of group approaches; (ii) farmer-led extension, such as farmer field schools with demonstration plots and on-farm trials; and (iii) the provision of communications technology (ICT) to support agricultural extension (Nyagaka 2009).

In addition to farmers, traders are also in need of comprehensive training to improve the capacity of those involved in post-harvest handling and storage, and in processing and marketing. Training should also be provided to operators in the wholesale and retail markets on how to improve product handling and storage and thereby maintain quality and reduce physical losses.

Agricultural finance

A major problem also seen as affecting the financial situation of farmers is that of achieving economies of scale. When operating small potato plots of 0.2 to 0.6 hectares, it is difficult for an individual smallholder to earn enough income to cover the costs of the required inputs. The banking system in Kenya is well capitalised and is known to work well, even in rural areas. Access to short-term credit for input supply or working capital has improved and is increasingly being used. Yet, reaching the majority of smallholders needing to invest in their agriculture remains a challenge.

Given that enhanced access to credit will contribute to productivity gains, innovative ways need to be devised to ensure farmers can access credit at a reasonable cost. Contract farming can also play a role in opening up access to finance and achieving economies of scale – for instance, the economies of scale that a contractor (a large farm or processor) can achieve will cut the cost of inputs and transportation. Furthermore, the contract can be used as guarantee for the banks, resulting in a tripartite agreement between the bank, processor and farmer.

4.3 List of important actors in the potato sub-sector

The following table provides an overview of relevant actors in the potato sub-sector who may be able to contribute to minimising losses in potato production and marketing.

Table 25: Relevant institutions and actors along the potato value chain[30]

Actors	Name	Role
Government	Ministry of Agriculture, Livestock and Fisheries (MoALF), State Department of Agriculture	The Ministry is aiming to revitalise the Kenyan potato sector and is responsible for implementing the Agricultural Sector Development Strategy 2010-2020, the National Root and Tuber Crops Policy (2010), the Seed Potato Strategy (2009) and the Seed Potato Sub-sector Master Plan 2009-2014, as well as legal notices addressing the packaging of seed and ware potatoes.
	Extension services	In 2012, the Government published the National Agricultural Sector Extension Policy to improve the extension system.[31] Extension services are mainly provided by the public sector (central and local governments, research and training institutions) and private and civil society sector operators (companies, NGOs, cooperatives and community-based organisations).
Research/ institutions	Kenyan Agricultural Research Institute (KARI)	This national institution brings together research programmes in various fields. Seed potato research is dominated by KARI-Tigoni (National Potato Research Centre) and supported by the International Potato Center (CIP). Along with being the main bodies involved in potato research in the country, these two organisations constitute the major sources of breeding materials and pre-basic seed potatoes.

30 Main sources: MoALF 2010 and Kaguongo 2013.

31 Government of Kenya, Agricultural Sector Coordination Unit (ASCU), National Agricultural Sector Extension Policy (NASEP), June 2012.

Actors	Name	Role
	Kenya Plant Health Inspectorate Service (KEPHIS)	KEPHIS is the regulatory agency for the quality assurance of agricultural inputs and produce in Kenya. It undertakes plant variety protection, seed certification, phytosanitary inspection of imports and exports, and analysis of soil, water, agricultural produce, fertilisers and pesticides. KEPHIS is a government institution with the mandate for both quarantine issues and seed certification. KEPHIS is also responsible for providing import permits for seed potatoes and performing import inspections.
	Kenya Industrial Research and Development Institute (KIRDI).	The processing value chain is regulated by KIRDI. It is a national research institute under the Ministry of Trade and Industry and is mandated to undertake multidisciplinary research and development in industrial and allied technologies. The mandate includes reducing post-harvest food losses through development, adoption, adaptation and transfer of appropriate food processing and storage technologies. Specific activities or projects related to the potato processing industry are not known.
	The National Potato Council of Kenya (NPCK)	NPCK was formed as a result of the transformation of the potato value chain development committee, which had been formed through GIZ-PSDA and MoALF initiatives. The NPCK was registered in August 2010 and was launched on 25th November 2010 by the Permanent Secretary of the Ministry of Agriculture. NPCK provides coordination, linkages and information support for the various actors and operators in the potato industry.
	International Potato Center (CIP)	CIP is headquartered in Peru and has a regional office in Nairobi. CIP is an international research institute that is part of the Consultative Group on International Agricultural Research (CGIAR). It is responsible for global potato germ plasm and develops and disseminates new and improved clones, varieties and technologies aimed at improving yields, nutrition and market access. Over the years, CIP has provided technological backstopping to the seed potato industry in the country.
Farmers' organisations	Kenyan National Federation of Agricultural Producers (KENFAP)	KENFAP is the umbrella body of farmers in the country, bringing together 60 farmers' associations at the county level, 36 national commodity-based associations, 16 cooperatives and close to 8,000 farmers' groups. Since the federation started focusing on group-based institutional members, the membership has grown to include commodity associations such as the Kenyan National Potato Farmers Association. KENFAP partnered MoALF in implementing the legal notice on standard bags in 2005 and developed a bag specifically for handling potatoes.

Actors	Name	Role
	Kenya National Potato Farmers Association (KENAPOFA)	KENOPOFA operates under the umbrella of KENFAP and is also engaged in implementing standard bags. KENAPOFA officials are now also recognised as enforcement officers. The association was founded in 2003 and has a membership of 10,400 farmers who grow 3,350 hectares of potato. KENAPOFA's offices are located within KARI-NARL and it employs a coordinator under the supervision of the NPCK.
Large-scale farms involved in seed production	Agricultural Development Corporation (ADC)	As a provider of quality seed to Kenyan farmers, the parastatal institution ADC is a main seed grower in Kenya. ADC currently has around 80 ha under certified seed potatoes, but this area is projected to increase to almost 300 ha. The corporation's long-term goal is to cultivate 1,200 ha of certified seed potatoes. ADC is in the process of building up its capacity for basic seed production by installing greenhouses and aeroponics units. ADC's major weakness is its lack of a distribution system for the certified seeds it produces – farmers seeking their seed potatoes must travel to Molo.
	Midlands	Midlands is a private company with farmers owning shares and is registered to produce certified seed.
	Kisima Farm	Kisima Farm is a farmer-owned company specialising in horticulture (flowers) and arable farming (1,300 ha), and is registered to produce seed potato (100 ha). As a leading certified seed producer, Kisima Farm has supported over 40,000 smallholders with clean seed material. The farm produces 2,700 tonnes of certified clean seeds with its aeroponics system.
Processing sindustry	DEEPA Industries Ltd	This processor has an 80% market share of potato crisp production and uses contract farming approaches to work with ware potato growers in Bomet county.
	NORDA	NORDA is a smaller-scale but high-quality potato crisp manufacturer. The crisp processing line has a capacity of 15 tonnes of fresh potato per week. Norda exclusively sources the Dutch Robjin variety, mainly from Bomet County, but also from Narok and Meru Counties (which operate irrigation systems).
	Njoro Canning	Njoro Canning contracts farmers to produce and supply potatoes. It processes and stores frozen fast food in its storage depots located in Njoro, Nairobi and Mombasa.
	MIDLANDS Processing Co. Ltd	MIDLANDS Processing Co. Ltd has contracted with up to 10,000 farmers in Nyandarua County. It has a processing capacity of 50 tonnes per hour. The company has contracted farmers to produce potatoes and other horticultural produce. It is the only company that produces and processes potatoes, offering fresh, pre-cooked, frozen and blanched potatoes.

