Sweetpotato value chains in Kenya:

a business opportunity for puree processing and the potential role for commercial fresh root storage

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Contents

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We hope this report is of use in providing greater understanding of the different but related aspects of current and potential future sweetpotato value chains in Kenya.

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Acronyms and Abbreviations

ACZ	Agro-Climatic Zone
ADS	Anglican Development Services
ASAL	Arid and Semi-Arid Land
ASARECA	Africa Harvest Biotech Foundation International
CBK	Central Bank of Kenya
CC	Climate Change
CIP	International Potato Center
DVM	Decentralised Vine Multipliers
EAAPP	East African Agricultural Productivity Programme
F	Female
FAO	Food and Agriculture Organisation
FCI	Farm Concern International
GDP	Gross Domestic Product
GII	Gender Inequality Index
GNI	Gross National Income
GoK	Government of Kenya
GUSSGA	Gem Ugunja Sweetpotato Seed Growers Association
HDI	Human Development Index
HA	Hectare
HH	Household
IHDI	Inequality-Adjusted Human Development Index
ITCZ	Inter-Tropical Convergence Zone
KARI	Kenya Agricultural Research Institute
KAVES	Kenya Agricultural Value Chain Enterprises
KHCP	Kenya Horticulture Competitiveness Project
KIHBS	Kenyan Integrated Household Budget Survey
Ksh	Kenyan Shilling
KTDA	Kenya Tea Development Agency
M	Male
MAP	Months After Planting
MLND	Maize Lethal Necrosis Disease
MoA	Ministry of Agriculture
NGO	Non-Governmental Organisations
NRI	Natural Resources Institute
OFSP	Orange-fleshed sweetpotato
RATIN	Regional Agricultural Trade Intelligence Network
REFSO	Rural Energy and Food Security Organization
PALWECO	Program for Agriculture & Livestock in Western Communities
PV	Solar Photovoltaic
QC	Quality Control
SASHA	Sweetpotato Action for Security and Health in Africa
SP	Sweetpotato
SSA	Sub-Saharan Africa
UCRC	Ugunja Community Resources Centre
UN	United Nations
UNDP	United Nations Development Programme
USD	United States Dollar
VAD	Vitamin A Deficiency
VAT	Value Added Tax
WV	World Vision

CURRENCY EQUIVALENT

1 USD = 91.25 Ksh (Jan 2015)

Executive Summary

Background

The Sweetpotato Action for Security and Health in Africa (SASHA) project was launched in 2009, to improve food security and health conditions of poor families in sub-Saharan Africa (SSA) by supporting them to exploit the full potential of the sweetpotato (SP) crop. Evidence of the benefits of the high concentrations of pro-vitamin A in orange-fleshed sweetpotato variety (OFSP) to young children and pregnant women, and positive experience on the large-scale commercial production and marketing of bakery products that incorporated OFSP puree in their recipes were among the main goals achieved by the SASHA Phase 1.

Building on these findings, SASHA Phase 2 has redirected the strategic focus to improving the utilization pathways for SP consumption and production to boost the economic viability of SP value addition and business activities, as well as alleviating vitamin A deficiency through intake of processed products containing OFSP.

Method

As part of SASHA Phase 2, this study initially investigated fresh SP root production, availability, trading and service provision in the counties of Homa Bay, Migori, Siaya, Busia, and Kericho in Kenya and fresh SP root trading, retailing and consumption in major urban markets in Nairobi, Nakuru and Kisumu (Figure A). Based on the information gathered from the value chain studies we then assessed the feasibility of OFSP puree processing activities. We then used the detailed value chain and root supply information acquired to provide insights into the opportunities for establishing fresh SP root storage facilities.

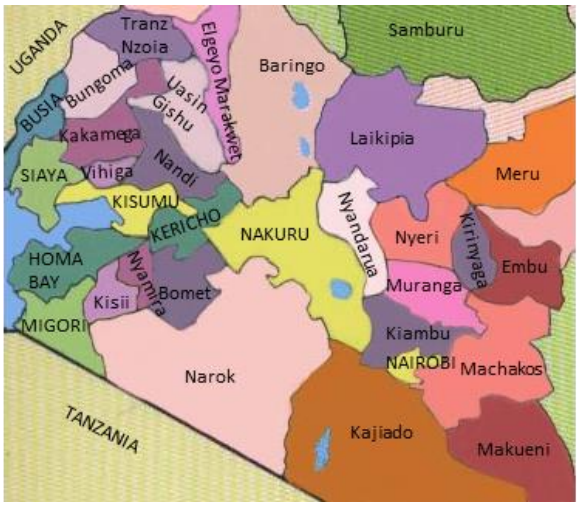


Figure A – Focal sweetpotato producing counties *(in green)* **and urban markets** *(in yellow)* **in Kenya**

The methodology of the study is grounded on: i) the analysis of the context where the various value chains are located, ii) the accounting of the physical and monetary flows characterizing the agents and the activities of the chain, iii) the preliminary assessment of the OFSP puree processing business and related requirements, and iv) the potential economic viability of storage facilities, especially at processor' level, taking into account the SP year-round supply, price variations, transportation issues and storage costs.

The production systems of yellow-, white- and orange-fleshed SP varieties were considered, and the associated trading and processing activities. For each of the five focal SP production counties, specific attention was given to OFSP roots as the raw input for OFSP puree production and storage.

The data used in the study mainly come from interviews with key value chain agents (e.g. farmers; traders; transporters; retailers; processors; and service providers). Secondary data have been provided by the Kenyan Ministry of Agriculture (MoA) officers in each county, and through relevant literature on Kenya, SP value chains and processing/storage. The (primary) data collection was carried out in the eight counties between 9th and 17th December 2014, involving more than 100 respondents, through 59 focus group and individual discussions carried out by researchers from the Natural Resources Institute (NRI), UK (Ilaria Tedesco and Tanya Stathers) and the International Potato Centre (CIP), Kenya (Olivia Wahonya and Sarah Kariuki) with support from local MoA and NGO staff. The interviews were conducted in Swahili, Luo or English. The data entry, analysis and report writing has been done by the NRI researchers.

Contextual information on Kenya and the focal sweetpotato production sites and urban markets

Kenya is now recognised as a lower middle-income country, following the 're-basing' of its national statistics in September 2014, making it the ninth largest economy in Africa with a GDP of $55.2 billion and an annual GDP growth of 5.7% in 2013. Kenya had an estimated population of 44.35 million people in 2013 and a GNI per capita of $1,160. The country is rapidly urbanizing, 24.8% of the population lived in urban centres in 2013 and at least 3.3 million of them in Nairobi. Projections suggest that by 2050, 44% of Kenya's 97 million people will live in urban centres. Sweetpotato roots are an important part of the urban food system as they are a comparatively cheap, easy to prepare, filling and healthy food.

Maize, Irish potato, banana, sweetpotato and cassava are the major staple carbohydrate food crops produced in Kenya. Expansion of the area of land planted to these crops has increased since 1961. When the area planted to each of these crops is compared to the 1994 area, sweetpotato and rice can be seen to have expanded particularly rapidly (Figure B).

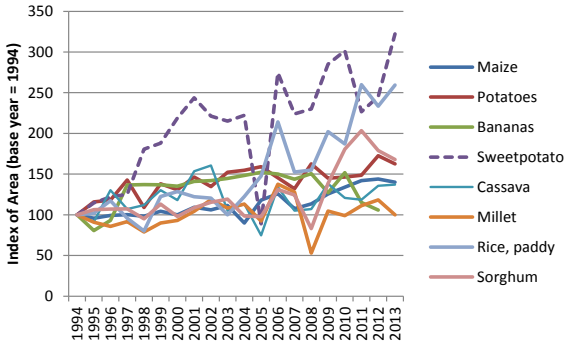


Figure B – Proportional growth in areas of different staple crops in Kenya from 1994-2013

Data source: FAOSTAT

In the study's focal SP production counties 33-57% of young children are stunted, and exclusive breastfeeding ranges from just 1.4 months around the Kabondo area to 5.2 months in Busia. Nationally 84% of preschool children were shown to be Vitamin A deficient in 2006, yet only 30% of children were found to have received Vitamin A supplements in the previous 6 months during the 2008/9 demographic health survey. However, over 79.6% of young children had eaten foods rich in Vitamin A in the previous 24 hours.

Sweetpotato value chains in the focal counties

There are differences between the five focal SP producing counties (Busia, Homa Bay - Kabondo area, Siaya, Migori and Kericho) in terms of: their climatic and socio-ecological features; the role SP plays in their food systems; the scale of SP fresh root trading; whether the farmers cultivate OFSP or not; and the presence of OFSP processing-related activities. In the three major urban markets of Kisumu, Nakuru and Nairobi, the main differences were related to their food systems and the role of SP within them, their population sizes, and the trade volumes and business margins of the traders and retailers involved in the SP value chain.

SP roots are harvested almost all year round in the focal producing counties, with farmers typically planting the crop twice per year (Table A). In Busia, Kabondo and Kericho the fresh SP root supply peaks in Jan-March after the short rains; the supply increases again after the longs rains in Jun-July and in July-Aug (for the 6 MAP) in Busia and Kericho, respectively. In Migori and Siaya the peak supply is in March-May.

Table A. Varying supply seasons of fresh SP roots in Busia, Homa Bay, Migori, Siaya and Kericho counties

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Busia	***	***	***	*	*	***	***	**	**	*	*	**
Kabondo	***	***	***	**	*	**	**	**	**	*	*	*
Migori	**	**	***	***	***	*	*	***	***	**	**	**
Siaya	**	**	***	***	***	***	*	*	***	***	***	*
Kericho	***	***	***	*	*	*	***	***	*	**	***	***
Key: *** = Peak supply; **= Medium supply; * = Low supply												

Source: Field visits

From our focus groups and individual interviews, the highest profits per acre (per cycle) for SP and OFSP and OFSP vines are reported in Busia, followed by Kericho and Kabondo. The farmers in Siaya reported much lower profits and smaller production areas. Limited amounts of OFSP are cultivated in the focal counties, despite service providers in Busia having promoted various OFSP varieties for more than 10 years. The low uptake by farmers is reported to be due to limited and often unreliable markets for OFSP roots or products, with the exception of OFSP vines which are currently highly profitable and bought by Government and NGO development actors to distribute to different areas of the country. Some characteristics of the OFSP varieties released have not been attractive to farmers, e.g. poor taste, roots turning to slush when boiled. Where cultivated, e.g. in Busia, Kabondo and Siaya, the OFSP varieties seemed to give higher profits per acre (per cycle) than the traditional white or yellow-fleshed varieties.

Large quantities of yellow-fleshed red-skinned SP roots are traded from both Kabondo and Migori. Farmers may harvest and deliver their SP roots to the roadside collection area by donkey load or motorbike, or brokers may arrange the root transport from the farmer's field. The farmers are mainly paid on a per sack basis, after the broker or trader has separated the different sized roots and discarded any weevil damaged roots; a much lower price is paid for the small or cut roots than for the medium and large-sized roots. The sack sizes vary substantially by location and at different stages along the value chain, making it complex to compare prices. On reaching the roadside the sacks of roots are typically poured onto the ground or into a drum of water and then trampled on by the root washing lady to remove the soil from them. Parts of the skin are also removed during this washing process, and the roots are then tossed onto the ground to allow some of the water to evaporate while they are sorted by size and damage, and then tightly packed into the trading size of sack (usually an extended *Prim* size (~adult head height), or a *Bao* size (two and a half times the length of a 90kg capacity maize sack, and requiring four strong young men to lift it)). These sacks are then sewn closed, and heaved into the back of trucks headed to Nakuru or Nairobi. The trucks have delivered goods to Kisumu, Uganda or Tanzania and then use their empty backhaul space to transport the sacks of SP to the urban markets. The road journey is likely to take 6-8 hours and then the sacks overnight in the truck before being delivered at 5am to the wholesale market.

The wholesaling/trading activities in Kabondo appeared to the most profitable amongst all the rural areas visited due both to the large volumes of sacks traded (Kabondo is well-known throughout Kenya as a major producer of SP), and the high margins per sack. The trader in Siaya gained the least profits from the activity. The trading system in Nairobi is the most complex one, considering the numerous different sack dimensions and root types, and the various different geographical sources of SP used. Among similar agents in both rural and urban areas, the SP traders in Nairobi markets were also likely to gain the highest annual profits due to the huge amount of sacks traded.

From the data collected during the field visits, it emerged that the price variation between the peak and low supply season changes by agents and counties considered. The traders provided broad information in geographical terms. Considering all the markets (i.e. rural and urban), the buying price between the peak and low supply season varies between 9% in Kisumu and 67% in Kabondo and Nairobi, while the average % variation of the selling price is lower (Table B).

Table B - Price variation from peak to low supply season (white and yellow fleshed varieties) (buying-selling price)

	Farmers	Traders	Retailers
Busia			
Kabondo	67%	67%-29%	
Migori	70%	31%-14%	
Siaya		20%-5%	
Kericho		NA-136%	81%
Nairobi		67%-55%	120%-~60%
Nakuru		63%-10%	23%
Kisumu		9%-13%	15%

Source: Information from stakeholders and own elaboration

A few discrepancies emerged between the reported selling price of the traders and the buying price of the retailers (e.g. in Kericho and Nairobi). To sell the fresh SP roots, the retailers convert the sacks

into piles: the price per pile does not vary during the year but the number of SP roots per pile changes to help the retailers maintain their profit levels during the low supply seasons.

Consumers select SP roots based on their size, freshness, colour, absence of damage, washed skin. Most of the consumers interviewed preferred to eat the traditional yellow- or white- fleshed SP varieties as boiled roots, mainly for breakfast. They said they provide a tasty, cheaper, healthy and more filling alternative to bread. Campaigns to encourage increased consumption of locally produced unprocessed foods such as SP roots were reported. However, despite this retailers and consumers felt that SP root consumption declines as household income rises.

In this study's focal locations OFSP consumption currently appears to be more popular when the roots are incorporated into processed products as opposed to being taken in a boiled root form (as occurs for the traditional white or yellow fleshed SP varieties). OFSP production and processing is happening on a very small-scale, with one processor in each of Busia, Kabondo and Siaya processing the OFSP roots into OFSP flour or composite flour. A few individuals in these locations are also using OFSP roots in preparing chapatis, mandazi, onion bites, and bread etc. No evidence of processing of the traditional yellow or white fleshed SP varieties was found during the study.

To date the buying price of fresh OFSP roots has not varied during the year in the three focal counties where it is produced. In Kabondo the OFSP fresh roots are sold by the farmers to an OFSP flour producing Cooperative at 14 Ksh/kg all-year-round, and in Busia to an OFSP flour and dry chip processor at 12 Ksh/kg. The trader in Siaya paid the farmers Ksh2,000/ flat-sized bag of fresh OFSP all year round (~20Ksh/kg).

Due to the different sized sacks used in the different counties and by different agents, direct price or margin comparisons between counties and agents per sack cannot be made in this analysis.

OFSP puree processing

The information gathered in the value chain studies and from various stakeholders helped to assess the viability of orange-fleshed sweetpotato (OFSP) puree processing in Kenya and associated fresh root storage opportunities. An exciting business opportunity to produce OFSP puree for inclusion in Vitamin A rich bakery products such as bread, scones, cakes and cookies in four stores of one of Kenya's large supermarket chains, has recently been agreed. The initial quantity of OFSP puree required could easily be provided on a regular year-round basis by one processor, but longer-term the demand is likely to increase as the product's potential becomes established and more OFSP processors may be required. OFSP planting material multiplication sites have been set up in several counties to provide additional planting materials to supply roots into this OFSP puree value chain. Good organisation will be required to help schedule and stagger the planting/harvesting seasons to avoid gluts in root production, which would likely lead to wastage if no fresh root storage facility was available and to shortages during other periods of the year.

OFSP puree processing involves washing the fresh roots, peeling and boiling and mashing them. Choices need to be made at each stage on which method to use including which energy source for the boiling, and which machines and equipment for the peeling, boiling and mashing. The OFSP puree then needs to be packed and transported to the stores. Packaging options currently include: reusable plastic containers or vacuum packed bags. High standards of food quality management are crucial. In addition to the fresh roots, equipment and labour costs mentioned above there will also be building rent, security, water and electricity supply, and staff costs.

The proposed supply scenarios for the processor to provide OFSP puree to the supermarket are the following:

Scenario 1 considers that OFSP puree will substitute 30% of the wheat flour used in the bakery products. The amount of wheat flour processed for bakery products is 630 kg per day per shop and the initial number of shops to be supplied is 4;

Scenario 2 considers that OFSP puree will substitute 40% of the wheat flour used in the bakery products. The amount of wheat flour processed for bakery products is 630 kg per day per shop and the number of shops to be supplied is 4;

Scenario 3 considers the provision of 0.5 tonne of OFSP puree per day, without specifying the quantity of wheat used or the number of shops supplied.

Scenario 4 considers that OFSP puree will substitute 30% of the wheat flour in bakery products in 52 shops, as an example of longer-term demand for OFSP puree.

The coefficients and the fresh OFSP root quantities required (per day, week, month and year) for the 4 Scenarios are shown in Table C.

Table C. OFSP puree and fresh roots requirements for meeting the supermarket chain's demand

	Scenario 1	*Scenario 2*	*Scenario 3*	*Scenario 4*
Wheat utilization without OFSP puree per day per shop (kg)	630	630	NA	630
Quantity of OFSP puree in enriched bread (wheat substitution in %)	30%	40%	NA	30%
OFSP puree for wheat substitution per day per shop (kg)	189	252	NA	189
Number of shops to be supplied	4	4	NA	52
OFSP puree for wheat substitution per day for all the shops (kg)	**756**	**1,008**	**500**	**9,828**
Conversion rate OFSP roots: OFSP puree	1.35:1	1.35:1	1.35:1	1.35:1
OFSP root requirements per day for all the shops (including 5% in bag root losses) (kg)	**1,072**	**1,429**	**709**	**13,931**
Number of days per month	30	30	30	30
Number of days per year	365	365	365	365
OFSP root requirements per week for all the shops (including 5% in bag root losses) (tonnes)	**7.50**	**10.00**	**4.96**	**97.52**
OFSP root requirements per month for all the shops (including 5% in bag root losses) (tonnes)	32.16	42.87	21.27	417.93
OFSP root requirements per year for all the shops (including 5% in bag root losses) (tonnes)	391	522	259	5,085
Acres of OFSP crop required needed per year (assuming an average yield of 3.6t/acre/cycle and 2 cycles per year)	54.3	72.4	35.9	706.2

Source: Information from stakeholders and own elaboration

Fresh sweetpotato root storage

Given the high likelihood of a lack of a constant quantity and quality of supply of OFSP fresh roots during the early stages of the enterprise and the need to ensure that the processor is not let down during this critical period, it would be advisable to strategically address this issue. This could be achieved through both the well-organised scheduling and staggering of OFSP planting by producers and the use of a fresh OFSP root storage facility at the processor's site with the capacity to hold at least 1 month's root demand. Such a storage facility could help ensure: a continuous supply of raw materials (buffering against poor harvest or transport issues); avoidance of, or lessening the need to pay high root purchasing prices during the low supply seasons; increased control over the quality of fresh roots; improved flexibility to increase or decrease puree production quantities if market demand fluctuates.

A comparison of the weekly costs of various SP fresh root store types (mainly different sized plenum chambers with cooling or insulated tunnels with plenum), factoring in the potential extra costs of having to purchase higher priced OFSP roots during the low supply seasons in various scenarios differentiated in terms of puree supply, showed the economic convenience for an OFSP puree processor of having an (appropriately dimensioned) fresh SP root storage facility.

Our analysis showed that a minimum increase of 20% of the fresh OFSP root price due to seasonality may translate into an increase of weekly costs for the processor from Ksh 14,000 (Scenario 3) to Ksh 28,000 (Scenario 2), assuming the OFSP buying price of 14 Ksh/kg and the appropriate quantity of fresh OFSP roots needed in Scenarios 1 to 3.

Considering the root storage requirements for the different scenarios, and the capital and operational costs for various types of storage facility, the analysis calculated the weekly storage costs of using the plenum chamber with cooling at Ksh 13,490 and the use of insulated tunnel with plenum at Ksh 8,179, for the maximum storage capacity of 50 tonnes in each storage system.

The comparison between the investment costs in storage facilities and potential price variation of OFSP during the low supply seasons showed that it is more economic for the puree processor to have an appropriate storage facility than to have to pay higher root purchasing prices during the low supply seasons. During the high supply season, however, this advantage can vanish as the processor will continue to pay for the storage facility. Therefore once the puree requirements are confirmed, a further analysis would need to be done to select a fresh SP storage facility of the right dimensions and suitable for the environmental conditions at the processor's site to help ensure its economic viability.

A storage facility could also help in reducing the processor's transport costs, as the root collection truck could travel less frequently but with a full load with any surplus roots not immediately required for processing being placed into the store.

No commercial SP fresh root stores yet exist in the focal counties of the study, or elsewhere in Kenya to our knowledge. However, the Kericho County Government is investing Ksh2.5 million in a SP pack-house for sorting, washing and packaging traditional yellow-fleshed SP roots intended for a nascent export market to the Kenyan diaspora based in the UK, which in 2014 exported 9 tonnes of fresh SP roots. The facility's plan includes a store room but it is uncertain at this stage what level of utilisation of this will occur, especially as root freshness is such an important characteristic for Kenyan fresh SP root consumers. If fresh SP root storage was found to work well and the stored roots were acceptable to urban Kenyan consumers, allowing fresh SP root storage to play a role in enhancing SP producers' livelihoods, it is possible that other County's would also invest in such stores. As stakeholders reported that since the devolution process a higher proportion of resources were being targeted to tangible investments such as buildings as opposed to agricultural training. However, support for significant harvest and postharvest handling and storage training would also be required by SP producers and store managers for successful root storage.

The stakeholders interviewed felt that a fresh SP root storage facility at local level might bring a diverse range of advantages to their SP value chains, in terms of: opportunities to bulk and store SP roots to help access larger markets and better prices; motivating producers, traders or processor into practicing improved postharvest handling; driving a change from the use of volumetric sacks to per kg sales of SP roots; ensuring a constant supply of roots to a processor; enhancing local food security; avoiding weevil and mole rat damage and root quality deterioration which occurs when mature SP roots are left in the ground. Perceived problems included: additional storage costs making the roots too expensive; no/low market demand for stored fresh roots; weak store management leading to root quality deterioration and losses or theft; short shelf-lives of some varieties rendering them unfit for storage of more than 1 week; farmers need for instant cash returns from SP production making storage an unattractive option to them.

1. Introduction

1A. Objective of the study

The Sweetpotato Action for Security and Health in Africa (SASHA) project was launched in 2009, to improve food security and health conditions of poor families in sub-Saharan Africa (SSA) by supporting them to exploit the full potential of the sweetpotato (SP) crop. During the SASHA Phase 1 many goals were achieved, including improvements in conventional breeding and indisputable evidence of the benefits of the high concentrations of pro-vitamin A in orange-fleshed sweetpotato variety (OFSP) to young children and pregnant women. Moreover, during SASHA Phase 1 in Rwanda, experience has been gained on the large-scale commercial production and marketing of bakery products that incorporated OFSP puree in their recipes. The use of OFSP puree was found to be economically more advantageous than OFSP flour and was highly acceptable to consumers, justifying the broader diffusion of OFSP puree-based products in other SSA countries.

The SASHA Phase 2 project builds on the findings and recommendations of Phase 1, with a strategic focus on the remaining bottlenecks to improve the utilization pathways for consumption and production. To ensure continuous access to fresh roots to nutritionally at risk households, urban consumers and those engaged in SP processing, one of the main issues remains to better understand the year round availability and supply of fresh SP roots. Due to climatic conditions and cultivation of other crops, not all geographic locations allow year-round fresh SP root production. To help reduce SP root supply fluctuations it is important to deepen our understanding of appropriate SP root handling practices during and after harvest, including the development of appropriate and cost-effective fresh SP root storage technologies at medium/large and small -scale levels.

This study investigated the:

- fresh SP root production, availability and service provision in the counties of Homa Bay, Migori, Siaya, Busia, and Kericho in Kenya;
- trade of fresh SP roots to major urban markets in Nairobi, Nakuru and Kisumu;
- existing and proposed OFSP processing; and
- potential for fresh SP root storage.

The aim of this study was threefold. Firstly, we looked at the SP value chain in several counties and gathered detailed information about it from interviews with agents at different segments of the chain (i.e. production, processing, trading and agricultural service provision activities) and assessed the strengths and the weakness of each SP value chain. Secondly, based on the information gathered from the value chain studies we assessed the feasibility of OFSP puree processing activities. The initial OFSP puree demand from the supermarket chain which wishes to include it in their bakery products, will require the provision of OFSP puree from only one processor, but longer-term the demand is likely to increase as the product's potential becomes established. Thirdly, we aimed to use the detailed value chain and root supply information acquired to provide some insights on the opportunities for establishing fresh SP root storage facilities (and related technologies).

This report is structured as follows: the remainder of **Chapter 1** discusses the approach and methodology of the study and issues related to the data collected. **Chapter 2** provides a brief overview of the geographical and socio-economic contexts of focal SP producing areas studied. **Chapter 3** presents the structure of the value chain, identifying the agents and activities. It then provides detailed findings of the SP value chain in each of the focal counties, i.e. Kabondo in Homa Bay, Busia, Migori, Siaya, Kericho and an analysis of fresh SP root trade in the urban markets of Nairobi, Nakuru, and Kisumu. **Chapter 4** presents a comparative analysis of the SP value chains across the focal locations. **Chapter 5** provides an assessment of the potential role of fresh SP root storage facilities. **Chapter 6** discusses the OFSP puree processing business opportunity. **Chapter 7** summarises the conclusions of the study and formulates recommendations on interventions to

complement, operationalise and strengthen the fresh SP root supply and availability. A separate **Annex** containing the full transcripts of each interview has also been compiled.

1B. Approach and methodology

This section presents the approach and methodological underpinnings of the study. The analysis of the value chains in selected counties provides an overview of the current situation, identifying strengths, weaknesses and bottlenecks considering the context and the different agents engaged in one or more activities within the chain.

The data used in the study mainly come from interviews with key value chain agents (e.g. farmer focus groups; individual case study farmers; traders; transporters; retailers; processors; and service providers). Secondary data have been provided by the Kenyan Ministry of Agriculture (MoA) officers in each county, and through relevant literature on Kenya, SP value chains and processing/storage. The (primary) data collection was carried out in eight Counties (Kabondo in Homa Bay, Busia, Migori, Siaya, Kericho and the urban areas of Nakuru, Kisumu and Nairobi) between 9th and 17th December 2014. An overview of the interviews conducted during the field work is presented in Table 1.1, these interviews involved more than 100 respondents, through 59 focus group and individual discussions carried out by researchers from the Natural Resources Institute (NRI), UK (Ilaria Tedesco and Tanya Stathers) and the International Potato Centre (CIP), Kenya (Olivia Wahonya and Sarah Kariuki) with support from local MoA and NGO staff. Checklists for each value chain agent were prepared in advance and used during the fieldwork, notes were taken in notebooks. The data entry, analysis and report writing has been done by the NRI researchers. The interviews were conducted in Swahili, Luo or English.

The selection of the agents to interview were carried out by the main SP service providers in each county (typically the MoA staff together with an NGO active in SP promotion) with the support of the CIP and NRI team to ensure a representative level of coverage of different activities in each location. The primary data provides a detailed understanding of relevant activities, SP root exchanges and flows within these major SP producing and consuming locations of Kenya.

In Chapter 3 of this report there are several tables reporting revenues, costs, margins and main characteristics of selected agents interviewed during our field visits. The revenues take into account all the activities that deal with sweetpotato, orange-fleshed sweetpotato and vines; the costs listed represent all the expenses faced by each agent to run their activities. The production and trading activities are recorded in per sacks term; where possible, information about the dimensions of the sacks (and related differences between counties and agents) are provided. However, the highly variable and volumetric measures (e.g. flat sack, *Prim* extended sack, *Bao*-sized sack etc.) used for the SP root trade make it difficult to compare prices and profits between locations and agents along the value chain. We have included as much data as possible to help in understanding these complexities. The individual case studies with a few SP farmers at each location, present data on labour costs that can be hired and/or provided by family members; for family labour, it has been accounted the same wage recorded for hired labour (with the calculation of two different gross margins, with and without family labour cost). The production of SP for home consumption is recorded as a production amount to be traded, as it may represent a shadow revenue (or missed costs) for the farming household.

Table 1.1 - Focus group discussions and case study interviews conducted in Kenyan sweetpotato value chain study 9-17th December 2014

County *Type*	**Busia**	**Kabondo, Homa Bay**	**Migori**	**Siaya**	**Kibuye mkt, Kisumu**	**Kericho**	**Wakulima mkt, Nakuru**	**Muthurwa mkt, Nairobi**
Farmer focus group	X	X	X	X		X		
Indiv. farmer SP activity case study & COP	X,X	X,X	X,X,X	X,X,X		X,X		
Retailers					X X	X	X	X
Transporters		X X	X					
Traders		X	X	X	X	X X	X	X
OFSP Processors	-Siwongo	-Kabondo SP Coop -Homa SG		-HIV Group -Individual				
Extn & NGO	REFSO & MoA	MoA	FCI & MoA	MoA & UCRC		MoA	MoA - agribusiness	
Urban consumers					X,X,X,X,X,X		X, X, X	X,X,X,X,X,X
Total =59	**5**	**9**	**7**	**8**	**9**	**7**	**6**	**8**

Key: X represents each interview. For processors and Extension & NGO service providers the organisational names of those interviewed have been given

2. Brief description of the focal sweetpotato producing areas

2A. Geography and climate

Situated on the equator on Africa's east coast, Kenya borders Ethiopia to the north, Somalia to the east, Tanzania to the south, Uganda and Lake Victoria to the west, Sudan to the northwest, and the Indian Ocean along the southeast coast (Figure 2.1).

Figure 2.1- Political map of Kenya

Kenya is endowed with a large variety of ecosystems and habitats, which include wetlands, farmlands, wildlife, forests, lakes and rivers, and marine life. The total area of the country is 580,370 km^2, with an altitude that varies from sea level to about 5,000 m in the central highlands with the peak of Mt. Kenya. About 80% of the country is constituted by arid and semiarid land (ASAL).

Much of the ASAL is used for extensive livestock production, pastoralism as well as a habitat for wildlife living in or out national parks and reserves. An area of ~99,500 km^2 (~10 million ha), corresponding to 17% of the country, is land with high to medium agricultural potential for crop and dairy production supporting about 75-80% of the country's population food requirements[1,2] (FAO, 2005; FAO, 2013).

The climate of Kenya is mainly tropical with temperatures influenced by the altitudes, nearness to the equator, topography, and the Inter-Tropical Convergence Zone[3] (ITCZ).

[1] FAO (2006). AQUASTAT country profile Kenya. FAO, Rome

[2] FAO (2013). Monitoring African and Food Agricultural Policies (MAFAP), Review of food and agricultural policies, in Kenya 2005-2011, FAO, Rome

[3] Near the equator (from 5° north to 5° south), the northeast trade winds and southeast trade winds converge in a low pressure zone known as the Inter-tropical Convergence Zone or ITCZ bringing precipitation.

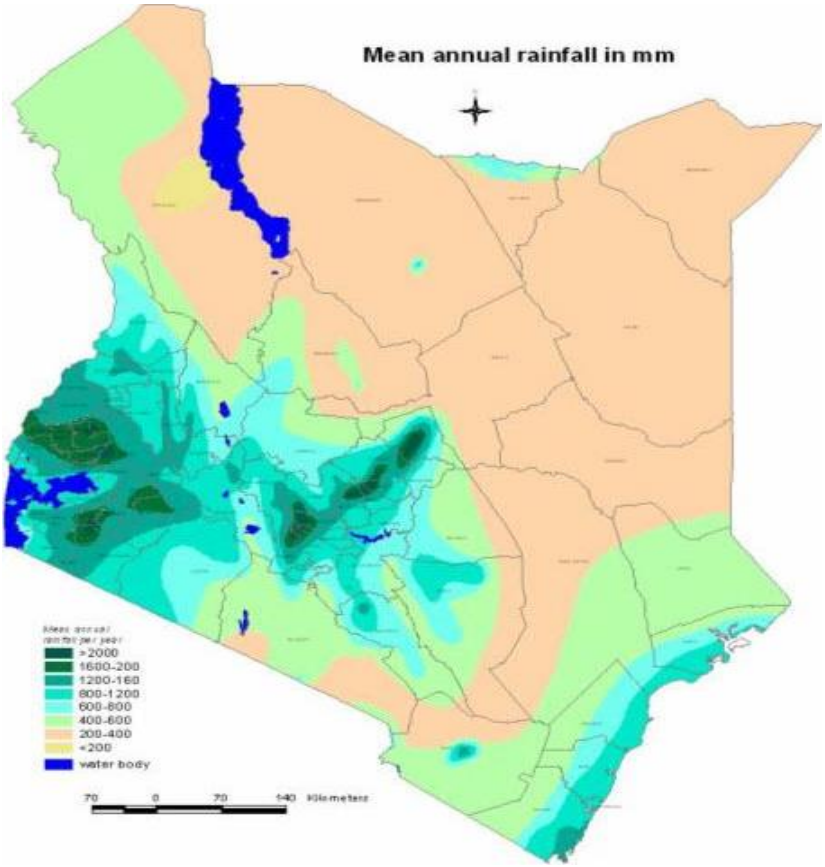


Figure 2.2 – Kenya annual rainfall (in mm)

Source: http://www.infonet-biovision.org/, FAO

The country's average annual rainfall is 630 mm, varying from less than 200 mm in northern Kenya to more than 2,000 mm on Mt. Kenya (Figure 2.2). The country's rainfall distribution pattern is generally bimodal with the long rains lasting from March/April to May/June and the short rains from October to November/December in most of the country, except for areas located in the west Rift valley where only one long annual rainy season is experienced.

On the basis of the ratio of average annual rainfall and average annual potential evaporation, Kenya can be divided into seven major agro-climatic zones (ACZ) (Figure 2.3).

Zone I (Alpine) is confined to high mountains and the land is not available for agriculture; Zones II to IV are the humid and sub-humid areas supporting agricultural activities; Zones V to VII include arid and semi-arid land where rainfall is generally poor and evapo-transpiration is high. Details on rainfall on each ACZ are in Table 2.1.

Table 2.1 – Agro-climatic zone and rainfall (in mm/year)

Agro-climatic zone (ACZ)	Rainfall (in mm/year)
Zone I	>1,500mm
Zone II	>1,000mm
Zone III	950-1,500 mm
Zone IV	500-1,000 mm
Zone V	300-600 mm
Zone VI	200-400 mm
Zone VII	NA

Source: FAO

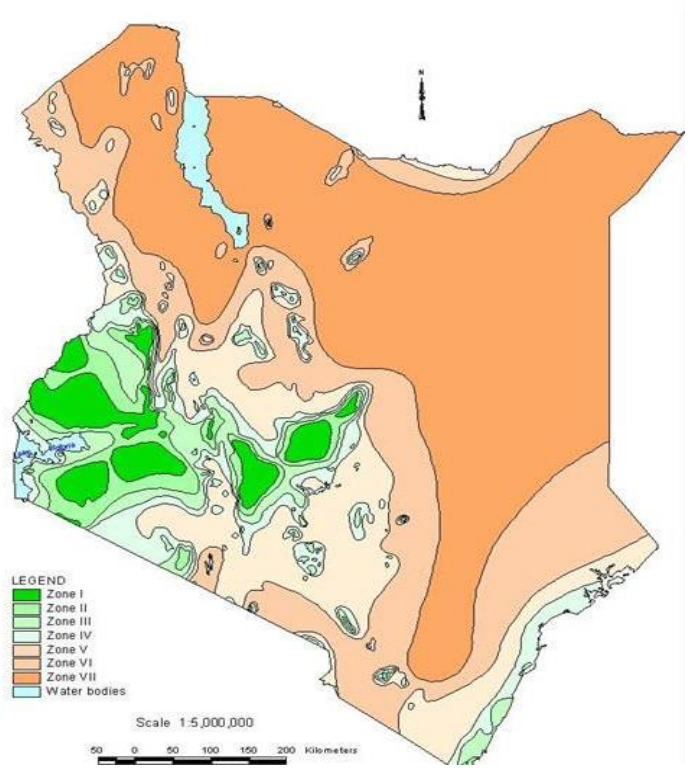


Figure 2.3 – Kenya's agro-climatic zones

Source: http://www.infonet-biovision.org/, FAO

Since the new constitution in 2013, Kenya has begun operating a devolved government and is geographically divided into 47 counties as opposed to the former eight provinces and 70 districts.