Annex

Annex 1. Surveys details and methodology

Table 26: Surveys by county

County	Sub-county	Ward/ location	Sub-location	Village	Number of farmers	Sample size
BOMET	**Bomet Central**	Township	Kapsimotwo	Kapsimotwo	4	
			Kipkoi	Kipkoi	4	
			Chesoen	Chesoen	4	
			Chepngaina	Kecheyat	4	
		Singorwet	Singorwet	Singorwet	4	
				Chuiyat	4	
				Chambor	4	
				Matumbru	4	
			Aisaik	Aisaik	4	
	Bomet East	Merigi	Merigi	Kaptemo	4	
			Merigi	Merigi	4	
		Chemaner	Chemaner	Chemaner	4	
			Chambori	Chambori	4	
Total	**2**	**4**		**13**		**52**

County	Sub-county	Ward/ location	Sub-location	Village	Number of farmers	Sample size
MERU	**Buri**	Kibiricha	Kibiricha	Kiriko	4	
			Mugae	Mugae	4	
			Karanene	Karanene	4	
		Timau	Ngushishi	Ngushishi	4	
			Mijogene	Lucerne	4	
			Kisima	Muroone	4	
		Kirua/Nari	Njotene	Njotene	4	
			Muruguma	Muruguma	4	
			Kironya	Kironya	4	
	Meru Central	**Marathi**	Marathi	Marathi	4	
			Mwereru	Mwereru A	4	
				Mwereru B	4	
County total	**2**	**4**	**12**	**13**	**53**	**53**

County	Sub-county	Ward/ location	Sub-location	Village	Number of farmers	Sample size
NAKURU	**Kuresoi**	Kuresoi	Kuresoi	Tegat	4	
				Kipsonoi	4	
				Temyota 2	4	
				Temyota 3	4	
		Kerenget	Keriget	Jagoror	4	
				Chepitoik	4	
	Njoro	Mau Narok	Njoro	Likia	3	
				Mathangauta	4	
				Gatimu	3	
		Mauche	Mauche	Mwishowalami	3	
				Mau	4	
	Molo	Molo	Molo	Molo	4	
				Tayari	4	
				Turi	4	
				Kiambiriria	4	
				Chandera	4	
				Milimatatu	4	
Total	**3**	**5**	**5**	**18**	**69**	**69**

County	Sub-county	Ward/ location	Sub-location	Village	Number of farmers	Sample size
NYANDARUA	**Kinangop**	Njabini	Njabini	Kiburu	4	
				Kiandege	4	
				Njabini	4	
				Mutonyora	4	
				Bamboo	4	
				Mutura	4	
	Mirangine	Tumaini	Tumaini	Karungu	4	
				Sabugo	4	
			Mirangine	Mirangine	4	
				Mathakwa	4	
				Kihoto	4	
				Maritati	4	
	Nyandarua North	Shamata	Shamata	Pesi	4	
				Shamata	4	
				Karandi	4	
	Ol Kalou	Ol Kalou	Gaswe	Gaswe-Mamugp	13	
Total	**4**	**4**	**5**	**15**	**73**	**73**

Table 27: Study methodology following the FAO's five-stage approach

1. Screening of food losses including rapid appraisal	2. Survey on food loss assessment
• Review of secondary data (sources: NPCK, PSDA, FAO, etc.) • Key-informant interviews as an input to prepare the study: KARI, market actors, etc. • Selection of marketing channels and definition of the regions • Rapid appraisal in the selected regions • Characterisation of food losses in selected value chains defining critical loss points • Planning the survey (questionnaires, interview guidelines, etc.) and the sampling methods	**a. Training enumerators** • recruitment • preparation and purchase of training materials • training arrangements • training • pre-testing **b. Survey implementation** • supervision: daily review and verification of collected data • data collection • mobility • tools • communication • handling of questionnaires **c. Key-informant interviews**
3. Load-tracking assessment	**4. Data analysis, verification and reporting**
• Evaluation of collected information, decision on necessary surveys/trials to get more information on specific problems • Setting the objective of surveys, e.g. based on critical loss points such as extended bags • Choosing the load/location and defining the unit of measurement • Surveying–tracking–replication • Analysis and findings on causes	• Evaluation of collected information, decision on necessary surveys/trials to get more information on specific problems • Setting the objective of surveys, e.g. based on critical loss points such as extended bags • Choosing the load/location and defining the unit of measurement • Surveying–tracking–replication • Analysis and findings on causes
5. Synthesis: recommendations and solution finding	
• Importance of causes • Investment options to reduce losses • Impact and feasibility of solutions/cost-benefit analysis • Final report	

Annex 2: Further survey data

Socio-economic data of farmers and traders

Table 28: Characteristics of potato farmers

	Meru n=53	Bomet n=52	Nakuru n=69	Nyandarua n=73	All n=247
Gender of respondent (%)					
Male	71.7	82.7	59.4	64.4	68.4
Female	28.3	17.3	40.6	35.6	31.6
Age of respondent in years	53.3	41.4	42.6	47.7	46.1
Family size of respondent (persons)	5.12	5.9	5.84	4.72	5.37
Level of education (%)					
Primary and below	49	26.9	50.7	42.5	43
Secondary	47.2	51.9	31.9	46.6	43.7
College	3.8	21.2	17.4	11.0	13.3

Table 29: Farmers' education levels by gender (%)

	Male n=169	Female n=78	All n=247
Illiterate	2.4	10.3	4.9
Primary	34.3	46.2	38.1
Secondary	47.9	34.6	43.7
Post-secondary	15.4	9.0	13.4

Table 30: Characteristics of potato traders

	Retailer n=27	Wholesaler n=27	Both roles n=9	All n=63
Gender of respondent (%)				
Male	29.6	77.8	77.8	57.1
Female	70.4	22.2	22.2	42.9
Age of respondent	40	38	35	38
Number of years in potato business	8	10	6	9
Level of education (%)				
Primary and below	33.3	33.3	33.3	33.3
Secondary	40.7	37.0	33.3	38.1
College and A-level	22.2	39.6	22.2	25.4
No education	3.7	0	11.1	3.2

Table 31: Traders' educational levels by gender (%)

	Male n=36	Female n=27	All n=63
Illiterate	2.8	3.7	3.2
Primary	30.6	37.0	33.3
Secondary	33.3	44.4	38.1
Post-secondary	33.1	14.8	25.4

Survey data: production, harvest and post-harvest

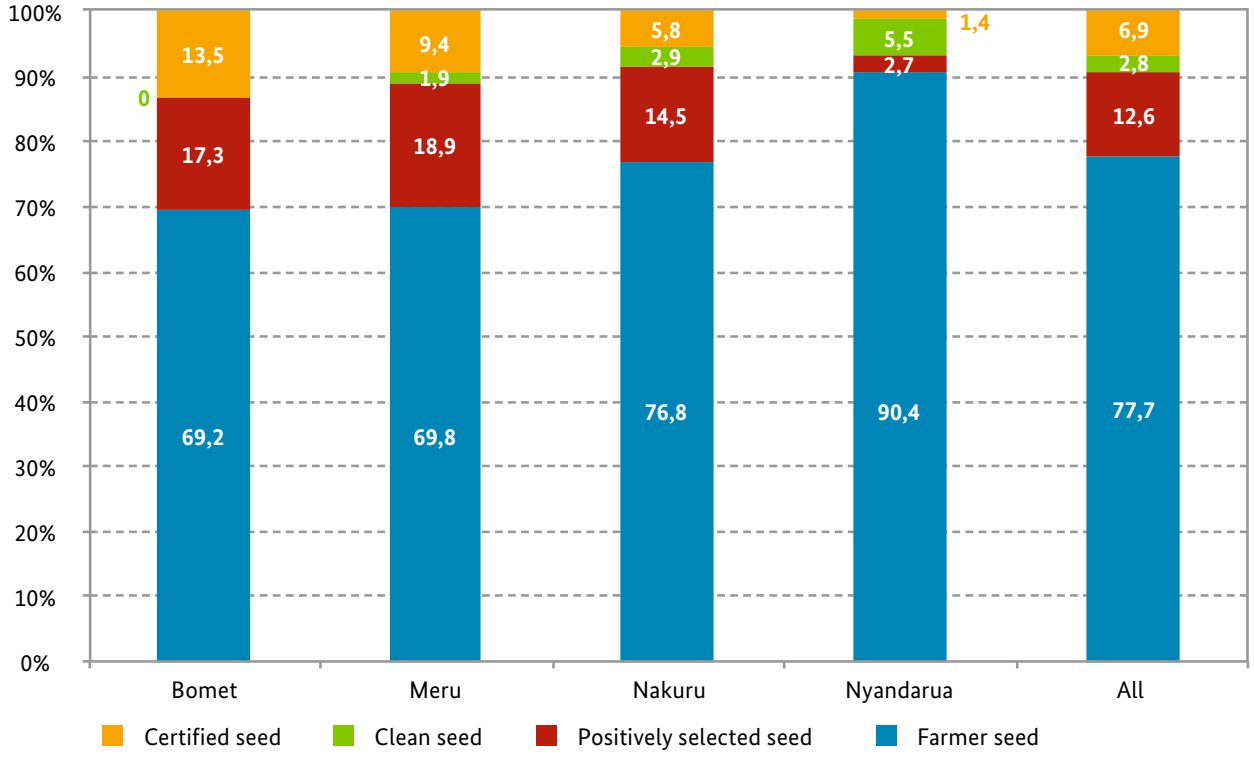
Table 32: Main challenges farmers face in potato production as a % (multiple choice)

Rank	Challenges	All n=247	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73
1	Prices	98.4	98.1	96.2	100.0	98.6
2	Diseases	97.2	96.2	98.1	95.7	98.6
3	Market demand	91.5	88.5	81.1	94.2	98.6
4	Inputs	89.5	82.7	83.0	88.4	100.0
5	Seeds	87.4	84.6	77.4	87.0	97.3
6	Storage	79.4	67.3	67.9	78.3	97.3
7	Mechanisation	70.9	82.7	20.8	88.4	82.2
8	Irrigation	60.7	50.0	56.6	58.0	74.0
9	Losses	59.9	53.8	30.2	68.1	78.1
10	Others	27.5	36.5	0	31.9	37.0

Table 33: Potato seed used by farmers

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Main source of seed (%)					
Own harvest	42	42.3	76.5	93.2	67.1
Neighbours	48	23.1	26.5	9.6	25.1
Shop/local market	0	36.5	1.5	1.4	8.6
Clean/positively selected producers	12	0	2.9	5.4	4.9
Certified seed producers	30	30.8	13.2	5.5	18.1

Graph 3: Types of seed used by farmers, as a %



Graph 4: Number of seasons after which farmers renew seed, as a %

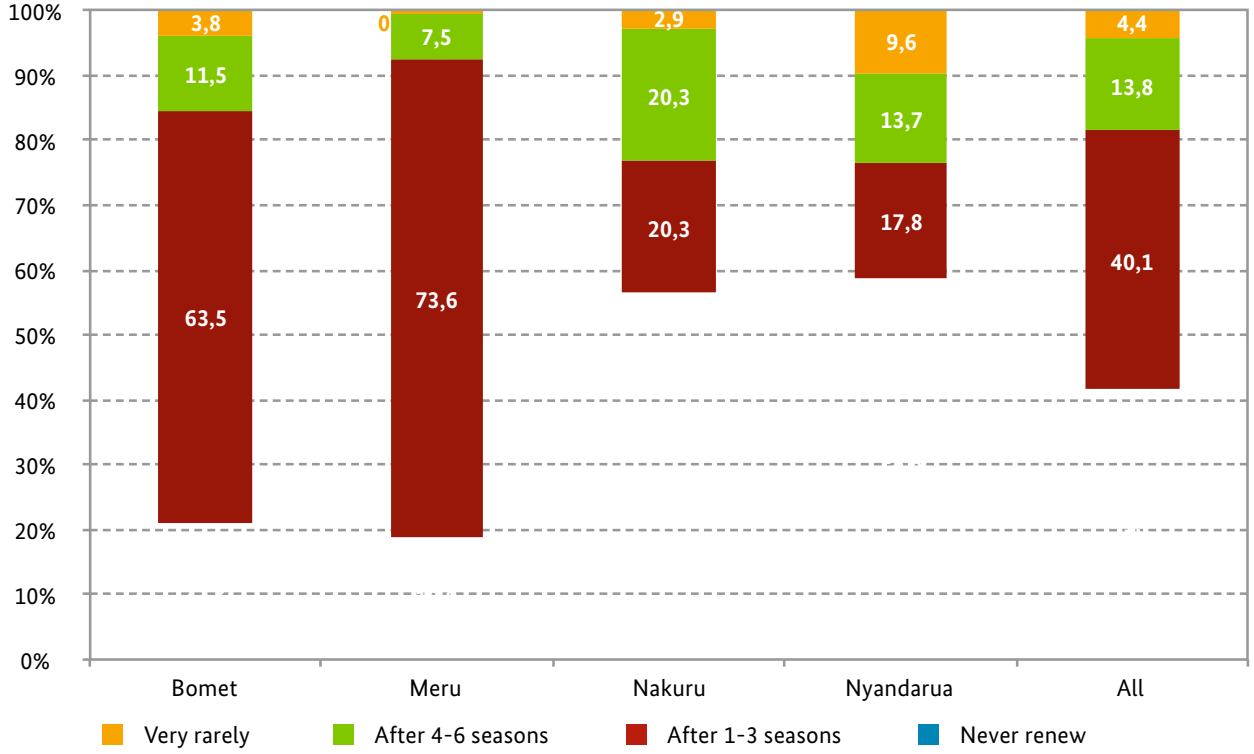


Table 34: Seasons for potato planting and harvesting expressed – relevance as a %

Planting months						Harvesting months				
	Meru	Nyandarua	Nakuru	Bomet	Total	Meru	Nyandarua	Nakuru	Bomet	Total
January	3.8	37	20.6	21.2	22.0	32.1	15.1	19.1	15.4	19.9
February	26.4	28.8	26.5	13.5	24.4	34.0	8.2	10.3	21.2	17.1
March	28.3	19.2	29.4	7.7	21.5	11.3	8.2	5.9	15.4	9.8
April	15.1	37	22.1	9.6	22.4	9.4	26.0	17.6	21.2	19.1
May	26.4	13.7	20.6	28.8	21.5	3.8	11.0	10.3	7.7	8.5
June	1.9	4.1	20.6	21.2	11.8	17.0	21.9	27.9	11.5	20.3
July	3.8	11	23.5	19.2	14.6	17.0	19.2	27.9	9.6	19.1
August	1.9	42.5	25	13.5	22.8	35.8	43.8	26.5	13.5	30.9
September	47.2	30.1	25	23.1	30.9	17.0	6.8	16.2	28.8	16.3
October	15.1	6.8	5.9	17.3	10.6	3.8	8.2	16.2	23.1	12.6
November	5.7	4.1	16.2	19.2	11	0.0	13.7	17.6	15.4	12.2
December	13.2	1.4	2.9	13.5	6.9	5.7	52.1	38.2	26.9	32.9

Table 35: Potato pre-harvesting practices

	Bomet n=52	**Meru n=53**	**Nakuru n=69**	**Nyandarua n=73**	**All n=247**
Pre-harvest practices					
Farmers who prepare potatoes before harvesting (%)	98.1	92.5	94.2	93.2	94.3
How farmers prepare potatoes for harvesting (%)					
Dehaulming	86.3	56.3	52.3	22.4	51.9
Leave shoots to dry	13.7	43.8	47.7	77.6	48.1

Table 36: Potato harvesting practices - time and protection from sunlight

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Time of day for harvesting (%)					
Morning	96.2	5.9	60.9	50.7	53.9
Afternoon	0	2.0	1.4	0	0.8
Morning and afternoon	3.8	92.2	37.7	49.3	45.3
Farmers protecting harvested potatoes from sunlight (%)	94.2	84.9	87	93.2	89.9
How potatoes are protected from sunlight (%)	n=50	n=44	n=60	n=68	n=222
Covered on the ground	24	55.6	33.3	35.3	36.3
Placed under shade	22	6.7	8.3	5.9	10.3
Bagged	36	37.8	35	23.5	32.3
Move to the store	18	0	23.3	35.3	21.1

Table 37: Potato harvesting practices - second gathering and handling of leftovers

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Second round of gathering					
Farmers conducting second round of potato gathering (%)	98.1	81.1	67.6	59.5	96.7
Quantity of potatoes gathered	96.2	5.9	60.9	50.7	53.9
In second round (kg/ha)	3,8457.5	2,267.5	4,2112.5	2,013	3,132
Farms left with potatoes after second gathering (%)	98.0	92.5	100	95.8	96.7
Quantity remaining in field after second gathering (kg)	553.3	1,000.4	724.2	403.1	650.1
What farmers do with leftovers (%)					
Allow them to grow for home use	74.5	55.1	48.5	40.6	53.2
Uproot	21.6	30.6	36.8	42	33.8
Others	3.9	14.3	14.7	17.4	14.0

Table 38: Potato harvesting practices - tools and labour

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Harvesting tools (%)					
Fork jembe	1.9	56.6	42.0	97.2	52.8
Oxen	92.3	1.9	11.6	0	23.2
Hoe	1.9	0	31.9	1.4	9.8
Sticks	0	41.5	0	0	8.9
Hands	3.8	0	13.0	1.4	4.9
Panga	0	0	1.4	0	0.4
Harvesting labour (%)					
Family	21.2	7.5	11.6	9.6	12.1
Casual	73.1	86.8	88.4	90.4	85.4
Others (oxen, etc.)	5.7	5.7	0	0	2.5