This value chain study focused on the SP production, trade and processing activities in five counties, Homa Bay, Migori, Siaya, Busia and Kericho (shown in green on Figure 2.4 and described in Table 2.2). It then followed the sweetpotato roots into the urban markets of Kisumu, Nakuru and Nairobi (shown in yellow on Figure 2.4).

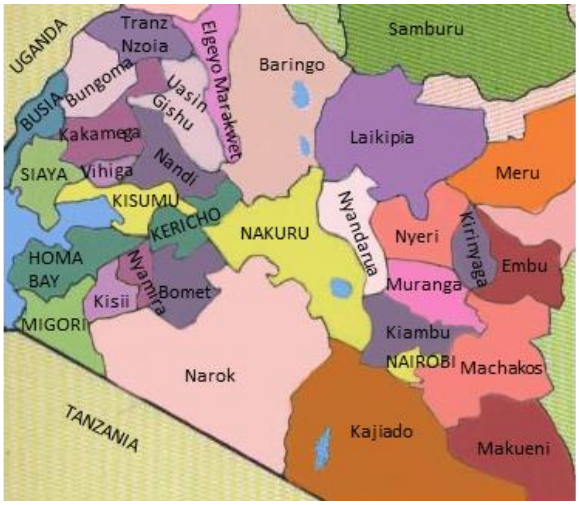


Figure 2.4 - Map showing the focal study counties in green and yellow

Table 2.2 Basic statistics of the focal counties

County	Former province	Area (km^2)	Population (as of 2009)
Homa Bay *(which Kabondo is part of)*	Nyanza	3,155	963,794
Migori	Nyanza	2,587	917,170
Siaya	Nyanza	2,496	842,304
Busia	Western	1,628	743,946
Kericho	Rift Valley	2,455	752,396

Kericho county is located in Zone II in a cool and wet medium altitude zone with high rainfalls >1,000 mm per year in 4 out of 5 years.

A large portion of former Nyanza Province (including Siaya, Homa Bay, Kisumu and Migori counties), Western Province (including Busia and Bungoma counties), and the Central Rift Valley area of Nakuru are placed in Zone III that constitutes the most significant part of the country for agricultural production.

Homa Bay county, has semi-arid climatic conditions with daily temperatures ranging between 26°C during the coldest months (April and November) and 34°C during the hottest months (January to March). The county receives between 250mm and 1,200mm of rainfall annually, with the average annual rainfall estimated at 1,100mm. It has two rainy seasons: long rains in March-May and short rains in September to November.

In Busia county, agricultural production can occur almost all year long, as they do not have more than a 1 month period without rain.

The soil types in Kenya vary due to topography, the amount of rainfall and the parent material. In particular, in the western parts of the country soils are mainly acrisols, cambisols and their mixtures highly weathered and leached with accumulations of iron and aluminium oxides (FAO, 2006). In the sub-humid regions, i.e. the Lake Region and western Kenya, soils are red clay.

The National Development Plan 2002-2008 recognizes Kenya as a water scarce country: 90% out of 164 sub-basins with perennial river flows suffer from surface water deficit and the water demand exceeds renewable freshwater sources (FAO, 2006). The main drainage areas of the country are: Lake Victoria, covering 8 percent of the country and constituting the largest water source near to our focal areas, Rift valley and inland lakes (covering 22.5% of the country), Athi River and Coast (11.5%), Tana River (21.7%), Ewaso Ng'iro (36.3%). The country's water distribution in the drainage basins is both skewed and uneven within the country.

2B. Socio-economic context

Kenya is now recognised as a lower middle-income country, following the 're-basing' of its national statistics in September 2014. This revision calculated its economy to be 25% larger than the earlier estimate, making it the ninth largest economy in Africa with a GDP of $55.2 billion. Kenya's annual GDP growth was 5.7% in 2013 and is forecast to be 5.4% in 2014. The population was estimated at 44.35 million in 2013, and had a GNI per capita of $1,160. Kenya along with other Sub-Saharan African (SSA) countries is rapidly urbanizing, Kenya's urban population is growing at a rate of 4.4% annually, compared to 2.1% for the rural population (UN, 2014[4]) In 2013, 24.8% of the nation's 43 million people lived in urban centres, with at least 3.3 million of them living in Nairobi (UN, 2014). Projections suggest that by 2050 44% of Kenya's 97 million people will live in urban centres (Figure 2.5).

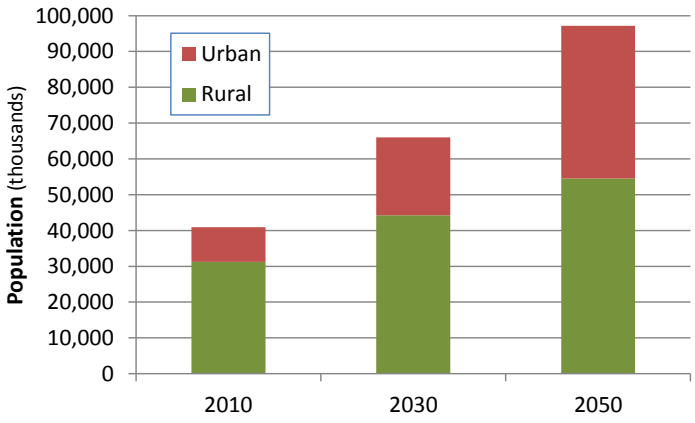


Figure 2.5 Kenya's projected rural and urban population by 2030 and 2050

Crop production data disaggregated to county or district level is not easily accessible for Kenya. However, national level crop data is available on the FAOSTAT database. The production of many of the staple food crops has been rapidly increasing since 1961 (Figure 2.6). Maize, Irish potato, banana, sweetpotato and cassava are now the major staple foods produced in Kenya. Much of this increased production is due to an expansion of the area of land having been planted to these crops since 1961. This is particularly the case for maize (Figure 2.7), however when the data for sweetpotato is studied alone the increase in area under sweetpotato can also be seen to have dramatically increased (Figure 2.8). When the area planted to each of these crops is compared to the 1994 area, sweetpotato and rice can be seen to have expanded particularly rapidly (Figure 2.9).

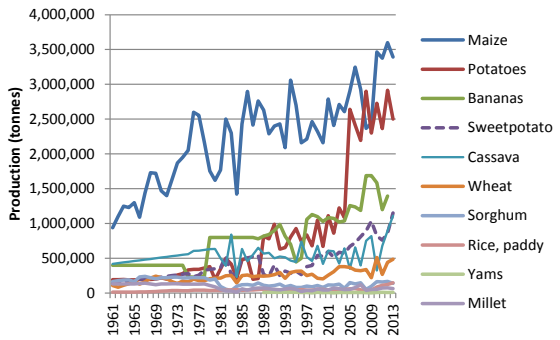


Figure 2.6 Kenyan staple food crop production trends from 1961-2013

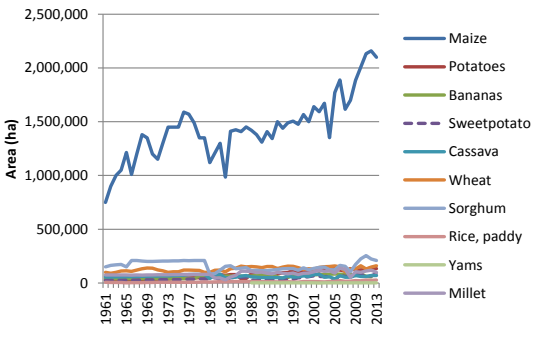


Figure 2.7 Kenyan staple food crop area trends from 1961-2013

[4] UN Statistics Division, 2014 World Pocket Book. http://data.un.org/CountryProfile.aspx?crName=kenya

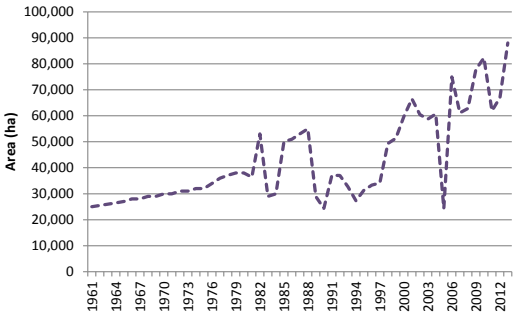


Figure 2.8 Area planted to sweetpotato in Kenya from 1961-2013

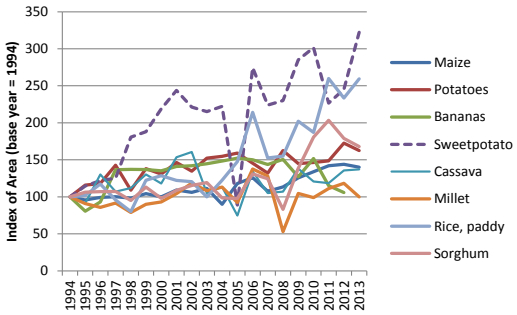


Figure 2.9 Proportional growth in area of different staple crops in Kenya from 1994-2013

Data source: FAOSTAT

The UNDP Human Development Index (a measure of three basic dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living) for Kenya was 0.519, placing it in the low human development category in 2012[5]. Kenya's HDI value has increased since 1980. The current HDI value positions Kenya at 145 out of 187 countries, placing it above the regional Sub-Saharan African (SSA) average HDI of 0.475, and above the average 0.466 for countries in the low human development group. Other SSA countries which are close to Kenya in 2012 HDI rank and population size are Cameroon and Tanzania, their human development indicators are also shown in Table 2.3.

The Inequality Adjusted HDI (IHDI) takes into account inequality in all three dimensions of the HDI, so whilst the HDI can be viewed as an index of 'potential' human development, the IHDI is an index of actual human development. The loss in potential human development due to inequality is given by the difference between the HDI and the IHDI.

Table 2.3 UNDP 2012 Kenya Country Profile of Human Development Indicators

		Kenya 2012	Tanzania 2012	Cameroon 2012	Sub-Saharan Africa 2012
Health: Life expectancy at birth (years)		57.7	58.9	52.1	54.9
Education: Mean years of schooling (years)		7.0	5.1	5.9	4.7
Income: GNI per capita in PPP terms (constant 2005 international $)		1,541	1,383	2,114	2,010
HDI value		0.519	0.476	0.495	0.475
Human Development Index Ranking		145	152	150	-
Inequality: Inequality-adjusted HDI value		0.344	0.346	0.33	0.309
Overall loss due to inequality (%)		33.6%	27.3%	33.4%	35%
Gender: GII: Gender Inequality Index, value		0.608	0.556	0.628	0.577
Maternal mortality (per 100,000 live births)		360	460	690	475
Population with at least secondary education (%)	Female	25.3	5.6	21.1	23.7
	Male	52.3	9.2	34.9	35.1
Labour force participation rate (%)	Female	61.5	88.2	64.2	64.7
	Male	71.8	90.3	77.4	76.2
Poverty: Multidimensional poverty index		0.229	0.332	0.287	
% of popn. living in multidimensional poverty		47.8	65.6	53.8	
% of population living in income poverty		43.4	67.9	9.6	
% of population living in severe poverty		19.8	33.4	30.4	
Demography: Population, total both sexes (million)		43.178	47.783	21.699	

Data source: http://hdr.undp.org/sites/default/files/Country-Profiles/KEN.pdf and http://data.worldbank.org

[5] http://hdr.undp.org/sites/default/files/Country-Profiles/KEN.pdf

The Gender Inequality Index (GII) reflects gender-based inequalities in three dimensions – reproductive health, empowerment, and economic activity. Maternal mortality in Kenya is lower than the SSA average, and an above average number of women have reached secondary or higher level education that across SSA, however it is still a much lower percentage of women than men that reach secondary education in Kenya.

However, development within Kenya is uneven, with a higher incidence of poverty in the former provinces of Western (59% poverty) and Nyanza (63% poverty) where most of the focal sweetpotato producing counties visited are located (Figure 2.10). While the map provides a general impression of how overall poverty differs between the provinces, in reality hotspots of poverty are not concentrated and many of the counties in Kenya have at least one location with more than 70 percent poverty incidence. Using data from the Kenyan Integrated Household Budget Survey of 2005/06[6], an overview of how the focal counties compare to the national and provincial averages for various factors can be obtained. It should be noted that in 2005/06 Kenya still used a province and district administration system and so the data presented is for the districts which the focal counties fall within, most have the same name, although the Kasipul-Kabondo sweetpotato producing area fell within the former Rachuonyo district (and then was later placed within Rachuonyo south district).

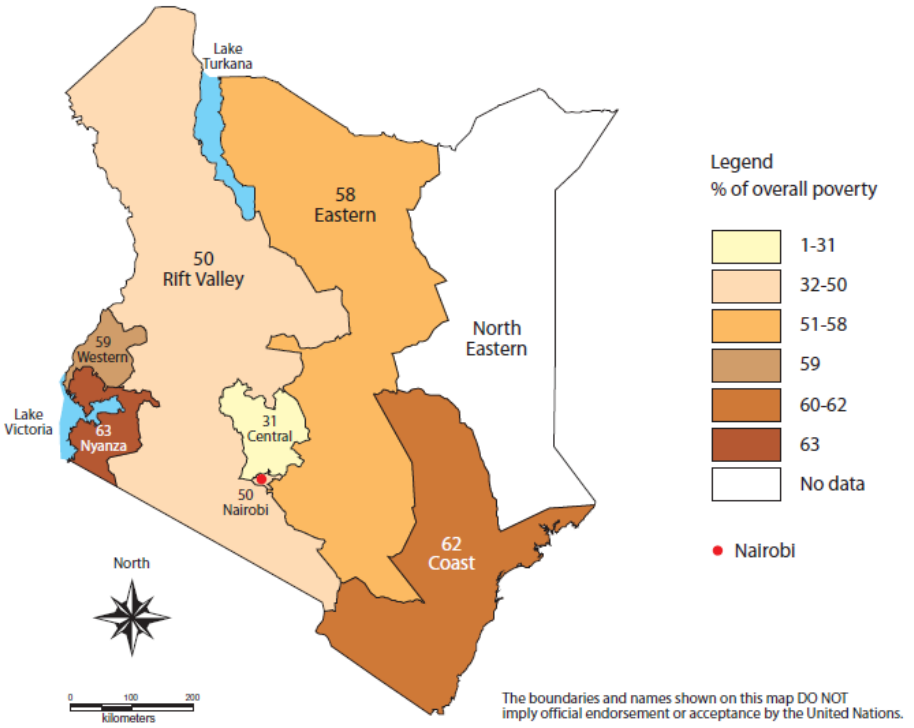


Figure 2.10 Kenya: Incidence of poverty by province

Data source: UNDP, 2006

Due to the youthful populations in our focal areas, the age dependency ratio is above 90% in all with the exception of Kericho where it is slightly lower (Figures 2.11 and 2.12). In all the focal counties except Siaya, >45% of the population are children below 15 years old, and less than 5% of the population are above 65 years old. The mean household size was larger than the national rural average (5.5 people) in Rachuonyo and Busia districts at 5.6 and 6.3 people per household respectively. The figures for Migori, Siaya and Kericho districts were 5.1, 4.4, and 4.2 people per household respectively.

In the focal counties in Nyanza the proportion of households headed by women is higher than the Kenyan national rural average (Figure 2.13). In Rachuonyo, >40% of households were female headed in 2005. In the focal counties in Nyanza and Busia, the proportion of polygamous or widow/widower headed households is much higher than the national average, but this is not the case in Kericho.

[6] the KIHBS survey was done again in 2013 but the data in not yet publically available

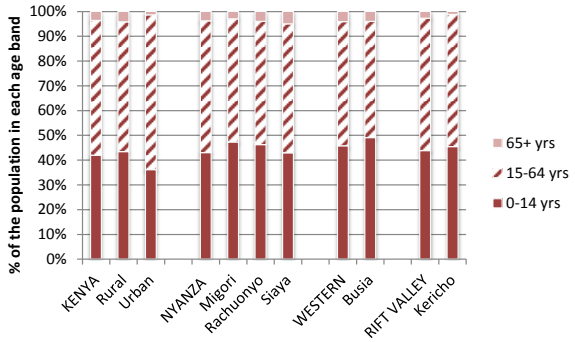


Figure 2.11 Proportional age bands of the population in each location

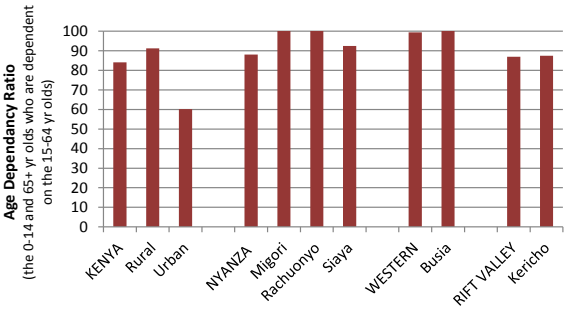


Figure 2.12 Age dependency ratio in each location

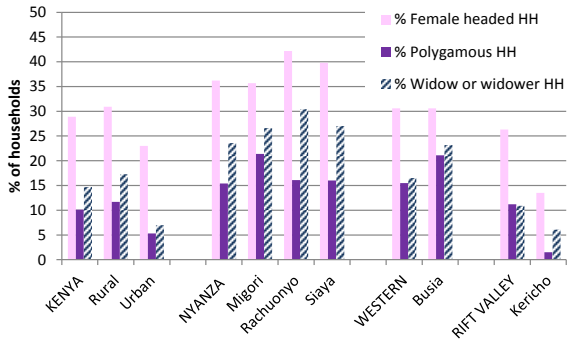


Figure 2.13 % of female headed, polygamous and widow or widower headed households

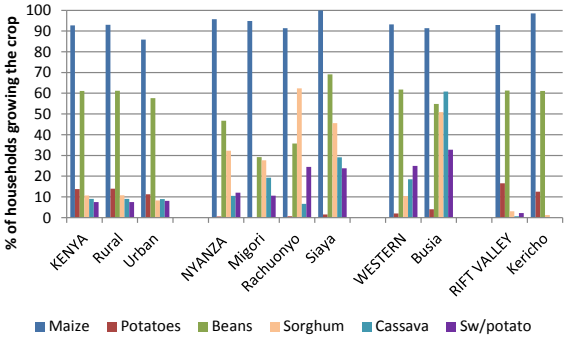


Figure 2.14 % households growing the listed crops (maize, Irish potato, beans, sorghum, cassava and sweetpotato)

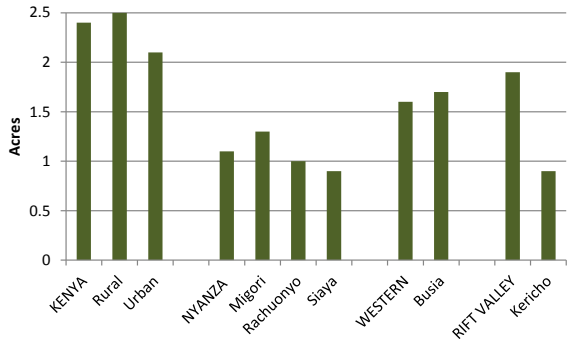


Figure 2.15 Mean agricultural farm/holding size

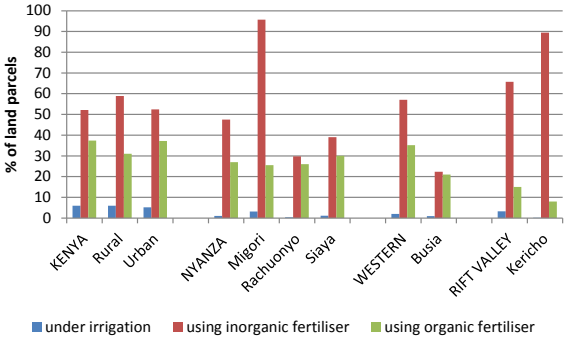


Figure 2.16 Proportion of land parcels under irrigation or using inorganic or organic fertilisers

Data source: Kenya Integrated Household Budget Survey, 2005/06

The KIHBS survey also asks households about some of the crops they are growing (Figure 2.14). Throughout our focal areas, maize and beans were the most commonly grown crops, with maize being grown by over 90% of households in all the focal areas. Sweetpotato was reportedly only grown by 33% of households in Busia, 25% in Rachuonyo, 24% in Siaya, 11% in Migori and less than 1% of households in Kericho, and by only 7.5% of rural households nationally. Cassava was more frequently grown than sweetpotato in Busia and Siaya districts, and sorghum was more frequently grown than sweetpotato in all the districts. Irish potato was more frequently grown than sweetpotato in Kericho but not in the other focal districts.

Average farm sizes are smaller in all our focal areas (0.9 -1.7acres) than the national average of 2.4 acres (Figure 2.15). This is particularly the case in Rachuonyo, Siaya and Kericho where farm sizes are ≤1 acre per household. Whilst nationally 6% of land parcels were irrigated in 2005, in all the focal areas it was ≤1.1% except for Migori where 3.2% of land parcels were irrigated (Figure 2.16). The % of land parcels where inorganic fertilisers were used was significantly higher than the national rural average of 58.9%, in Migori (95.7%) and Kericho (89.4%), but lower in all the other focal areas. Between 20-30% of land parcels had organic fertiliser applied to them in the focal areas, with the exception of Kericho where only 8% of land parcels had organic fertilisers applied.

Literacy is higher for males than females in all of the focal districts. Primary school attendance is generally high in the focal areas, and slightly higher for girls than boys in Siaya and Kericho districts (Table 2.4). Nationally only 17% of boys and 19% of girls attend secondary school, in Migori, Siaya, and Busia these figures are lower than 12%. While attendance of girls is notably high in Rachuonyo district at 27.6%, it is notably lower than that of boys in all the other focal districts.

There is extremely strong opposition to women being able to inherit land from their fathers in the focal areas of Nyanza province (>88% of households), and fairly strong opposition in Busia (64.5%) and Kericho (47.6%) (Table 2.5).

A higher than average proportion of young children suffered diarrhoea in all the focal areas of the former Nyanza province, where the incidence of households having no toilet facilities is much higher than average (Table 2.5). Water collection takes more than an hour for >15% of households in Rachuonyo and Busia.

Child stunting is higher than average in all the focal areas except Migori, while child wasting is lower than average in all the focal areas except Migori and Kericho (Table 2.5). Whilst exclusive breastfeeding is practiced for an average of 5.2 months in Busia, and 4.7 months in Siaya, it is only practiced for 1.6 and 1.4 months in Kericho and Rachuonyo.

Table 2.4 Gender disaggregated educational and literacy statistics for each location

	Net Primary School Attendance Ratio		Net Secondary School Attendance Ratio		Can Read and Write*	
	Male	Female	Male	Female	Male	Female
KENYA - national	**78**	**80.2**	**17**	**19.2**	**84.8**	**73.6**
Rural	77.5	79.1	14.4	17.4	82.2	69.9
Urban	80.6	85.7	30.7	29.1	93.6	88.1
NYANZA	**80.8**	**83.2**	**16.2**	**21.5**	**91.9**	**77.9**
Migori	83.8	77.1	8.5	6.8	95.6	81.4
Rachuonyo	86.1	83.9	14.8	27.6	92.3	81.9
Siaya	83.8	85.9	11.5	4	89.2	68.7
WESTERN	**78.2**	**83.1**	**13.9**	**11.2**	**87.5**	**76.4**
Busia	81.5	76.4	9.3	2.1	85.6	64.5
RIFT VALLEY	**74.3**	**75.5**	**15.8**	**18.9**	**77.7**	**68.2**
Kericho	80.7	83.5	14.9	3.2	95	81.1

Data source: Kenya Integrated Household Budget Survey, 2005/06

Table 2.5 Assorted gendered, health and nutritional livelihood aspects in each location

	% thinking that women should not inherit land from their fathers	Proportion (%) of children (0-59m) who suffered diarrhoea	% of households with no toilet facility	% of household taking >1hr to fetch and return from collecting drinking water	% of stunted children (6-59 months)	% of underweight children (6-59 months)	Mean length of exclusive breastfeeding (months)
KENYA	**48.5**	**10.7**	**14.8**	**14.4**	**34.7**	**20.9**	**3.1**
Rural	52.4	11	18.8	18.5	36.7	22.6	3.1
Urban	36.1	9.6	2.6	2.3	25.2	13.1	3
NYANZA	**92.2**	**18**	**23.7**	**16.7**	**36.2**	**17.8**	**2.5**
Migori	89	21.9	36.5	3.6	33.4	21.6	2.4
Rachuonyo	88.7	18.5	38.7	20.7	46.7	11.9	1.4
Siaya	100	15.2	16.8	9.1	53.7	14.9	4.7
WESTERN	**51.6**	**13.7**	**3.4**	**11.8**	**32.7**	**20.2**	**4.3**
Busia	64.5	3.9	9.5	15.7	43.5	18.3	5.2
RIFT VALLEY	**63.6**	**10**	**21.6**	**17.9**	**32.1**	**20.4**	**3.2**
Kericho	47.6	10.9	11.6	11.5	37.9	22	1.6

Data source: Kenya Integrated Household Budget Survey, 2005/06

The World Health Organisation's Global Database on Vitamin A deficiency (VAD)[7] reports that in 2006, 84.4% of pre-school age children and 17.3% of pregnant women across Kenya had serum retinol levels <0.7umol/l[8], and 1.4% of pre-school children and 6.4% of pregnant women suffered from night blindness.

National demographic health surveys typically record information on the specific micronutrient-rich types of food eaten by young children and women in the preceding 24 hours, and on any additional micronutrient supplements received. A summary of this data for the intake of vitamin A, iron and iodine rich foods and supplements across Kenya, with comparative national level data for Tanzania and Nigeria is shown in Table 2.6.

Table 2.6 Intake of Vitamin A, Iron and Iodine rich foods and supplements by young children in Kenya, Tanzania and Nigeria

	Micronutrient rich food use			**Micronutrient supplement use**		
	% who in the 24 hours prior to the survey ate foods rich in			*% of children 6-59 months old*		
	Children 6-35 months old		Women 15-49 years	given vitamin A supplements in the last 6 months	given iron supplements in the past 7 days	living in households with iodised salt
	Vitamin A	Iron	Vitamin A			
Kenya	**77.3**	**29.8**		**30.3**	**4.8**	**97.7**
Nairobi	84.2	37.8		38.7	5.5	99.2
Central	88.8	28.2		27.7	4.8	100
Coast	74.4	28.5		38.3	3.0	96.7
Eastern	80.3	25.4		25.5	1.7	92.3
Nyanza	79.6	34.7		25.8	7.7	99.1
Rift Valley	70.9	23.8		30.9	4.5	98.7
Western	86.6	42.6		19.8	4.1	98.9
N. Eastern	26.9	20.5		25.6	10.6	94.8
Tanzania	**61.5**	**29.8**	**62.0**	**60.8**	**1.4**	**55.2**
Nigeria	**69.6**	**57.8**	**66.8**	**25.8**	**15.7**	**52.9**

Source: National Demographic Health Surveys: Kenya, 2008/9[9]; Tanzania, 2010; Nigeria, 2008

[7] http://whqlibdoc.who.int/publications/2009/9789241598019_eng.pdf
[8] Serum retinol levels <0.7umol/l is a measure of VAD, as is the presence of night blindness
[9] KNBS (2010), Kenya: Demographic and Health Survey 2008-09. http://dhsprogram.com/pubs/pdf/FR229/FR229.pdf

In Kenya, 77% of children aged 6-35 months consumed foods rich in vitamin A during the 24 hours preceding the survey. The proportion of children consuming vitamin A rich foods increases with age, from 49% at 6-8 months to 86% at 24-35 months. Young children in both Western (87%) and Nyanza (80%) provinces were likely to have consumed vitamin A rich foods, while this likelihood is much lower in North Eastern Kenya (27%). The educational level of the mother was closely correlated with consumption of vitamin A rich foods. The proportion of children fed iron rich foods is much lower than those fed vitamin A rich foods. The percentage of children given vitamin A supplements in Kenya is low compared to Tanzania, with 20% and 26% of those in Western and Nyanza provinces receiving them. Nearly all children in Kenya live in households with adequately iodised salt.

Whilst data on the % of women who had consumed vitamin A rich foods prior to the survey was not collected in the Kenyan survey, information on what percentage of mothers received a vitamin A dose postpartum was presented revealing that nationally 45.8% of women did, with 47.6% of women in Western and 45.4% of women in Nyanza receiving it. Nationally only 1.5% of the 15-49 year old women who had had a child in the last five years reported suffering from night blindness.

Kenya's Vision 2030, is a long-term development blue print to create a globally competitive and prosperous nation with a high quality of life by 2030, that aims to transform Kenya into a newly industrialising, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment. The vision is anchored on three key pillars: economic, social and political governance. Agriculture is highlighted as it is one of the priority sectors that make up Kenya's GDP and employment opportunities. Agricultural production together with forestry contribute 21% of Kenya's GDP[10], with another 20% coming from agriculture related transport, processing and trade. The Vision 2030's flagship agricultural projects include: implementation of the consolidated agricultural reform legislation; fertiliser cost-reduction initiative; livestock disease free zones in the arid and semi-arid land (ASAL) regions; and irrigation projects in the ASAL region.

[10] Central Bank of Kenya, 2012

3. Description of the sweetpotato value chain

3A. General structure of the sweetpotato value chain

This study analysed the sweetpotato (SP) value chain in five sweetpotato producing counties of Kenya (Busia, Siaya, Homa Bay (Kabondo area), Migori and Kericho) and three major urban markets in Kenya (in Kisumu, Nakuru and Nairobi). The locations are indicated with blue arrows in Figure 3.1.

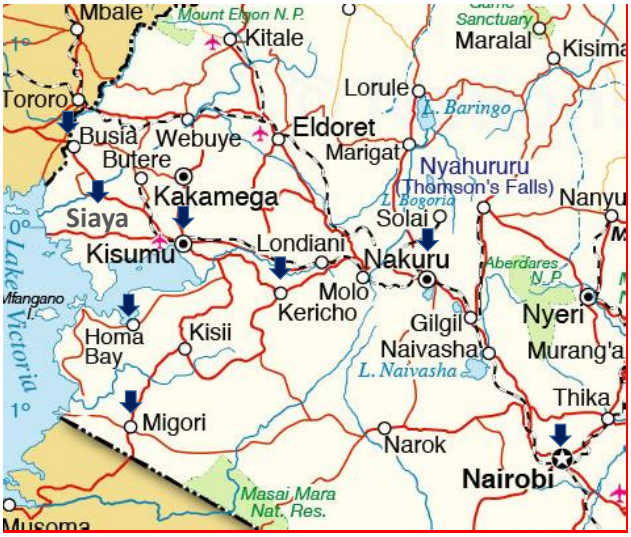


Figure 3.1. Map of areas covered by the analysis

The analysis focusses on the different contexts where the value chain is located and on the physical and monetary flows of inputs and outputs characterizing each agent and activity of the chain.

The data used are mainly elaborated from primary data, supported by secondary sources. The primary data were collected through 59 individual or focus group interviews involving more than 100 respondents, between 9th and 17th December 2014.

The aim of the value chain analysis was to deepen understanding of the entire flow of the SP value chain, i.e. from production to urban consumption, to learn about:

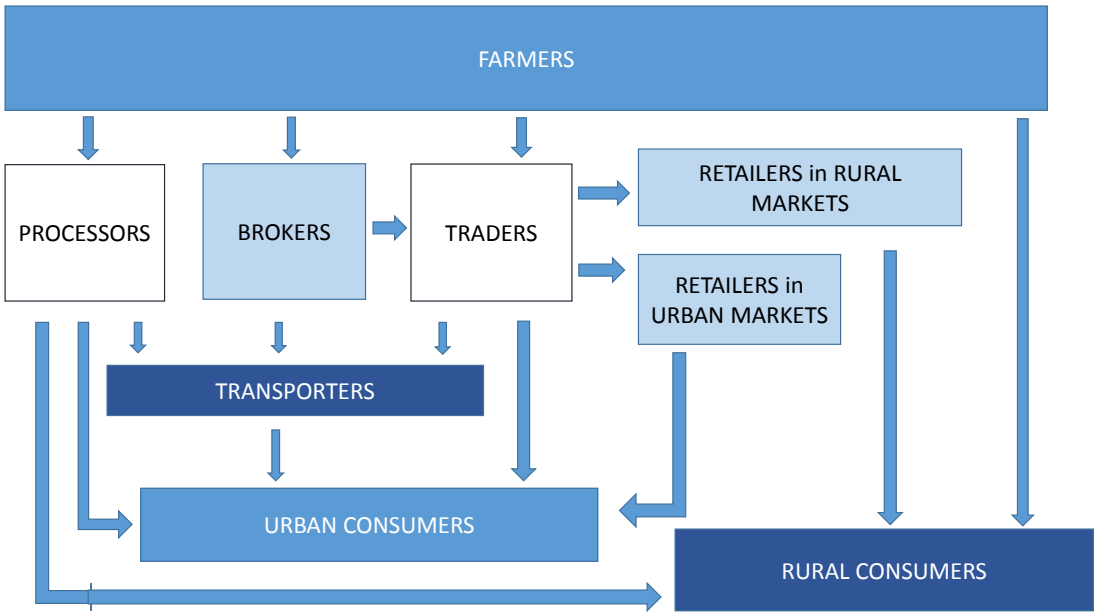
- the SP production activities, patterns and seasonality, and related productivity issues for different counties and SP varieties;
- the activities, strategies, linkages and margins of the agents involved in the value chain;
- how the price of fresh SP roots change along the chain and between peak and low production seasons, in the different counties and markets;
- consumers SP preferences, purchasing and food preparation habits, and choices;
- the strengths and the constraints of the overall chain.

The production systems analysed are located in Busia, Kabondo area of Homa Bay, Migori, Siaya, and Kericho counties, and consider the production of white-, yellow- and orange-fleshed SP varieties, the associated trading and processing activities. For each of the focal SP production counties, specific attention has been given to orange fleshed sweetpotato (OFSP) varieties as the raw input for OFSP puree production. The processing and storage opportunities for OFSP roots are analysed in more detail in Sections 5 and 6 of this report. In the main urban markets, i.e. Kisumu, Nakuru and Nairobi, the study analysed the trading, retailing and consumer purchasing activities generated by the fresh SP root supply from the aforementioned producing areas.

The main differences between the production areas are: the climatic and socio-ecological features, the role of SP in the food systems, whether the farmers cultivate OFSP varieties or not, the presence of processing-related activities using fresh OFSP roots, and the scale of SP fresh root trading occurring. The main differences in the urban areas are related to the food systems, population sizes, trade volumes and business margins of the agents involved.

The links between agents and activities are not straightforward, as an agent may be involved in more than one activity.

A simplified and stylised graphical illustration of the overall structure of the value chain is given in Figure 3.2.



Source: Own elaborations

Figure 3.2 Flow chart of the sweetpotato value chain

As already mentioned, the focal farmers are located in Busia, (Kabondo) Homa Bay, Migori, Siaya and Kericho counties. They use fresh SP root for their own consumption and/or sell it as cash crop: the respective percentages depend on farming orientation and SP varieties cultivated. As a cash crop, the farmers mainly sell the fresh SP roots packed in sacks the dimensions of which vary significantly between locations.

When farmers sell their SP roots it is mainly directly to traders or to brokers; the brokers are middlemen that sell the sacks of SP roots to the traders who then link with transporters (who have empty trucks after delivering their initial goods), and who truck the bags to major urban markets such as Kibuye market in Kisumu, Wakulima market in Nakuru and Muthurwa market in Nairobi. The brokers typically oversee the root washing, sorting, packing processes and the loading of sacks into the trucks.

The traders sell the sacks of SP to retailers in rural and urban markets; smaller scale traders may also act as retailers. In the retailing markets, the sack of fresh SP roots will be converted into small piles of roots (typically 4-8 medium or large sized roots or up to 20 smaller roots) for sale to the final consumers. Most female farmers also retail SP roots in their local markets during some period of the year in order to access cash for household goods.

In some counties, a few of the farmers are selling fresh OFSP roots to local processors who transform the roots into different processed products (such as flour, chapati, mandazi, bread etc.) which are sold to both urban and rural consumers through different channels.

Details of the value chain agents in each county, and their activities are presented in the following sections.