Small-scale potato producers still do most of their work manually

Table 39: Losses experienced on farms

		Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Farmers harvesting potatoes in the rain (%)		22.6	19.2	59.4	34.2	36.0
Damage caused by harvesting in the rain (kg/ha)		185.1	179.9	633.6	261.5	344.2
Farmers experiencing potato damage from harvesting tools (%)		84.6	94.3	94.2	97.3	93.1
Damage from harvesting tools (kg/ha)						
Hands	n=8	0.0	0.0	1,120.4	0.0	1,120.4
Sticks	n=19	0.0	77.7	0.0	0.0	77.7
Hoe	n=21	335.9	0.0	860.5	503.9	819.1
Oxen/ donkey plough	n=51	512.8	168.0	719.3	0.0	519.7
Fork jembe	n=127	503.9	903.0	735.1	560.2	678.8
Farmers experiencing damage from harvesting labour (%)		**83.0**	**54.0**	**84.1**	**94.5**	**80.8**
Damage caused by labour (kg)						
Casual labour	n=173	455.5	649.1	720.3	577.0	624.4
Family labour	n=23	297.4	336.9	894.1	256.9	444.6
Help from neighbours	n=3	503.9	923.8	0.0	0.0	783.5
Farmers experiencing storage losses (%)		**80.4**	**84.3**	**84.2**	**85.7**	**83.9**
Causes of damage during storage						
Pest and diseases (%)		40.5	10.5	10.4	9.3	16.4
Rotting (%)		59.5	84.2	89.6	90.7	82.5
Others (frosts, rodents, etc.) (%)		32.7	5.7	24.6	50.0	29.7
Losses during storage (kg)		122.8	414.0	105.6	62.6	119.0

Survey data: packaging, transport and marketing

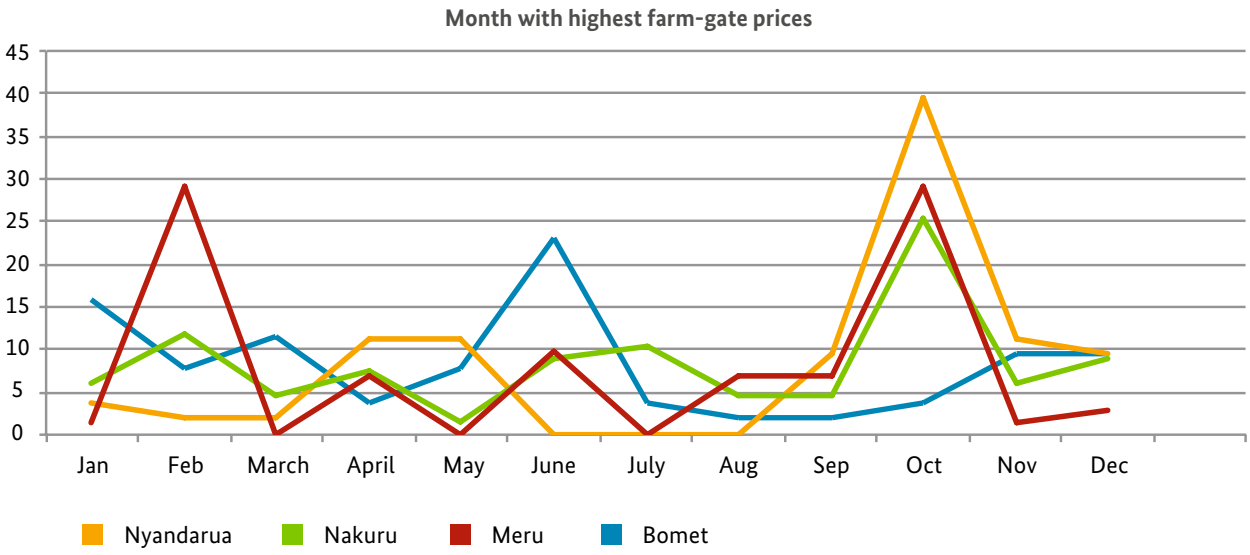
Table 40: Potato marketing practices

	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Farmers who transport potatoes before selling (%)	84.3	64.2	91.3	100	86.6
Where potatoes are transported (%)					
Homestead	46.5	75	24.2	41.1	41.9
Main road	53.5	25	74.2	58.9	57.1
Market	0	0	1.6	1.4	1
Main means of transport (%)					
On back	27.9	51.0	60.3	78.1	57.8
Lorry	7.0	25.5	11.1	1.4	10.4
Handcart	11.6	5.9	1.6	11	7.4
Donkey cart	44.2	5.9	4.8	2.7	11.7
Others (pick-up, tractor, etc.)	9.3	11.7	22.2	6.8	12.7
Packers of bags for selling (%)					
Broker	49.0	88.7	76.8	91.8	78.0
Trader	27.5	7.5	11.6	0.0	10.6
Farmer	19.6	3.8	8.7	4.1	8.5
Workers	3.9		2.9	4.1	2.8
Consumer	3.8		1.4	0.0	1.2
To whom farmer sells potatoes (%)					
Local trader	63.5	96.2	56.5	60.3	67.6
Wholesaler	3.8	15.4	40.6	37.0	26.3
Processor	17.8	0.0	0.0	0.0	4.8

Table 41: Farm-gate potato prices

Sales prices of potatoes in KES/kg	Bomet n=52	Meru n=53	Nakuru n=69	Nyandarua n=73	All n=247
Sales price in October 2013	14.1	14.8	13.1	11.4	13.2
Highest price	24.2	18.5	19.8	15.2	19.1
Lowest price	12.2	10.3	8.8	7.3	9.5

Graph 5: Months with highest and lowest farm-gate prices – relevance of month in %



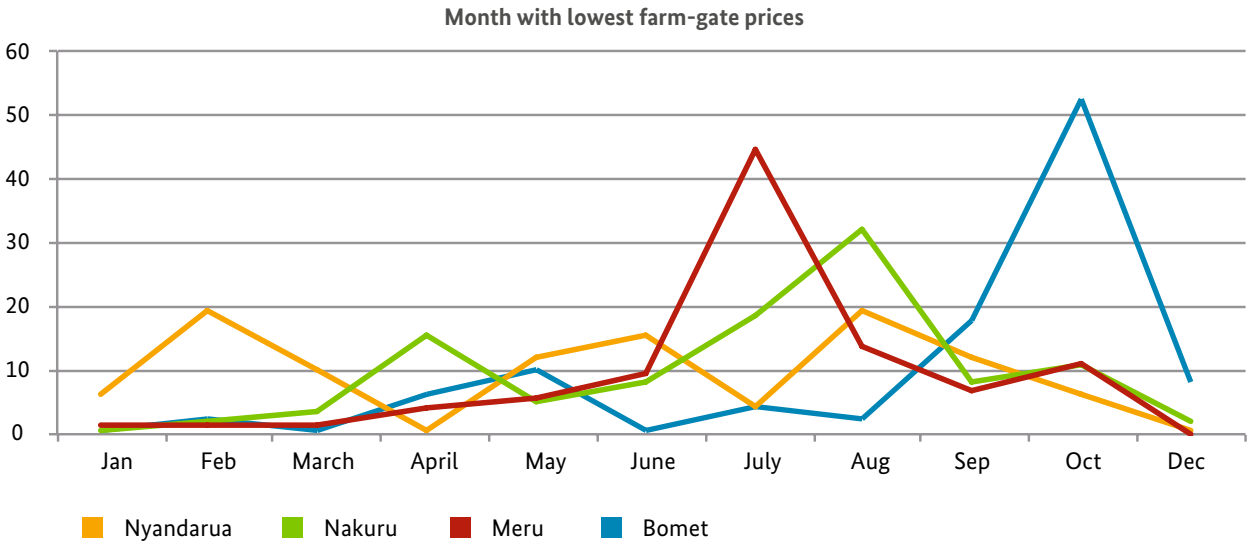


Table 42: Main sourcing and sales markets of traders

	Retailer n=27	Wholesaler n=27	Both roles n=9	All n=63
Most important source of potato (%)				
Nakuru	48.1	25.9	22.2	34.9
Narok	14.8	33.3	66.7	30.2
Nyandarua	22.2	7.4	11.1	14.3
Meru	11.1	18.5	0	12.7
Others (Bomet, Mombasa)	3.7	14.8	0	7.9
Most important sales county (%)				
Nairobi	37.0	51.9	77.4	49.2
Nakuru	22.2	7.4	11.1	14.3
Meru	11.1	18.5	0	12.7
Nyandarua	14.8	7.4	11.1	11.1
Mombasa	14.8	11.1	0	11.1
Bomet	0	3.7	0	1.6
Most important sales market (%)				
Gikomba Nairobi	7.4	7.4	44.4	12.7
Githurai Nairobi	7.4	14.8	11.1	11.1
Wakulima Nairobi	11.1	11.1	11.1	11.1
Kangemi Nairobi	11.1	7.4	11.1	9.5
Kongowea Mombasa	14.8	11.1	0	11.1
Wakulima Nakuru	18.5	7.4	0	11.1

Table 43: Most common bag types bought by traders

Potato bag types bought by traders (%)	Retailer n=27	Wholesaler n=27	Total n=63
Material type of packaged bags			
110 kg bag with flat net or no net 110 kg +	14.8	3.7	11.1
Kata 2 with flat net or no net	11.1	7.4	7.9
110 kg bag with Mukurinu top	14.8	25.9	23.8
Kata 2 and Kamba 2	3.7	14.8	9.5
Kata 2 and Kamba 4	7.4	11.1	7.9
Kata 4 and Kamba 4	11.1	7.4	7.9
110 kg bag and Kamba 11	11.1	3.7	6.3
Average weight of potato bags in kg	175.2	170.5	173.5
Material type of packaged bags			
Sisal or jute bags (%)	18.5	14.8	14.3
Nylon bags (%)	81.5	85.2	85.7

Table 44: Trader-perceived advantages and disadvantages of the main packaging materials

Material type	Material preference (%)	Advantages of material		
Sisal	30.1	Protects tubers (from sunshine)	Long lasting 89.5%	Easily available 26.3%
Jute	8.0	Protects tubers (from sunshine)	Can easily be joined 40.0%	Long lasting 100%
Nylon	92.1	Cheap 98.3%	Easily available 89.7%	Carries a lot of potatoes 79.3%
		Disadvantages of material		
Sisal		Not easily available 57.9%	Expensive 68.4%	Easily affected by water 52.6%
Jute		Cannot carry a lot of tubers 100%	Expensive 80.0%	Easily affected by water 60%
Nylon		Not long lasting 94.8%	Protects tubers (sunshine) 94.8%	Easily affected by water 72.4%

Table 45: Traders' preferences for potato varieties and reasons for these preferences (ranking)

Potato variety	Preferred variety (%)	Reason for preferring the variety				
		Good for mashing (%)	Good for chips (%)	Good taste (%)	Big tuber (%)	Early maturity (%)
Shangi	96.8	68.9	77.0	80.3	-	-
Tigoni	42.4	53.6	39.3	50.0	-	-
Asante	22.2	-	64.3	35.7	35.7	-
Sherekea	17.5	-	72.7	36.4	-	45.5
Dutch Robjin	15.9	40.0	40.0	-	-	50.0
Nyayo	14.3	44.4	66.7	-	44.4	-

Table 46: Current lowest and highest purchase price

Purchase prices of potatoes in KES/kg	Retailer n=27	Wholesaler n=27
Current price (November)	16.5	14.4
Lowest price	13.3	10.8
Highest price	26.6	21.4

Table 47: Causes of loss and suggested improvements (multiple choice)

	Retailer n=27	Wholesaler n=27	Both roles n=9	All n=63
How traders think losses can be reduced in the potato trade (%)				
Better handling methods	23.5	13.6	16.7	17.8
Better harvesting techniques	47.1	40.9	83.3	48.9
Improved packing methods	5.9	13.6	0.0	8.9
Timely delivery	29.4	13.6	0.0	17.8
Better transport	17.6	27.3	33.3	24.4
Kind of improvement needed to improve the quality/quantity of potatoes (%)	n=21	n=26	n=8	n=55
Educating farmers in better farming practices	9.5	26.9	12.5	18.2
Getting farmers to use quality seeds	42.9	30.8	50.0	38.2
Offering farmers subsidies on their inputs	19.0	3.8	12.5	10.9
Getting farmers to use appropriate fertilisers	42.9	11.5	25.0	25.5
Standardised potato pricing	9.5	11.5	12.5	10.9
Putting policies and rules/regulations in place for potato	28.6	42.3	37.5	36.4

Survey data: restaurants

Table 48: Restauranteurs' perceptions of the benefits of different potato varieties as a %

Preferred varieties as a %	Shangi n=19	Tigoni n=9	Asante n=4	Tana n=4
Cooks quickly	10.5	22.2	0.0	25.0
Tastier	84.2	55.6	50.0	25.0
Big tubers	21.1	22.2	25.0	75.0
Good looking	0.0	22.2	0.0	25.0
Uses relatively less oil	21.1	11.1	25.0	0.0
Variety of uses	10.5	11.1	0.0	0.0
Easily available	31.6	0.0	0.0	25.0

Annex 3: Questionnaires

- Study on post-harvest losses of potato – farmers
- Study on post-harvest losses of potato – brokers
- Study on post-harvest losses of potato – traders
- Study on post-harvest losses of potato – processors
- Study on post-harvest losses of potato – restaurants

Questionnaires

Respondent code_____

STUDY ON POTATO POST-HARVEST LOSSES – FARMERS

A1. FARMER PROFILE

Farmer name_____ Phone number_____Date___/___/____(DD/MM/YY)
County_____ ☐☐ Sub-county _____ ☐☐ Village _____

Enumerator's name_____ ☐☐ Entered by_____ ☐☐

1st check by _____ Date___/___/___ (DD/MM/YY)
2nd check by _____ Date___/___/___(DD/MM/YY)

A1. Farmer information (only for respondent or spouse if married)

	Name	Gender **(code)**	Age (Yrs)	Education Level **(code)**
Respondent				
Spouse				

Codes	**Gender**	**Education level**	
	1. Male	0= Illiterate	2= Secondary
	2. Female	1= Primary	3= College

A2. Family size _____ Number female _____Number male_____

B. INTRODUCTION

The National Potato Council of Kenya in cooperation with GIZ is implementing a study on losses in the production and marketing of Irish potatoes.

B1. What are the main challenges in potato production? Please rank the following where 1 is the most important and 10 the less important

☐ 1. Market demand
☐ 2. Prices
☐ 3. Extended bags
☐ 4. Mechanisation/machinery in production and harvest
☐ 5. Diseases
☐ 6. Inputs (fertilisers, pestisides)
☐ 7. Certified seed
☐ 8. Irrigation
☐ 9. Storage
☐ 10. Losses
☐ 11. Others
☐ 12. No problems

B2. Do you experience substantial losses in the production, harvesting and sales of your potatoes? ☐

0 = No 1 = Yes

B3. If yes, where does this mostly occur? ☐☐

☐ 1. During production
☐ 2. During harvesting
☐ 3. During storage
☐ 4. During sales
☐ 5. Others.

C. POTATO PRODUCTION

C1. What is your total farm size_____(acres) including rented/given land?

C2.What was your total potato acreage last season (own, rented and given)_____(acres)

C3. Which months of the year do you plant and harvest potatoes?

Time	B3i. Planting **(code)**	B3ii. Harvesting **(code)**
Season 1		
Season 2		
Season 3 (if applicable)		

Codes for Months		
1. Jan	5. May	9. Sep
2. Feb	6. Jun	10. Oct
3. Mar	7. Jul	11. Nov
4. Apr	8. Aug	12. Dec

C4. Do you use irrigation for your potato production? ☐

0 = No 1 = Yes

C5. Do you carry out crop rotation? ☐

0 = No 1 = Yes

C6. What varieties do you grow? (***name your four main varieties***)

Varieties grown

☐ 1. Shangi ☐ 5. Kenya Karibu ☐ 9. Nyayo
☐ 2. Tigoni ☐ 6. Kenya Mavuno ☐ *10. Others*
☐ 3. Asante ☐ 7. Kenya Mpya *(specify)*_____
☐ 4. Dutch Robjin ☐ 8. Sherekea

C7. What type of seed do you mainly use?