3B. Sweetpotato production, trading and processing in Kabondo, Homa Bay

Background information

Sweetpotato is an important food and cash crop in Homa Bay county, occupying ~ 6,071 ha (3% of the arable land). The main SP growing areas are Kabondo-Kasipul, Kasipul, Ndhiwa, Homa Bay and Rangwe in descending order (see Table K1). Kabondo is one of the most prominent sweetpotato production areas in Kenya.

The MoA report SP yields of 10-20 t/ha, and a 2013/14 total county production of 99,573 t. A very small amount of the SP grown is OFSP, although several programmes (e.g. APHYA, Great Lakes, JKU) are multiplying OFSP vines and giving them to farmers. The MoA suggest that higher incomes are obtained from SP production and sales grown twice per year, than from maize production and sales which bring Ksh36,000-55,000/ha (which can also be done twice/yr). In some years there are rains throughout the year, making it possible to continuously plant and harvest SP. Jan/Feb is usually the peak SP harvest season. The MoA estimate that ~60% of the SP produced is sold. The MoA perceive the main SP production challenges as unreliable rainfall, inadequate animal power and labour, nematode damage, and declining soil fertility. While the SP marketing challenges include: lack of standard measures and no weighing, low buying prices, unscrupulous middlemen, postharvest losses, transport related challenges due to poor roads, and minimal value addition.

Table K1. 2013/14 sweetpotato production by sub-county in Homa Bay county, Kenya

	Area in Ha			Production in MT			Yield in t/ha		
Sub County	Long rains	Short rains	LR+SR	Long rains	Short rains	LR+SR	Long rains	Short rains	LR+SR
Rachuonyo South	1,885	557	2,442	27,825	18,850	46,675	14.8	33.8	19.1
Ndhiwa	1,745	790	2,535	24,420	10,470	34,890	14.0	13.3	13.8
Homa Bay	712	293	1,005	9,900	7,120	17,020	13.9	24.3	16.9
Rachuonyo North	40		40	480		480	12.0		12.0
Suba	42		42	420		420	10.0		10.0
Mbita	7	2	7	68	20	88	9.7	10.2	12.6
TOTAL	**4,431**	**1,640**	**6,071**	**63,113**	**36,460**	**99,573**	**14.2**	**22.2**	**16.4**

Homa Bay County has a population of 963,794 (male - 48% and female - 52%) (GoK, 2009). The Luo and Abasuba people are the dominant communities in Homa Bay, making up 95% of the county's population.

Homa Bay County has semi-arid climatic conditions with daily temperatures ranging between 26°C during the coldest months (April and November) and 34°C during the hottest months (January to March). The county receives between 250mm and 1200mm of rainfall annually, with the average annual rainfall estimated at 1,100mm. It has two rainy seasons; March-April-May (long rains) and September to November (short rains).

Figure K1.Farmer delivering SP roots for sale at roadside; washed roots drying in the sun
(Photos: Tanya Stathers)

i. Production activities and producers

The climatic conditions and bimodal rainfall pattern in Kabondo are highly favourable for sweetpotato production, and irrigated/ wetland areas are not easily available. The average farm size in this area is 2 acres, 25%-50% of which is under sweetpotato. The main (local) varieties grown are the white- and yellow- fleshed (Nyawuor, Tombra, Wera). The orange-fleshed varieties (Vita and Kabode) are only cultivated in a few plots: OFSP has been recently introduced in the last year or so to provide the Kabondo Sweetpotato Marketing Cooperative with fresh roots for processing into OFSP flour. It is expected that ~50 acres of OFSP will be harvested by the Cooperative members in March 2015.

Sweetpotato has two production cycles per year: the first cycle starts in December and the second in June/July after the harvesting of maize, considered the main staple crop in the area. Land preparation, mounding and ridging are, in general, activities carried out by men. The main duties of women are choosing and planting the vines, weeding, and washing the fresh roots. Harvesting using oxen is a man's task while women harvest manually with a hoe/*jembe*. Young men do the sorting, packing and loading of sacks into trucks. The local SP varieties take 5 months to mature, while the OFSP varieties takes 3/3 ½ months, enabling future OFSP production to possibly reach 3 cycles per year. The yields of OFSP can be up to 28 bags[11]/acre per annum, while the most common yellow-fleshed variety (Nyawuor) has higher yields (up to 40 bags per acre annually). During the last 10 years yields of local SP varieties have decreased, which farmers link to over-recycling of the vines.

In Kabondo sweetpotato is considered as more of a cash crop than a food crop: with home consumption only taking 30%-40% and 10%-20% of the total production for white-fleshed and yellow-fleshed varieties, respectively. Less than 5% of the OFSP roots produced are used for home consumption. This low level of home consumption of OFSP is due to the premium price that the farmers receive for their fresh OFSP roots from the cooperative and because farmers do not particularly like the taste of the OFSP boiled roots. Most of the SP is sold to downstream agents, i.e. brokers and traders who pick the roots up directly from the farmers and/or at the collection centres near the roadside. Only 5% of the total SP produced is retailed by the farmers to final consumers in the local market. The cartel of traders prevents farmers from retailing more of their SP in the local market; root transport can also be a problem as most farmers do not own a donkey and have to rent one to carry sacks of SP to the local market at an average price of 100 Ksh/sack.

The average farm-gate price for local varieties is 1,500 Ksh per sack filled with medium-big size roots. The small fresh roots are sold at 300/500 Ksh/sack. In February/March high production of local SP varieties brings the price down to 1,300/1,400 Ksh per sack. Occasionally the price drops to as low as 1,000 Ksh/sack. When the root supply is lower, the price goes up to 2,500 Ksh per bag (see Table K2). When the farmers bring the local varieties to the collection centre (paying the transportation costs), they can sell to brokers, big wholesalers and retailers at a higher price of 1,800-2,000 Ksh/sack. The OFSP roots have a guaranteed fixed price of 14 Ksh/kg at the Cooperative.

Table K2. Kabondo SP root availability and price during the year (approx.)

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
SP root supply	few	**	***	***	**	**	**	**	**	**	*	*
SP root price (Ksh/sack)	2000/ 2500	1300/ 1400	1300/ 1400	1300/ 1400	1400	1500/ 1800	1500/ 1800	1500/ 1800	1800	1600-1700	2000/ 2500	2000/ 2500

To produce OFSP varieties, the farmers buy OFSP vines at 1 Ksh/cutting (1 acre needs on average 12,000 cuttings). ADS-Nyanza, the development wing of the Anglican Church of Kenya in the Nyanza

[11] The approximate weight of the sacks is 165kg.

region, is facilitating the OFSP vine multiplication and provides planting materials to the farmers. The vines for the local SP varieties are, recycled by individual farmers or received free from neighbours.

The profitability of local SP varieties is estimated at 20,000/30,000 Ksh per acre/ annum while the OFSP varieties can result in profits of 40,000/45,000 Ksh/acre/ annum. Table K3 offers an overview of revenues and production costs, of one farmer. The main problems for local SP varieties are weevils and whitefly that cause 10% to 20% of fresh roots losses. If the fresh roots are cut during harvesting and do not reach the market within 1 or 2 days they start rotting and are vulnerable to rodent attack. This high perishability ensures farmers sell the fresh roots almost immediately, often accepting low prices from brokers as a result. Root transport in sacks on donkeys sides, can due to the poor state of the roads, also damage the roots as they can break, rot and may then be rejected by buyers. Motorcycles may be used but roads conditions are considered quite bad. The perception of OFSP varieties as highly perishable and easily skin damaged after harvest is undoubtedly a disadvantage for their development as cash crops. The farmers consider it a disadvantage that they can only sell OFSP to the Cooperative. They believe that other market opportunities might increase their profits. The strong dependence on middlemen is seen as a general constraint forcing the farmers to sell SP at a low price. Brokers have quite substantial control over farmers' activities, considering their crucial role in bulking, transporting to the roadside, and linking with traders, etc. Even if the farmers get information about the price (through radio, mobile phone communication), the broker may still take advantage and offer a lower price, the brokers sometimes secure the harvest in advance by advancing some money to the farmers, as they are well informed about the farmers' problems and threats.

Table K3. SP cost of production (per cycle) case study, Kabondo

	Farmer: 1 acre of SP		
	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)
Revenues			**24,000**
Sweetpotato	bag	12	24,000
Orange-fleshed Sweetpotato	bag		
Vines	bag		
Costs			**4,835**
Vines	bag		
Hoe	unit	1	35
Bags (for roots)	unit	12	600
Fertilizer			
Land rent			
Land clearing	man/day	2	400
Land preparation	man/day	2	400
Mounding/ridging	man/day	4	800
Labour for vines			
Planting	man/day	4	800
Weeding	man/day	2	400
Applying fertilizers			
Harvesting	man/day	2	400
Transporting	bag	10	1,000
Selling			
Gross margin			**19,165**
excluding family labour			23,600
Gross margin per acre			**19,165**
Gross margin per bag			**1,597**
Gross margin per year			38,330
Total acreage	3		
SP acreage	**1**		
% Total	33%		
SP Price per bag (Ksh)	**2,000**		
Bag size (approx)	165 kg		
Home consumption (% total production)	17%		
In-ground losses	16		
Other losses	-		
Labour	Family		
Irrigation (Y/N)	N		
Use of tractor (Y/N)	N		

Note: The farmer interviewed owns 3 acres in total, with one acre under yellow-fleshed SP (Nyawour variety). The yields are 12 sacks/acre per cycle. The farmer sells 80% of the SP production at an average price of 2,000 Ksh/sack. The higher gross margin may be explained by the underestimated labour costs. She also cultivates maize, beans, and millet with yields of 10 sacks, 6 sacks and 15 sacks/acre per cycle, respectively. Half of the production of these crops is used for home consumption. The farmer starts to prepare the land for SP production in January/February (and July/August), to plant in March (and August) and harvest in July (and in November/December). All the farming activities are carried out by her and family members. She would like to substitute the yellow-fleshed with OFSP to increase her profit opportunities.

ii. Transporters

The transporter (driver) interviewed transports the sacks of fresh SP roots from the main roadside collection zone in Oyugis (Homa Bay County) to Nairobi, via Nyamira and Narok, covering about 400 km. Each journey costs 8,000/8,500 Ksh and he transports an average of 45 sack[12] of fresh SP roots/ journey. In August, September and December he transports up to 60 sacks[13] per journey (see Table K4), probably taking advantage of the higher market prices. The number of sacks of fresh SP roots transported per year is about 4,000-4,500.

On his outward journey from Nairobi to Oyugis, the transporter routes via Kisumu, (a journey of 470 kms costing 8,500/9,000 Ksh per trip), carrying building materials to Homa Bay area. He travels these routes 7 months per year, doing the round trip Nairobi-Oyugis-Nairobi three times a week.

Once a week, the transporter also travels from Nairobi to Kampala (and back), via Busia and Kisumu, carrying maize and beans from Uganda to Nairobi's urban markets. Each route costs 19,000 Ksh.

Table K4. Number of SP sacks/journey carried by one transporter from Homa Bay (Oyugis)

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
SP fresh root sacks	60	-	-	45	45	-	45	45	60	60	-	-

The driver works for a trader: he receives the sacks from a broker in Homa Bay at an average price of 2,150 Ksh/sack and, once arrived in Nairobi, he gives the load to another broker that pays 3,500-3,800 Ksh/sack. The bags are packed in the truck in order to avoid damaging the fresh roots. The driver receives a wage of 2,000 per trip and he usually drives as a part of a pair. To transport a sack from Oyugis to Nairobi, the detailed running costs are fuel (about 8,000 Ksh/journey), oil (1 litre/day at 300Ksh/litre), insurance (10,000 Ksh/month), maintenance 2,000 Ksh/week), tyres (30,000Ksh/tyre with a full set of new tyres every 3 months) and bribes at the roadblocks (approx. 100Ksh).

Table K5. SP transport per sack and annual profits

SP fresh roots	**Ksh/sack**
Selling price	3500-3800
Buying price	2150
Other costs	290
Labour (2 drivers)	20
Fuel	200
Oil	7
Taxes	-
Insurance	7
Maintenance/Service	6
Tyres	48
Informal roadblock payment	2
Gross margin per sack	1,210
Annual Gross margins (4320 sacks/year)	5,226,057
Annual costs for truck (20%, 15 years)	1,000,000 (approx)
Annual profits (including truck costs)	4,226,057
Profits per sack (including truck costs)	**978**

The trader has an estimated gross margin per sack of 1,200 Ksh/sack: including the depreciation costs for the truck, the profits are Ksh978/sack (see Table K5). The cost of the truck is estimated at 1 million Ksh per year that brings the annual profits to about 4 million Ksh.

Another transporter (driver) who delivers goods to shops in Kisumu and then routes back via Kabondo to Limuru twice per week all year round, explained that he charges traders Ksh450/ Prim sack for SP transport from Kabondo to Limuru. His truck can carry up to 60 Prim sacks. He has to pay the truck owner a flat rate of Ksh10,000 for the return journey and whatever else he makes is his profit. 60 sacks @Ksh450 = Ksh27,000, minus Ksh10,000 payment to truck owner = Ksh17,000 minus fuel etc. costs of ~Ksh9,000 = Ksh8,000/trip. 2 trips per week for 48 weeks per year = Ksh768,000/yr, plus the truck owner will also make Ksh960,000/yr from this SP transportation.

[12] The sacks has a 120 kg capacity; the approximate actual weight may be ~165kg.
[13] He is formally supposed to carry a maximum amount of 45 sacks.

iii. Traders

Two SP traders were interviewed, one male based in Kabondo and sending roots to Nairobi (Trader 1), one female based in Nakuru but collecting roots twice/wk from Kabondo or Migori (Trader 2). Many SP traders are women. Data on fresh SP root buying and sales prices is shown in Table K6, the root supply seasons are linked to the timing of the rains. Using the figures in Table K6, Trader 1 would be making an annual profit of ~Ksh2,707,900 (~US$31,858) from trading SP, and Trader 2 an annual profit of Ksh1,497,600 (~US$17,618) although she is likely to have to deduct her additional per trip costs of travelling to Kabondo from Nakuru to source roots and food and accommodation while there. These traders felt the SP trading business fluctuates, and is best when roots are scarce as other people switch to trading SP when root supply is high, creating competition between traders. These traders felt that SP trading and production is increasing to meet growing urban consumer demand, as urban dwellers prefer light foods such as SP.

Table K6. Fresh SP root trading prices and volumes in Kabondo

SP root supply season	Peak (Feb>Apr)	Medium (Aug > Jan)	Low (May > Jul)
SP buying price in Kabondo (Ksh/Prim sack)	1,500	1,700-2,000	2,500
SP sales price Nakuru or Nairobi (Ksh/Prim)	3,500	4,200-4,500	4,500
Trading costs (see detailed Table K8) (Ksh/ Prim sack)	1,010 - Kabondo to Nairobi 810 - Kabondo to Nakuru		
Trading profits – Kab. to Nbi (Ksh/Prim)	*990*	*1,490*	*990*
Trading profits – Kab. to Nak. (Ksh/Prim)	*1,190*	*1,690*	*1,190*
Trader 1 volumes to Nairobi (Prim sacks/wk)	60	40-45	30
Trader 2 volumes to Nakuru (Prim sacks/wk)	30	20	10

The SP market days in Kabondo are Monday, Tuesday, Thursday and Friday, these are the days most of the SP is traded, less is traded on Wed, Sat & Sun. The roots are transported to Nairobi or Nakuru using backhaul space of trucks which have delivered good to Kisumu and are then returning to Nairobi or Nakuru and want to transport something profitable during the journey. A 10 tonne truck can carry up to 60 Prim sacks of SP if loaded to roof level. The trucks just carry SP. The traders are assisted by brokers who help source and aggregate the roots from farmers, the sacks of roots are then transported to the roadside by donkeys, washed and sorted (Table K7) and packed into new bags. The broker income from working with Trader 1 would be 2,210 sacks/yr @Ksh100 = Ksh221,000 ($2,600). The truck drivers also sometimes pay a broker to help ensure the maximum number of sacks are aggregated and ready for loading into their truck when they arrive. The drivers, brokers and traders communicate regularly by mobile phone to ascertain loads and timings.

Table K7. Sweetpotato root sorting categories

Main category	medium sized clean roots which are bought at Ksh2,000/sack
Small or broken roots (*koroga*)	are separated from the medium roots and bought at Ksh500/sack (to be used by retailers, so that the pile they sell has 3 big roots plus 2 small roots (the small roots being referred to as ('*nyongeza*', extras or discounted roots)
Rejects	weeviled pieces of roots which are not purchased

The roots are washed prior to purchase, so they appear fresh, and to make it easier to see whether the root has insect damage. Washing has been practiced for the last 7 years, if sunny the roots may be placed on old sacking to dry off or may be packed immediately into the extended Prim sacks. Washing is done by women who pour the roots into a metal drum of water then step up and down on them, then rinse them by hand in a second drum (Figure K2). The water has to be purchased and brought to the roadside by donkey. Not all markets want washed roots, some buyers like to see fresh soil on the roots in order to know that they have been harvested in the last couple of days, and the colour of the soil helps them know where the roots were produced (e.g. Kabondo = red soils). The main SP variety traded is called Nyawo, and has a red/pink skin and yellow flesh.

The broker (or trader if present) is responsible for overseeing the washing, sorting, packing and truck loading of the roots (the costs are shown in Table K8).

Table K8. Sweetpotato root trading costs from Kabondo to Nairobi or Nakuru

Assistant brokers (needed if a lot of roots have to be sourced)	Ksh 100/sack
Washing of roots	Ksh 50/ Prim sack
Water for washing (40 lts is sufficient to wash 1 sack of roots)	Ksh20/ 40 litre bucket
Packing into elongated sacks and sewing the sacks closed	Ksh 50/ Prim sack
Loading on to truck	Ksh 50/ Prim sack
Cess (truck driver then carries the receipt with them)	Ksh 40/ Prim sack
Sacks (= 2 sacks combined, long @ Ksh70 & short @ Ksh35)	Ksh 105/ Prim sack
Rope for sewing sacks closed (Ksh150/ 4kg of rope = 10/ 12 sacks)	Ksh 15/ sack
Transport	Ksh 300/ sack Kab. > Nakuru Ksh 500/ sack Kab. > Nairobi
Off-loading at destination market	Ksh 50/ sack
Market tax	Ksh 30/ sack
Total trading costs *(these costs remain fixed all year round)*	Ksh 810/ sack – Kab. > Nakuru Ksh1,010/ sack – Kab. > Nairobi

These traders said that OFSP roots turn to slush when boiled, and that customers therefore prefer the yellow or white-fleshed sweetpotato. Kabondo traders do not get involved in promoting the consumption of SP, but were aware of traders/retailers in Gikomba market Nairobi who take a small cook stove with them to boil some roots and allow customers to sample them before buying.

The main constraints in trading SP were identified as:

- High perishability of SP roots, which can start to rot 2-3 days after harvesting
- Transportation being tricky to arrange when you only have a few bags to send by truck
- Rainy weather which makes it difficult for farmers to deliver the roots to the roadside collection points resulting in aggregation delays
- Competition from cheap roots from other areas, e.g. in Sirare which borders Tanzania, the price can be Ksh1,200/ sack (cv to Ksh2,000/ sack in Kabondo) for a similar variety

Figure K2. Root washing, packing and loading of Prim sized sacks of sweetpotato, Kabondo
(Photos: Tanya Stathers)

iv. Processing and types of processors

In Kabondo county two OFSP processors have recently started operations, the Kabondo sweetpotato cooperative society since July 2013, and Homa SG since May 2014.

Homa SG

Homa SG is a partnership between Homa Bay County Government and a private investment company Organi Ltd (a Kenyan businesswoman based in the US). Homa SG aims to provide a market for farmers OFSP roots and thereby improve their incomes, improve the nutrition of the local community through the production of OFSP food products, and create some employment for young people in the factory. The County Government were to provide 3 phase electricity, 700 acres of land to bulk OFSP on, and a water connection. However power is currently being tapped from a nearby posho mill, the land was reclaimed, and Homa SH has only recently got water after a lot of trouble. The investor was initially prepared to invest up to Ksh50 million, but so far has invested Ksh10 million (~$117, 650), this includes a consultant, substantial OFSP processing and bakery equipment (chipping machine, drying unit, posho mill, industrial mixer, proofer/bread rising unit, large double unit oven, 2 stainless steel workbenches, bread trays, bread slicer, stainless steel racks), a vehicle and driver. Their current building is rented but they have a 5 acre plot they own nearby.

A manager was hired in August 2014, he hired Kenya Industrial Research and Development Institute (KIRDI) staff to visit Homa SG and train 8 school leavers in food processing (3 of whom are working in the bakery on a volunteer basis (@Ksh10,000/m) while operations get started). They then developed several recipes substituting OFSP flour for some of the wheat flour. They are currently washing, chipping and drying OFSP roots, and then milling the OFSP chips into flour in order to produce small quantities of bread loaves (400g loaf sells at Ksh40, 200g loaf at Ksh20), scones (bread rolls) (12 scones sold at Ksh50), using 10% OFSP flour, and a composite flour of OFSP, sorghum and soyabean for making porridge. They can obtain 20kg of OFSP flour from 110kg OFSP roots, a 5.5:1 conversion ratio. Currently the products are being sold unlabelled in the local area, as Homa SG work towards achieving KEBS certification. Customer feedback on the products is positive.

In May they gave OFSP vines to 250 farmers, and have been buying OFSP roots produced by these farmers at Ksh15/kg. Unfortunately due to all the farmers planting at the same time, they experienced gluts in the supply of OFSP which led to serious wastage as they did not have the facilities to chip and dry such quantities. They have subsequently agreed with the Anglican Development Society (ADS) that ADS will organise the seed bulking and staggering of production with farmers, and Homa SG will focus on processing the OFSP roots.

While they started by producing OFSP flour, they are now interested in using OFSP puree which the manager feels will be more cost effective. When asked, the manager felt that a fresh root storage facility at the processing unit could help reduce wastage during production gluts.

Kabondo sweetpotato cooperative society

This cooperative processes OFSP roots into flour which they sell to an increasing number of customers (health companies in Nairobi who repackage and sell it, local bakeries). After sorting, they buy the OFSP roots from their members at Ksh14/kg (rejecting only the insect damaged roots), and then a worker is paid to wash them, chip and solar dry them and mill them into flour at their facility (Table K9). USAID donated the chipper, milling machine, scales, stainless steel workbenches, drying unit, and root washing facilities.

OFSP root supply is still a problem, as not all the cooperatives 2,560 members are producing OFSP roots. Some of the cooperative members have been identified as vine multipliers, and then produce and sell OFSP vines (@Ksh1/cutting). Root supply fluctuates, a lot of roots were produced in November but they did not have the drying capacity to cope with such large quantities. Feb-Mar is also a high supply month as many plant SP in December. The Cooperative coordinates the harvesting and delivery of OFSP roots amongst its member (who are organised into 8 collection centres), to

match the deliveries with the orders for OFSP flour. They felt fresh root storage could be useful in reducing wastage during production gluts.

Their activities are still very new, and the table below highlights the challenges in developing profitable markets for the OFSP flour they produce which is packed into gunny bags and transported by bus to Nairobi or local town centres.

Table K9. Processing costs of OFSP roots at Kabondo Cooperative

OFSP root purchase	Ksh14/kg of OFSP roots
Washing & sorting	Ksh50/Prim sack
Chipping, spreading out to dry	Ksh1/kg of OFSP roots
Milling into flour	Ksh1/kg OFSP flour
Sales	Ksh80-110/kg OFSP flour

Table K10. Kabondo Cooperative's OFSP flour processing and sales for Mar-Oct 2014

	Raw material delivered (kgs)	Quantity processed (kgs)	Costs incurred (ksh)	OFSP sales		Profit Ksh
				Quantity (kgs)	Ksh	
March	55	55	918.5	13.75	2400	1481.5
May	173	173	2889.1	43.25	3600	710.90
July	642	642	10721.4	160.5	3280	(7441.40)
August	231	231	3857.70	57.75	400	(3457.7)
Sep	75	75	1252.5	18.75	320	(932.5)
Oct	302	302	5643.40	75.50	8200	2556.6
Mar-Oct	**1,478**	**1,478**	**25,282.6**	**369.5**	**18,200**	**(7,082.6)**

Although not included in Table K10 above, the manager reported that during Nov and Dec they had processed and sold 1.5t of OFSP flour, a huge increase on their Mar-Oct processing figures. From the data in Table K10 their root: flour conversion rate is 6.55kg roots: 1 kg flour, although they had reported a 1:4 conversion rate previously. In at least half the months they have operated at a loss (note their processing costs incurred do not include any of the equipment which was donated by USAID, nor the business manager's salary which is currently paid by USAID). The per kg OFSP flour sales price fluctuates significantly in the above data, ranging from Ksh7/g to Ksh174/kg, with an average of Ksh49/kg, although they report that they sell the OFSP flour at Ksh80-110/kg.

Figure K3. (top row) **Kabondo Cooperative: OFSP sorting, processing facilities, and washing area;** (lower row) **Homa SG: Mixer, drying racks, and OFSP bread loaves** *(Photos: Tanya Stathers)*

v. Consumption

The Cooperative farmers and Ministry of Agriculture staff explained that in Homa Bay people typically boil the SP roots and take them with a cup of tea, they also make SP roots into stews with pulses such as groundnuts, beans and mung beans, they use OFSP flour, and eat the SP leaves as a vegetable. They typically eat SP (mainly the yellow-fleshed variety) twice a week (~3 roots per meal/ person). They also make chips, cook porridge using a mixture of OFSP, maize and sorghum flour. The low level of home consumption of OFSP is due to the fact only a few farmers produce it in Kabondo, and those who do receive a premium price from the Cooperative for their fresh OFSP roots, and many farmers do not particularly like the taste of the OFSP boiled roots.

vi. Main findings

- In Kabondo, SP is a major cash crop, as well as being an important food crop.
- The climatic conditions allow almost all year round production, and though the peak SP supply occurs in February/March fresh SP roots are harvested and traded all year round.
- Data collected during the field visits suggests average SP yields of 3-4 tonne/acre per cycle of SP production.
- Truckloads of extended sacks (Prim) of fresh SP roots are traded daily from Kabondo to Nairobi, Nakuru and other urban markets. The trade utilises the empty backhaul space in trucks after they have delivered items to Kisumu or Homa Bay.
- The traders' SP root buying price in Kabondo fluctuates between Ksh1,500 – 2,500/ Prim sack during the course of the year.
- The traders root selling price in Nairobi and Nakuru mirrors their buying price fluctuations and ranges from Ksh3,500-4,500/ Prim sack during the course of the year.
- The SP roots are graded by size and damage, with the medium and big whole roots being bought and sold at the above prices, and the small or cut pieces of root (*koroga*) being sold at a much lower per sack price. Insect damaged roots are rejected.
- Brokers are involved in sourcing the roots, overseeing their sorting, washing, packing and loading in sacks into the trucks.
- Traders/ wholesalers (often based in Nairobi and Nakuru) need to ensure the brokers on the ground have funds for purchasing the roots from farmers, hiring labour to wash, sort, pack and load the roots, paying advance transport amounts and levy cess. These funds are typically sent by traders/wholesalers in the urban centres through MPESA to the brokers who withdraw cash from a local MPESA agent in order to pay farmers, and labourers.
- There are two OFSP root processors in Kabondo, both currently chipping and drying OFSP roots into flour and then either selling the OFSP flour to large companies who repack it or local bakeries, or incorporating it into their own bakery products. Both processors only started within the last 18 months and are currently operating at a very small-scale.
- The few farmers growing OFSP sell their OFSP fresh roots to the Kabondo SP Cooperative at a fixed price of (14 Ksh/kg) all year round.
- The comparative gross margins/ Prim sack at different stages along the value chain, and the approximate annual profits per value chain actor are shown in Figures K1 and K2 respectively. It is evident that the volume of sacks of SP transported and traded from Kabondo make these activities extremely lucrative.
- A general breakdown of the trader's costs per Prim sack of sweetpotato roots from Kabondo to Nairobi is shown in Figure K3.

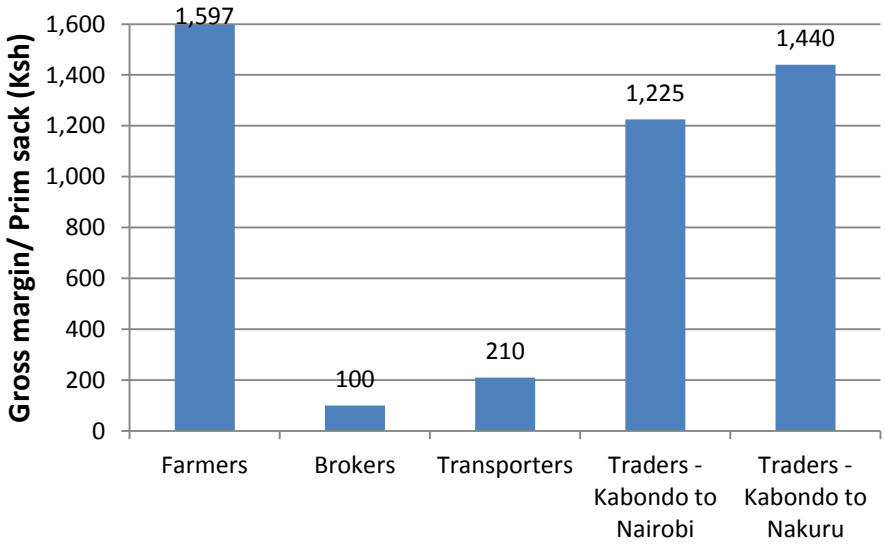


Figure K1. Comparison of gross margins/ Prim sack of sweetpotato roots along the value chain

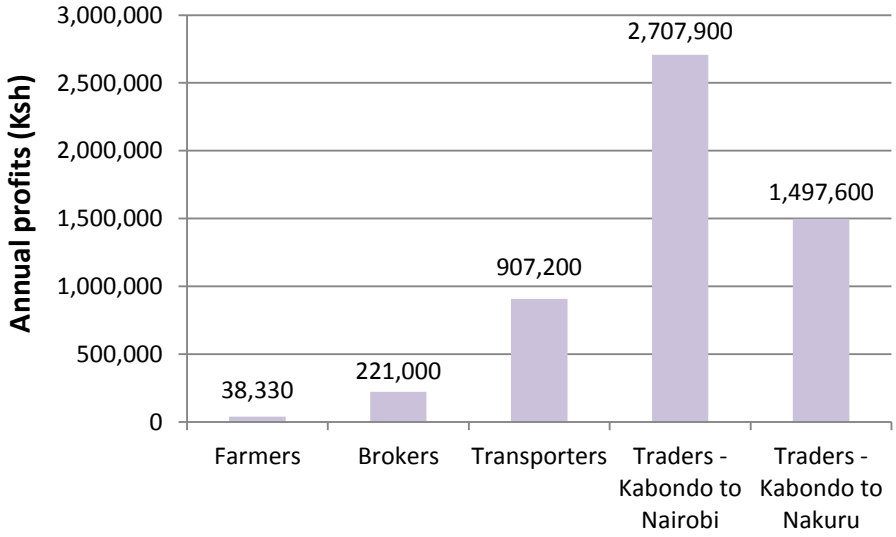


Figure K2. Comparison of annual profits per sweetpotato value chain actor

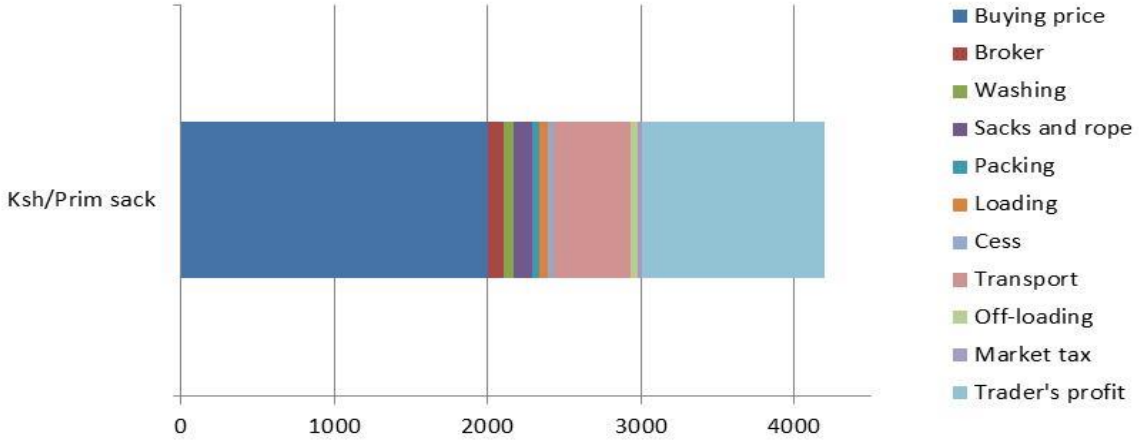


Figure K3. Breakdown of sweetpotato trader's expenditure and margin when trading Prim sized sacks between Kabondo and Nairobi in December 2014

3C. Sweetpotato production and trading in Migori County

Background information

Sweetpotato is a major cash crop in Migori County, where 90% of the SP produced is sold to traders or consumers. Sweetpotato yields are high due to the good quality of the soil and favourable climatic conditions. In recent years farmers have been increasing the area they plant to SP, this is because it has lower production costs than tobacco or maize due to it being grown without inputs such as fertiliser and wood for curing. Sweetpotato is a cheap food, and demand for it has increased as the cost of living has gone up and the population grown. However, farmers' marketing linkages are weak and they currently lack the ability to negotiate the SP selling price, the transport arrangements are complex as it relies on empty backhaul space in trucks heading back to Nairobi and the local brokers have strong links with the transporters and traders. Many of the current SP initiatives therefore aim to strengthen the links between the farmers and traders and remove further intermediation levels (Table M1). The authorities, organisations and NGOs are also involved in strengthening SP seed systems to help provide clean vines for the main SP varieties.

Table M1. Overview of sweetpotato initiatives in Migori County

MoA (Ministry of Agriculture)	train SP farmers on agronomy and are helping to link them directly to the market thus removing the brokers. They used to provide clean vines. There are 4 OFSP DVMs starting. KARI and the Ministry also have a site producing disease-free planting materials of traditional SP varieties.
FCI (Farm Concern International)	focus on market linkage, nutrition and food security. The Kenya Horticulture Competitiveness Project (KHCP) project ended last month, it was difficult to get SP vines so they increased their focus to traditional African vegetables. It covered Kuria West, Uriri, Suna East, Suna West and Nyatike s/c's. They use the commercial village approach, whereby farmer groups work collectively for bulking and marketing, and a trader is then called to directly collect the produce.
WV (World Vision)	trying to introduce OFSP in Kuria West
CIP (International Potato Centre)	is introducing OFSP DVMs in Kuria West

SP is produced almost all year-round in Migori. The peak fresh SP root supply occurs from Mar-May, and in Aug-Sep due to the rainy seasons; the medium SP supply is June-July and Oct-Dec. During Jan and Feb, SP vines are planted and, even though they are the dry months, there are still a few wet days which allow a limited supply of fresh roots. Within Kuria, almost 100% of farmers grow SP but this is not typical for all of Migori county. Kuria West, Kuria East and Uriri are the 3 s/c's producing the most SP, and in these locations farmers will plant ~25% of their land to SP, and grow the crop twice per year. The average SP yield is about 20 extended bags/acre.

i. Production activities and producers

A focus group of 17 farmers (mainly women) from 8 different community groups were interviewed in Iraha village, Kuria West s/c, Migori county. SP roots are the major cash crop in the area followed by tomatoes. SP is also the second most important food crop after maize. Other commonly grown crops include: beans, onions, millet, cassava, groundnut, soya, traditional vegetables and kales.

Farm sizes are typically 3-4 acres, of which about 1 acre is under SP production, sometimes distributed across more than one plot. In this area, husbands and wives farm together. SP is rotated with maize but is not intercropped. Most HHs plant two SP varieties, one for HH food and one for sale. The main local SP varieties grown are Balozi, Nyabisguguki, Surambaya, Rongambo, Morozigori (Table M2). OFSP had not been heard of by these farmers, although two vine multipliers are beginning to produce it nearby.