☐ 1. Farmer seed ☐ 3. 'Clean' seed
☐ 2. Positively selected seed ☐ 4. Certified seed

C8. What is the main source of your seed?

☐ 1. Own harvest
☐ 2. Neigbour
☐ 3. Shop/ local market
☐ 4. Clean/ positively selected seed producer
☐ 5. Certified seed producer (ADC, Kisima etc)
☐ 6. Other (specify)_____

C9. After how many seasons do you buy new seed?

☐ 1. Never buy new seed
☐ 2. 1-3 seasons
☐ 3. 4-6 seasons
☐ 4. 7-10 seasons
☐ 5. Over 10 seasons
☐ 6. Other (specify)_____

D. PRE-HARVEST PRACTICES

D1. Do you do anything to prepare your potato before harvesting? 0 = No 1 = Yes

a. If **yes,** what do you do to prepare your for potato harvesting?

☐ 1. Dehaulming
☐ 2. Leave the shoot to dry
☐ 3. Other (specify)_____

b. If **no**, why don't you do anything to prepare your for potato harvesting?

☐ 1. I don't know how to prepare
☐ 2. I harvest early to get high prices
☐ 3. I harvest early to avoid rains
☐ 4. Don't want to incur extra cost
☐ 5. Other (specify)_____

E. POTATO HARVEST ACTIVITIES

E1. What was your largest portion of land under potatoes harvested last season? _____acres

E2. What was the total quantity harvested from this largest portion of land?

	Quantity	**Units (code)**
Total quantity harvested		
Potatoes from the largest plot eaten at home		
Potatoes from the largest plot sold		

Codes
1. Bags
2. Crates
3. kg
4. Other (specify) _____

E3. Could you define the type and size of bag/crate that you are using? In the table below, describe the main type of bag used for harvesting and selling potatoes.

	Local name of the bag	Type of bag/ container **(use Code)**	Net type **(use code)**	Number of buckets (17 kg bucket)	Weight in kg	Material type	Picture code
Harvesting bag/crate							
Selling bag/crate							

Type of bag
1. 50 kg crate
2. 110 kg bag
3. Kata 1
4. Kata 2
5. Kata 3
6. Kata 4
7. Kata 5
8. Kata 6
9. Kata 7
10. Other (specify) _____

Net/top type
0. No net
1. Flat net
2. Mukurinu
3. Kamba 1
4. Kamba 2
5. Kamba 3
6. Kamba 4
7. Kamba 6
8. Other (specify)_____

Material type
1. Sisal/jute bags
2. Half sisal/jute half nylon
3. Nylon bags
4. Crates
5. Other (specify)_____

E4. What tools do you most commonly use for harvesting?

Harvesting tools
☐ 1. Hands
☐ 2. Sticks
☐ 3. Panga
☐ 4. Fork Jembe
☐ 5. Hoe
☐ 6. Ox/ donkey plough
☐ 7. Other (specify) _____

E5. Do the types of tools you use in harvesting damage the tubers? 0 = No 1 = Yes

a. **If yes,** estimate the damage caused by each mentioned tool?

		Tool 1	Tool 2
Harvesting tool (use codes)			
Quantity damaged per ¼ acre	Amount		
	Unit (use codes)		
	In kg		

Codes for harvesting tools
1. Hands
2. Sticks
3. Panga
4. Fork Jembe
5. Hoe
6. Ox/ donkey plough
7. Other (specify)_____

Codes for units
1. 17 kg bucket
2. Crate (50 kg)
3. Other (Specify)_____

Enumerators: please note the quantity in units given and then convert into kg

E6. What type of labour do you mainly use for harvesting? ☐

Type of labour

☐ 1. Family labour	☐ 4. Permanent employee(s)
☐ 2. Casual labour	☐ 5. Help from neighbours/ relatives
☐ 3. Oxen/ donkey plough	☐ 6. Others (specify)_____

E7. Does the type of labour used for harvesting on your farm cause damage to the tubers? 0 = No 1 = Yes ☐

a. If yes, estimate the amount of damage per ¼ acre_____☐ = ____kgs/ ¼ Acre

Unit codes 1. 17 kg bucket 2. Crate (50 kg) 3. Other (specify)____

Enumerators: please note the quantity and units given and then convert into kg

E8. What time of the day do you harvest your potatoes? ☐

☐ 1. Morning
☐ 2. Afternoon
☐ 3. Morning and afternoon

E9. Do you protect potatoes from direct sun after harvesting? 0= No 1=Yes ☐

E10. If yes, how do you protect the harvested potatoes from direct sun? ☐

☐ 1. Cover the tubers
☐ 2. Put them in the shade
☐ 3. Put them in the bag
☐ 4.Move them into the store immediately
☐ 5. Other (specify)_____

E11. Do you harvest potatoes when it is raining? 0 = No 1 = Yes ☐

a. **If yes,** what is the estimated damage caused by harvesting when it is wet?

_____☐ = _____ kg per ¼ acre

Unit codes 1. 17 kg bucket 2. Crate (50 kg) 3. Other (specify)_____

Enumerators: please note the quantity and units given and then convert into kg

E12. Do you conduct a second round of harvesting to gather/collect potatoes left in the field? 0= No 1=Yes ☐

a. If yes, what is the quantity of potatoes gathered in the second round per ¼ acre of harvested land?

i. _____☐ ii. In weight _____kgs

Unit codes 1. 17 kg bucket 2. Crate (50 kg) 3. Other (specify)_____

Enumerators: please note the quantity and units given and then convert into kg

E13. Do any potatoes remain in the soil after harvesting and second-round gathering ('left overs'/'volunteers')? 0 = No 1=Yes ☐

a. **If yes,** what is the estimated quantity of potatoes 'left over' in a harvested ¼ acre?

i._____☐ ii. In weight_____kgs

Unit codes 1. 17 kg bucket 2. Crate (50 kg) 3. Other (specify)_____

Enumerators: please note the quantity and units given and then convert into kg

b. What does the farmer do with the" left overs" in the farm? ☐

☐ 1. Allow them to grow for eating
☐ 2. Allow them to grow for selling
☐ 3. Uproot them when they grow
☐ 4. Other (specify)_____ ☐

F.STORAGE ☐

F1. Do you store potatoes after harvest? 0 = No 1 = Yes

a. If yes, where do you store your potatoes? (main store)

Types of stores

☐ 1. Dark store	☐ 9.Kept covered in a concrete floor house
☐ 2. Store allowing light	☐ 10.Heaped in a concrete-floored store
☐ 3. Uncovered in the field	☐ 11. Heaped in a wooden-floored store
☐ 4. Covered in the field	☐ 12. Diffused light store (DLS)
☐ 5. Placed in a hole in the ground	☐ 13. Heaped in a mud-floored store
☐ 6. Dark area in the house	☐ 14. Gunny bags placed in the open
☐ 7.Kept uncovered in a concrete floor house	☐ 15. Other (specify)
☐ 8. Kept covered in a mud floor house	_____

b. How long do you store? Number of days _____

c. Why do you store them?

☐ 1. To wait for better prices
☐ 2. For home consumption
☐ 3. Seed potatoes
☐ 4. Other (specify)_____

d. What quantity of harvested potatoes from the largest portion of land was stored?

_____bags or _____kgs

F2. Do you experience any losses/ damages due to storage? 0 = No 1 = Yes

I. If yes, what causes the losses/damages?

☐ 1. Rotting
☐ 2. Pests and diseases
☐ 3. Other (specify)_____

II. What quantity of potatoes are lost/damaged due to storage?

i._____ ii. In weight_____kgs

Unit codes 1. 17 kg bucket 2. Crate (50 kg) 3. Other (specify)_____

Enumerators: please note the quantity and units given and then convert into kg

G. SORTING AND GRADING

G1. Do you sort and grade your potatoes? 0 = No 1 = Yes

a. If yes, at what stage do you grade?

☐ 1. During harvest
☐ 2. Just before storing
☐ 3. When selling
☐ 4. (Other specify)_____

b. How do you sort and grade potatoes?

Codes for grading

☐ 0. Do not grade
☐ 1. Remove damaged
☐ 2. Grade by sizes charts, small, medium, large
☐ 3. Remove charts/small stock for seed
☐ 4. Remove greening tubers
☐ 5. Grade by variety
☐ 6. Others (specify) _____

G2. Of the total potatoes sorted, what quantity of each category is obtained from a ¼ acre plot?

Category	Quantity per ¼ acre	Units code	Uses code
1. Small and charts			
2. Medium and large			
3. Cut and bruised potatoes			
4. Greening potatoes			
5. Off-type variety			

Units
1. 17 kg bucket
2. 10 kg bucket
3. 110 Kg bag
4. Net bag
5. Kata 1
6. Kata 2
7. Kata 3
8. Kata 4
9. Others (specify) _____

Uses
1. Seed
2. Home consumption
3. Sell
4. Livestock feed
5. Processing
6. Throw away as waste
7. Other (specify) _____

H. PACKAGING AND MARKETING

H1. Do you transport potatoes before selling? 0 = No 1 = Yes

a. To where?

☐ 1. Homestead
☐ 2. Main road
☐ 3. Other place (specify)_____

b. Distance? _____(in km)

H 2. What are the main means of transport?

☐ 1. Hand cart
☐ 2. Bicycle
☐ 3. Motorcycle
☐ 4. Tractor
☐ 5. Pick-up/car
☐ 6. Lorry
☐ 7. On back
☐ 8. Other (specify)_____

H3. Who packs the bags for selling?

☐ 1. Farmer
☐ 2. Brokers
☐ 3. Trader
☐ 4. Employees/workers
☐ 5. Others_____

H5. To whom do you mostly sell?

- ☐ 1. Local trader
- ☐ 2. Wholesaler
- ☐ 3. Consumer
- ☐ 4. Processor
- ☐ 5. Others (specify)_____

H5. What are the current, lowest and highest prices of the type of potato bags you have sold in the recent past to local traders?

Type of bag recently sold	Current price (KES)	Lowest price and month		Highest price and month	
		Price (KES)	Month	Price (KES)	Month

Codes for months		
13. Jan	17. May	21. Sep
14. Feb	18. Jun	22. Oct
15. Mar	19. Jul	23. Nov
16. Apr	20. Aug	24. Dec

H6. Other than what has already been mentioned, do other losses or damage occur during potato production and marketing? 0 = No 1 = Yes

a. If **yes**, explain and give an estimate for each type of loss or damage mentioned.

_____

Enumerators: please note the unit (use code) and convert into kg

STUDY ON POST-HARVEST LOSSES OF POTATO – BROKERS

PROFILES

1. Location, average age, average education levels of brokers
2. What are the gender categories of brokers?

POTATO BUSINESS

1. What are the main challenges experienced when dealing with potatoes?

VARIETIES

1. What are the different potato varieties available from farmers?
2. What are the different potato varieties preferred by customers?
   a. What are the reasons for preferring the different potato varieties?
3. Do traders have a problem with the quality, availability, packing of bags, and prices of marketed potato varieties?
   a. If yes, what are the problems?

FINDING FARMERS

1. How do brokers identify farmers who sell potatoes?
2. How many farmers do brokers deal with on average?
3. Do brokers know quantities and qualities of potatoes farmer have?

SORTING/GRADING

1. Do brokers buy potatoes by grade?
2. Who packs potatoes for traders?

PACKAGING

1. What materials are the packing bags made of?
2. Are the packaging bag sizes the same for all the farmers?
3. Do traders have different names for different types of bags, if yes what are the names?
4. How many 17 kilogram buckets can fit into each type of bag used for potato packaging?
5. How many times can each type of bag be reused? (jute, sisal, nylon)
6. Are there any handling problems associated with any type of bags used in the market?
   a. If yes, explain?

PRICES

1. What is the current farm-gate and market price for each size of bag sold?
2. Which months of the year do farmers get the highest and lowest prices, and what are these prices?

TRANSPORT

1. How do you transport potatoes from farm to the selling point?
2. How do you load and offload potato bags ob to/from the means of transport you use?
3. How far from the farm are the traders' selling points?
4. Who are the main buyers and where are they from?

LOSSES

1. What kind of losses/damage do traders incur for each variety and when? **(Estimate the damage/losses in weight, if any.)**
   a. Purchasing from farmers
   b. Packaging
   c. Transporting
   d. Selling to the market/ customers
   e. Storing
   f. Others (please specify)_____
2. Are there any other losses traders incur in the course of their business?
   a. If yes, please explain?
3. How could losses be reduced?
4. What kinds of improvements are necessary to increase the yields, quantities and quality of potatoes?

STUDY ON POTATO POST-HARVEST LOSSES – TRADERS

ID number (*C = County, S = Subcounty of operation, M = Market of operation and last 3 digits = Number of the person interviewed)*

C	S	M			

A. BASIC DATA

Trader name_____ Phone number_____
Date___/___/____(DD/MM/YY)

County_____ ☐☐ Sub-county _____ ☐☐

Enumerator's name_____ ☐☐ Entered by_____ ☐☐

1st check by _____ Date___/___/___(DD/MM/YY)

2nd check by _____ Date___/___/___(DD/MM/YY)

A.1 Name of the market/ place of interview _____ ☐☐

B. DETAILS OF INTERVIEWEE AND POTATO BUSINESS

B1. Gender 1= Male 2= Female ☐ **B2. Age of trader** ☐☐ years

B3. Education Level ☐ Use education codes below

B4. What kind of potato business are you doing?

1. Retailer 2. Wholesaler 3. Both retailer and wholesaler 4. Other (specify)_____

B5. Most important source of potato

a. County_____ ☐ b. Sub-county/town_____ ☐ Market_____

B6. Most important selling place/ destination

a. County_____ ☐ b. Sub-county/town_____ ☐ Market_____

B7. How many years have you been in this business? ☐☐ years
(should be more than six months old)

Codes for Counties		**Codes for education level**	
1 = Nairobi	4 = Bomet	0 = no education	13-14 = A level 1 to A level 2
2 = Nyandarua	5 = Meru	1-8 = standard 1 to 8	15 = college
3 = Nakuru	6 = Mombasa	9-12 = form 1 to form 4	16 = can read and write

B8. Which months of the year have no sale, minor sales and major sales?
(use codes for each month)

Jan	Feb	Mar	Apr	May	Jun	0 = No sale 1 = Minor sale 2 = Major sale
☐	☐	☐	☐	☐	☐	
July	Aug	Sept	Oct	Nov	Dec	
☐	☐	☐	☐	☐	☐	

B9. What are the main potato varieties you trade in and what are the reasons for the market preferring the variety? (Name maximum of four main varieties).

Variety sold		Reason 1	Reason 2	Reason 3
Variety 1	☐			
Variety 2	☐			
Variety 3	☐			
Variety 4	☐			

Codes for varieties	***Reason for variety preference***
1. Shangi	1. Good for mashing
2. Tigoni	2. Good for chips
3. Asante	3. Good taste
4. Dutch robjin	4. Early maturity
5. Kenya karibu	5. Big tubers
6. Kenya Mavuno	6. Colour of the skin
7. Kenya mpya	7. Other (specify)_____
8. Sherekea	
9. Nyayo	
10. Others (specify)_____	

B10. How do you identify farmers who sell potatoes? ☐☐

1. By using brokers
2. Move around/visiting the farms
3. I do have farmer contacts
4. Farmer contract
5. Other, please specify_____

B11. Do you buy sorted or graded potatoes? 0 = No 1 = Yes ☐

a. If yes, how are potatoes graded or sorted? ☐☐☐

Codes for grading

0. Not graded	4. Remove greening tubers
1. Remove damaged	5. Grade by variety
2. Grade by sizes-charts: small, medium, large	6. Others (specify)
3. Remove charts/small for seed	

B12. Who mainly packs the bags? ☐

1. Farmer and his/her workers
2. Broker
3. Trader himself
4. Others **(specify)**_____

C. PACKAGING, TRANSPORTATION AND MARKETING

C1. How far do you transport potatoes from the buying point to your main selling point?
_____km

C2. Do you buy potatoes from farms that are far from tarmac roads?
0 = No 1 = Yes ☐

a. If yes, what kind of feeder roads do you use to access these farms? ☐

1. Muddy earth roads
2. Moram road
3. Footpath
4. Other, please specify_____

b. What mode of transport do you use on the feeder roads? ☐☐

Codes

1. On head/ back	5. Motorcycle
2. Hand cart	6. Tractor/pick-up/lorry/truck
3. Donkey/ ox cart	7. Public transport/matatu
4. Bicycle	8. Other (specify)_____

c. How far from the main road do you source your potatoes? _____km

d. Do you use a different mode of transportation to transport potatoes to the tarmac roads?
0 = No 1 = Yes ☐

a. **If yes**, what means of transportation do you use to transport potatoes on tarmac roads? ☐☐

Codes for means of transportation

1. On head/back	5. Motorcycle
2. Hand cart	6. Tractor/pick-up/lorry/truck
3. Donkey/ox cart	7. Public transport/matatu
4. Bicycle	8. Other (specify)_____

C3. For traders who buy near/along tarmac, what is your main mode of transport to the selling point? ☐

Codes for means of transportation

1. On head/back	5. Motorcycle
2. Hand cart	6. Tractor/pick-up/lorry/truck
3. Donkey/ox cart	7. Public transport/matatu
4. Bicycle	8. Other (specify)_____

C4. How are the potatoes you buy packaged?