Table M2. Main SP varieties grown by focal farmers in Migori

SP variety	Good characteristics	Bad characteristics
Nyabisguguki – 4MAP; Red skin, yellow flesh, Sold	• High market demand for it; good price; good yield; good shelf-life ~2 wks	• Don't use it for food here; it may cause diarrhoea as it does not have high dry matter; don't know how to cook it well
Balozi – 4MAP; Red skin, white flesh, HH food	• Sweet; doesn't give stomach problems	• No market; rots easily within 1 week of harvest; gets insect damaged in field
Surambaya – 3MAP; Grey skin, white flesh, HH food	• High dry matter ; easy to cook and stays dry; big roots and many; high yields	• Not much market; can rot in the field before you harvest it; colour is not appealing

SP is planted twice per year in April/May and November/December with women typically doing the planting bit by bit as the rains continue. The men use oxen to plough the land, and then one week later to prepare the ridges, which the SP vines are planted on. Women typically source the vines from the field of a neighbour who has not yet harvested her SP crop, each sack of vines costs Ksh500. Vines showing virus symptoms are not used. The SP crop is weeded 2-3 weeks after planting, and then again after a further 1 - 2 months, weeding is done by the wife or by both the husband and wife. Most of the SP varieties grown mature by 3 or 4 MAP, usually in Aug/Sept or Mar/Apr/May. Insect pest damage can be a problem if roots are left in the field longer than 4 MAP. When an area is to be harvested the vines are cut off, and then the plants dug up by the wife using a jembe/hoe, removing all the roots of each plant and carrying them home by headload. If a large area is to be harvested the husband will use an oxen-drawn plough to lift the roots, and will hire transport (motor bike or vehicle). During harvesting some roots get cut/ damaged and then rot, exposure to the sun can also damage the roots, and mole rats may destroy in-ground roots.

Some brokers come to the field with vehicles and sort the roots after the farmers have washed them. However, farmers report that finding a buyer or a broker can be a problem, and transport can be expensive. Traders mainly want the medium-sized roots, while extra big roots are left (and then eaten by the HH or given to neighbours) and small or broken roots are packed as *koroga* and sold at Ksh100-200/ flat sack. Farmers complain that during the sorting a lot of roots get left behind, and too many roots are packed into each sack. Due to most roots being harvested at the same time there is a lot of competition, prices are poor and brokers have all the power. Farmers visit the market to find out about the current buying price. Some traders want roots to be washed while others do not.

The farmers estimate that 20-25 flat bags of SP are produced / acre, with each currently being bought at Ksh800. The buying price fluctuates during the year: Ksh800 in O/N/D/July; Ksh500 in J/F/M/Apr/Aug/S; Ksh700 in May/Jun. Peak root supply occurs from Mar-May, and in Aug/Sep. The traders then convert 2 flat bags into one extended bag. Farmers can also sell *Prim* sized sacks @ Ksh1,600, and *Sudeka* sized sacks @ Ksh2,000. Farmers view SP as a profitable crop that does not require fertiliser to produce a high yield. The farmers in the focus group estimated that they typically earn about Ksh12,000/ season from selling SP, and do this twice per year. This income is used for school costs, housing, cattle and clothing.

Detailed SP cost of production figures were obtained from three farmers (see Table M3), who cultivate SP twice per year and estimate that they make gross margins of between Ksh7,300 to 23,500 per acre per cycle from their SP root sales to brokers, the differences are mostly due to the different cost of labour and sales price paid at farm-gate level. Their total land size ranges from 4 acres to 8 acres; and they each have 1.5 to 2 acres under SP per cycle. These 3 farmers sell their SP to brokers, and Farmer B and C are also retailers in the local market. They do not cultivate OFSP; Farmer A just started planting 1 acre and Farmer B would like to start OFSP cultivation. They have access to credit and Farmer A and B borrow money for their farming activities.

The farmers in the focus group estimated that they consume only 5% of the SP produced with most of it being sold. When eaten SP will be boiled and peeled and taken for breakfast, lunch or dinner or

as a school snack. SP is not eaten each day, nor is it dried and stored as a food stock in this area. Between June and August most HHs will buy some SP roots for food, ~20 piles of 4 roots @Ksh20 each / year (these roots will come from nearby Tanzania). In most HHs women will also occasionally sell a few small piles of roots at the market in order to access cash. From Apr to Dec, 4 medium roots are sold at Ksh20, while from Jan to Mar a Ksh20 pile will contain 6-8 medium roots.

SP vines are fed to cattle, rabbits, goats and sheep, but the SP roots are not used as animal feed.

In the last 10 years key changes to SP enterprise include: farmers now doing the harvesting of SP roots to be sold which previously was done by traders this is due to there being more farmers selling SP now; the culture of leaving a few roots in the field and allowing your neighbours to harvest them no longer happens as there is now a strong market for SP; labour costs have increased but it is easier to find labourers now as the crop has become more commercialised; oxen are now used for harvesting SP; SP used to be sold by bucket load but the increased demand has led to it now being sold by the sack load; and SP yields have decreased due to soil exhaustion.

Table M3. Farmers' gross margins for SP and OFSP production (per cycle)

	Farmer A: 2 acres of SP			Farmer B: 1.5 acres of SP			Farmer C: 2 acres of SP		
	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)
Revenues			**80,000**			**48,750**			**32,000**
Sweetpotato	bag	20	80,000	bag	25	48,750	bag	20	32,000
Orange-fleshed Sweetpotato	bag			bag			bag		
Vines	bag			bag			bag		
Costs			**32,920**			**28,245**			**17,320**
Vines	bag			bag	9	675	bag		
Hoe	unit	1	70	unit	1	70	unit	1	70
Bags (for roots)	unit	20	2,000	unit	25	1,250	unit	20	1,000
Fertilizer	liter			liter					
Land rent	acre		2,500				acre		2,000
Land clearing	hiring ox	1	3,750	hiring ox	1	2,250	hiring ox	1	3,750
Land preparation	man/day	6	3,600	man/day	5	3,000	man/day	6	included above
Mounding/ridging	man/day	8	8,000	man/day	8	4,800	man/day	5	4,000
Labour for vines	man/day			man/day			man/day		
Planting	man/day	12	6,000	man/day	6	2,700	man/day	12	included above
Weeding	man/day	4	4,000	man/day	2.5	10,500	man/day	7	3,500
Applying fertilizers	man/day			man/day			man/day		
Harvesting	man/day and ox	5	3,000	hiring ox	1	2,000	man/day	10	3,000
Transporting	motorbike			motorbike	10	1,000	motorbike		
Selling	market spot			market spot			market spot		
Gross margin			**47,080**			**20,505**			**14,680**
excluding family labour			47,080			**18,445**			14,680
Gross margin per acre			**23,540**			**13,670**			**7,340**
Gross margin per bag			**1,177**			**547**			**367**
Gross margin per year			94,160			41,010			29,360
Total acreage	8			4			5		
SP acreage	**2**			**1.5**			**2**		
% Total	25%			38%			40%		
SP Price per bag (Ksh)	**2,000**			**1,300**			**800**		
Bag size (approx)	165 kg			90-100 kg			100 kg		
Home consumption (% total production)	5%			15%			10%		
In-ground losses	12%			20%			20%		
Other losses				5%					
Labour	Hired			Family/hired			Family/hired		
Irrigation (Y/N)	N			N			N		
Use of tractor (Y/N)	N			N			N		

Source: Field visits

Note: Farmer A uses to recycle the vines to produce sweetpotato, planting to the field that rotates for the SP cultivation. After the land preparation (done in January and August), Farmer A plants the vines in March (and October) and harvests the roots after 4/5 months, i.e. in August (and March). She sells the SP to a broker that passes by her plot. The selling price per bag refers to an extended bag (165 kg). Farmer B is a medium-scale farmer (4 acres), with 1.5 acre cultivated with SP. Farmer B keeps about 3 bags for home consumption, and sell the most of the remaining quantity (80%) to the broker from Kisii (at a price ranging from 800-2,000 Ksh/bag). He is also retailer at the local market (selling price at 1,100 Ksh/bag). Farmer B would like to start the cultivation of OFSP and plans to cultivate 2 acres. Farmer C is a medium-scale farmer, owning and renting, respectively, 3 and 2 acres. She cultivates 2 acres of yellow-fleshed SP using the vines from her plot. Farmer C consumes 2 bags of SP at home, and sells both to the broker and to the trader at the market (700-800 ksh). The latter option occurs when the price the broker wants to pay her harvest is too low.

ii. Traders

One female SP trader, who is based in Migori but travels regularly to Nairobi with the sacks of SP roots she trades, was interviewed. She is a widow and has traded SP for the last 4 years, using the profits to educate her two children.

She identified the peak root supply months as being February and August, following the two rainy seasons. The lowest root supply is in December. The SP root variety produced in Migori fetches a lower price than that from Kabondo. Brokers or farmers usually bring the SP roots to her at the roadside collection area in Migori town, very occasionally she has to source roots from the farmers' fields. She has a team of 5 helpers/ brokers who are paid Ksh100/ sack as commission. After purchasing the roots she sorts them by size and damage signs; placing the small and the harvest damaged roots into one sack labelled '*koroga*' which sells at Ksh2,500. The medium and larger roots are sold at the prices specified in Table M4, the very large roots are sold @Ksh50 for 3. The extended (*bao*) sacks of roots are transported to Nairobi by truck using backhaul space, at Ksh600/*bao*-sized sack. Once there is trust between her and the transporter she can send the sacks alone on the truck without accompanying them. She typically pays a deposit in Migori for the transport, but may also pay the full amount in advance. Sometimes it is hard to access transport.

Table M4. Fresh SP root trading prices, Migori to Nairobi

Ksh	July to Dec	Jan to June
Buying price – flat bag) Migori	1,000 -1,100	800
Sales price – extended bag (bao) Nairobi	4,000	3,500
Trading costs/ bao sack	1,250	1,250
Calculated profit/ bao sack	550-750	650

She travels twice per week, with 7-10 extended sacks/ bao's of SP roots per trip (see Figure M1, *a bao is more than twice the size of what is referred to as a flat sack*). She makes 8 trips per month all year round, except in Dec when she rests for 2 weeks over the Christmas period. She therefore trades between 644-920 extended sacks of SP/ year. After deducting her trading costs (Table M5), she estimates (but does not keep records) that her profit is usually Ksh900-1,000 per extended bag (bao size). Note: this estimate is higher than the profit figures obtained using the buying, sales and cost figures she provided (Table M4). Her per bag profit estimate would give her an annual profit of Ksh579,600 – 920,000 (US$6,820-10,820).

Table M5. Sweetpotato root trading costs from Migori to Nairobi

Item	Costs (Ksh)	Unit
Broker	100	bag
Root washing	50	flat bag
Root sorting, packing, sack closing	100	Ext bag
Loading	100	Ext bag
Transport	600	Ext bag
Cess	30	Ext bag
Empty bag purchase	120	Ext bag
Rope	10	Ext bag
Off-loading in Nairobi	40	Ext bag
City council tax - Nairobi	50	Ext bag
Total	**1,250**	**Ext bag**

She trades just one SP variety, locally known as called Ratong, which is yellow fleshed with a red skin, and in high demand in Nairobi markets. She has eaten delicious OFSP chips in Rongo, but has never traded OFSP. She sells the SP in Muthurwa and Kangemi markets in Nairobi, using a broker in Muthurwa to receive and distribute the SP, while in Kangemi she sells the bags directly to the female retailers who have placed orders with her. She then has to wait around in Nairobi to receive cash payment for the roots, which she then pays into her M-PESA account for safety while travelling back to Migori where she then withdraws the cash she needs to purchase roots and pay washers, packers, brokers etc. She feels she lacks sufficient capital to increase her business.

She belongs to a group of 10 traders who operate a merry-go-round savings group, with each member contributing Ksh1,000/ week.

iii. Transporters

This transporter (driver) transports sacks filled with fresh SP roots from Migori to Nairobi, occasionally going to Sirare (Tanzanian border) if there are not enough sacks to fill the truck in Migori. He covers about 450 km in 10-11 hours (from 7PM to 5AM). On his outward journey from Nairobi to Migori, the truck carries cement, other building materials and bottles of drinking water. He drives this complete route 3 times/week, every week. The trader in Nairobi gives the driver 30,000 Ksh to cover the transport costs and broker fees, so that the driver can bring back a truck filled with sacks of fresh SP roots. Any funds remaining from the Ksh30,000 are returned to the trader. In March and August, the transporter carries 35-40 sacks[14]/ journey while during the other months the average quantity is 45-50 sacks (see Table M6). The annual quantity of bags transported is ~6,480. On reaching Migori, the transporter contacts a broker who aggregates the sacks of SP; the driver pays the broker an intermediation fee of 1,500 Ksh.

Table M6. Number of sacks per trip from Migori

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
SP sacks	45-50	45-50	45-50	35-40	45-50	45-50	45-50	45-50	35-40	45-50	45-50	45-50

The driver works for a trader that gains the extra profits from the revenues per trip, i.e. from the Ksh 30,000 paid by the trader in Nairobi. The driver receives a monthly wage of Ksh25,000 and usually drives as part of a pair. Other running costs are fuel (~13,000 Ksh/journey), oil (1-1.5 litre/day at 500Ksh), tyres (260 Ksh/trip) and bribes on the roadblocks (approx. 100Ksh). The owner of the truck generates an estimated gross margin of Ksh13,920 per trip, equivalent to Ksh278-400/sack of SP. If we include the cost of the truck, the profits are ~Ksh185/sack (Table M7). The cost of the truck is estimated at 1 million Ksh per year and brings the annual profits for transporting SP to about 1.196 million Ksh.

Table M7. SP transport per sack and annual profits

SP fresh roots	Ksh/travel
Travel price from the trader in Nairobi	30,000
Other costs	16,080
Broker	1500
Labour (2 drivers)	2000
Fuel	13000
Oil	500
Taxes	20
Parking in Nairobi	200
Insurance	NA
Maintenance/Service	NA
Tyres	260
Informal roadblock payment	100
Gross margin per travel	13,920
Gross margin per bag	278-400
Annual costs for truck (20%, 15 years)	1,000,000 (approx)
Annual Gross margins (6480 sacks/year)	2,196,720
Annual profits (including truck costs)	1,196,720
Profits per sack (including truck costs)	**185**

iv. Consumers

SP roots are typically eaten boiled and peeled for breakfast, lunch or dinner or as a school snack. However, although large quantities of SP are produced, most (>90%) is sold, and SP is not eaten each day, nor is it dried and stored as a food stock in this area.

Between June and August most HHs will buy some SP roots which will have been produced in nearby Tanzania for food, ~20 piles of 4 roots @Ksh20 each / year. The consumption of SP changes based on the wealth status of the family: the people that earn a salary may take SP for breakfast a few times per week. The poorer urban communities may consume SP roots for lunch or dinner.

[14] He is formally supposed to carry a maximum amount of 45-50 sacks.

v. Main findings

- SP is a major cash crop in this area, with >90% of the SP roots produced being sold;
- Good quality of the soil and favourable climate conditions lead to higher yields. Production and sales have been increasing in recent years; tobacco was their main cash crop, but farmers are now struggling to cure the tobacco due to lack of wood and high input costs. Many farmers have therefore decided to switch to SP that is also a cheap food to cope with the increased living costs. SP virus is a problem in this area and farmers select vines without disease symptoms for planting;
- The SP yields are reported to be between 20-25 flat bags and 20 extended/Prim bags /acre . The per flat sack farm gate price fluctuates during the year: Ksh800 in Oct-Dec and July; Ksh500 in Jan-Apr and Aug-Sept; Ksh700 in May-Jun. Farmers can also sell *Prim* sized sacks @ Ksh1,600, and *Sudeka* sized sacks @ Ksh2,000;
- The farmers sell the bags to brokers and traders; when they are not happy with the price agreed with the intermediaries, the farmers can sell the SP fresh roots in the local retailing market. The farmers' margins per sack are between Ksh 367-647 per flat sack, and >Ksh1,000 per extended (*bao*) sack; the SP profits per acre/cycle account to between 7,000-23,000 Ksh.
- The size of the extended bags and the presence of brokers are exploitative for farmers. Often there is no opportunity for farmers to negotiate on the price with the intermediaries. Brokers are local people that have a link to the traders. Some of the brokers buy the whole field before harvesting and then sell it to the trader. There is not much direct linkage between farmers and traders.
- Currently, no OFSP is yet being harvested: a few farmers have planted the vines and/or are willing to soon start cultivating it;
- The trader interviewed buys a flat sack at 800 Ksh (Jan-June) and 1,000-1,100 Ksh (July-Dec). Traders convert 2 flat bags into one extended (*bao*) sack, and then sell the bao-sized sack at 3,500 Ksh (Jan-June) and at 4,000 (July-Dec). She estimates that her profit is usually Ksh900-1,000 per extended bag, but from the costs she provided it may be 25-40% lower;
- The brokers receive Ksh100/ sack from the traders, and some transporters also use and pay brokers. No broker was interviewed.
- From the information collected, there appear to be no SP processing activities in Migori;
- Migori is a major SP production area, and many truck drivers collect sacks of fresh SP roots on the main road and transport them to Nairobi markets. If they do not manage to fill the truck in Migori, they may go to Sirare (~130 Km) to source more bags of SP. The transport profits per bag of SP are estimated at ~Ksh185.

Figure M1. Roadside sweetpotato root trading of bao-sized sacks, Migori. *Root washing, closing, interviewing traders and service providers, washed SP roots drying before packing (Photos: Tanya Stathers)*

3D. Sweetpotato production, trading and processing in Siaya County

Background information

In the 1960/70s sweetpotato (SP) was a major food crop in Siaya County; its importance reduced during the 80's as maize became more dominant. Climate change and low soil fertility have recently revitalized SP production as both a cash and food crop. As a commercial crop, SP is replacing sugarcane due to both the delayed payment process have farmers suffered with sugarcane, and the fact farmers prefer to access cash more regularly and faster. However, SP is still mainly a food security crop in Siaya, providing food when other crops are not available in the market: its seasonality is thus affected by the scarcity of cereal crops and the timing of the rains (i.e. SP is considered a back-up crop when poor rains lead to maize failure).

The Ministry of Agriculture and Ugunja Community Resource Centre are contributing to the development of SP through selected initiatives to improve the farmers' livelihood (Table S1). SP is considered, in fact, a crop that: i) works well for poorly resourced and female farmers, ii) can be expanded due the current low land pressure, iii) is starting to be consumed as a healthy food choice, and iv) has the potential for increased market demand due to the internal diaspora, e.g. people from Siaya that live in Nairobi and want to eat food produced from their home area. However, the absence of value addition along the chain, poor planting practises and quality of the vines, and uncoordinated production are still hampering the potentials of the crop.

Table S1. Overview of sweetpotato initiatives in Siaya County

MoA (Ministry of Agriculture)	provides technical backstopping in all 3 wards of Ugunja on: SP propagation; production; linking farmers with seed producers, researchers, processors
UCRC (Ugunja Community Resources Centre)	promotes OFSP varieties to help mitigate VAD. They work with all farmers disseminating clean recommended OFSP and other SP varieties, providing capacity development, sharing information to extension and communities. Recently they are focusing on children to bring OFSP into school feeding programmes. UCRC have helped set-up 3 thematic groups of farmers in Ugunja and Gem to represent the parts of the value chain – seed, root production, processing. UCRC was supported by ASARECA on SP activities, now Self Help Africa are supporting with SP and tissue cultured banana.

Data from MoA reports that the area under SP increased by 12% in the last year, bringing the production to more than 35,000 tonnes[15] (Table S2). The average quantity of land under SP is 0.2-0.3 acres for small farmers and 1 – 1.5 acres for commercial farmers. ~90% of the households grow SP, mostly for home consumption although it is not straightforward to figure out the proportion of SP sold or consumed as farmers' food. In Ugunja it is estimated 40% of the harvests is sold in the market while in Gem the quantity increases to 70%.

Table S2. Sweetpotato production data

	2013			2014		
	Area (ha)	**Prod (tons)**	***Yield t/ha***	**Area (ha)**	**Prod (tons)**	***Yield t/ha***
Aleso Usonga	760	9,187	*12.1*	800	9,600	*12.0*
Bondo	45	472	*10.5*	50	500	*10.0*
Gem	1,100	15,125	*13.8*	1,300	17,875	*13.8*
Rarieda	105	1,181	*11.3*	125	1,400	*11.2*
Ugenya	470	5,900	*12.6*	490	6,000	*12.2*
Ugunja	105	1,312	*12.5*	135	1,687	*12.5*
TOTAL	**2,585**	**33,177**	***12.8***	**2,900**	**37,062**	***12.8***

Source: CDA Siaya, Annual report, 2014

[15] Data was generated through the extension annual transect surveys (the farmers were asked to show how much land was under which crops and how many sacks of SP were harvested). Yields seem, however, too high and it is likely these estimates should be at least halved to represent the actual yield per planting.

i. Production activities and producers

A group discussion was held with 14 (5M, 8F) farmer members of Kodiaga Community Resource Centre, who are within the Gem/ Ugunja SP seed growers association (GUSSGA). In this area of Siaya county they have developed thematic groups (seed, roots, processing) to represent the different sections of the SP value chain (VC).

Sweetpotato is grown mainly as a food security crop in Siaya County, particularly to cover periods of the year when there is no maize. Most households sell small quantities of SP at the local market when they need cash, but large scale SP trade such as that seen in Kabondo and Migori does not occur. The farmers' estimate 80% of the SP produced is used for home consumption, and 20% is sold. The main staple foods are maize, beans, SP, bananas, cassava, groundnuts and millet. Cash crops include: groundnuts, kales, pineapples and watermelon. Sugarcane is not widely grown as land pressure is high in Gem s/c with most households owning only ~1 acre of land, and leasing other small portions in different places. Only about 5% of farmers have access to irrigated/wet land.

The SP crop is rain-fed, and most HHs plant local SP varieties (Table S3) twice per year as a pure stand on ~¼ - ½ acre spread across at least 2 different plots. SP is rotated with maize, groundnuts and kales. SP is viewed as a woman's crop and they typically make the decisions concerning it. Land preparation is done manually with a jembe in November and June by the wife or occasionally by young male labourers. The wife will collect vines from SP plants in one of her existing SP plots or a neighbour's plot for free. She will plant the nice looking vines on ridges in November and June (the other vines are fed to livestock (cattle, rabbits and cut up for fish feed)), and will weed the SP plot about 3 weeks after planting, using a hoe.

Harvesting starts from 3-4 MAP, and is usually done by the wife in the morning. Weevils are reported to damage the SP roots, but early harvesting helps reduce the severity. Typically two piecemeal root harvesting rounds of the plants in the field are made using a metal spike (*chuma*), followed by a final clearing of the field using a jembe/hoe. This piecemeal harvesting of a ½ acre area of SP may occur over a 2.5 month period, with some roots being harvested every few days. The roots are carried home in a basket on the wife's head. Once home, they wash the roots and boil them and start eating them. Boiled roots are typically consumed with a cup of tea about 2-3 times/ week, and occasionally boiled with beans. Harvested roots are reported to last up to 1 week before they get soft/ spongy and change colour. If the wife requires cash for sugar, maize or cooking oil, she will wash some undamaged SP roots and take them to the market and sell them in Ksh30 or Ksh50 piles. They estimate they sell ~1 flat bag (~110kg)/ year of SP. There are not always buyers so they may return home with the roots which then rot. They also give a couple of baskets of SP to relatives when they are short of food. In months when their own HH is short of food (such as Mar-May, Nov& Dec) they may buy SP roots as they are cheaper than maize. During ~4 months of the year, SP may be bought twice a week; a total of 32 x 3 x Ksh30 piles (=4 medium and 2 bonus roots), or 32 x 2 x Ksh 50 piles (4 big roots & 6 small ones). A few HHs chip and sun-dry some SP as a food stock.

Table S3. Main sweetpotato varieties grown by focal farmers in Gem sub-county of Siaya county

SP variety	Good characteristics	Bad characteristics
Kunykibuonjo (translates as: *you dig it smiling*); 3-4 MAP, red skin, yellow flesh	• Big roots; good yield; matures 3-4MAP; sells easily in market; very sweet	• Mole rat likes it a lot; vines starting to exhibit crunching-up disease symptoms
Ya Kakamega; 5 MAP; red skin, cream flesh	• At 5 MAP you get very big and long roots; sweet	• Slow to mature
Olombojapidi; 3 MAP; white skin, purple flesh	• Fast maturing; vines don't get diseased; lasts well in-ground without rotting	• Gives very tiny roots (*this depends on the soil type*)
Maraoko; 6-8 MAP; white skin and flesh	• Big roots; slow maturing which means it doesn't rot in the soil; lasts a long time	• Takes 6-8 months to mature

In the last 10 years, inflation and the standard of living has increased. SP production has decreased as land size has shrunk due to sub-division between children, and soil fertility has reduced. The increased cost of labour (Ksh200/d now versus Ksh50/d in the past), means they use their only own labour and so prepare and plant smaller areas. The changing climate has led to less reliable timing of the rain seasons. Although still limited, there is more sale of SP now than 10 years ago as maize production is low and they need to sell SP in order to buy maize to eat.

Post maturity loss issues include: poor in-ground storage characteristics of SP roots which become watery, tasteless and bitter, and they need to leave the roots in-ground to extend their food security; mole rat damage; unreliable market even for small-scale sales; and careless harvesting by children may result in roots being left in the field.

These SP seed system members have recently been given planting materials of the OFSP variety, Kabode, which they have been informed: matures 3MAP; is high in vitamin A; can be used for making chapatis, juice, mandazi, crisps, cakes; and has good yields. There is a strong market for OFSP vines amongst relief organisations at Ksh500/sack, the members are each hoping to sell 2-6 bags of vines per year. However, not all of them like the taste of the boiled Kabode root (some say it is not as sweet as the local variety), although they do like it when it is incorporated into products. They felt they might need more awareness on how to use OFSP in order for it to become more popular. The farmers interviewed knew of one lady and one group who have started using OFSP in processed products, but said OFSP is still very rare in this area.

Additionally, case studies with three individual farmers were conducted to learn more about SP revenues, costs, margins of these SP farmers (Table S4).

Table S4. Farmers' gross margins for SP and OFSP production (per cycle) *Source: Field visits*

	Farmer A: 1 acre of OFSP, 0.5 acre of SP and small area for vines			Farmer B*: 0.125 acre of SP			Farmer C: 1 acre of SP		
	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)
Revenues			**41,125**			**13,500**			**6,432**
Sweetpotato	bag	35	13,125	bag	18	13,500	bag	6	6,432
Orange-fleshed Sweetpotato	bag	9	27,000	bag			bag	not yet harvested	
Vines	bag	4	1,000	bag			bag		
Costs			**18,850**			**2,265**			**4,194**
Vines	bag			bag	1	130	bag	0.5	250
Hoe	unit	1	70	unit	1	35	unit	1	35
Bags (for roots)	unit	~30	1,325	unit			unit	3	150
Fertilizer	liter			liter			liter	Easy Grow foliar	93
Land rent	acre	3,500	1,000						
Land clearing	man/day	7	1,575	man/day	1	150	man/day	6.66	1,333
Land preparation	man/day	12	2,700	man/day	1	150	man/day	incl in above	
Mounding/ridging	man/day	6	1,350	man/day	1	150	man/day	incl in above	
Labour for vines	man/day			man/day			man/day		
Planting	man/day	8	1,600	man/day	1	150	man/day	2	400
Weeding	man/day	8	2,400	man/day	1	150	man/day	2.5	500
Applying fertilizers	man/day			man/day			man/day	0.3	66
Harvesting	man/day	8	2,400	man/day	2	350	man/day	5.0	1,000
Transporting	motorbike		4,500	motorbike		1,000	man/day	0.2	33
Selling	market spot			market spot			man/day	1.7	333
Gross margin			**22,275**			**11,235**			**2,238**
excluding family labour			23,575			12,335			5,904
Gross margin per acre			**14,850**			**89,880**			**2,238**
Gross margin per OFSP bag			**1,683**						
Gross margin per SP bag			**611**			**5,245**			**373**
Gross margin per year			44,550			22,470			6,715.02
Total acreage	2.5			0.25			2.5		
SP acreage	0.5			0.125			1		
% Total	20%			50%			40%		
OFSP acreage	**1**						**0.25**		
% Total	40%						10%		
Vines acreage									
% Total									
OFSP Price per bag (Ksh)	3,000						Not yet sold		
SP Price per bag (Ksh)	750			6,000			1,072		
Vines Price per bag (Ksh)	500								
SP Bag size (approx)	50 kg			100 kg			90 kg		
OFSP Bag size (approx)	90 kg								
Home consumption (% total production)	5%			66%			50%		
In-ground losses									
Other losses									
Labour	Family/hired			Family			Family		
Irrigation (Y/N)	N			Y			N		
Use of tractor (Y/N)	N			N			N		

The gross margins per acre and per bag are calculated. Farmer A is a small-scale farmer (2.5 acres) that cultivates both yellow SP, OFSP and the vines for her plot. Around 5%-10% of the OFSP produced is used for home consumption; she sells most of the OSFP in the local market at 100Ksh/pile (in March-May) and at 50 Ksh/pile (in June-August), depending on the availability of other food. Farmer B is a very small holder (0.25 acres) cultivating SP and kale. Most of the SP production is used for home consumption. He manages to transport one bag of SP to Nairobi and sell it at 6,000 Ksh (the cost of transport is 1,000 Ksh/bag). The intermediation takes place through MPESA payment. Farmer C has 2.5 acres, 1 of them cultivated with SP and 0.25 with OFSP. He is also producing irrigated vegetables for sale, but the rest of his crops were grown for HH consumption.

ii. Traders/ wholesalers

The trader interviewed in Siaya started his business in 1993, selling the SP he cultivated on his plot and, then collecting local fresh SP roots from other farmers, he was encouraged by the increasing demand for SP in Gem/Ugunja area. He sells the local SP varieties (mainly Nyagunj and Nyandere) to retailers located near to the lake (i.e. beaches). Occasionally, he and his wife sell the fresh roots as retailers on the local market in Gem (Wahgaa). He also sells OFSP (Kabode variety), mainly to schools and orphanages.

The supply cycles of local SP mainly follows the scarcity of other food crops in the market. Starting from March, when there is low supply of other food crops (especially maize), the availability and the related trade of fresh SP roots increases. In June, July and August, the supply/sales are medium due to the presence of other crops in the market. From September, the availability of local SP fresh roots goes up again until November. During the periods of medium supply, the trade volumes lower by 40%-50%, as well as the profits considering that the selling price is fairly constant during the year (Table S5). The monthly profits are Ksh 18,000-24,000 during the peak season and lower to Ksh 9,600-11,800 during the low supply season. For the OFSP variety, the supply remains quite flat during the year, mostly due to its short maturity period (3 months) which means OFSP roots are virtually available all year-round.

As a retailer, the profits/bag are quite stable during the different supply seasons, considering the sale of fresh roots in piles and the adjustment of the number of roots per pile accordingly.

Table S5. Fresh SP root trading prices and volumes in Gem

SP root supply season	Peak (March-Apr and Sept-Nov)	Medium (Dec-Feb, Jun-Aug)
SP selling price (Ksh/ flat sack)*	2,000-2,300	2,000-2,500
OFSP selling price (Ksh/flat sack)*	2,500	2,500
SP buying price (Ksh/ flat sack)*	1,200-1,300	1,500
OFSP buying price (Ksh/ flat sack)*	2,000	2,000
Trading profits		
SP sold to retailers (Ksh/bag)	*500-700*	*350-400*
SP to Wahgaa market (retailing profits) (Ksh/bag)	700-1,000	*700-1,000*
OFSP (Ksh/bag)	*450*	*450*
Volumes of local SP (flat sacks/wk)	6	3-4
Volumes of OFSP (flat sacks/wk)	3	3

* weight of a flat bag for SP is approx. 100 kg and for OFSP is 90 kg (approx.)

The trader first sells the roots from his plot and then he aggregates the local varieties and OFSP fresh roots from other farmers in Gem, i.e. 8 -10 farmers. He makes an (informal) agreement with farmers, without paying in advance. He used to pick the bags with his bicycle but now he relies on external transporters with bicycles or motorcycle that go to the farmers and deliver to the retailers that are located near to the lake. This delivery service costs Ksh120-150/bag and he is paid by the retailers using MPESA.

If he sells directly to final consumers in the local market the trading costs are just 20Ksh/day plus 80Ksh for transporting the sack (Table S6). He thinks that SP trading is a good business and he is happy with his activities, having trustful relationships with both farmers and retailers. He is also glad to help promote the consumption of OFSP in schools; the main constraints for broader consumption of OFSP are the low dry matter content and the few OFSP processors involved, as the consumers prefer to eat OFSP as flour, in chapatis or mandazis etc.

Table S6. Average Costs per bag

Costs (ksh)		Unit
Transport from Gem-> Lake area	120/150 Ksh	100kg/ bag
Transport from Gem-> local market	80 Ksh	100kg/ bag
Empty bags for local varieties (the bag is used 2 or 3 times)	50 Ksh	100kg
Empty bags for OFSP varieties	50 Ksh	90 kg
Spot in the local market	20 Ksh	day

iii. Processing and types of processors

Two processors were interviewed, the first was part of a group who produce OFSP flour, the second was an individual who produces OFSP based food products.

Processor A: This group formed to address the challenges of HIV/AIDS in their community, and began processing OFSP in 2012. They produce a pure OFSP flour, a composite flour (incorporating finger millet, OFSP flour, sorghum, soya, green Amaranth), and occasionally OFSP onion bites to order.

They manually wash, peel, grate, and dry the OFSP roots into chips, and then mill them using the neighbouring posho mill after first flushing it through with sorghum and millet. 5kg of OFSP roots produces 1 kg dried OFSP chips which produces ~800g of OFSP flour. Both the composite and pure OFSP flour are sold at Ksh200/kg. In the last year they have produced and sold 1.5t of composite flour and 700kg of OFSP flour. Their main customer is a centre for vulnerable children which orders 70kgs of composite OFSP flour 8 times a year to provide nutrient-dense porridge (*uji*) during weekends and school holidays. Their other customers are individuals and small bakeries, the OFSP flour is used for making cakes and breads. They believe they could easily sell more of their flours which customers enjoy due to the flavour and orange colour, however due to the manual nature of their current operations they are not able to produce anymore. They are soliciting for funds to help them invest in a mechanised grater. They have run out of packaging and will not reorder until they are KEBS certified and can then get that printed on their product labels.

The group purchase OFSP roots (mainly Kabode, and a bit of Vita) from the few local farmers growing them, they also have their own nucleus farms (3-3.5 acres of OFSP) which help ensure a steady supply of roots. OFSP root availability and price fluctuates widely during the year, affecting their margins (Tables S7 and S8).

Once mature (4 MAP) OFSP roots do not last well in the soil, they are heavily damaged by weevils and mole rats if left in the ground. The group purchase all the OFSP roots, using damaged or small roots as animal feed and processing the others. If they run out of OFSP roots to process and have an order, they can purchase dry OFSP chips from Busia.

Table S7. Siaya OFSP flour processor's perception of annual OFSP root availability and price

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
OFSP root supply	-	-	-	**	*	*	***	****	*	**	**	**
OFSP root price (KSh/sack)	-	-	-	1800	1800	1800	1000-1200	1000-1200	1800	1600-1700	1500	1500

*Key: - = no roots available; * = shortage; ** = low supply; ***=medium supply; ****=good supply*

Root washing is done manually. If the roots are harvested at 3-4 MAP the skin is still soft and will rub off during washing removing the need to peel the roots.

Otherwise the roots are peeled manually and grated using a handheld grater; the gratings are then spread into a thin layer on top of plywood sheets covered in flip-chart paper in a room for ~2 days to dry. They chips are milled into a fine flour and packaged. The group hires labour for peeling and grating, but may wash the roots, and will dry and turn the gratings, and package the milled flour themselves.

Table S8. OFSP flour costs of production

	Ksh/kg flour	Annual margin (Ksh)
OFSP flour from fresh roots		
Cost per flat sack (roots, wash, peel, grate, dry) excluding group labour	100-150	
Cost/flat sack (roots, wash, peel, grate, dry)	125-175	
Milling and packaging cost	6.25	
Sales price	200	
Gross margin range excl. group labour	44 - 94	
Gross margin range	19 - 69	13,300 – 65,800
OFSP flour from purchased dry chips		
Purchased dry chips (& transport)	112.5	
Milling and packaging cost	6.25	
Sales price	200	
Gross margin excl. group labour	81	
Composite OFSP flour		
Milled OFSP flour processed by group	34-38	
Milled other ingredients (finger millet, sorghum, soya, green Amaranth)	72	
Sales price	200	
Gross margin range	90 - 94	135,000- 141,000

Processor B:

The second processor interviewed was a business woman from Naywara who produces at home, composite porridge and mandazi from OFSP roots (Kabode and Vita varieties), and less frequently, chapati and onion-bites.

To make the composite porridge, she uses: OFSP (fresh roots), mixed flour with soya, amaranth, groundnuts, finger millet and warm water. She can store the composite flour for only 1 day.

For the mandazis, the main ingredients are OFSP, wheat flour, oil, sugar.

Her business is not constant or scheduled: she sells her products 2-3 days a week at public/religious ceremonies, sports events and/or outside the schools. The average profits per day are Ksh400-500 (see Table S9), bringing her returns to Ksh 800-1,500 per week. Beside the ingredients and the cooking costs, she pays the transportation at Ksh 100 that includes a person that helps her bringing the necessary tools to operate. She brings with her more than 10 cups, pan, roller, grater, spoon for frying and soap to wash the cups. She could organize the business in a group, but she prefers to carry out the activities individually (having a max. of 1 person to help her), as she is afraid of uneven distribution of work in a group. She uses OFSP because it is a nutritious and energetic

Table S9. Profits from processing activities

OFSP processed products	Ksh/kg
Revenues from one day porridge selling (100-120 cups)	1000-1200
Costs	560
1 pile of OFSP Fresh roots	50
0.5 kg of soya	75
Amaranth (25 grams)	50
Finger Millet (2 kg)	200
Groundnuts (25 grams)	50
Firewood/Charcoal	25
Milling the finger millet	10
Transport	100
Gross margins/Profits	440-640
Revenues from one day mandazi selling (90-100)	750-850
Costs	390
OFSP (1kg)	50
Wheat flour (2kg)	75
Sugar/yeast (25 gr)	25
Lemon	10
Oil (1 liter)	100
Baking costs	30
Transport	100
Gross margins/Profits	360-460

One cup of porridge is sold at 10Ksh while a bag with 6 mandazi at 50 Ksh.

ingredient for processed food and, occasionally, she explains the vitamin A contents of mandazi outside schools.

She grows OFSP on her plot, harvesting in April-May and in Oct-Nov. During the rest of the year, she goes to Yala market on Tuesday and Friday where she buys the mixed piles of fresh roots for Ksh 50. In January, February and March, the supply of fresh SP roots lowers and the costs per pile increase (small root and big root piles are sold at 50 Ksh/pile and 100 Ksh/ pile, respectively). She usually finds the fresh roots in the market. If there are food shortages, farmers may not retail their roots in the market, so she then goes to pick up the roots directly at the farmers' fields. She started her business 7 years ago, and she is happy about what she has achieved. She thinks she can improve their production volumes and employ a retailer to ease her business but she does not have enough capital or access to credit to go into a larger scale. She thinks that the puree may be a successful business as people like the OFSP processed products more than boiled roots.

iv. Consumers

The farmer group interviewed explained that they eat boiled SP roots about 2-3 times/week; usually in the morning with a cup of tea after coming back from their morning's farming activities. They also occasionally boil the SP roots with beans. They view SP roots as a convenient food, as if a mother expects to be late home she can tell her children to harvest a few roots and start boiling them for dinner. Farming households typically purchase small piles of SP during 4 months of the year when they have limited food, as SP is cheaper than maize. A few HHs chip and sun-dry some SP as a food stock.

Urban families in Siaya also like to consume SP for breakfast and lunch, especially during school holidays, as it is a cheap staple crop, easy to prepare and is more filling for the entire family than other foods (e.g. bread). The urban consumers prefer straight medium sized roots that can easily fit into the *suffria* (pan); there is no strong preference for washed or unwashed roots. SP is eaten across all wealth groups. Yam and SP are becoming more popular now and are being promoted to encourage healthy eating habits.

v. Main findings

- Climate changes and declining soil fertility have recently revitalized sweetpotato production in Siaya. SP is planted twice per year and is rotated with maize, groundnuts and kales. SP seasonality is affected by the scarcity of cereal crops and the timing of the rain (i.e. SP is considered a back-up crop when poor rains lead to failed maize);
- SP production is mainly for food security and has a limited market focus; most households cultivates SP (average SP plot size: 0.25-0.5 acre/cycle) for home consumption (>50% of the quantity harvested) and sell small quantities at the local market when they need cash;
- The farmer profits from SP range from Ksh 6,000 to 13,000/acre per cycle; the production of OFSP increases the profit up to Ksh15,000 due to the higher price of OFSP fresh roots. The SP yields (white and yellow varieties) are around 14 bags per acre per cycle, and 9 bags for OFSP per acre (per cycle) (bag dimension: 100kg);
- There is a limited knowledge about OFSP amongst farmers, although Kabode vines have been given out and there is market demand for these vines, especially from relief organisations that sell the vines at Ksh500/sack;
- Large scale SP trade is absent. The trader interviewed buys a SP bag at farm level at 1,200-1,300 Ksh during the peak supply season (March-Apr and Sept-Nov) and at 1,500 during the lower supply season (Dec-Feb, Jun-Aug), i.e. implying a 20% price variation during the year. The price of a bag of OFSP is stable during the year at 2,000 Ksh. He sells the bag at 2,000-

2,300 (March-Apr and Sept-Nov) and at 2,000-2,500 (Dec-Feb, Jun-Aug). The OFSP bag is sold at 2,500Ksh all year-round. His monthly profits are Ksh 18,000-24,000 during the peak season, and lower to Ksh 9,600-11,800 during the mid-low supply season. He uses external transporters and most of the payments from the retailers he supplies are made through MPESA;

- One of the two processors buys the OFSP at Ksh 1,000-1,800 Ksh (depending on seasonal variability) while the other buys a pile of OFSP at 50 Ksh (small roots and big roots piles are sold at 50 Ksh/pile and 100 Ksh/ pile, respectively). The profits for the first processor (a group) are estimated at Ksh 145,000-200,000/year, selling 1kg of OFSP flour at 200 Ksh. In the last year they have produced and sold 1.5t of composite flour and 700kg of OFSP flour. The home-based processor has estimated profits of Ksh40,000-75,000/year; 2-3 times a week she sells composite porridge and mandazi during celebrations, sport event and outside school. She would like to expand her business but has capital and credit constraints.
- The OFSP fresh roots bags are mostly sold to school and orphanages as school meals. The OFSP processing activities (i.e. flour production) is mostly targeted to a centre for vulnerable children. Other customers are individuals and small bakeries, as the OFSP flour used for bakery products.
- The value chain players think OFSP will be more easily consumed as flour in processed products than as boiled roots.

3E. Sweetpotato production, trading and processing in Busia County

Background information

Sweetpotato is an important food and cash crop in Busia county, and its importance is increasing as the short rains are becoming longer. However, maize is the main crop grown. Peak SP supply is Jun/Jul & Jan-Mar in Busia, SP production can occur almost all year as they do not have >1 month without rain. OFSP varieties have been grown in Busia for >10 years, and many development organisations have been involved in promoting them. Service providers estimate that 50% of HHs in Busia grow SP and 1/3rd of HHs may grow OFSP, planting two crops of it/ year, with an area of ~35 acres under OFSP. However, the original OFSP vars. (Ejumula and SPK), did not have high enough dry matter content, and the planting materials were often allowed to die off. There are problems with weevils and virus, and reports of degeneration leading to reduction in the yield and the orangeness of the roots over generations. The more recently introduced OFSP vars. Vita and Kabode, have better dry matter contents but are not drought tolerant, and the vines need preserving in swampy areas otherwise they get eaten by livestock. The sweetness of the OFSP roots attracts theft by pigs, mole rats and monkeys.

OFSP production fluctuates depending on the market demand. The three main markets are i) flour (through Siwongo); ii) dried chips (through Siwongo), iii) local value-added products (chapati, mandazi etc). Campaigns by the Ministry of Health, Agriculture and NGOs lead to locally increased demand for OFSP fresh roots for home consumption. While SP production for HH consumption is typically done by women, as it becomes more commercial men get involved. As OFSP is mainly done commercially (~80% of it is sold) it appeals to men, particularly the OFSP planting material production. OFSP has attracted many players including researchers who have released new varieties, and NGOs, Government and projects (Table B1). But farmers have been left hanging when market promises don't materialise or return.

Table B1. Overview of sweetpotato initiatives in Busia County

REFSO (Rural Energy and Food Security Organisation)	train farmers on good agronomic practices; mobilisation/farmer groups (to unify product to help meet market demands); awareness creation on SP and what the attributes of each variety are (e.g. OFSP/ Vitamin A sensitisation); encourage value-addition
MoA (Ministry of Agriculture)	used to promote traditional crops and give out OFSP vines purchased from Kenya Agricultural Research Institute (KARI). But in the current devolved system, just do field days and exhibitions on OFSP nutrition. At Busia Agric. Training Centre they do agronomic training, and farmer sensitisation about OFSP products
PALWECO (Program for Agriculture & Livestock in Western Communities) (2012-18)	supporting agricultural activities, some training and supply of OFSP vines and support farmer groups' priority areas. They supported SIWONGO with a processing hall, washing basins and water systems. They bring in agric. extn and NGOs to train farmers.
Agricultural strategies for coping with climate change (CC)	SP (including OFSP) was promoted as a coping strategy for CC by REFSO in a GIZ funded program in Busia and Homa Bay. OFSP is early maturing (3 MAP) & drought tolerant if grown in swamps. While the traditional varieties take 5,6,8m to mature
Farm Concern International	Responsible for linking farmers to markets/ buyers. But absence of a robust buyer is a problem, & some buyers want high quantities v. fast
Mama SASHA/ CIP	OFSP vines and nutritional education promoted at ante-natal visits
Siwongo	OFSP processor (see sub-section below)

There is some SP trading in Busia, but much less than in Kabondo. Busia's SP marketing is affected by being so close to the Ugandan border. Much of the SP sold in and traded from Busia into other areas of Kenya is from Uganda, as lower land pressure, higher soil fertility, lower costs of production and the exchange rate means Ugandan prices are cheaper than Kenyan, and empty trucks which have delivered goods in Uganda are looking for produce to fill their backhaul with. Onions, bananas, boiled groundnut, tomatoes, dried fish and extended bags of SP from Uganda are sold in Busia.

i. Production activities and producers

A group discussion was held with 9 members (6M, 3F) of Tangakona Commercial Village, Busia.

Sweetpotato is grown as both a food and cash crop in Busia. Although maize and cassava are the major staple foods, sorghum, millet, SP, beans and groundnuts are also important. Most farming households (HHs) plant ½ to 1 acre of their 2 acre farms to SP. The SP is not usually intercropped but may be planted among the maize after the maize has flowered as maize pollen inhibits plant growth; SP is rotated with beans, soya and maize. Households may farm land in several different plots, some rented some owned. In some HHs men and women have separate cropping areas. Both are allowed to sell the produce they cultivate, but are also both expected to cater for HH food needs first.

Sweetpotato is typically rain-fed and planted twice per year (in Apr/May and Oct/Nov), although in wetland plots (which are commonly hired) it can be planted throughout the year. Some HHs use oxen for the initial land breaking, and then makes the mounds manually using a *jembe*, men and women are equally involved in this. Vine sourcing is typically done by men using their bicycles. The vines are planted manually by the husband and wife, or hired female labourers. After 3-4 weeks the first weeding is done, followed by a 2nd weeding a month later, women do most of the weeding (as men tend to double dig due to the big hoes they use), if the HH has funds they will hire female labourers to help. If roots are needed for HH food, then the wife will do the harvesting in a piecemeal fashion in the morning or evening using a 30cm long metal spike (*chuma*) and carry sufficient roots for a couple of days meals, home in a basket on her head. If a market has been identified, the whole field will be harvested by labourers using *jembes*, and the roots will be transported in sacks on bicycles, motorbikes or a vehicle depending on the quantity. Either the husband decides alone or a joint-decision will be made about the use of the income from a large SP harvest. Harvested SP roots usually last for 1 week if not damaged. Women farmers may also act as retailers from time to time selling a few piles of SP roots in the market in order to get cash to buy soap etc. In the past they used to dry SP and store it as food stocks, but they no longer do as they can access cassava and maize.

Post maturity issues include: weevil and mole rat damage to mature roots in-ground; root weight loss if they overstay in the field; flooding in wetland fields causing roots to rot; very dry weather resulting in lower yields; SPK variety is reported to become less orange if it overstays in the field.

Some HHs plant several SP varieties, others just one. The members of Tangakona commercial village grow traditional SP varieties and some OFSP varieties (Table B2).

Table B2. Main SP varieties grown by focal farmers in Busia

SP variety	Good characteristics	Bad characteristics
Kampala -3MAP	• Good market due to its straight shape & as feel full after eating it	•
Maraoko	• High yielding; can harvest from it for up to 1 year; can be sold or used as HH food	• Slow to mature
Bungoma-4MAP	• High yielding; can be sold or used as HH food	• Can't be left in-ground for long
Busi – 3MAP	• Matures quickly	• Round and very tiny roots
SPK004 – matures 3MAP (OFSP)	• Easy to peel; easy to sell; delicious; drought resistant seed; texture not fibrous; can be made into chapati, juice, cake	• Once mature it needs to be harvested straight away
Kabonde – matures 3MAP (OFSP)	• Bulky vines, so it is easy to fill a sack & good for business; large roots and lots of roots; retains the nice orange colour well; good for use in industrial products and for dry chips as its very dark orange; can be made into chapati, juice, cake	• Difficult to harvest; shape of roots very variable; sand sticks in the creases of the roots/ ridges; roots not easy to sell; if you cook it with a lot of water you just get slush
Vita – matures 3MAP (OFSP)	• Boils well; high yields; can be made into chapati, juice, cake	• Not drought tolerant; difficult to distinguish vines of Vita & Kabode

The OFSP vines are sold to development programs, while the roots are sold to the local processor or used for home consumption. If the market is good OFSP can be more profitable than sugarcane, however the OFSP market is often unreliable. If growing OFSP for vine and root sales, one can get 120 bags of vines from 1 acre, each of which can be sold @Ksh500-700/bag = Ksh60,000-84,000/acre. Vine production costs (labour, vines, planting, 2 weedings, harvesting) are Ksh36,000-38,000/acre. 30-40 bags of roots will also be produced/acre, each of which can be sold at Ksh800-1500 = Ksh24,000-60,000/acre, root harvesting & packing labour and transport costs to the Siwongo processors are Ksh200-280/sack (Ksh6,000-11,200/acre). OFSP vine profit = Ksh22,000-48,000/acre, and OFSP root profit =Ksh12,800-54,000/acre. The OFSP crop can be produced twice per year, or more if in wetlands. The OFSP processor also confirmed that OFSP root yields in Busia range from 4.5t/acre in Feb/Mar and Jun/Sep to 2.2t/acre in Apr/May and Nov/Jan harvest periods.

Additionally, case studies with two individual farmers were conducted to learn more about SP revenues, costs, margins of these SP farmers (Table B3).

Table B3. Busia farmers' gross margins for OFSP production (per cycle)

	Farmer A: 2 acres of OFSP and 1 acre of vines			Farmer B: 1 acre of OFSP and vines		
	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)
Revenues			**186,000**			**112,500**
Sweetpotato						
Orange-fleshed Sweetpotato	bag	45	126,000	bag	50	60,000
Vines	bag	120	60,000	bag	150	52,500
Costs			**48,070**			**32,080**
Vines	bag	5	5,000	bag	6	2,100
Hoe	unit	1	70	unit	1	35
Bags (for roots)	unit	45	4,500	unit	50	2,500
Fertilizer				liter	0.5	25
Land rent				acre	1	5,000
Land clearing	tractor	1	7,000	man/day	2	2,400
Land preparation	man/day	4	3,000	hiring cows		2,000
Mounding/ridging	man/day	7	8,000	man/day	4	4,000
Labour for vines	man/day		4,500	man/day	15	4,500
Planting	man/day	4	3,000	man/day	5	1,500
Weeding	man/day	2	4,000	man/day	4	2,000
Applying fertilizers				man/day	1	200
Harvesting	bag	45	6,750	man/day	20	4,000
Transporting	bag	45	2,250	motorbike		1,500
Selling				market spot	16	320
Gross margin			**137,930**			**80,420**
excluding family labour			141,430			84,020
Gross margin per acre			**96,715**			**80,420**
Gross margin per acre for OFSP roots			**41,215**			**32,420**
Gross margin per bag			**916**			**652**
Gross margin per year			275,860			160,840
Total acreage	6			1.75		
OFSP acreage	**2**			**1**		
% Total	33%			57%		
Vines production acreage	1			1		
% Total	17%			57%		
Bag size (approx)	100 Kg			90 Kg		
OFSP Price per bag (Ksh)	**1,400**			**1,200**		
Vines price per bag (Ksh)	500			350		
Home consumption (% total prod)	12%			5%		
In-ground losses	30%			10%		
Other losses	10%			-		
Labour	Mostly Hired			Mostly Hired		
Irrigation (Y/N)	Y			N		
Use of tractor (Y/N)	Y			N		

Source: Field visits

The revenues take into account the production of OFSP roots and vines, including those used for home consumption. The latter is recorded at the price per bag sold by the same farmer. The labour can be both hired and/or provided by family members; for family labour the same wage recorded for

hired labour is used (and two different gross margins calculated, with and without family labour cost). The gross margins per acre and per bag are calculated.

These two farmers both produce two crops of OFSP twice per year, but their land size differs. Farmer A farms 6 acres. His main plot is located in the upland area that is partially irrigated with spring water. His OFSP vine production is located in the wetland. He plants OFSP vines in Feb and Aug and harvests the roots after 4 months. He sells most of the OSFP to a processor, small retailers and supermarkets, direct consumers, while the vines are sold to farmers. Farmer A also cultivates maize, banana and cassava. Farmer B farms 1.75 acres, and rents the wetland where she cultivates OSFP vines, roots and maize. She sells the OFSP vines to neighbours and an NGO (One Acre Fund) while the roots are sold in the market. She plants OFSP in May and Oct. and harvests the vines 2MAP and roots in small quantities from 3MAP.

ii. Processing and types of processors

This processor has produced dried chips and flour from OFSP since 2002. The OFSP flour is sold in bags of 110 kg to a distributor in Nairobi[16] that repacks the flour in smaller bags (250g and 500g) for supermarkets and groceries. The dried OFSP chips are sold in 100 kg bags and used by a milling facility in Nairobi to produce OFSP flour. The OFSP flour is used for porridge, bakery products and daily home consumption.

The OFSP fresh roots are manually washed and peeled by women: ~30% of the fresh root is cut-off during peeling and the peels are used for animal feed (mainly for chicken and fish).The peeled roots are mechanically chipped, and dried in a solar greenhouse: part of the chips are directly sold to the milling facility and part are milled at processor's site to produce the OFSP flour (Figure B1). 5kg of OFSP roots produces 1 kg of dried OFSP chips and/or 1 kg of OFSP flour. The dried chips are sold at 95 Ksh/kg while OFSP flour is sold at 110 Ksh/kg. The processor's profits are about 23 Ksh and 12 Ksh per kg of OFSP flour and dried chips, respectively (see Table B4). In the last year the processor has produced and sold about 10 to 12 tonnes of OFSP flour and of OFSP dry chips. The annual profits for the two processing activities are Ksh300,000-370,000.

The processor sends 1 tonne of OFSP flour per month (in two trips) to Nairobi on public transportation (bus). The distributor pays the cost of transport that accounts to 600 Ksh/bag (the loading and off-loading costs are about 150-200 Ksh/bag each). The distributor collects and stores the bags in a warehouse in Nairobi. The price of OFSP flour at retailing level is 122Ksh for a pack of 0.5 kg (244 Ksh/kg). For the bags of dried OFSP chips, the processor pays the transportation costs to the milling

Table B4. OFSP flour costs of production

OFSP flour from fresh roots	**Ksh/kg**
Revenues	110
Costs	87
Fresh roots	60
Labour costs for peeling and washing	15
Labour costs for chipping	0.5
Petrol for chipping	0.8
Drying costs	0.8
Millings costs (labour and maintenance)	8
Diesel for milling	2
Gross margins/Profits	23
Equivalent annual cost for chipping machine (10%, 10 years)	8,137
Equivalent annual cost for milling machine (10%, 5 years)	40,625
OFSP dry chips from fresh roots	**Ksh/kg**
Revenues	95
Costs	83
Fresh roots	60
Labour costs for peeling and washing	15
Labour costs for chipping	0.5
Petrol for chipping	0.8
Drying costs	0.8
Trasport	6
Gross margins/Profits	12
Equivalent annual cost for chipping machine (10% @10 years)	

Note: The costs of the chipping and milling machines are not accounted in the profits per kg of dried chips and OFSP flour. The labour costs refer to hired labour.

[16] Azuri Health Limited (http://azurihealth.webs.com/azurihealthproducts.htm)

facility in Nairobi.

The processor buys OFSP roots from farmers' groups and smallholders (300 in total) located within a 30-50 km radius. He pays the farmers a fixed price of 12 Ksh/kg of fresh OFSP roots. The OFSP availability is variable: from February to April (and from July to September) the supply is high, but is lower in May, June and from October to January. During these months, the processor manages the production of OFSP flour using the stored processed OFSP chips, especially in December.

The OFSP dried chips and flour processing activities are considered a good business that may improve if the awareness of consumers regarding the nutritional content and use of OFSP processed products increases. The processor thinks the consumption of OFSP (as fresh roots and processed products) needs to be promoted by the Government through media or village/road shows to reach a wider audience.

Figure B1. OFSP processing activities in Busia County: p*eeling of fresh roots, chipping, drying the chips and the milling machine (Photos: Ilaria Tedesco)*

iii. Consumers

The farmer group interviewed explained that they eat boiled SP and OFSP roots about 3 times/week, while kids may eat OFSP each day if the roots are available. SP roots are also used in other dishes (e.g. cooked with beans).

In Busia town, consumers typically buy small quantities of SP in the evening (*the size of the Ksh30 or Ksh50 pile of SP is larger in the mornings or evenings, making them cheaper*), boil them and then eat them for breakfast the next morning. Others boil SP with beans, and some may mash it and take it instead of ugali particularly with beans maybe twice/week. SP is probably eaten once or twice/ week in most households in Busia town.

Nationwide there is a major campaign to eat more traditional foods, for health reasons. OFSP vines are being promoted at antenatal centres along with nutritional information. In Busia most people are aware of OFSP, and consumers like OFSP and the yellow fleshed SP.

Agricultural service providers felt there were opportunities to get OFSP into school feeding programmes, one businessman is already supplying OFSP mandazi, chapati, crackies, crisps to school canteens and requires a lot of OFSP roots for processing – he wants to contract OFSP root supply.

iv. Main findings

- SP is an important food and cash crop in Busia, and is being promoted as a climate change agricultural adaptation strategy due to its early maturity, drought tolerance and the nutritional benefits of OFSP varieties. National healthy eating campaigns to encourage the consumption of more traditional, less processed and locally grown foods has also raised the consumption of SP and OFSP fresh roots.
- SP is typically grown twice per year, but with good management and early maturing varieties this could be increased to 3 times per year and staggered planting could help smooth supply peaks and troughs, as they normally get some rains each month of the year. In the wetlands SP is planted throughout the year.
- SP is typically produced by women when intended for HH food, however as it becomes commercialised men get heavily involved and hired labour is used to help scale activities.
- OFSP varieties were introduced to farmers in Busia >10 years ago, there is therefore greater awareness and production of OFSP by farming HHs than in the other counties we visited. The earlier OFSP varieties (Ejumula and SPK) did not have sufficient dry matter and have been replaced by Vita and Kabode; Vita boils well but is not drought tolerant, while Kabode has very variable shaped roots which are hard to market fresh and so are directed more towards processing plus its orange colour is retained well during processing, but it easily becomes a slush when boiled.
- The OFSP root yields in Busia range from 4.5t/acre in Feb/Mar and Jun/Sep, to 2.2t/acre in Apr/May and Nov/Jan harvest periods. Busia SP stakeholders estimate there are about 35 acres under OFSP in Busia.
- The production, promotion and processing of OFSP has been and is still the focus on several joint NGOs/ Government/ donor projects. As a result production of OFSP vines has become highly profitable for farmers, particularly as they also sell the roots they obtain during the vine multiplication. The OFSP vines are typically being taken by NGOs (e.g. One Acre Fund) to other parts of Kenya.
- As a result of having had several projects focused on the promotion of OFSP, the Busia based NGO and Government partners are well connected with each other.
- The gross margins obtained by farmers for both OFSP vine and root production range from Ksh34,800-96,715 per acre per cycle, and for just the OFSP roots Ksh12,800-54,000.
- Sustainable markets for OFSP have been a problem, as buyers often either do not return or want very large quantities very quickly.
- Whilst there is some trading of SP in Busia it does not compare to the scale seen in Kabondo or Migori. The proximity to the Ugandan border, means trucks delivering items to Kampala then load up their backhaul with Uganda produce including SP as it is cheaper due to lower costs of production, less land pressure and the exchange rate.
- The OFSP processor has been producing dried chips and flour since 2002. In the last year he produced and sold more than 10 tonnes of both OFSP flour and OFSP dry chips. OFSP flour at a profit of Ksh23/kg, and dry chips at a profit of Ksh12/kg, giving an annual profit of about Ksh370,000. The conversion rate is 5 kgs of OFSP roots: 1 kg of OFSP flour or dried chips.

3F. Sweetpotato production and trading in Kericho County

Background information

Kericho County has a wide range of altitudes and is well-known for its tea production; the other main cash crops cultivated are coffee and sugarcane. Maize, beans, Irish potatoes, sweetpotato, sorghum and millet are grown as food crops. Maize was the most widely cultivated but its productivity is now seriously affected by Maize Lethal Necrosis Disease (MLND) creating the need to find alternative crops to diversify the over-reliance on maize revenues. In 3 of its 6 sub-counties there are large areas of land at low and mid altitude and farmers have been increasing their SP production in these areas as the rainfall and the loamy soil conditions are favourable. The main SP growing sub-counties are Sigowet and Belgut, where 50% and 10% of households are growing sweetpotato respectively, and Kipkelion.

Table KE1. SP production, area and yields in Kericho

	2010	2011	2012	2013	2014
Total Prod (tonnes)	3,984	4,150	3,446	7,758	6,712
Total area (ha)	332	381	326	431	637
Yield (tonnes/ha)	12	10.8	10.5	18	10.5

Source: MoA

There are currently about 600 hectares (~1,482 acres) under SP for a total production of 6,700 tonnes (see Table KE1); 5 hectares are instead under OFSP. Across the county, there are 11,200 households growing SP (with an average acreage of 0.13 acres/HH), and just 10 of these households are growing OFSP. In 2012, SP production was negatively affected by the drought during the short rain season; in 2013, SP production increased due to the switching from maize to SP as a result of the spread and severity of MLND. A small part of the Kericho SP production is starting to be exported to the UK through SACOMA (paying the farmer 20 Ksh/kg): the agreement is for 2 tonnes of SP/week (about 104 tonnes/year) but so far only 9 tonnes were exported in 2014.

The long-rains are between Mar and May, and short rains are in Sept-Oct. Most of the SP is planted during the short rains. The MoA calculations suggest that SP is as profitable as tea production (about Ksh76,300/acre per annum) while the gross margin of maize is lower and is estimated at 8,450 Ksh per acre.

The MoA (Ministry of Agriculture) is involved in different SP initiatives such as the building of a SP packhouse in Sigowet for the farmers who will be producing roots for export to UK (through SACOMA), the cultivation of 10-20 acres under OFSP at the Agric Training Centre, etc. OFSP initiatives started in 2010, with the dissemination of 100 bags of OFSP vines (obtained from KARI) to farmers. The main weaknesses in the SP value chain in Kericho are perceived by stakeholders to include:, the price fluctuation, incomplete implementation of the SP business with SACOMA, and the poor bargaining power of the farmers who are exploited by middlemen.

i. Production activities and producers

A group discussion was held with 9 members (6M, 3F) of Sigowet SP farmers group. In Sigowet sub-county, maize is the main staple food, followed by SP and millet. The importance of SP as a cash crop has increased significantly since 2008/9 in some areas of Kericho county, and it competes with tea and beans depending on the location. The tea returns decreased significantly over the last two years, stimulating tea farmers to look for other sources of income. The farmers estimated that 80-90% of the SP grown was sold.

Farmers estimated the average farm size to be 5 acres, of which ~1 acre was typically under SP production. SP is mainly farmed jointly by the husband and wife, although some HHs allocate a part of the farm for the wife or older children to farm. SP is not intercropped, and is rotated with maize and beans. Rainfall is good in the area; the dry months are January to March.

Sweetpotato is typically planted twice a year, in February (harvested in July) and in September (harvested in March). Land preparation is done jointly by the husband and wife, with land size dictating the method (e.g. medium = oxen, small = jembe, big = tractor). Ridges are made manually by *jembe* by the husband and wife, who then source vines from nearby fields for free. They plant the 30cm long vine portions by hand, and after 1 month the wife (sometimes helped by the husband) will weed slowly with a *jembe* so as not to damage the roots. The main local variety, Chebolo (high yielding, with a red skin and yellow flesh) takes about 6 months to mature. The harvesting practice depends on the quantity, if a small quantity is being harvested for HH food the wife will dig up all the roots from a few plants with a jembe at about 10 or 11am and carry them home by head load to boil. Boiled SP roots can be eaten at breakfast, lunch or dinner time, but are mainly taken as lunch with water or tea. The SP roots may also be cooked with banana, beans and *sukuma* in a stew for dinner. After harvesting the roots last just 3 days unless they are kept in a cool place where shelf-life may be extended to 1 week. The roots taste sweeter when they have been kept for a few days after harvest. SP is eaten all year round, and in April/May when the maize stocks are finished SP is the main food eaten. Most HHs buy about 4 *moets* (=24 *suffrias* (pans) * Ksh30/*suffria*) of SP for food use in Apr-Jun. While sweetpotato is sold by the *suffria* load amongst neighbours, some female farmers will also sell small amounts of SP roots in piles of Ksh30 or Ksh50 in the Saturday market in Kiptere, the woman can decide how to use any income earnt this way.

Harvesting for market sales is done early in the morning in order to coordinate with the market times at Kiptere. If about 3 sacks of roots are needed for a sales order, the husband and wife will harvest together with *jembes*. However, if the order is ≥10 sacks, they hire labourers (either sex) who use *jembes* and also pack the roots after sorting the medium/big roots from the small ones. Very damaged/cut roots are taken home as food, less damaged cut roots are sold. Sometimes they delay harvesting in order to let the roots grow bigger. Weevils damage the roots after maturity if the weather is dry, but not if the season has been wet. If weevil damage has become severe in the plot, the SP has to be rotated to another area. Donkeys are used to transport large amounts of roots to market, organised by either the farmer or the trader, one sack (*moet*) of roots is hung on each side of the donkeys back. Medium/big roots can be sold at Ksh1,000 for two *moets*, while small roots sell at Ksh300 for two *moets*. The farmer receives payment before the roots are taken. SP is a profitable cash crop especially as its price has risen at a time when the tea price has dropped drastically. The farmer group said the gross income/ acre from SP = Ksh75,000, and after deducting expenses = Ksh40-50,000/ acre. Peak sales month is February, although SP is sold throughout the year. If the SP income is large the HH decide together on whether to use it for school costs, cattle purchasing etc. Marketing is typically done individually, but Sigowet SP growers have recently started selling a little bit of SP as a group to SACOMA who export the roots to London. Self-help groups may farm a group field and sell the proceeds to address hunger etc. The farmers explained that during the low season in Kabondo e.g. May, traders come to Kiptere market to buy SP roots to supply to Nakuru or Nairobi.

Post maturity losses may result from: inaccurate price projections, damaging roots during harvesting so they then cannot be sold; insect damage when it is hot and the soil cracks making it easier for insects to reach the roots; sun exposure turning the roots green. Weak market demand and high root perishability can be a problem, as can donkey transport shortages.

SP vines are commonly fed to livestock, the vines are left to wilt/dry for 2 days and then fed to the cattle and goats. While rabbits can eat them fresh.

The farmers felt SP demand was increasing across Kenya due to population growth, urbanisation and because the maize crop has been so seriously affected by maize leaf necrosis disease.

The farmers were aware of OFSP, as the Ministry of Agriculture had distributed OFSP vines to a farmer. They said the roots were nice to eat with tea, but that the vines were currently very limited.

Additionally, case studies with two individual farmers were conducted to learn more about SP revenues, costs, margins of these SP farmers (Table KE2). The gross margins per acre and per bag are

calculated. They sell the SP bag at 1,000 Ksh (flat bag) and their calculated profits are between 30,000-40,000 Ksh (per acre per cycle): their margin per bag is between 664-695 Ksh.

Table KE2. Kericho farmers' gross margins for SP production (per cycle)

	Farmer A: 1.5 acre of SP			Farmer B: 0.5 acre of SP		
	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)	Unit	Quantity per acre/cycle	Total Value per plot/cycle (Ksh)
Revenues			**65,420**			**30,000**
Sweetpotato	bag	30 (big roots) + 12 (small roots)	65,000	bag	60	30,000
Orange-fleshed Sweetpotato	bag			bag		
Vines	bag	12	420	bag		
Costs			**21,635**			**10,090**
Vines	bag	7	735	bag	14	245
Hoe	unit	1	70	unit	1	35
Bags (for roots)	unit			unit		
Fertilizer	liter			liter		
Land rent	acre	1	3,750	acre	1	1,500
Land clearing	man/day	3	1,125	man/day	4	500
Land preparation	tractor		1,000	man/day		
Mounding/ridging	man/day	4	1,000	man/day	4	1,000
Labour for vines	man/day	7	315	man/day		
Planting	man/day	3	2,500	man/day	6	750
Weeding	man/day	8	3,000	man/day	6	750
Applying fertilizers	man/day			man/day		
Harvesting	bag	42	2,940	bag	60	1,500
Transporting	matatu	4 times for 10 bags each	3,250	donkey	60	3,000
Selling	council tax		1,950	council tax		810
Gross margin			**43,785**			**19,910**
excluding family labour			43,285			24,910
Gross margin per acre			**29,190**			**39,820**
Gross margin per OFSP bag						
Gross margin per SP bag			**695**			**664**
Gross margin per year			43,785			29,865
Total acreage	6			1.2		
SP acreage	1.5			0.5		
% Total	25%			42%		
OFSP acreage						
% Total						
Vines acreage	0.5					
% Total						
OFSP Price per bag (Ksh)						
SP Price per bag (Ksh)	1,000			1,000		
Vines Price per bag (Ksh)	70					
Bag size (approx)	90 kg			90 kg		
Home consumption (% total production)	5% (only small roots)			10%		
In-ground losses				7%		
Other losses	NA			7%		
Labour	Hired			Family		
Irrigation (Y/N)	N			N		
Use of tractor (Y/N)	Y			N		

Source: Field visits

Note: Farmer A is a medium scale farmer (6 acres) that cultivates both yellow SP (Chepolol), and the vines for her plot. She also farms tea that she harvests twice a month and sells to the cooperative. She cultivates SP once a year. After the land preparation (in June/July), Farmer A plants the vines in August and harvests the roots after 5/6 months, i.e. in January. She keeps 5% of the SP for home consumption (mainly the smaller SP roots) and the rest is sold in the market to consumers (average price: 1,000 Ksh/bag). Farmer B is a small holder (1.2 acres) cultivating SP, beans and maize, in almost equal quantity. He produces 1.5 cycles of SP per year. 10% of the SP production is used for home consumption. After preparing the land and planting (in October and November), Farmer B harvests the roots in June/July (SP variety that matures in 6 months); he then starts another cycle in January.

ii. Traders/ wholesalers

A group discussion was held with 6 traders (1M, 5F) based at Kiptere market. All of these traders also have their own SP fields that they farm, and they sell their own roots as well as those they purchase from neighbouring farmers. They trade 4 days per week at Kiptere all year round, selling the roots to traders from nearby areas who then sell them during their market days (e.g. on Monday buyers come from Sosiot, on Wednesday and Friday buyers come from Kapsoit, on Saturday buyers come to take roots to sell at Kiptere market day and some of these are transported on to Nakuru for sale). These buyers usually make an order by phone for a certain number of *moet* sacks. One of the traders

also sells SP roots in Eldoret, and this business is described later. During the week most of the traders are women, but on Saturdays, the main market day more men are involved. The root supply fluctuates with the seasons (Table KE3), peak production occurs Nov to Jan when the SP crop is planted after harvesting the maize in Jun/Jul.