Bag type	Common name of the bag	Type of bag	Net type	Number of buckets (17 kg bucket)	Weight in kg	Material type	Picture code
Type 1							
Type 2							
Type 3							

Codes

Type of bag
1. 50 kg crate
2. 110 kg bag
3. Kata 1
4. Kata 2
5. Kata 3
6. Kata 4
7. Kata 5
8. Kata 6
9. Kata 7
10. Other (specify) _____

Net/top type
0. No net
1. Flat net
2. Mukurinu
3. Kamba 1
4. Kamba 2
5. Kamba 3
6. Kamba 4
7. Kamba 6
8. Other (specify) _____

Material type
1. Sisal/jute bags
2. Half sisal/jute, half nylon
3. Nylon bags
4. Crates
5. Other (specify) _____

C5. What are the advantages and disadvantages of the main packaging materials used?

Material type	Advantages			Disadvantages		

Material type	**Advantages**	**Disadvantages**
1. Sisal bags	1. Cheap	1. Expensive
2. Sisal half nylon	2. Easily available	2. Not easily available
3. Jute bag	3. Long lasting	3. Don't last long
4. Jute half nylon	4. Can carry a lot of potatoes	4. Can't carry a lot of tuber
5. Nylon bags	5. Water/rain proof	5. Easily affected by water/rain
6. Crates	6. Protect tubers from sunshine	6. Does not protect tubers from sunshine
7. Other (specify) _____	7. Can easily joined together	7. Can't be easily joined together
	8. Other (specify) _____	8. Other (specify)_____

C6. What are the current, lowest and highest prices of the potato bag type you purchased in the recent past from farmers/at the farm gate?

Type of bag bought	Current price (KES)	Lowest price and month		Highest price and month	
		Price (KES)	Month	Price (KES)	Month

Codes					
Bag type		**Months**			
11. 50 kg crate	16. Kata 4	1. Jan	5. May	9. Sep	
12. 110 kg bag	17. Kata 5	2. Feb	6. Jun	10. Oct	
13. Kata 1	18. Kata 6	3. Mar	7. Jul	11. Nov	
14. Kata 2	19. Kata 7	4. Apr	8. Aug	12. Dec	
15. Kata 3	20. Other (specify) _____				

C7. Do you expect/experience damages caused

- ☐ on the farm? 0 = No 1 = Yes
- ☐ during transportation? 0 = No 1 = Yes
- ☐ by market conditions (sun, no shades, rain, etc.) 0 = No 1 = Yes
- ☐ Other (specify)_____ 0 = No 1 = Yes

C8. Can you quantify the expected damages in kg or as a %?

- ☐ during transportation 1 = kg 2 = %
- ☐ on farm 1 = kg 2 = %
- ☐ by market conditions 1 = kg 2 = %
- ☐ Others (specify)_____ 1 = kg 2 = %

C9. In which case do you open the bags and repack? 0= No 1 = Yes

a. If yes, for what reason do you open the bags?

- ☐ When there is visible damage 0 = No 1 = Yes
- ☐ When potato greening is visible 0 = No 1 = Yes
- ☐ To break into smaller quantities for selling 0 = No 1 = Yes
- ☐ Others (specify)_____ 0 = No 1 = Yes

C10. In case that you do not open the bag despite there being visible damages/green potatoes, by what percentage do you lower the price on average?

_____%

C11. If, after opening the bag, there are bruised or rotten potatoes, what do you consider to be the cause for this damage?

Category	**Damage cause 1**	**Damage cause 2**	**Damage cause 3**
1. Cut tubers			
2. Bruised tubers			
3. Greening potatoes			
4. Rotten			

Codes	
1. Use of nylon packaging material	6. Harvesting pre-mature tubers
2. Dragging and dropping of extended bag	7. Harvesting uncured tubers
3. Bruised by means of transport: bicycle, motor cycle, donkey,	8. Harvesting in the rain
	9. Variety weakness
4. Mishandling when loading and unloading	10. Market conditions (sun/rain)
5. Use of fork/hoe for harvesting	11. Others (specify)_____

C12. When you breaking up bags into smaller quantities, in what packages/ smaller units do you mostly sell potatoes? ☐☐

a. Heaps/mounds
b. Buckets of 10 kg
c. Buckets of 17 kg
d. 110 kg bag
e. 50 kg crates
f. Other specify_____

C13. Do you grade or sort potatoes when breaking up bags into smaller units? ☐

0 = No 1 = Yes

b. If yes, how do you sort and grade the potatoes? ☐☐☐

Codes for grading

1. Do not grade
2. Remove damaged
3. Grade by sizes-charts: small, medium, large
4. Remove charts/small for seed
5. Remove greening tubers
6. Grade by variety
7. Others (specify)_____

C14. Of the potatoes sorted, what quantities of each category is obtained from each type of bag bought? ☐

Category	Type of bag/ container purchased	Quantity (kg) sorted	Uses
1. Small and charts			
2. Medium and large			
3. Cut and bruised potatoes			
4. Greening potatoes			
5. Off-type variety			
6. Rotten			

Units

1. 17 kg bucket
2. 10 kg bucket
3. 110 Kg bag
4. Net bag
5. Kata 1
6. Kata 2
7. Kata 3
8. Kata 4
9. Others (specify) _____

Uses

1. Seed
2. Home consumption
3. Sell
4. Livestock feed
5. Processing
6. Throw away as waste
7. Other (specify) _____

☐☐

STUDY ON POST-HARVEST LOSSES OF POTATO – PROCESSORS

Name of county_____

Name of sub-county/town_____

1. What potato products does the processor produce?
2. What varieties are suitable for producing each product?
3. What qualities do processors look for when choosing the varieties to produce each product?
4. What are the shortcomings in each variety chosen for each product?
5. From where do processors get their potatoes?
6. What problems do processors have when acquiring the varieties they need?
7. Does the processor contract farmers? If yes, what are the pros and cons of contract farming?
8. Are there any problems associated with potato bags and the materials used for the supply of potatoes?
9. If yes, describe the potato bags and materials, and the problems associated with each.
10. What is the current buying price for each size of bag bought?
11. Which months of the year have the highest and lowest buying prices and what are those prices?
12. How are potatoes transported from the farm to the processing point?
13. How do you load and off load potato bags on to/from the means of transport you use?
14. Please describe the stages of processing.
15. Do processors experience any losses from processing potatoes?
    a. If yes, how do the losses occur? How much is lost at each stage of processing?
16. What are the main challenges experienced when dealing with potatoes?

STUDY ON POST-HARVEST LOSSES OF POTATO – RESTAURANTS

Name of the county _____

Name of sub-county/town _____

1. Where do you buy potatoes?
2. Which varieties of potatoes are commonly preferred by consumers/clientele and why?
3. How are potatoes prepared for consumption?
4. In what packages/quantities are potatoes bought?
5. What types of packaging material are potatoes packed in when buying and when selling?
6. Are there any losses associated with packaging potato bags or sizes of bags used in trading?
7. What are the unit prices of the different potato varieties bought?
8. Does potato availability vary according to the season?
9. Do you buy sorted and gradeg potatoes?
    a. If yes, what are the different grades on the market?
    b. What are the different sizes preferred?
10. What is the current buying price for each size of bag bought?
11. Which months of the year have the highest and lowest buying prices and what are these prices?
12. How are potatoes transported from buying to selling points?
13. Do you experience any losses from potatoes you buy?
    a. If yes, how do the losses occur?
    b. What is the scale of the losses?
14. What are the main challenges experienced when dealing with potatoes?

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