Table KE3. Seasonal fluctuations of root supply to Kiptere market

Nov > Jan	Peak supply of roots	Low price; Ksh800/ 2moets
Feb	Variable supply of roots	Fluctuating price Ksh800-1,200 / 2 moets
Apr > Sept	Few roots	High price; Ksh1,500-1,800/ 2 moets
Oct	Variable supply	Low price ;Ksh600-800/ 2 moets

The traders trade SP roots 4 days per week at Kiptere (M, W, Fr, Sat), each bringing between 20-35 donkey loads of SP per week. One donkey load comprises two *moets* (partially filled maize sacks). However, it should be noted that there are many more SP roots per *moet* being bought from the farmers than being sold by the traders (2 farmer *moets* > 3 sales size *moets*), and this difference accounts for a lot of their profit plus they sell at Ksh100 more per *moet* than they bought. They also sort the roots at the farm and pay according to root size, but will then mix the big and the medium sized roots for sales which adds further profit, as they buy them at 400 and 200/ moet respectively and then sell the mixed root size moet @Ksh500. They keep the small roots separate and don't mix them with the other sized roots and these are sold much more cheaply. For 2 donkeys (4 moets of mixed med/big roots) worth of roots from the farmer they will make a profit of Ksh1,100 in Dec (Table KE4). They usually take the big and the small roots. They estimate that for selling 3 donkey loads of SP at Kipkere they make a profit of Ksh500- 600 in Dec. But in April the profit from 3 donkey loads would be Ksh1000=1,500. Their buyers (traders at local markets) usually transport the SP roots on in the boots of a Probox vehicle.

If they do not sell all the roots that day, they twist the sack closed and leave it under the shop verandah, or may give it to a customer on credit. They sell two varieties mainly, one cylindrical shaped root with a red skin and yellow flesh, the other heart shaped root with a red skin and white flesh (called *chebolool*). On Tuesdays and Thursdays they source SP roots from local farmers.

Table KE4. Buying, selling prices and profits of sweetpotato traders in Kiptere market

	Buying price/ *moet* (Ksh)		Donkey transport farm to Kipkere/ moet (Ksh)	Purchase of empty sacks, own transport to & fro (Ksh60), market tax (Ksh200/d), food (Ksh20)	Sales price/ moet (Ksh)	Profit/ donkey load
Big roots	400, 400	Mix the med. & big roots	100	7.5/ moet	500, 500, 500, 500, 500	((500 + (200*4))-(200+(7.5*5))/2 = 531.25/ donkey
Medium roots	200, 200		100	7.5/ moet		
Small roots	100, 100		100	7.5/ moet	200, 200	(400-(200+115)) = 85/ donkey

They explained that SP is a food which makes you feel full, and helps in managing high blood pressure and poor eyesight, however they do not promote its health benefits when selling, but they eat SP every day for breakfast or lunch. They have never traded OFSP as it is new in this area, they do not know whether customers will like it. One had tasted it and said it was not as sweet as the local variety and was a bit slimey.

They consider their SP trading a good business, which earns them enough income to afford to have tea at home. The main constraints include: buyers choosing to buy elsewhere when the SP root

supply season is high; difficulties harvesting and transporting the SP roots to market when it rains hard; not having sufficient funds to buy roots with due to having to meet school fee costs etc., and then having to borrow from friends or take roots on credit from a farmer.

In the past the traders used to have to transport the SP to Kericho town, but now the buyers come to Kiptere to buy it, there are many more buyers these days. SP has become the substitute food for maize in the wake of the maize lethal necrosis disease's serious impact on maize yields.

Since May 2014, one of the Kiptere traders, has also started taking SP roots twice per week on order, to a buyer in Eldoret. She met the buyer (a trader in Eldoret) when she visited Eldoret. She takes 20 *moets* per trip, and does 2 trips/wk = 40 *moets*/wk. She sells them in Eldoret at Ksh1,000/*moet*. She transports them to Eldoret using a probox car which collects her and the SP from her house at ~5am. The driver charges her Ksh250/*moet* transport, and she gets a free lift back to Kiptere market with him. She starts the day at 3am, packing the roots for 2 hours, and after a ~3 hour journey she arrives in Eldoret at 8am. Her buyer pays her in cash immediately. They take tea in Eldoret @Ksh20 and then return to Kiptere, picking up other passengers and arriving back at about midday, she then takes a motorbike taxi home for Ksh30. There are two roadblocks on the way to Eldoret and she has to pay Ksh100 at each in order to pass. The county tax in Eldoret is Ksh300/trip (Ksh600/wk) .

She has calculated that her profit per trip is Ksh3,000, which she uses for her children's uniforms and food, and has started to build a house. Her husband is a motorbike driver, and they also sell produce from their farm. There are 3 other traders who go from Kiptere to Eldoret. Table KE5 shows our calculation of her profit per *moet* is 222.5 – 322.5 Ksh, and per trip is Ksh4,450 -6,450. This may vary during the year due to the fluctuations in the buying and selling prices.

Table KE5. Kiptere to Eldoret SP trading costs

Costs	*(Ksh/ moet)*
Root (medium/big) buying price from farmers and donkey transport to her farm	400-500
Root transport Kiptere to Eldoret by probox	250
2 roadblocks	10
Eldoret tax	15
Tea & motorbike to home	2.5
Total costs	*277.5*
Root selling price in Eldoret	1000
Profit	**222.5 – 322.5**

iii. Retailers

Three female sweetpotato retailers were interviewed in Sosiot market, they each run individual businesses. The market is not very busy, being located in a farming area that directly provides food to the inhabitants. The climatic conditions (i.e., long and short rains) and the different maturity time of the SP varieties cultivated allow two/three harvests per year and an almost year-round presence of fresh roots in the market. The main varieties cultivated and traded are Cheptkit and Chebolol that mature, respectively, after 3 and 6 months.

The three retailers buy their fresh SP roots from a trader who comes to Sosiot market in the morning and sells about 50 bags/day. The price of the fresh roots bags only partially follows the SP supply, it is mainly influenced by the demand/presence of other staple food crops in the market. In Jan-April/Nov-Dec, it is mainly just fresh roots of the variety which matures 3 MAP which are available: despite the peak supply, the price paid by the retailers for bags of SP can be high due to the scarcity of other staple foods at that time. In May-July, the Chebolol variety matures; the supply is, however, lower than the previous months because other crops are also being produced on the land during its production[17]. From Aug-Oct, the SP root supply is at its minimum, so is its price, due to the presence

[17] The retailers pointed out that the bag size of SP fresh roots increases during May-July, as does the price (see KE6).

of maize, beans, and Irish potatoes in the market that are the favourite food for the customers of the area. Details on the prices are in Table KE6.

The retailers sell SP fresh roots in piles, varying their prices and dimensions during the year to keep the profits sufficient and to promote the consumption of SP fresh roots. The average prices for small roots and big roots piles are, 30 Ksh and 50 Ksh, respectively. From Aug-Oct, the price per pile lowers to compete with other commodities in the market.

Table KE6. Fresh SP root trading prices and supply in Sosiot Market

SP root supply season	Lower (Aug-Oct)	Medium (May-July)	Peak (Jan-Apr Nov-Dec)
SP buying price (Ksh/ flat bag)			
Small roots bag	100-300	700-1,200 (/prim bag)	200-300
Big roots bag	250-450	1,400-1,500 (/prim bag)	600-1,000
SP selling price (Ksh/pile)			
Small roots pile price/Number of roots	10Ksh/40 roots	30 ksh/20-22 r.	30 Ksh/20-22 r.
Big roots pile	30Ksh/10-12 r.	50ksh/7-8 roots	50ksh/10 roots
Average profits per bag (Ksh/bag)	150	300	200
Retailer 1 volumes (flat bag/wk)	6 (mixed small and big roots bags, all year round)		
Retailer 2 volumes (flat bag/wk)	5 (all year round, but only 1 is sold in Sosiot mkt)		
Retailer 2 volumes (flat bag/wk)	3 (mixed small and big roots bags, all year round)		
Retailer 1 profits (Ksh/wk)	900	1,800	1,200
Retailer 2 profits (Ksh/wk)	750	1,500	1,000
Retailer 3 profits (Ksh/wk)	450	900	600

Note:* The bags can contain a lower quantity of SP fresh roots with respect to the peak supply period

Table KE7. SP main retailing costs in Sosiot market

Trolley porter from the trader to the market spot	20 Ksh/bag
Spot in the market/City Council taxes (it includes the security for the bags that remain unsold on the spot)	50 ksh/bag
Transport of the remaining bags to home	50 ksh/bag
Transport to arrive at the market	30 ksh/day
Total costs per day *(1 bag sold on average per day)*	100-150 Ksh

The retailers' profits vary depending on the season and number of bag sold: in Aug-Oct they are quite low (450-900 Ksh/wk), while the Chebolol harvesting season allows for highest profits (900-1,800 Ksh/wk). The costs for a single retailer amount to 100-150 Ksh per day, and include carrying bags to the market spot, market costs, individual and bag transport on the bus (see Table KE7). They judge their business as satisfactory, even though they indicate several weaknesses that limit their profits. For example, the transport is expensive and difficult due to the poor road conditions and the distances; when there is no availability of SP roots in Sosiot market, they have to go to Kiptere market or directly to the farmers and pay more than 100 Ksh for transporting the bags. Moreover, there is no security in the market and no warehouse to store the SP not sold during the day, so they have to take them back home, paying extra money. Often, they find the bags contain about 25% rotten SP roots inside, and this spoils their daily profits.

However, the consumption and trade of SP fresh roots has increased during the last year due to the spread of a maize disease in the area.

iv. Consumers

Sweetpotato roots are mainly just boiled and eaten at lunch time with water or tea straight after they have been harvested in the field. They can also be taken as breakfast or dinner. The SP roots may also be cooked with banana, beans and sukuma in a stew for dinner. SP is eaten all year round,

and in April/May when the maize stocks are finished SP is the main food eaten. Most HHs have to buy about 4 *moets* (=24 *suffrias* (pans) * Ksh30/*suffria*) of SP in Apr-Jun from neighbours for HH food. SP is usually considered a poor man's food, so most is sold to the outside market. Older people who eat more traditional foods may take more SP and millet.

SP is not typically within the family menu in this area. The consumers at Sosiot market choose the root piles based on their economic status. Poor families cannot afford to buy bread, so they buy piles of small roots and eat SP for breakfast and even during the evening, as this is the cheapest healthy food they can afford. Wealthier people, instead, buy bigger roots but less often. They report that eating too many SP roots has some counter effects, such as stomach aches and heart palpitations, confirming consumers' preference for maize and beans.

There is a project with AMREF that looks at food utilisation, in which the agricultural extension workers are collaborating with the health people. To initiate OFSP consumption there will need to be a step-up campaign on its utilisation.

v. Main findings

- Currently about 80-90% of the SP grown in Kericho is sold. The importance of SP as a cash crop has increased significantly since 2008/9 in three sub-counties of Kericho County. The tea returns, decreased significantly over the last two years, stimulating tea farmers to look for other sources of income. Moreover, in the last two years the Maize Lethal Necrosis Disease (MLND) has affected the area and has drastically reduced farmers' maize production, and led to them diversifying into SP to reduce their risky over-reliance on maize revenues;
- Population growth, urbanisation, and severity of maize lethal necrosis disease are also driving the increasing domestic demand for fresh SP roots;
- MoA (Ministry of Agriculture) is building a SP packhouse in Sigowet for the farmers to wash, grade and pack SP roots for export to UK (through SACOMA);
- Sweetpotato is typically planted twice a year, in February (harvested in July) and in September (harvested in March). The peak supply season is between November and March, and July-Sept. The main local variety, Chebolol (high yielding, with a red skin and yellow flesh) takes about 6 months to mature, but the farmers also plant other varieties that take less time to mature. There is therefore a fairly continuous supply of SP during the year;
- In the SP production s/c's the average farm size is around 5 acres, of which ~1 acre is typically under SP production. The SP profits per acre are Ksh30-50,000/cycle;
- The farmers explained that during the low season in Kabondo e.g. May, traders come to Kiptere market to buy SP roots to supply to Nakuru or Nairobi. Traders usually go to the farms to purchase SP, and the relationship seems to be cordial;
- No chipping or drying of SP roots occurs in this area;
- Traders in Kiptere sell SP fresh roots 4 days per week, each bringing between 20-35 donkey loads of SP per week. One donkey load comprises two *moets* (partially filled maize sacks). Their estimated profits are ~Ksh200,000/year;
- The retailers sell SP fresh roots in piles, varying their prices and dimensions during the year to keep the profits and promote the consumption of SP fresh roots. The average prices for small roots and big roots piles are 30 Ksh and 50 Ksh, respectively. From Aug-Oct, the price per pile lowers to compete with other commodities in the market (mainly maize).
- The price of the sacks of fresh SP roots in the retailing market only partially follows the SP supply while it is mainly influenced by the demand/presence of other staple crops in the market;

- The consumers at Sosiot market choose the roots size/piles based on their economic status. Poor families buy piles of small roots and eat SP for breakfast and dinner, considering SP the cheapest healthy food they can afford. Wealthier people, instead, buy SP less often and prefer the bigger roots.

Figure KE1. Kiptere market, Kericho: *(clockwise from top left)* Kiptere sweetpotato trading area with traders sitting on moet sacks of sweetpotato; trader shows how much smaller the size of the moet they sell will be than the moet they have bought from the farmer; bucket of SP roots called a 'tolit'; two elderly SP farmers during the focus group discussion; donkeys carrying two moet sacks of SP. *(Photos: Tanya Stathers)*

3G. Sweetpotato trading in urban markets of Nairobi, Nakuru and Kisumu

Sweetpotato roots are a popular food amongst urban populations in Kenya. We followed the SP fresh root value chain through to three major urban centres (Nairobi, Nakuru and Kisumu (Table U1)) and in each interviewed SP traders, retailers and consumers. Descriptions of their SP activities are summarised in the sub-sections below. Kenya's urban population is growing rapidly at a rate of 4.4% annually, compared to 2.1% for the rural population (UN, 2014[18]). In 2013, 24.8% of the nation's 43 million people lived in urban centres, with at least 3.3 million of them living in Nairobi (UN, 2014). Sweetpotato roots are viewed as a popular, healthy, traditional, easy-to-prepare and relatively low-cost food by urban as well as rural Kenyan communities; thus this rapid urbanisation is likely to be accompanied by increased demand for SP roots in urban centres.

Table U1. Population in Kenya's major urban centres, 2009

Urban centre	Total urban population	Core urban population	Peri-urban population	% of total urban population
KENYA	**12,023,570**	**9,090,412**	**2,933,159**	
Nairobi	3,109,861	3,109,861	0	25.9%
Mombasa	925,137	905,627	19,510	7.7%
Kisumu	383,444	254,016	129,428	3.2%
Nakuru	367,183	343,395	23,788	3.1%
Eldoret	312,351	247,500	64,851	2.6%
Kikuyu	264,714	200,285	64,429	2.2%

Source: UNFPA, 2013[19]; Ministry of Planning and National Development and Vision 2030 (VIII)

i. Urban sweetpotato trading

Nairobi market sweetpotato trading

In Nairobi's Muthurwa fruit and vegetable wholesale market, four SP traders were interviewed. Although not originally from Nairobi, three of them (all men) are now based in Nairobi trading SP roots from Kabondo and Sirare, while the other trader a woman is based in Kabondo but travels to Nairobi regularly for SP trading. They said the gender balance of SP traders was about 50:50.

The traders explained that the SP root supply fluctuations were linked to the rains and farmers cropping systems. SP root supply peaks in the market from January to March, as farmers in Kabondo area, clear their fields of all remaining SP crop in order to plant maize in April. When SP root supply in Kabondo is low the traders, source SP roots from areas of Tanzania surrounding Lake Victoria via the Sirare border. The Kabondo SP roots are perceived as better quality, heavier and sweeter than the Sirare roots by both the traders and consumers and

Table U2. Sweetpotato root buying and selling prices during the year for different sized sacks and production locations

Buying price (Ksh)	Dec	J	F	M	A	M	J	Jy	Au	S	O	N
Kabondo/ Prim bag of SP	1800-2200	1400-1500	1400-1500	1600-1700	1600-1700	1600-1700	1800	1800	1800	1800	1800	2000
Sirare/ Prim sack of SP	1500	1300	800-1000	800-1000	800-1000	800-1000	1400	1400	1400	1400	1400	1400-1500
Sirare/ Bao sack of SP	2400	2400	1300-1400	1300-1400	1300-1400	1300-1400	1300-1400	1300-1400	1400	1500	1700-1800	1900-2000
Sirare/ Mtoro sack	3000-3200	2500	1700-2000	1700-2000	1700-2000	3000-3500*	2000-3000	2000-3000	2000-3000	2500	3000	3000
Selling Price (Ksh) Muthurwa mkt	Dec	J	F	M	A	M	J	Jy	Au	S	O	N
Kabondo - Prim bag of SP	2800-3500	1800-2500	1800-2500	1800-2500	2500-2800	2500-2800	2800-3000	2800-3000	2800-3000	2800-3000	2800-3000	2800-3000
Sirare - Prim bag	2600-3300	1600-2300	1600-2300	1600-2300	2300-2600	2300-2600	2600-2800	2600-2800	2600-2800	2600-2800	2600-2800	2600-2800
Sirare – Bao bag	3000-4000	2800-3000	2500-2800	2500-2800	2800-3000	2800-3000	3000-3500	3000-3500	3000-3500	3000-3500	3500-3800	3500-3800
Sirare - Mtoro	5500	5000	3500-4000	3500-4000	3500-4000	3500-4000	4500-5000	4500-5000	4500-5000	4500-5000	4500-5000	4500-5000

**If rains fail. NB Prices are for medium and big undamaged SP roots, the small and broken roots are separated out by the packer and sold at a much lower price/sack.*

[18] UN Statistics Division, 2014 World Pocket Book. http://data.un.org/CountryProfile.aspx?crName=kenya

[19] UNFPA, 2013. Kenya Population Situation Analysis

fetch a higher price (Table U2). SP roots sourced via Sirare roots sell at ~Ksh200/ *bao* sack less than Kabondo roots; the Sirare roots rot faster, are a different variety and are grown on black soils, but have the red skin and deep yellow flesh similar to the Kabondo variety. Root availability and price influence where the traders source roots from. In dry years when Kabondo's SP production is down, they source a lot of roots via Sirare, Kabondo based brokers may source roots via Sirare from July to September. Occasionally, in severe drought years Sirare traders buy roots from Kabondo. An overview of the buying and selling prices for different sized sacks of SP roots (medium/ big roots only) is given in Table U2.

These traders explained that during the peak season of Jan/Feb. One of them alone is likely to bring 60 sacks of SP per day, 3 times in a week = 180 sacks /week (the highest amount each trader would bring = 150-200). In the low season (before the dry season) = Jun/July – a trader might bring just 10-20 Prim sacks of SP /wk. In the medium season (Mar-May) – a trader may bring 50 sacks during each of two trips per week = 100 sacks/wk. On 17 December 2014, a total of 5 vehicles delivered sacks of SP roots to Muthurwa market, 2 were carrying Prim sacks of SP from Kabondo (60 per vehicle), 3 were carrying Bao sacks of SP from Sirare (50 per vehicle) =270 sacks (probably >40 tonnes of SP).

Three sizes of sacks are used for SP root trading: *Prim* = extended sack; *Bao* = two full length sacks plus a bit (Figure U1); *Mtoro* = even longer and with a rounded head area on top (this one wasn't in the market while we were there). *Prim* and *Bao* sacks are brought from Kabondo, and *Bao* and *Mtoro* from Sirare. They have never measured the weight of these sacks (one trader guessed the following weights: *Prim*=120kg, *Bao*=200kg, *Mtoro*=300kg). It takes four men to load or off-load the *Bao* sack. The traders were aware of the current new enforcement of the maximum 50kg sack weight for Irish potatoes, but said this did not apply to SP and was unlikely to in the long-term future although they acknowledged such a ruling could seriously impact on their SP trade practices and costs.

Figure U1. Loading a *bao* sized sack of SP onto trolley at Muthurwa market, Nairobi
Photo: T. Stathers

To determine their selling prices the traders regularly liaise with the brokers on the ground in Kabondo and Sirare to find out how many trucks of SP left that area headed for Nairobi – they use these supply estimates to decide whether to increase, decrease or keep their selling prices the same. When it is raining in Kabondo, it makes SP harvesting more difficult and so fewer roots will be sent to Nairobi and sales prices will increase. Prior to mobile phones, the traders and farmers had to guess the market oscillations. The high perishability of SP means the sales price fluctuates more than with maize across the course of a few days. If the SP roots do not get sold the day they arrive, and thus have to stay overnight at the market, customers will prefer the fresh ones that have arrived that morning at 5am, so the price of the left-over sack has to be decreased (by Ksh500-700) to make it attractive to buyers. If any roots are rotten the price of that sack goes down, sorting of roots prior to packing them helps reduce the incidence of rotting, but leaving the sacks in the hot sun leads to condensation inside the bags. If trucks break-down, roots can rot.

The traders mainly deal in medium/big sized roots, but also sell *bao* sized sacks of smaller or broken roots (called *koroga*) at a lower price. The December 2014 buying price for *koroga* from Kabondo is Ksh500-600/sack, which will then be sold at Ksh1,700-1,800 in Nairobi. The buying price fluctuates during the year akin to that of medium/big roots, from Ksh400-600, and the sales prices Ksh1,500-2,200. A sack of *koroga* from Sirare were being bought in December 2014 for Ksh300 or less, and sold at Ksh1,700-1,800; during the year buying prices fluctuate from Ksh150-300, and sales prices from Ksh1,500 to 2,200. Insect damaged roots are not purchased by traders.

Customers want the red skinned, yellow fleshed roots, and do not like roots that are white inside. The traders do not actively promote SP consumption, but say it's a nutritious traditional food which is not contaminated by input chemicals such as fertiliser or pesticides. They felt the government has been promoting the consumption of local less processed foods such as yams and sweetpotato. The traders felt that the number of SP traders in Nairobi had increased in the last 3 years particularly, and 10 years ago there were only 10 SP traders at Muthurwa market, while there are now >100. Rural to urban migration has increased the demand for SP roots. The traders interviewed eat boiled SP with milk or tea, and one of them snacks on the raw roots while at the market. The traders said they had tried to sell some OFSP roots, but it is too soft inside and customers said it tasted like pumpkin and did not purchase it again, preferring the traditional yellow-fleshed variety.

The traders typically each work with 2-3 brokers who are on the ground in Kabondo and Sirare, being linked to several brokers makes it faster for each trader to aggregate roots and fill a whole truck. They use empty backhaul space of truck which have delivered goods in Kisumu, accessing transport can sometimes be difficult and then SP roots may rot while waiting. Some of the transporters also have brokers who link them up with traders and sacks of SP. Most of the traders organise SP root deliveries to Muthurwa market 3 times/wk, they typically focus on aggregation of SP roots at point of source one day and then sales of these sacks in Nairobi the next day. Traders based in Nairobi will still travel to Kabondo or Sirare at least once/wk to supervise the root sourcing and keep an eye on their brokers activities to ensure they aren't inflating the buying prices and are sorting the roots carefully etc.

The trading costs incurred by the traders are shown in Table U3, for the different sack sizes (Prim, Bao, Mtoro) and root sourcing locations. These costs do not vary during the course of the year.

The traders estimated that they make profits of Ksh 200/ Prim and Ksh 300/ Bao from Kabondo, and Ksh500/ Prim, Bao or Mtoro from Sirare. They use their phones for banking and pay in and withdraw cash as needed that way. They use M-PESA to send money long distances to brokers and transporters They estimated that capital of ~Ksh 100,000 (US$ 1,175) was required to operate in the SP trading business.

Table U3. Trading costs of sweetpotato roots sold in Nairobi

Root source:	Kabondo		Sirare		
Costs (Ksh)	Prim	Bao	Prim	Bao	Mtoro
Broker at source /sack	100	100	100	100	100
Broker in Nbi /sack	100	100	100	100	100
Washing/sack	50	70	/ (farmer)	/ (farmer)	/ (farmer)
Sorting & packing/sack	50	70	50	70	100
Loading/ sack	50	70	50	50	100
Washing water & drum/ sack	50	70	/ (farmer)	/ (farmer)	/ (farmer)
Sacks & rope/ sack	100	150	100	150	200
SP transport*/ sack	500	600	550	700-750	900-1000
Cess/ sack	40	40	20	20	20
Miscellaneous** /sack	100	100	150	150	150
Off-loading/ sack	40	70	40	70	70
City council tax/ sack	60-80	80	60-80	80	80
Market cleaning/ delivery day	50	50	50	50	50
Overnight watchman if unsold SP/ night	100	100	100	100	100
Travel to supervise/ wk	3000	3000	4000	4000	4000
Tz vehicle entry/ truck	/	/	3000	3000	3000
Total costs/ sack	**1272.5-1292.5**	**1552.5**	**1322.5 - 1342.5**	**1592.5-1642.5**	**1922.5 – 2022.5**

*Truck capacity: 60-62 Prim sacks/ truck; 45-50/ Bao sacks/ truck (but can vary by truck)

**Miscellaneous = to and froing and airtime per bag, Sirare involves lots of long journeys on motorbikes

*** assuming 100 sacks/wk in 2 consignments

The trucks carrying the sacks of SP enter the wholesale area of Muthurwa market at 5am each morning, and the sacks are off loaded and sold there (see Figure U3). The buyers vary, and include bulk buyers who then transport the sacks of roots onto Ukambani or Mombasa. Most buyers are retailers, who typically buy a sack every few days and then sell it in small piles of ~5-6 roots at the Muthurwa market or in the neighbouring Marikiti (wholesale and retail) market or other markets around Nairobi. Usually the sacks are all sold by 7.30am. The retailers will hire a trolley porter to move the sack to their nearby market spot. If a retailer cannot afford a whole sack, several of them may group together and split one sack between them (Figure U2). Other retailers buy a whole sack, but then split it into two so it can fit in the *matatu*/minivan to reach retail markets on the outskirts of Nairobi city, where they will sell SP roots in piles worth Ksh50 or 100. One trader has a customer who airfreights the SP roots to Dubai.

Figure U2. Splitting a bao-sized sack of SP between retailers at Muthurwa market, Nairobi *Photo: T. Stathers*

Initially the traders make new buyers pay in cash before taking the roots, but once some trust is established they allow buyers to take the sacks of SP roots on credit, and pay later in the day or the month once they have retailed or sold-on the SP roots. The traders spend a lot of time chasing these buyers for their payment, and keep records of who owes what to them in small notebooks. For example one trader had sold all 29 of the sacks he had brought in that morning, but had only been paid for 5 of them by the buyers. At 10 am he goes across to Marikiti market (which closes at 1pm) to collect his payments. Supermarkets rarely if ever purchase sacks of SP roots at Muthurwa.

The traders started a SP traders association with 200 members about 4 months ago, so that they could help each other out socially and plan to pay a monthly contribution to help cover funeral and hospital costs etc.

The traders interviewed were interested in learning how to process SP into different products and wanted to be involved in supplying SP roots to processors and exporters, and improving their record keeping and leadership skills.

Figure U3. Muthurwa market: porters resting on Prim sized sacks of sweetpotato roots; off-loafed *Bao* sized sacks of sweetpotato roots; sweetpotato traders being interviewed *(Photos: T. Stathers)*

Nakuru market sweetpotato trading

Two female SP traders were interviewed at Nakuru's Wakulima market, both purchase SP roots from Kabondo and Sirare and sell them to retailers in Nakuru's Wakulima market, who then retail the roots in small piles in Nakuru's Wakulima and other markets. They each have trusted brokers in Kabondo who they deal with by phone, placing an order for a certain number of Prim sized sacks of SP and then forwarding the funds required by M-PESA, paying the transporters the remaining balance when the roots are delivered at Wakulima market. However, when sourcing roots from Sirare they travel there themselves as they do not have a trusted broker there.

They both source SP roots from Kabondo from November to January, when lots of roots are available there. Then they travel to Sirare, where roots can be sourced all year round from Tanzania, but they have to buy a full truck load (e.g. 60 Prim size bags of SP). The buying and selling prices for the different sized sacks of SP sourced from the two locations during the year are shown in Table U4.

Table U4. Buying and selling prices of SP roots sold in Nakuru

Buying price	**Dec**	**J**	**F**	**M**	**A**	**M**	**J**	**Jy**	**Au**	**S**	**O**	**N**
Kabondo - Ksh per Prim sack of SP	2,000	1,800*	2,500	2,500	/	/	2,800	2,800	2,000	2,000	2,000	2,000
Sirare - Ksh / Prim sack of SP	1,200	1,200	1,200	1,400	1,400	1,400	1,500	1,600	1,600-1,700	1,200	1,200	1,200
Sirare - Ksh/ Bao sack of SP ***					2,500	2,500	2,500	2,500				
Selling Price												
At Nakuru Wakulima mkt/ Prim bag of SP (from Kabondo or Sirare)	3,500	3,500	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,800	3,800	3,500
At Nakuru Wakulima mkt/ bao bag of SP (from Sirare)	4,000	4,000	4,000	4,500	4,500	4,500	4,500	4,500	4,500	4,000**	4,000**	4,000**

**If yield is high in Jan the price goes down.*

*** In Sept-Dec they don't buy much from Sirare*

**** In Apr-July the Tz farmers want to pack in bao bags to increase their profit*

In Nakuru there is a high demand for SP if there is not much maize or Irish potato available, but when rains are good the demand for SP is lower. In a normal year there is high demand for SP from Feb-May, if rains are bad there is also demand from Aug-Nov, then in Nov farmers typically start harvesting a bit of maize so do not need SP. In January no one has much cash so SP trading is poor.

One of the traders delivers about 30-40 Prim-sized sacks of SP to Nakuru per week, while the other delivers about 10 Prim size sacks per week, all year round, except for between April-July when they each deliver 1 truck of ~30 sacks from Sirare/ week. They only trade SP roots with red skin and yellow flesh and do not know the name of the varieties. They say customers are familiar with the nutritional and other benefits of SP (e.g. good source of energy, grown without chemical, can be cooked without oil). They tried selling OFSP but customers did not like it, saying it was watery and tasteless.

Their brokers oversee the sourcing, washing and packing of the roots in Kabondo or Sirare, the costs of all the activities are shown in Table U5. The small and the broken roots (*koroga*) are sorted and bagged separately. A Prim sack of *koroga* roots costs Ksh500 in Dec, and the broker gets Ksh50. In Feb the *koroga* Prim costs Ksh600, and in Aug the Prim goes at Ksh500. The other costs are the same as those for medium/ big roots shown in Table U5. About 20% of roots are classified as *koroga*, e.g. 2 out of 10 sacks.

Brokers organise the roots to be taken to the collection point, this is by donkey in Kabondo. Farmers cover the cost of washing the roots.

These traders perceived their profits on roots sourced from Kabondo to be Ksh500/ Prim in Dec-Feb and Ksh300 Mar to Aug. For roots sourced from Sirare, Ksh1000/ Prim or Bao sack all year round.

Although the figures they supplied suggested: profits per Prim from Kabondo of Ksh1,030 in Sep/Oct, Ksh930 in Jan & Aug, Ksh730 in Nov/Dec, and Ksh430 in Feb/Mar; profits per Prim from Sirare of Ksh1,500 in Sep/Oct, Ksh1,400 in Feb, Ksh1,200 in Nov-Jan & Mar, Ksh900-1,000 in Aug; and during the month of April to July when Sirare farmers pack SP in bao sacks profits of Ksh537/ bao sack. Using either their per bag profit estimates or calculations based on the prices they provided, Trader A is likely to make an annual profit of ~Ksh1.5million (~US$ 17,000), and Trader B ~Ksh615,000 – 750,000 (~USD 7-9,000).

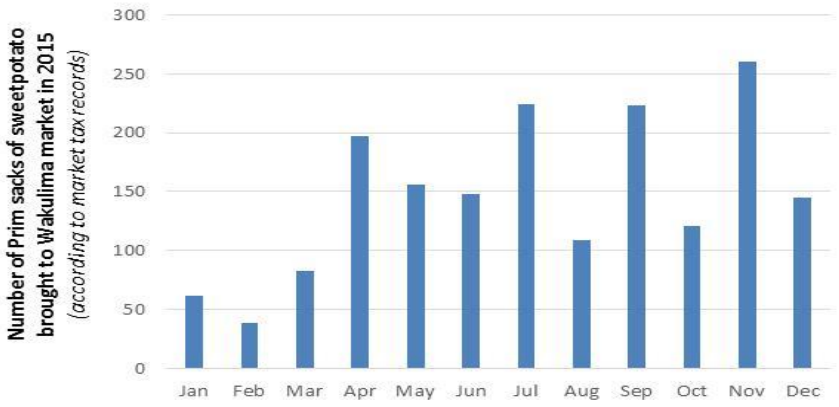
Table U5. Trading costs of sweetpotato roots sold in Nakuru

Costs (Ksh)	**Kabondo > Nakuru/ Prim sack of SP**	**Sirare > Nakuru/ Prim sack of SP**	**Sirare > Nakuru/ Bao sack of SP**
Broker	100	100	100
SP transport	300	600-700	700-800
Loading sacks	50	50	100
Packing roots	50		100
Empty sacks	100	50	100
Cess	80	1000 for 60 sacks/ truck (16.7/ sack)	1000 for 45 sacks/ truck (22.2/ sack)
Municipal tax	50	50	50
Off loading	20	20	30
Rope	20	20	20
3x Accomod.	/	900	900
Food	/	900	900
Own transport **some return free in the truck*	/	1000 (one way)*	1000 (one way)*
Tz fees TRA (2000) & other	/	5800/ truck (96.7/ sack)	5800/ truck (128.9/ sack)
TOTAL (Ksh)	**770/ Prim**	**1,100/ Prim** **66,000/ truck load 60 sacks**	**1,463/ Bao** **65,850/ truck load 45 sacks**

They both felt the SP trading business was good and helped them cover their children's school costs. They estimated that nowadays a SP trader needed ~Ksh100,000 of capital to operate, while in the past they could operate with just Ksh5,000. One of these traders got into it as her mother used to do it, and the other had learnt it from her sister, and her husband also trades SP but from a base in Limuru. These traders said that most SP traders were women, and that when SP root supply is high more people start trading it. Security can be a problem, and one of these traders had been travelling overnight from Sirare in a truck that was attacked, they were all cut with machetes, robbed and she had only escaped being raped as she was pregnant. Since then she now travels back from Sirare during daylight in a separate vehicle.

Data on the number of Prim sacks of SP sold at Wakulima market, based on the market officers' market tax payment records are shown in Figure U4. These records report a total of 1,767 Prim sacks traded in 2014. This is likely to be an underestimate as just the two traders interviewed bring 1,760 sacks a year.

Figure U4. Market tax records of number of sacks of SP sold at Wakulima market, Nakuru in 2014



Kisumu's Kibuye market sweetpotato trading

Two female SP traders were interviewed in Kibuye market, Kisumu. They both sell local SP varieties (and occasionally OFSP) cultivated by farmers in Kabondo, and deliver them to Kibuye market four times a month, i.e. each weekend (arriving on Sat and leaving on Monday after all the bags are sold). They started their trading business in order to pay their children's school fees. The two traders are also farmers, and sell the fresh SP roots from their own plots to a *Kikuyu* trader who picks up the roots from Kabondo in July to October and in January and who sells them in Nairobi markets.

The peak supply season as traders is in Feb/Mar and in Nov/Dec, when they each trade about 6 sacks per week (Flat and Prim sacks), which brings them profits of about Ksh 4,800/ month. The quantity traded may halve in May-June leading to a reduction of the traders' profits, as the buying/selling prices between the peak and the low supply season are quite constant. Details are in Table U6.

Table U6. Fresh SP root trading prices and volumes in Kibuye market, Kisumu

SP root supply season	Peak (Feb-March and Nov-Dec)	Medium (July-Sept, Oct, Jan, Apr)	Low (May-June)
SP selling price (Ksh/ flat sack)	1,000-1,200	1,000-1,200	1,000-1,200
SP selling price (Ksh/prim sack)	1,600-1,800	1,800	1,800
SP buying price (Ksh/ flat sack)	800	800-900	900
SP buying price (Ksh/prim sack)	1,500	1,500-1600	1,600
OFSP buying price (Ksh/ flat sack)	1,000	1,000	1,000
Trading profits to Kibuye (Ksh/various sack size)	*100-400 (all year round depending on how they sell the sacks)*		
Trader 1 and 2 volumes to Kibuye (various sacks/wk)	6	3-4	3

The profits per sack can be less than Ksh 200/sack when they sell the sack as a whole. When they divide the sacks into piles and retail the piles of SP roots, their profits may increase to Ksh 400 /sack - selling the small size roots and the large size roots[20] piles at Ksh30 /pile and Ksh50 /pile, respectively. The trading costs for selling SP at Kibuye market are shown in Table U7. As farmers, they sell a Prim sack at Ksh1,800: during a good harvest they can produce 30 bags per acre (with revenues of Ksh54,000). Farmers marketing costs are donkey transport (Ksh 80/Prim), and harvesting labour (Ksh50/Prim).

Table U7. Average trading costs per bag, Kabondo to Kisumu

Costs (Ksh)	**/ flat sack**	**/ Prim sack**
Root washing	40	40
Packing	50	50
Loading	30	50
Transport: Kabondo to Kisumu	50	100
Cess	14 (70/ 5 sacks)	14 (or 70/5 sacks)
Unloading	12 (50 for all your bags)	12 (50 for all your bags)
Market Tax to City Council	30	40
Accommodation	Free in hostel built for traders	
Supper	12 (50/ day)	12 (50/ day)
Transport back home	40 (200/ trip)	40 (200 /trip)
Total costs	**278**	**418**
Dec buying price	**800**	
Dec selling price	**1,200**	
Dec calculated profit/ sack	**122**	

The traders consider their trading profits low, due to the high costs of transporting the fresh SP roots from farmers to the market. They think that the SP trading business in Kisumu is reducing in terms of both profits and volumes; even though the quality of the fresh roots from Kabondo still remains high, the yields are decreasing because the vines are over-used. OFSP is traded in a much smaller quantity than the local varieties in Kibuye market, as it is still new and farmers in Kabondo prefer to sell OFSP roots to the local cooperative at Ksh 14/kg.

[20] The large size roots pile has 5 medium roots plus two complimentary.

Figure U5. Urban sweetpotato retailing *(clockwise from top left):***Piles of SP roots on sale in Nairobi's Muthurwa market; more sweetpotato retailing in Muthurwa market; plastic bags of washed SP roots on sale for Ksh30 each in Muthurwa market; market tax records from Nakuru's Wakulima market; piles of different sized SP roots on sale in Kibuye market, Kisumu; urban consumer interview Kibuye market; SP retailer, Kibuye market; another SP retailer with separated piles of small and medium/big SP roots, Kibuye market; SP retailers and market master in SP area of Wakulima market, Nakuru.** *(Photos: T. Stathers)*

ii. Urban sweetpotato retailing

Nairobi, Muthurwa market: sweetpotato retailing

Three female sweetpotato retailers were interviewed; they run individual businesses in the busy Muthurwa market of Nairobi. They mainly sell white- and yellow-fleshed SP; occasionally they find some orange- and purple-fleshed roots in the bags they buy from the traders. They source the roots from the different traders in Muthurwa market who bring SP roots from Kabondo, Sirare and Bongoma. They prefer to buy SP roots in *Prim* or *Bao* sized sacks from Kabondo traders as the fresh root quality is higher. Most of the traders in Muthurwa market bring SP roots from Sirare often in very large sacks called *Mtoro*.

The peak supply of SP roots is from Jan to April while the availability reduces between Oct and Dec. The SP root supply is mainly influenced by Kabondo production cycles: during Oct-Dec the farmers are planting the vines and they start harvesting in Jan-Feb in order to have money to pay school fees. In contrast, the supply from Sirare is stable throughout the year[21]. The buying price depends on the supply and sack size. The average buying price is Ksh 2,000 for a flat sack, Ksh 2,500 for a Prim sack, Ksh 3,500 for a *bao* sack and Ksh 4,000 Ksh for *mtoro* sacks. Between peak and low supply season, the prices can increase up to 100% or more. Details are in Table U8.

Table U8. Retailers records of fresh SP root trading prices and supply at Muthurwa market, Nairobi

SP root supply season	Low (Oct-Dec)	Medium (May-Oct)	Peak (Jan-Apr)
SP buying price (Ksh/sack)			
Flat sack	3,000	2,000	1,000
Prim sack	4,000	3,000	1,500/2,500
Bao sack	5,000	3,500	2,500/3,000
Mtoro sack	7,000/7,500	4,000	3,000/3,500
Sack of *koroga* (small/ broken)	2,500	1,500/1,800	800/1,000
SP selling price (Ksh/sack)			
4 roots pile (size: medium and big roots)	40	35	30
5 roots pile (size: 3 or 4 big roots)	50	40/45	35/40
3 roots pile (size: medium roots)	30	25	20
9-12 *koroga* roots (size: small roots)	20/30	15	10
Composition of supply in Muthurwa mkt (%)			
Sirare	60	60	50
Kabondo	30	30	40
Bungoma	5-10	5-10	5-10

Note: Terminology for sack size: Flat is the smaller size, Prime is the medium size (reaches to adult head height), Bao is the size of two flat bags, Mtoro is the biggest size, *Koroga* is the bag with small or broken roots

The retailers sell SP fresh roots in piles of different dimensions the prices of which vary during the year, to ensure a certain amount of profit (Figure U5). Between peak and low supply season, the prices per pile increase between 35% and 50% for medium and big roots piles, and over 100% for *koroga* roots (see Table U9). The retailers do not know how many piles they get from one sack but they estimate average profits between Ksh 200-500

Table U9. Retailing profits and volumes in Muthurwa market

Average profits per bag (Ksh/sack)	
Flat-prime-bao	200-500
Mtoro	600-800
Koroga	200-600
Retailer 1 volumes (Prim sack/wk)	14
Retailer 2 volumes (bao sack/wk)	12
Retailer 3 volumes (bao/mtoro sack/wk)	18

[21] They attributed the continuous and larger production in Sirare to the larger amount of land under SP, the higher soil fertility and rains. They suggested that the higher soil fertility in Sirare was due to extensive tobacco cultivation and the related use of fertilizer.

for flat/prim/bao sacks that mostly depends on the retailers' ability to organize the roots in piles. It is however more likely that the profits are between Ksh 200-300 per bag. The profits per week depend on the volumes sold (see Table U9) and are estimated at between Ksh 2,400-6,000 Ksh for the retailers interviewed.

The costs for a single retailer amount to Ksh 450-800 per day, and include portering, market costs (city council taxes and security) and bus transport (Table U10). The retailers are satisfied with their business, as the sales are good, although not constant. In some months, especially during the rainy season in Kabondo, they find that 20-30% of the fresh roots in the bags are rotten, and this lowers their profits. During other months <5% are rotten.

Table U10. SP main retailing costs in Muthurwa market

Trolley porter to market spot	100 Ksh/flat-prim-bao sacks 150 Ksh/mtoro sack
Spot in the market/City Council taxes	50 Ksh/day (on Friday price is 100 Ksh)
Security (for the roots in the bag that remain unsold on the spot)	100 Ksh/day
Transport to reach the market	100-140 ksh/round-trip
Total costs per day (excluding buying the SP roots)	**450-800 Ksh**

The constraints of their retailing activities are mainly financial; the absence of capital and credit may limit the business potential as some retailers would like to become traders themselves. When the retailer does not have enough money to purchase the SP roots from the traders, they may go back home or borrow the money from other retailers. Alternatively they can request to take the roots on credit from the trader (allowed only during the peak season), paying an extra of Ksh 100-200 as interest. They can use also their "merry-go-round" savings system to access some money.

The retailers reported that the change of lifestyle and the increased availability of money for some consumers had caused a reduction in the consumption of SP in Nairobi during the past years. The customers in this market are middle-class consumers; richer people go to supermarkets while the poorer shop in the markets of their suburbs. The consumers prefer fresh roots with a bright colour and, among all the SP varieties, Amina is the favourite.

Nakuru, Wakulima market: sweetpotato retailing

Two retailers who operate individual business in the busy and well-organized Wakulima market in Nakuru were interviewed (Figure U5). They sell local SP varieties (mostly Nyabondo, yellow fleshed with red skin), and cassava roots. The retailers buy SP roots (prim sized sack) from traders located in the same market, coming from Kabondo. In Wakulima market, there are also SP traders bringing roots from Sirare mostly in the largest sized sacks (*mtoro*). The price at which they buy SP roots remains quite constant thought the year (around 3,000-4,000 Ksh/prime sack, see Table U11): the variation between 15%-30% is attributed to the variation of supply from Kabondo. The traders from Sirare always sell *mtoro* sized sacks at 4,000 Ksh.

The retailers sell SP roots in piles. In general, the price per pile does not vary during the year: they sell a pile containing smaller roots at Ksh 30 and bigger roots at Ksh 50, instead they change the number of SP roots per pile. During the low supply season, they may reduce both the number of roots and increase the price per pile to Ksh 40 and Ksh 100, respectively, for small and big SP roots. The quantity of SP piles sold may be higher during the school months, as SP is included in school meals.

Table U11. Fresh SP root trading prices and supply in Wakulima Market, Nakuru

SP root supply season	Lower (Apr-June)	Medium (Oct-Dec)	Peak (July- Sept and Jan-Apr)
SP buying price (Ksh/ prime sack)	4,000	3,500*	3,000-3,500
SP selling price (Ksh/pile)			
Pile of small roots price/Number of roots	30-40Ksh/9-10 r.	30 Ksh/10-12 r.	30 Ksh/10-12 r.
Pile of big roots	50-100Ksh/4-5 r.	50Ksh/6 roots	50Ksh/6 roots
Average profits per sack (Ksh/sack)	1,000-1,200	500-1,000	500-1,000
Retailer 1 volumes (prime sack/wk)	4-5 (all year round)		
Retailer 2 volumes (prime sack/wk)	5-6 (all year round, 6 mostly during the school months)		
Retailer 1 avg profits (Ksh/wk)	4,000-5,200	2,000-3,500	2,000-3,000
Retailer 2 avg profits (Ksh/wk)	6,000-7,200	2,500-6000	2,500-6000

Note:* The bags can contain a lower quantity of SP fresh roots with respect to the peak supply period

They do not know how many piles they can get from one bag but they estimate their profits are Ksh 500-1,000 /sack during the peak/medium supply seasons. The low season sees an increase in profits, i.e. Ksh 1,000-1,200/sack (~50% more). The costs for a single retailer amount to Ksh 135 per day, and include portering, city council taxes and security, individual transport on bus/motorcycle (see Table U12).

Table U12. SP main retailing costs in Wakulima market

Trolley porter to market spot	70 Ksh/ prim sack (100 Ksh if sack is bigger)
Spot in the market/City Council taxes (it includes the security for sacks that remain unsold)	360 Ksh/month (being in the market 6 times a week: the cost is 15 Ksh/day)
Transport to the market (by bus)	50 Ksh/round-trip
Total costs per day (excluding buying the SP roots bags)	135 Ksh

The retailing business is considered profitable as they are able to pay their house rent, the school fees, and their food. They have good relationships with the traders that allow them also to delay their payment, i.e. after the sack is sold on to consumers. They communicate through mobile phones, which they also use to deliver payments with MPESA. They report that their customers choice is not influenced by their socio-economic status, age, etc. In general, the customers prefer washed and bright roots, and their preferred staple foods are maize and wheat (bread), not SP.

One of the retailers thinks that the SP business has been decreasing during the last 10 years, in terms of lower supply and demand (-40%). She thinks the shrinkage can be attributed to a (general) increase in agricultural commodity prices and policy changes (i.e. devolution, tax increases, etc.) at central and local level.

Kisumu, Kibuye market: sweetpotato retailing

Two focus group discussions were held with sweetpotato retailers in Kibuye market[22], Kisumu on the main market day (Sunday). One group comprised three female retailers based at the Mama Ngina area, and the other was with four female retailers based at the Jua Kali site. In Kibuye market the SP retailers tend to be women, while in nearby Kondele market there are also men retailing SP.

The three retailers from the Mama Ngina area sell local varieties of SP (such as Otyoyo, yellow fleshed with red skin) and, if the customers do not have carrier bags for the SP roots, they also sell

[22] In Kibuye market the majority of SP roots retailers (50 approx.) are women and are scattered in a large space. On Saturday and Sunday the number of retailers may be larger because some of the weekly traders also retail in the market.

plastic bags at 10Ksh (small size) and 20Ksh (large size). These retailers also sell maize, cassava, and banana[23]. They come to the market 6 or 7 days per week.

These retailers buy SP roots (flat sack size) from traders coming to Kibuye market from Kabondo on Saturday, after having placed an order by phone two days in advance. In general, the retailers buy 2-3 bags or 5 bags per week (see Table U13); the volumes can increase slightly during Dec and March due to the higher availability of SP roots. They buy the flat bag at Ksh 1,300-1,500; the price variation (15%) is attributed to seasonal changes in SP root availability. The retailers sell the SP roots in piles of different sized roots, at 30 Ksh and 50Ksh all year round but the number of SP roots per pile changes in the peak and low SP supply season (Figure U5). They do not know how many piles they get from one sack but they sell more of the 30 Ksh piles of small roots because the customers prefer to have more roots to feed the family. Their estimated average profits account to Ksh 200-300/flat sack, although they can go as high as Ksh500/ flat sack.

Table U13. Fresh SP root trading prices and supply in Mama Ngina area of Kibuye Market

SP root supply season	Low (May-July, Sept-Nov)*	Peak (Dec-April, Aug)
SP buying price (Ksh/ flat sack)	1,500	1,300
SP selling price (Ksh/pile)		
Small roots pile price/Number of roots	30Ksh/5 roots	30Ksh/10 roots
Big roots pile price/Number of roots	50 Ksh/3 roots	50 Ksh/5 roots
Average profits per bag (Ksh/sack)	200-500 Ksh (all year long)	
Retailer 1 volumes (flat sack/wk)	2-3 sacks/wk	3 sacks/wk
Retailer 2 volumes (flat sack/wk)	5 sacks/wk	5-6 sacks/wk
Retailer 3 volumes (flat sack/wk	2-3 sacks/wk	3 sacks/wk
Retailer 1 avg profits (Ksh/wk)	600-800 Ksh/wk	
Retailer 2 avg profits (Ksh/wk)	1,200-1,500 Ksh/wk	
Retailer 3 avg profits (Ksh/wk)	400-900 Ksh/week	

Note:* The sacks can contain a lower quantity of SP fresh roots with respect to the peak supply period

The SP retailing costs in Mama Ngina area amount to Ksh 100-120 per day, and include carrying the bags to the market spot, city council taxes and security, individual transportation to Kibuye market (see Table U14). The retailers are quite satisfied by their SP business. It becomes difficult to keep the profits level when the demand lowers (when the supply is higher there can be fewer customers in the market) or when many roots get spoiled in one bag. This can happen if they receive rotten roots from the traders or if the fresh roots start to rot if they do not sell the bag quickly enough. For this reason, they prefer to buy unwashed roots, as they get spoiled more slowly than washed roots.

Table U14. SP main retailing costs in Kibuye market

Off-loading and trolley porter to the market spot	20 Ksh/flat sack *(or 50 Ksh for larger distance)*
Spot in the market/City Council taxes	30 Ksh/day
Security in the market	50 Ksh/week
Food	50 Ksh/week
Own transport to/fro the market	50 Ksh/round-trip (approx)
Total costs per day (excluding buying the SP roots)	**100-120 Ksh**

The retailers think the customers prefer yellow-fleshed SP, and prefer SP as a staple food more than cassava and maize. The small roots are, in general, given to children while adults prefer the bigger roots. Most wealthy people buy SP once in a week on a Sunday; the middle class tend to buy 1 to 2 piles @ 50 Ksh/pile, 1 to 3 times per week, while the poorer eat SP almost daily buying 2-3 piles of 30 Ksh per week especially during the school holidays.

[23] The profits of maize and cassava are ~800 Ksh/week. Their selling price is 70 Ksh/goro goro (both). Banana sales have profits of 200 Ksh/basin; which can bring in profits of Ksh 1,000 per week.

Of the four retailers interviewed from the Jua Kali site of Kibuye market, three sell SP roots three times per week at the market, while the other is there 6 days a week (Table U15).

Table U15. Overview of four SP retailers' trading prices and supply at Jua Kali site of Kibuye market

	Flat sacks of SP sold/ week	No. of times/ wk they sell	Buy their SP from	Buying price	Retail costs		Retailers estimated profit	
				(Ksh/sack)	(Ksh/ sack)	(Ksh/ wk)	(Ksh/ sack)	(Ksh/ wk)
A	1 sack * 3x = 3	3x	Wathorega farmers	1,700	300	900	300	900
B	1 sack * 3x = 3	3x	Retailers at Gitaa market	1,700	300	900	300	900
C	2 sack * 3x = 6	3x	Traders, Kabondo	1,400	70	420	100	600
D	7 sacks/wk	6x (Mo-Sat)	Traders, Kabondo	1,400	99	690	100	700

Those bringing the most sacks are purchasing them from traders in Kabondo, others harvest and buy the roots from farmers using motorbikes to get them to the roadside then trucks to Kibuye market. Some use a per pile price to purchase the roots, while others use a per sack price (which ranges from Ksh1,300 per flat sack in the peak supply months of Nov-Jan, Ksh1,400 in the medium supply months of Apr-Oct, and Ksh1,500 in the low supply month of Feb & Mar). Those using a per pile method will typically also be given a lot of free roots (*nyongeza*) and will also sell smaller pile sizes than the piles they bought in order to make a profit. During months of very low SP supply, just a few trucks bring SP from Kabondo to Kibuye market, so the retailers have to get to the truck very early in the morning (3 am) to buy them; retailers may only manage to access 1 sack/ wk of SP roots to sell in the low season or may go home without having got any. In May and June, farmers are busy with maize so there is no SP in Wathorega and Gitaa areas. So the retailers who normally source roots there switch and start purchasing flat sacks of roots from the Kabondo trucks/ traders that come to Kibuye.

Once at Kibuye, the retailers hire a trolley porter to wheel the sack to their market spot. The other costs incurred are shown in Table U16. As per the other retailers, they sell SP roots in piles of either Ksh30 or Ksh50, and only knew their per sack profit, not how many piles they got from one sack. They alter the size of the piles during the course of the day, and also during the year to reflect their need for customers and the supply of roots. In the early morning the piles are bigger and then reduce around 9am, and then increase in size again around 4pm to attract customers. Each retailer rents a fixed market spot. On Sundays when the market is at its busiest their spot may get squeezed by other retailers.

Table U16. SP retailing costs in Jua kali area, Kibuye market

		Retailer			
	Ksh	A	B	C	D
Motorbike transport/SP sack farm to road Ksh50-100 depending on distance	50	X	X		
SP root transport to Kibuye Ksh50/sack	50	X	X		
Own transport to/from Kibuye (Ksh50/trip)	100	X	X		
Trolley porter to market spot (Ksh30/ sack)	30	X	X	X	X
Municipal council market tax (Ksh50/sack) (per sack for wholesalers)	50	X	X		
Municipal council market tax (Ksh50/d) *(per day for those buying roots from the Kabondo trucks)*	50			X	X
Overnight storage of unsold roots (Ksh/sack 20 for storage, 10 for trolley)	30			X	X
Food (~15-90 Ksh/wk)		X	X	X	X
No. of flat sacks of SP retailed/ week		3	3	6	7
Per day retail costs (excl buying SP roots)	Ksh	300	300	140	115
Per week retail costs (excl buying SP roots)	Ksh	900	900	420	690
Per sack retail costs (excl buying SP roots)	Ksh	300	300	70	99
Per week SP root buying cost	Ksh	1700	1700	1400	1400

The SP retailers are scattered throughout the market not aggregated in one area. These retailers think consumers prefer SP roots which are: clean; undamaged by insects; and sold by a friendly retailer. The root size preference varies, some customers prefer small roots, others big roots. When there is lots of fresh maize in the market they do not sell much SP, and have to look for alternative markets for their SP, such as smaller scale retailers who walk around selling SP, or small restaurants. The retailers say they sell a mixture of varieties, even within one pile, and that some customers are looking for white-fleshed varieties others yellow-fleshed.

The retailers say SP is a good energy source, similar to that of ugali (*stiff maize porridge*). The roots are more affordable than bread so for poorer families it is an important, healthy food and highly convenient as one can leave the boiled roots at home for the children to help themselves to. However, if you eat SP every day you will suffer from flatulence problems. Most of their customers eat boiled SP roots several times/week. Two of the retailers have sold OFSP roots in the market, but did not get repeat customers as customers said it did not have a high enough dry matter content and had a strange smell when cooked. The retailers said they used to tell customers not to boil it with too much water. Despite this negative experience one of the retailers felt that if customers were more aware of the vitamin A benefits of OFSP they would buy it.

These retailers enjoy selling SP roots. The main constraints are when: SP roots are in low supply (then they switch to sell other fruits or vegetables); many of the roots in the sack they have bought, or farm area they have harvested are rotten; high weevil damage to roots during the dry season.

The retailers use MPESA to send advance funds to traders in Kabondo to order their SP roots, they occasionally also get orders from customers who send a motorbike courier to pick up the roots from them and then MPESA the payment. None of these retailers access the internet yet.

iii. Urban consumption of sweetpotato roots

In each of the urban markets visited (Kibuye in Kisumu, Wakulima in Nakuru, and Muthurwa in Nairobi), a short interview was held with consumers purchasing SP roots in order to learn about how frequently they consume them, how they prepare them, what their main root selection criteria are, how much they spend on SP roots and how this varies during the year, and what they knew about SP nutritional benefits, and whether they knew about OFSP. Information was obtained from 6 consumers (4M, 2F) in Kibuye market, 3 female consumers in Wakulima market, and 6 consumers (5F, 1M) in Muthurwa market. There was a lot of similarity between consumers' responses irrespective of which market they were in, their gender or age.

How are the SP roots prepared

In Kisumu, the SP urban consumers explained that they typically boil the SP roots for 40-45 mins in a pan with a little water, some add some salt, typically using a charcoal stove. Whether the roots are peeled before or after boiling or left unpeeled varies by household and the preparation time available. SP roots are often purchased in the afternoon/evening and then boiled that evening, with a few being eaten straight after boiling but most being kept overnight and then taken as the breakfast food the next day together with a cup of tea, milk or water. Some people reheat the boiled roots in the morning while others just take them at room temperature. Men as well as women may do the boiling of the roots. The SP roots are also cooked with beans for an evening meal about once per week by about half of the households. The boiled SP roots were reportedly enjoyed by all members of the family.

In Nakuru, the urban consumers interviewed explained that they boil the sweetpotato roots with a little water in the evening and then take them for breakfast the next day with tea or fermented milk, occasionally they may be taken for lunch. Sometimes the roots are peeled, but one consumer explained that she leaves them unpeeled as the boiled roots are then sweeter. The boiled SP roots are consumed by the whole family, although one lady explains that she has to force her children to eat it as they do not like it.

In Nairobi, the urban consumers interviewed explained that they boil the sweetpotato roots unpeeled usually in the evening and then take them as breakfast food the next morning with tea or milk. One woman explained that she cooks them early in the morning and takes them straight away, as if she cooks them the night before and then leaves them overnight before consuming them they give her heartburn. In most cases the whole family enjoys eating SP, but one family explained they have to force their kids to eat it, and another said her family often feel fed up/bored of eating it.

How much SP is eaten and how often

In Kisumu, the urban consumers explained that they usually eat boiled roots for breakfast two or three times per week all year round, with each person eating 1 or 2 roots, and fresh roots being bought each time. One of the consumers eats SP every day and purchases fresh SP roots 4 times/ wk.

In Nakuru, the urban consumers interviewed suggested that SP roots were purchased and consumed less frequently than in Kisumu and Nairobi, about once per week or just once per month, with each family buying 6-14 roots at a time. The alternative breakfast foods consumed are maize porridge, bread, pancakes and bananas.

In Nairobi, the urban consumers interviewed reported buying SP roots between once and seven times per week, with most buying one pile for Ksh30-50, 2-3 times per week.

Expenditure on SP during the year

In Kisumu, the urban consumers bought piles of SP roots for Ksh50/ pile, with most families spending about Ksh200/wk on SP roots, although one family of nine reported spending Ksh600/wk. The price of the piles remains fixed at Ksh50 throughout the year, but the number of roots in the pile varies depending on root supply. These consumers eat SP all year round, getting more roots per week when the pile size is larger, and fewer when the pile size is smaller. One consumer explained that when the pile size only has a few roots in it in Nov-Feb she buys additional piles in order to have sufficient roots. One gentleman who stays alone explained that he buys more SP when his children come home for the school holidays. One consumer explained that if the SP roots being sold are not fresh she would rather not buy SP.

In Nakuru, the urban consumers bought piles or small transparent pre-packed plastic bags of SP roots for Ksh50/pile (~6-7 roots). They were not so aware of fluctuations in the number of roots per pile during the year as the Kisumu and Nairobi consumers, as they consume SP less frequently.

In Nairobi, the urban consumers bought piles or small transparent pre-packed plastic bags of SP roots for Ksh30-50, typically spending Ksh90-200/wk on SP. Both the quantity of roots in the pile or bag varies during the year and the price of the pile/bag. Most of the consumers explain that they still consume the same amount of SP all year round but have to pay more for it between Mar-Aug. Some consume less SP when there are other crops such as arrow root or maize available, although they explained that arrowroot was very expensive at Ksh200-300 for 3 pieces.

What selection criteria are used when purchasing SP roots

In Kisumu, the urban consumers selected the roots based on size, freshness, colour, cleanliness. Whilst some consumers prefer big roots as they are sweeter, others prefer the medium size and small ones as they are not so sweet, some find the very big roots difficult to prepare and the small roots not so tasty. Consumers prefer freshly harvested SP roots, some think that unwashed roots last longer and allow one to see whether the roots have been freshly harvested (fresh soil), others prefer to buy washed roots as the cooking preparation is then faster and one can more easily see if the root is damaged or rotten. One consumer explained how she breaks off the tip of the root to check the flesh colour, and looks for the milky like white latex as those with it are the most delicious. Most preferred a red skinned root with a yellow or white flesh colour, although one liked a cream skin with white flesh colour.

In Nakuru, the consumers select by size and cleanliness. One consumer preferred the medium roots as they cook faster than the bigger ones, another preferred the bigger roots saying they were sweeter. They preferred washed roots.

In Nairobi, the consumers selected the SP roots based on size, price, texture, and colour. Medium roots are preferred by most as they cook faster and are easier to share (e.g. can be cut in half and distributed), some think the medium roots taste better than the small ones. One gentleman preferred the smaller (*koroga*) roots as you get a lot more roots for your money. Half the consumers look for the cheapest deal. They prefer red skinned roots. They like fresh roots as opposed to ones which are soft when you touch them, and they do touch the roots to check prior to purchasing. Two of the six consumers mentioned preferring washed roots.

Consumers' nutritional knowledge about SP

In Kisumu, SP roots were particularly valued as a good energy source helping one to carry out one's daily work activities, one man explained that if you eat bread you get hungry faster than if you eat SP. Some felt SP had a lower fat content to alternative breakfast foods such as *mandazi* (doughnuts), bread. Another mentioned that SP is grown without any chemicals being sprayed on it so is healthy. Some mentioned that it can be part of a balanced diet, and has a high vitamin K content.

In Nakuru, SP was viewed as a good source or carbohydrate providing one with energy.

In Nairobi, SP was viewed as a healthy cheap delicious food which gives you energy, and is more filling and cheaper than bread.

Consumers' knowledge of OFSP

In Kisumu, two of the six consumers interviewed had never heard of or seen OFSP. Of the remaining four consumers, two had tasted it, one liked it and would like to be able to purchase it, the other did not like it as it was not sweet. Another consumer said that there was a retailer during the week (but not on the big Sunday market) who sells OFSP in Kibuye market but she hadn't bought it as she did not like the look of the orange flesh colour. One consumer had heard of people making cakes from SP but has not seen or eaten one.

In Nakuru, none of the consumers were aware of OFSP.

In Nairobi, all the consumers had heard about OFSP, 4 out of 6 of them had seen it, 3 had consumed it two of whom liked it and would like to be able to consume it if they could find it in the market, the other said it had too high a sugar content.

iv. Main findings

- Traders in Nairobi's Muthurwa market explained that SP root supply peaks from January to March as farmers in Kabondo clear their fields in order to plant maize and due to their need to access money for school costs and inputs. When SP root supply from Kabondo decreases they purchase SP roots from across the Tanzanian border at Sirare. The Kabondo SP roots are preferred by consumers and sell at a higher price. All the SP roots they sell are red skinned and yellow fleshed varieties.
- The Nairobi based SP traders each sell 180 sacks of SP per week during the peak season (Jan/Feb), 100 sacks per week in the medium season (Mar-May), 10-20 sacks in the low season (Jun/Jul). On the day we visited the market in mid Dec 2014, 270 sacks (probably >40 tonnes of SP roots) had been delivered, most of the traders bring 3 consignments of SP per week.
- Buying and selling prices are lowest during the peak season and highest in the low season. These Nairobi traders' SP buying prices can fluctuate by 52-78% during the year, selling

prices fluctuate by 42-69%, other costs (e.g. broker fee, root washing, packing, loading, transport, cess, market tax etc.) are reported to stay the same all year round.

- SP is traded in a range of different sized sacks, in Nairobi's Muthurwa market this includes the Prim (extended sack reaching adult head height), the Bao (two and a bit sacks sewn together), the Mtoro (even larger with a head shape). The sacks are never weighed and trade is purely volumetric, but it takes 4 strong men to load or off-load a Bao sized sack.
- The small roots and broken roots are packed and bought separately from the medium/big roots and are referred to as '*koroga*' – they are much cheaper than the medium/big roots and may be sold in piles to consumers who like to buy lots of small roots, or are used as 'complimentary/ *nyongeza*' roots by retailers. Typically about 20% of roots are classified as *koroga*.
- The traders are in regular contact with their brokers on the ground in Kabondo and Sirare to organise the next consignment, and to check how many trucks of SP have left the production area and are headed for Nairobi that afternoon so they can determine their next day's selling price.
- Any sacks of SP that remain unsold on the day they are delivered are then sold at a discounted price the next day, as they will be competing with freshly delivered SP roots and retailers and consumers value root freshness.
- The Nakuru based SP traders source SP roots from Kabondo during the peak season of Nov to Jan, and from Sirare when roots from Kabondo are not available. There appears to be a greater difference between the SP sack buying and selling prices in Nakuru than Nairobi.
- In Nakuru the demand for SP roots increases when there is not much maize or Irish potato available, typically Feb-May.
- The Nairobi and Nakuru based traders perceive their profits to vary between Ksh200-500 per Prim or Bao sack of Kabondo roots, and Ksh500-1,000/ Prim, Bao or Mtoro sized sack of Sirare roots. The Kisumu based traders suggest their profits range from Ksh100-200 per flat or Prim sized sack during the year, although if they sell the roots themselves in piles their profits can reach Ksh400 per sack. However, for the Nairobi and Kisumu traders these profit perceptions are generally higher than those arrived at from calculations based on the costs and sales figures they reported, which are compared across the urban markets in Figure U6. It is likely that the Nairobi and Kisumu traders rounded up some of the costs they reported, and did not report the economies of scale they achieve.
- The retailers in all three markets visited sell SP roots in piles for Ksh10-Ksh100 (with Ksh30, 50 and 100 per pile being the most common sizes) depending on the number of roots and the season. They alter the size of the piles during the day and the year to maximise their profits. Some retailers sell piles of mixed size roots, while others sell the medium and big roots in separate piles from the small roots. Many customers expect a few complimentary roots as well making it very complex to estimate the cost of the roots.
- None of the retailers had calculated how many piles they get from a sack, but they had calculated their profits. The retailers in Nairobi's Muthurwa market estimate their profits at Ksh200-500 per sack, and say the profits are dependent on the retailer's ability to organise the roots in piles. Retailers in Nakuru's Wakulima market estimated their profits at Ksh500-1,200 per sack. The Kibuye market retailers estimate their profit at Ksh100-300 per flat sack.
- The retailers in Nairobi and Nakuru markets purchase sacks of SP from traders in the market, some of the retailers in Kibuye market (Kisumu) do this, while others purchase SP roots directly from farmers and then transport them to the market and retail them.

- SP retailers, most of whom are women, generally consider the SP business to be profitable enabling them to pay their rent, school fees and food.
- Traders felt that due to high levels of rural to urban migration, consumption of SP in urban areas has increased and there is therefore increased trading and retailing of SP roots. Some Nairobi retailers explained that the middle-class consumers who shop in Muthurwa market had become richer and were eating less SP in the last few years. They felt poorer consumers would still be eating a lot of SP but were more likely to shop in small markets in their suburbs, while richer consumers shop in supermarkets.
- After purchasing SP roots consumers typically take them home and boil them for about 40 minutes, perhaps eating a few that evening but mainly having them for breakfast the next morning either re-heated or at room temperature preferably with a cup of tea or milk. In most cases the whole family enjoys boiled SP for breakfast or lunch, but in a few households the children do not enjoy eating it. Most of the consumers interviewed have boiled SP roots for breakfast 2 or 3 times per week, with each person eating 1 or 2 roots. SP roots may also be boiled with beans and served for dinner once a week. Most of the consumers were buying piles of SP costing Ksh50, and typically spend about Ksh200/week on SP roots, buying them 2 or 3 times during the week in order to have fresh roots.
- Consumers were choosing the SP roots based on their size (preference for small or large varies by consumer), freshness, colour, absence of damage, price. Whilst several felt that unwashed roots last longer, the washed roots made it easier to see if any roots were damaged or rotten, and reduced the preparation time. Most consumers said they preferred a red skinned root with a yellow or white flesh colour.
- SP roots are viewed as a cheap energy food source, explaining that if you eat bread you get hungry again much faster than if you eat SP roots, and that bread is more expensive than SP.
- In Nairobi all the consumers interviewed said they had heard of OFSP, in Kisumu half had, and in Nakuru none had. Some of the retailers in Kisumu had sold OFSP, but did not get any repeat customers for it as they said it did not have a high enough dry matter content and had a strange smell when cooked.

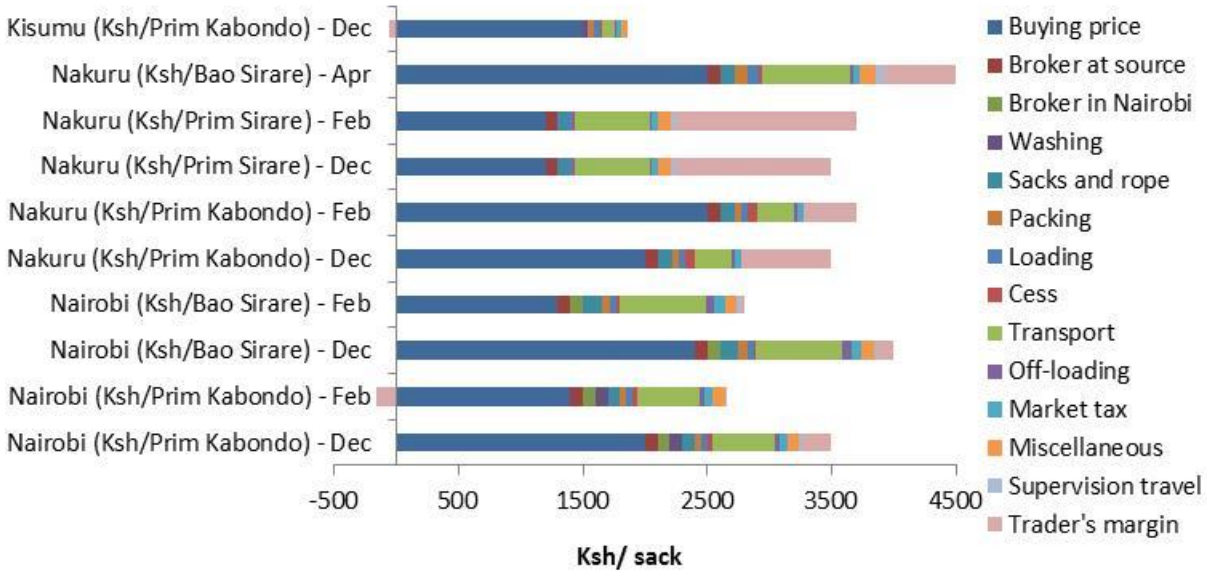


Figure U6. Comparison of traders in Nairobi, Nakuru and Kisumu reported costs and margins per Prim and Bao sized sacks of SP roots at different times of the year

4. Comparative analysis of the sweetpotato value chain across focal locations

4A. SP and OFSP production activities and key findings

In much of former Nyanza and Western provinces of Kenya fresh SP roots are harvested almost all year round, with farmers typically planting the crop twice per year. Those months where fresh SP root supply peaks and those where supply is low are shown in Table 4.1, based on information from farmer focus group discussions and individual case studies, Ministry of Agriculture staff. There was often some discrepancy amongst the different value chain actors in a location as to when the main peak, medium and low supply seasons were.

In Busia, Kabondo and Kericho the fresh SP root supply peaks in Jan-March after the short rains; the supply increases again after the longs rains in Jun-July and in July-Aug (for the 6MAP) in Busia and Kericho, respectively. In Migori and Siaya the peak supply is in March-May, from the Nov/Dec planting season for SP varieties which mature by 3 or 4 MAP.

Table 4.1 Peak and low supply seasons of fresh SP roots in Busia, Homa Bay, Migori, Siaya and Kericho counties

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Busia	***	***	***	*	*	***	***	**	**	*	*	**
Kabondo	***	***	***	**	*	**	**	**	**	*	*	*
Migori	**	**	***	***	***	*	*	***	***	**	**	**
Siaya	**	**	***	***	***	***	*	*	***	***	***	*
Kericho	***	***	***	*	*	*	***	***	*	**	***	***
Key: *** = Peak supply; **= Medium supply; * = Low supply												

Source: Field visits

An overview of average farm sizes, area under SP or OFSP, presence of farmers' producing OFSP, the degree or commercialisation of SP production and the main varieties grown is given for each of the focal production areas in Table 4.2. The reported yields per acre per cycle, the total production area and quantity of SP per county are shown in Table 4.3.

Table 4.2 and 4.3 report data collected during interviews with individual case study farmers[24] and, whenever possible, this information has been cross-checked and complemented with that provided in farmers' focus group discussions. Although the extensionists were asked to select a range of different farmer types, the farmers interviewed do not necessarily convey information that can be considered statistically representative of their geographical area.

The farmers in Kericho and Migori counties report the largest farm sizes, while in Siaya the farmers have the smallest farm sizes. Across the counties, the area under SP and/or OFSP was typically between ¼ and ½ of the total farm area. The percentage of SP traded is ~80% for all the counties with the exception of Siaya where the SP and OFSP are mostly used for home consumption. The presence of OFSP production is reported in Busia, Kabondo and Siaya.

[24] For details, see the Farmers' case studies in the "Production Activities and producers" paragraph for each geographical section of Ch.3.

Table 4.2 Information on farming activities for SP and OFSP fresh roots in Busia, Homa Bay, Migori, Siaya and Kericho counties

	Farm size		Fresh roots		Main SP/OFSP varieties cultivated
	Average acres	% SP or OFSP on total farm area	Presence of OFSP	% of SP or OFSP traded	
Busia	2	25-50	Yes	80%	Kampala, Maraoko, Bungoma, SPK004, Kabode, Vita
Kabondo	2	25-50	Yes	60-80% (SP), 95% (OFSP)	Nyawuor, Tombra, Wera, Kabode, Vita
Migori	4	25-40	No	90%	Balozi, Nyabisguguki, Surambaya, Rongambo, Morozigori
Siaya	1.5	20-50	Yes	20-50%	Kunykibuonjo, Ya Kakamega, Olombojapidi, Maraoko, Nyagunj, Nyandere, Kabode, Vita
Kericho	5	20-40	Yes (limited)	80-90%	Chepolol, Cheptkit

Sources: Fields visits

Table 4.3 Yields, production and cultivation area for SP/OFSP roots in Busia, Homa Bay, Migori, Siaya and Kericho counties

	Yields (per acre/cycle)			Bag Type	Yields from field visits (per cycle)(est)*	Area under SP (MoA)	Total production (MoA)	Yields (t/ha) (MoA)
	SP	*OFSP*	*Vines*					
Busia	30-50 bags	30-50 bags	120-150 bags	flat	2.2-4.5 t/acre (SP/OFSP)	NA		
Kabondo	up to 20 bags	up to 14 bags		prim or extended	3-3.5 t/acre (SP); 2.5 t/acre (OFSP)	6,071 ha	99,573 t	10-20 t/ha
Migori	20-25 bags	NA	NA	prim or extended	2.5-3.3 t/acre	NA		
Siaya	14 bags	9 bags	NA	flat	~1.5 t/acre (SP); 1 t/acre (OFSP)	2,900 ha	37,062 t	10-13 t/ha
Kericho	40-60 bags	NA	12 bags	moet	3.6-5.4 t/acre	637 ha	6,712 t	10.5 t/ha

Sources: Fields visits and own elaboration

* the yields reported are based on the information received by the few farmers interviewed in each county and the approximate dimension/volume of the bag.

Note: Flat bag corresponds to an approximate capacity of 90-100kg, prim or extended bag to 165 kg, one moet is about 3/4 of a flat bag.

From the individual farmer case study responses the counties with higher SP yields appear to be Kericho, Busia and Kabondo; although data from MoA is not available for all the counties, a minimum of 10 tonnes per ha per year of fresh SP roots is reported for all the selected counties. Kabondo county has the largest area under sweetpotato (6,071 ha with yields of 10-20t/ha), with Rachuonyo South, Ndhiwa and Homa Bay sub-counties accounting for 2,442, 2,535, and 1,005 ha of this SP production respectively (Table 4.3).

4B. SP and OFSP marketing activities and key findings

The seasonal range of prices obtained by farmers for sacks of SP and OFSP roots and OFSP vines in the different counties are shown in Table 4.4. It should be noted that different sized sacks are used in the different counties (Figure 4.1), which means direct price comparisons between counties cannot be made, only between those counties where the same sized bags are used.

Table 4.4 Prices and profits for SP/OFSP in Busia, Homa Bay, Migori, Siaya and Kericho counties

	Farmers				
	Roots/vines	**Price (Ksh/bag)**	**Profits (Ksh/cycle) per acre**	**Price variation from peak to low season**	**Bag type**
Busia	*SP*	800-1500	12,800- 54,000	NA	flat
	OFSP	1,000-1,500	32,000-45,000	NA	
	OFSP vines	300-700	22,000-48,000		
Kabondo	*SP*	1300-1400 (peak) (1,000 rarely); 2,000-2,500 (low)	10,000-20,000	67%	prim or extended
	OFSP	14 (per kg)	20,000-25,000	no var	
	OFSP vines	1 ksh/cutting	12,000		
Migori	*SP*	500 (peak); 700-800 (medium); 500 (low)	7,300-23,400	50%	prim or extended
	OFSP	NA			
	OFSP vines	50			
Siaya	*SP*	750-1,000	6,000-13,000		flat
	OFSP	3,000	~15,000		
	OFSP vines	500			
Kericho	*SP*	1,000	30,000-40,000		moet
	OFSP				
	OFSP vines				

Sources: Fields visits and own elaboration

Note: The calculations of the price variation from peak to low supply season considers the average price per supply season.

The highest profits per acre (per cycle) for SP and OFSP and OFSP vines are reported by the Busia farmers (although the range of profits is wide), followed by the farmers in Kericho and Kabondo. The farmers in Siaya reported much lower profits per acre (per cycle), and they also have much smaller production areas. Where cultivated, the OFSP varieties give higher profits per acre (per cycle) than the traditional white or yellow-fleshed varieties. The price of a Prim (extended) sack is highest in

Flat-sized sacks of SP delivered by farmer to roadside, Kabondo

Prim-sized (extended) sack of SP being packed at Kabondo for trade to Nairobi

Tight packing of SP roots

Prim-sized (extended) sacks of SP waiting for porterage at Nairobi's Muthurwa market

Bao-sized sacks (2 and a bit sack length) of SP at Nairobi's Muthurwa wholesale market

Kiptere trader showing profit margin of resizing the 'moet' volume between purchase and sale

1 punda (donkey) = 2 moets (one each side)

'Tolit' bucket. 4 Tolits = 1 moet, Kericho

Retail piles of different sized SP roots in Kibuye market, Kisumu

Figure 4.1 Overview of some of the volumetric measurements for SP roots along the value chain

(Note the largest Mtoro sized-sack is not shown as we did not see it during the study) Photos: Tanya Stathers

Kabondo where a price variation of +67% is registered between the peak and low supply season. In Busia, a flat bag of SP and OFSP is sold between Ksh 800-1,000 and Ksh 1,500 respectively.

The prices at which the traders reportedly bought the sacks and then sold them during the year is summarised in Table 4.5a, again attention has to be paid to the size of the bag which the price is being quoted for, as in areas such as Migori the traders will buy the flat sack size of roots, and then wash, sort and combine the roots and pack them into *bao*-sized sacks (2.25 times the height of the flat sack). A wide range of profits and volumes have been reported and tracked with our calculations for the traders operating in these counties**.**

Table 4.5a Prices, volumes and profits for traders in Homa Bay, Migori, Siaya and Kericho counties

	Traders					
	Bag/Total	**Price (Ksh/bag)**	**Volumes (bags/week)**	**Profits (ksh/bag)**	**Price variation from peak to low season**	**Bag type**
Kabondo	*Bag sold*	3,500 (peak: Feb/Apr); 4,200-4,500 (med: Aug/Jan); 4,500 (low: May/Jun)	30-60 (peak: Feb/Apr); 20-45 (med: Aug/Jan); 10-30 (low: May/Jun)	990-1,190 (peak: Feb/Apr); 1,490-1,690 (med: Aug/Jan); 990-1,190 (low: May/Jun)	29%	prim or extended
	Bag bought	1,500 (peak: Feb/Apr); 1,700-2,000 (med: Aug/Jan); 2,500 (low: May/Jun)			67%	
	Total			~1.4-2.7 million/year		
Migori	*Bag sold*	3,500 (peak: Jan-June) 4,000 (low:July-Dec)	14-20	650 (Jan-June); 550-750 (July-Dec)	14%	bought: flat sold: bao
	Bag bought	800 (peak: Jan-June) 1,000-1,100 (low: July-Dec)			31%	
	Total		644-920 bao/year	580,000-920,000/year		
Siaya	*Bag sold*	2,000-2,300 (SP) (peak: March-Apr and Sept-Nov); 2,000-2,500 (SP) (mid-low: Dec-Feb, Jun-Aug); 2,500 (OFSP) (all year-round)	6 (SP), 3 (OFSP) (peak: March-Apr and Sept-Nov); 3-4 (SP), 3 (OFSP) (med: Dec-Feb, Jun-Aug)	500-1,000 (SP), 450 (OFSP) (peak: March-Apr and Sept-Nov); 350-700 (SP), 450 (OFSP) (med: Dec-Feb, Jun-Aug)	5%	flat
	Bag bought	1,200-1,300 (SP) (peak: March-Apr and Sept-Nov); 1,500 (med: Dec-Feb, Jun-Aug); 2,000 (OFSP) (all year round)			20%	
	Total		~210/year	150,000-200,000/year		
Kericho	*Bag sold*	800 (peak: Nov-Jan); 800-1,200 (Feb); 1,500-1,800 (low: Apr-Sept); 600-800 (peak:Oct)	20-35	~500 (medium-big roots, 2 moet), ~85 (small roots, 2 moet)	136%	2 moet
	Bag bought	1,000 (medium-big roots); 400 (small roots)				
	Total			~300,000-600,000/year		

Note: The profits per bag are based on our calculations. The calculations of the price variation from peak to low supply season considers the average price per supply season.

Sources: Fields visits and own elaboration

From the above data gathered during the trader interviews, the traders in Kabondo appear to earn the largest annual profits (>1.4 million Ksh/year) due both to the large volumes of bags traded and the high margins per bag (i.e. the difference between the buying and selling price is on average 2,000 Ksh/bag). The Siaya trader appears to gain the least profits from his trading activities; a similar finding has been observed from the comparison between farmers in different counties, confirming that the SP value chain margins were lowest in Siaya. The seasonal price variation ranges from 5-10% in Siaya up to >100% in Kericho, considering both the selling and the buying prices of the bags. In

Kabondo, the price variation between the peak and low supply season is 29-67%, while in Migori it ranges from 14-31%.

The purchase and sales prices and profits reported by the sweetpotato traders based in the urban centres of Nairobi, Nakuru and Kisumu, and season price variations are shown in Table 4.5b.

Although an exact figure of the profits per bag of the traders in Nairobi[25] cannot be provided, they may earn the highest amount profits (per year) with respect to other urban traders due to the huge volumes of sacks of SP traded. From our calculations using the traders' data, the traders in Nakuru earn the highest profits per bag, while the traders in Kisumu have low wholesaling margins which force them to also retail the fresh SP roots in piles to increase their incomes. The urban traders located in Nairobi and Nakuru report the largest trading profits among the different counties. The trading system in Nairobi appears the most complex one, considering the numerous different sack dimensions and root types (prim, bao, mtoro, koroga) and the geographical SP supply (Kabondo and Sirare).

Considering all the bag sizes for each urban market, the average price variation between the selling price during the peak and low supply seasons is ~55% in Nairobi, ~10% in Nakuru, and ~13% in Kisumu. The traders report that the buying prices tend to vary more than the selling price, suggesting the traders bear more of the 'price variability due to seasonality' in order to secure their sales.

Figures 4.2 (a-d) show the different sales price trends for each focal point, taking the various sack dimensions into consideration. Figure 4.2a shows that the prim bag in Kabondo has a higher average price than the bao-sized bag sold in Migori; the flat bag in Siaya shows the lowest price variability between the supply seasons. Figures 4.2b, 4.2c and 4.2d show the price trends for Nakuru, Kisumu and Nairobi: it is interesting to notice that the larger size bags account for the largest variation (both in absolute and % terms). In Nairobi, the prim bag from Sirare is the cheapest one to sell (and to buy).

The purchase and sales prices and profits reported by the sweetpotato retailers based in the urban markets of Nairobi, Nakuru, Kisumu, and Kericho and season price variations are shown in Table 4.6.

Few discrepancies emerge between the buying price of the retailers and the selling price of the traders, especially for the lowest and highest seasonal values that increase the price variation per bag bought for the retailers. The retailers sell fresh SP roots in piles, in general, the price per pile does not vary during the year, and it is on average Ksh 30 for a pile containing smaller roots and Ksh 50 for a pile containing bigger roots. Instead, they change the number of SP roots per pile to keep their profits level, when they buy the bags at a higher price during the low supply season they reduce the number of roots per pile. Retailers in Nairobi and Nakuru appear to have similar profits, even though the range is quite wide. The retailers in Kisumu have lower profits levels.

[25] The figures in Table 4.5b refer to the profits per bag reported by the same traders. However, the profit calculations based on the costs given by the traders (Table U3) and their reported purchasing and sales prices (Table U2) suggest lower profits per sack.

Table 4.5b Prices, volumes and profits for traders in urban markets of Nairobi, Nakuru and Kisumu

	Bag (origin and/or type)			Price (Ksh/bag)	Profits (ksh/bag)	Price variation from peak to low season	Volumes (bags/week)
Nairobi	Bag sold	Kabondo	Prim	1,800-2,500 (peak: Jan-March); 2,500-2,800 (med: Apr-may); 2,800-3,000 (low: Jun-Dec); 3,500 (Dec)	200-300	63%	150-200 (Jan-Feb), 100 (March-May); 10-20 prim bags (Jun-Jul); ~100 (Dec)
		Sirare	Prim	1,600-2,300 (Feb-Apr); 2,300-2,600 (May-Jun); 2,600-2,800 (Jul-Dec); 3,300 (Dec)	500	69%	
			Bao	2,500-2,800 (Feb-March); 2,800-3,000 (Apr-May); 3,000-3,500 (Jun-Sept); 3,500-3,800 (Oct-Nov); 3,000-4,000 (Dec); 2,800-3,000 (Jan)		42%	
			Mtoro	3,500-4,000 (Feb-May); 4,500-5,000 (Jun-Jan); 5,500 (Dec)		47%	
		Koroga		1,600-1,800			
	Bag bought	Kabondo	Prim	1,400-1,500 Prim (peak: Jan-Feb);1,600-1-700 (med: March-May); 1,800-2,000 (low: Jun-Dec); 2,200 (Dec)		52%	
		Sirare	Prim	Prim (800-1,000 Feb-May; 1,400-1,500 Jun-Dec; 1,300 Jan)		61%	
			Bao	1,300-1,400 Feb-Aug; 1,400-2,000 Sept-Nov; 2,400 Dec-Jan)		78%	
			Mtoro	1,700-2,000 Feb-Apr; 2,000-3,000 Jun-Dec; 3000-3500 May		76%	
		Koroga		400-600			
	Total				NA		
Nakuru	Bag sold	Kabondo	Prim	3,700 (Feb-Aug) 3,800 (Aug-Sept) 3,500 (Oct-Jan)	430 (Feb-Mar); 1,030 (Sept-Oct); 730 (Nov-Dec)	9%	~30
		Sirare	Prim	3,700 (Feb-Aug) 3,800 (Aug-Sept) 3,500 (Oct-Jan)	530 (Apr-Jul); 900-1,000 (Aug); 1,200 (Nov-Jan, Mar); 1,400 (Feb); 1,500 (Sept-Oct)	9%	
			Bao	4,000 (Sept-Feb) 4,500 (Mar-Aug)	531 (Apr-Jul); 900-1,000 (Aug); 1,200 (Nov-Jan, Mar); 1,400 (Feb); 1,500 (Sept-Oct)	13%	
	Bag bought	Kabondo	Prim	2,500 (Feb-Mar); 2,800 (Jun-Jul); 2,000 (Aug-Dec); 1,800 (Jan);		56%	
		Sirare	Prim	1,400 (Mar-May)1,500 Jun 1,600-1,700 (Jul-Aug)1,200 (Sept-Feb)		38%	
			Bao	2,500 (Apr-Jul)			
		Total			~615,000-750,000/year (a); ~1.5 million/year (b)		
Kisumu	Bag sold	Kabondo	Flat	1,000-1,200 (all year round)	100-400 (depending on the way they sell the bag, i.e. the whole bag (100-200) or in piles (400))		~3-6
			Prim	1,600-1,800 (Feb-March and Nov-Dec), 1,800 (all the other months)		13%	
	Bag bought	Kabondo	Flat	800 (Feb-Mar and Nov-Dec); 800-900 (Jul-Oct, Jan, Apr), 900 (May-Jun)		13%	
			Prim	1,500 (Feb-Mar and Nov-Dec); 1,500-1,600 (Jul-Oct, Jan, Apr), 1,600 (May-Jun)		7%	
			OFSP flat	1,000 (all year round)			
	Total				~40,000-50,000/year		

Sources: Fields visits and own elaboration

Note: The profits per bag are estimated by the traders in Nairobi and when the bag is sold in pile in Kisumu; in the other cases, the profits per bag are based on our calculations. The calculations of the price variation from peak to low supply season considers the average price per supply season.

Figure 4.2a Sweetpotato root sales price seasonal trends as reported by traders in Kabondo, Migori, Siaya and Kericho)

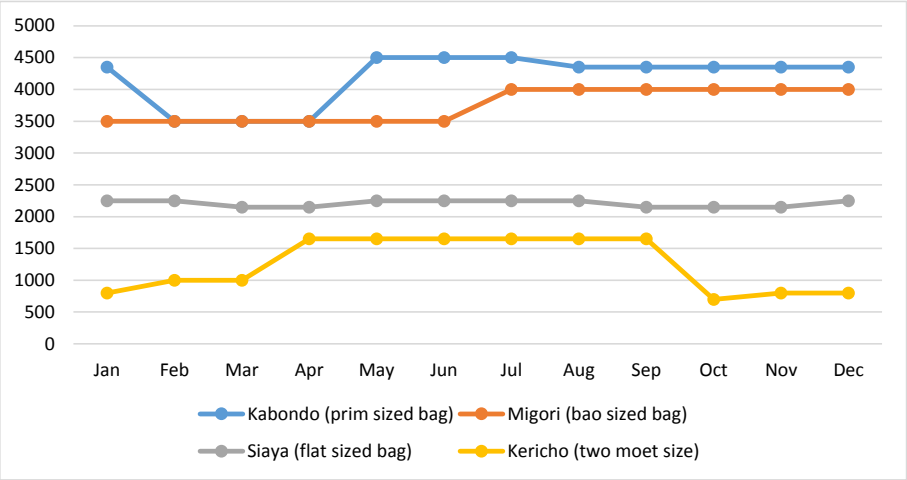


Figure 4.2b Nakuru market traders sales prices of sweetpotato roots from different production areas during the year (note different bag sizes)

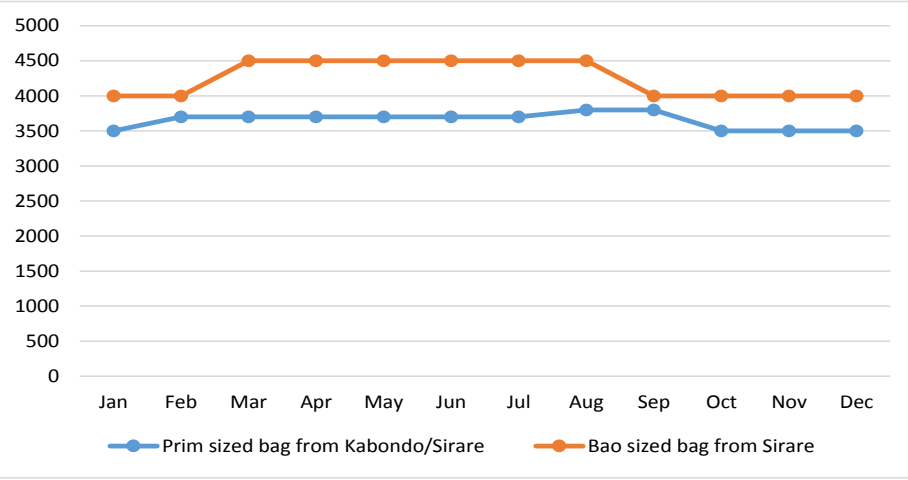


Figure 4.2c Kisumu market traders sales prices of sweetpotato roots from Kabondo during the year (note different bag sizes)

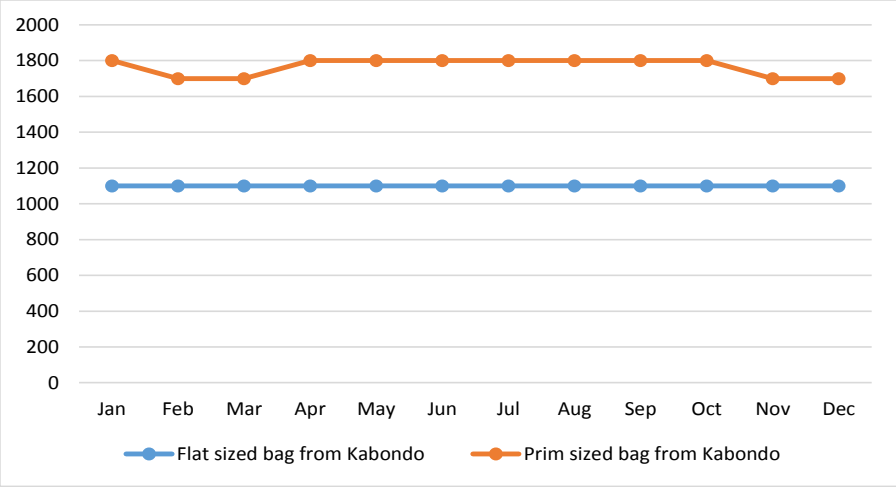
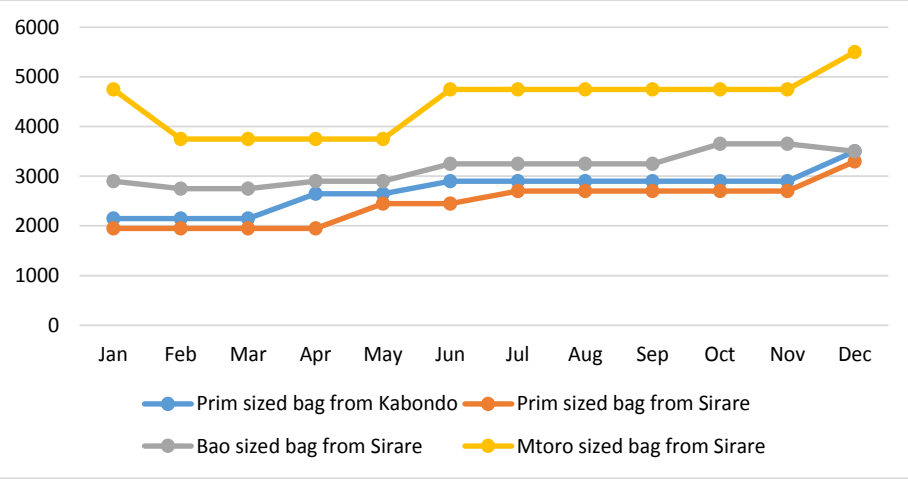


Figure 4.2d Nairobi market traders sales prices of sweetpotato roots from different production areas during the year (note different bag sizes)



Sources: Fields visits and own elaboration

Table 4.6 Sweetpotato prices, volumes and profits reported by retailers in different urban markers

		Bag type	Price (Ksh/bag)	Volumes (bags/week)	Profits (ksh/bag)	Price variation from peak to low season
Nairobi	*Pile sold*		4 roots (med-big): 40 (Oct-Dec), 35 (May-Oct), 30 (Jan-Apr); 5 roots (med-big): 50 (Oct-Dec), 40-45 (May-Oct), 35-40 (Jan-Apr); 3 roots (med-big): 30 (Oct-Dec), 25 (May-Oct), 20 (Jan-Apr); koroga roots (10-12): 20-30 (Oct-Dec), 15 (May-Oct), 10 (Jan-Apr)	~12-18		4 roots (med-big): 33%; 5 roots (med-big): 33%; 3 roots (med-big): 40%; koroga roots (10-12): 150%
	Bag bought	Flat	3,000 (Oct-Dec), 2,000 (May-Oct), 1,000 (Jan-Apr)		200-500	200%
		Prim	4,000 (Apr-Jun); 3,500 (Oct-Dec); 3,000-3,500 (Jul-Sept and Jan-Apr)		200-500	23%
		Bao	5,000 (Oct-Dec), 3,500 (May-Oct), 2,500-3,000 (Jan-Apr)		200-500	82%
		Mtoro	7,000-7,500 (Oct-Dec), 4,000 (May-Oct), 3,000-3,500 (Jan-Apr)		600-800	123%
		Koroga	2,500 (Oct-Dec), 1,500-1,800 (May-Oct) 800-1,000(Jan-Apr)		200-600	178%
	Total				~120-300K/year	
Nakuru	*Pile sold*		Small roots pile 30 ksh: 9-10 roots (Apr-Jun); 10-12 roots (Oct-Dec); 10-12 roots (Jul-Sept and Jan-Apr); Big roots pile 50 ksh: 4-5 roots (Apr-Jun, with peak of 100ksh/pile); 6 roots (Oct-Dec); 6 roots (Jul-Sept and Jan-Apr)			
	Bag bought	Prim	4,000 (Apr-Jun); 3,500 (Oct-Dec); 3,000-3,500 (Jul-Sept and Jan-Apr)	~4-6	500-1,000 (peak-medium); 1000-1,200 (low)	23%
	Total				~100,000-360,000/year	
Kisumu	*Pile sold*		(a)small roots at 30ksh: 5 roots (Jan, May-Jul, Sept-Nov); 10 roots (Feb-Apr, Aug, Dec); big roots at 50ksh: 3 roots (Jan, May-Jul, Sept-Nov); 5 roots (Feb-Apr, Aug, Dec)		(a) ~200-500 (b) 100 (Kabondo bags), 300 (others bag)	
	Bag bought	Prim	(a) 1,500 (Jan, May-Jul, Sept-Nov); 1,300 (Feb-Apr, Aug, Dec) (b) 1,400 (Kabondo traders) 1,700 (others)	(a) 3-6 (b) 3-7		15%
	Total				(a) 30,000-75,000/year (b)21,000-45,000/year	
Kericho	*Pile sold*	2 moet	30 (small roots), 50 (med-big roots) (peak: Nov-Jan, Jan-Apr); 10 (small roots), 30 (med-big roots) (low: Aug-Oct); 30 (small roots), 50(med-big roots) (mid: May-July)	3-6 bags	150-300	
	Bag bought		200-300 (small roots), 600-1,000 (med-big roots) (peak: Nov-Jan, Jan-Apr); 100-300 (small roots), 250-450 (med-big roots) (low: Aug-Oct); 700-1,200 (small roots), 1,400-1,500 (med-big roots) (mid: May-July). In May-July the bags dimension is twice the bags of the other months.			81%
	Total				30,000-300,000/year	

Note: The profits per bag are estimated by the retailers because it is not possible to estimate the number of piles per bag. The calculations of the price variation from peak to low supply season considers the average price per supply seasons.

Sources: Fields visits and own elaboration

5. Business opportunity: Processing of OFSP puree

This section of the report aims to provide information to help assess the viability of orange-fleshed sweetpotato (OFSP) puree processing in Kenya. The OFSP puree can be incorporated into bakery products helping to promote the uptake of vitamin A amongst consumers of these products.

During SASHA Phase 1 in Rwanda, experience was gained on the large-scale commercial production and marketing of OFSP puree products: the use of OFSP puree was found to be economically more advantageous than OFSP flour and was popular with consumers, justifying the promotion of OFSP puree-based products in other SSA countries. The establishment of OFSP puree manufacturing in Kenya is expected to contribute to value addition in local sweetpotato chains and to have multiplicative effect in terms of rural income, employment opportunities and the reduction of foreign exchange costs of wheat imports.

The Kenyan supermarket chain aims to introduce OFSP puree into commercially-processed products, such as bread, scones, cakes and cookies. The initial demand of OFSP puree will require the provision of OFSP puree from only one processor, but longer-term the demand is likely to increase as the product's potential becomes established. The processor(s) will be supplied with fresh OSFP roots from focal producing areas in the former Nyanza and Western provinces.

The following information was gathered during the value chain study field visits and from additional discussions with various stakeholders; it relates to the value of the roots, the year-round provision of roots, technical conversion rates, production and transport costs. The contractual agreement between the processor and the supermarket chain is still in-process, as is the set-up and design of processing facilities; therefore the following information should be simply considered as preliminary but incomplete information which will be improved over time.

Despite its limitations it should be helpful in providing some guidance for implementers; the limitations are mainly related to the future scale of processing, energy costs and contractual issues. A full business assessment will be conducted by the processor.

5A. Technical factors and production costs for OFSP puree processing activities

1) OFSP root to puree conversion rates and composition of bakery products

The varieties of fresh OFSP roots likely to be supplied by the farmers are Kabode and Vita. The conversion rate from fresh OFSP roots into OFSP puree is 1.35:1 and takes into account the weight loss of the fresh roots which occurs during the manual peeling (estimated at 20-30%). We are not currently aware of any difference in the conversion rate due to different OFSP varieties used, although this does occur in the production of OFSP flour due to different moisture contents of the varieties.

Rotten roots need to be removed before the fresh roots start to be processed into puree. Postharvest losses were mentioned as a major SP marketing challenge by farmers, extensionists and MoA officers. Farmers stated their concerns regarding the rapid postharvest perishability of OFSP varieties and how easily they were skin damaged during the transport as fresh roots in overfilled bags. Retailers in Nairobi mentioned that during the Kabondo rainy season period, up to as many as 20-30% of the fresh SP roots in a sack purchased in a Nairobi market may be rotten, while during the other times of the year this percentage is ≤5%.

In order to reduce postharvest root losses, training on SP harvesting practices and postharvest handling practices is needed at all stages of the value chain from farmer through to retailer. Quite major changes to the way SP is currently handled from harvest onwards would be required to reduce

postharvest loss levels, but there is likely to be strong opposition to many of these suggested changes by various agents along the value chain.

It would be sensible to estimate that losses are about ~5% per sack when processors purchase sacks of fresh OFSP roots. Although with good training and quality management systems this loss level could easily be reduced.

The supermarket chain aims to introduce OFSP puree into commercially-processed bakery products, such as bread, scones, cakes and cookies. The current amount of wheat processed for these products is 630 kg per day per shop (Table 5.1); the OFSP puree can be used as a substitute for 30%-40% of the normally used wheat flour in bread products (details are discussed in Section 6). This proportion can be increased further for other bakery products such as biscuits and cakes (up to 45%).

Table 5.1 OFSP fresh root to puree conversion rates and composition of bakery products

Wheat utilization without OFSP puree per day per shop (Kg)	630
number of bag per day per shop	7
bag size (Kg)	90
Conversion rate OFSP roots: OFSP puree	1.35:1
Quantity of OFSP puree in enriched bread (wheat substitution %)	30%-40%
Rotten roots (approx. per bag losses)	5%

Source: Information from stakeholders and own elaboration

The wheat wholesale price trends in different areas of Kenya are illustrated in Figure 5.1; during 2014 the wholesale price in Nairobi was ~40 Ksh/kg. Substituting for 30%-40% of the normally used wheat flour in bread products, the supermarket chain will remove ~7,560-10,080 Ksh per day per shop of its wheat costs but will need to purchase OFSP puree instead[26].

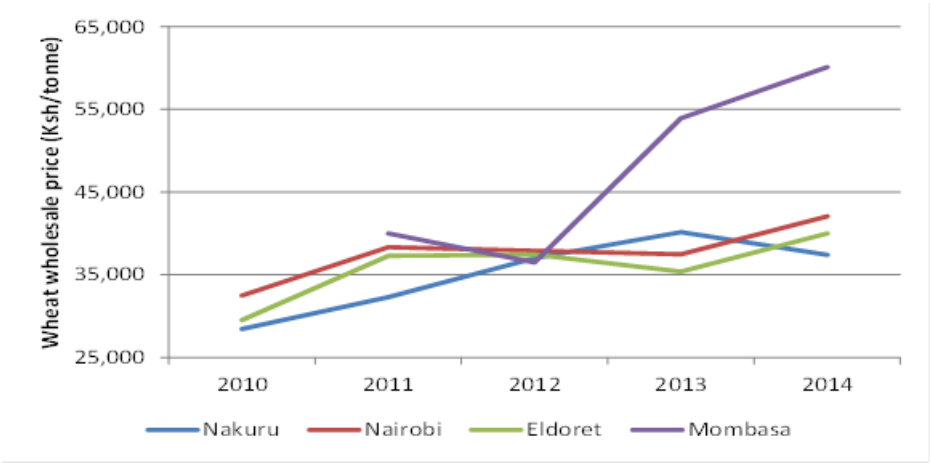


Figure 5.1. Wheat wholesale price trends across Kenya (2010-2014) - annual averages Ksh/tonne
Data source: RATIN http://www.ratin.net/index.php/markets/yearly-prices Jan 2015

2) Fresh OFSP roots supply

It is envisaged that the OFSP fresh roots will be aggregated at dedicated collection centres in the main producing area, i.e. Homa Bay, Migori, Siaya, Busia and Bungoma. Local NGOs and organizations are mobilizing the farmers and coordinating time schedule to help organize harvesting and fresh roots bulking to avoid glut problems. From our field visits, it emerges that in Busia and Kabondo the fresh SP root supply normally peaks in Jan-March; in Busia, it increases again in Jun-

[26] The supermarket chain may agree to pay the OFSP puree processor more than Ksh40/kg if there are some other cost advantages using OFSP puree, e.g. reduced quantity of sugar, butter, etc.

July. In Migori and Siaya the peak supply is in March-May. In Kericho, which could act as a root supply zone in the future, the fresh SP root supply peaks in July-Sept and Nov-Dec. The OFSP varieties being grown are reported by farmers to typically mature 3-4 MAP, given the fairly good distribution of rains during the year in the focal counties, it is possible to be producing OFSP almost all year round. Some of the traditional white and yellow fleshed varieties typically take 3-4 months to mature, others up to 6 months. Availability and yields will naturally be reduced following dry periods; and irrigated/ swamp production areas can help enable continuously staggered planting and harvesting. Fresh root storage facilities at either processor and/or county levels could also be valuable in ensuring the constancy of the root supply to the processor throughout the year.

The MoA officers explained OFSP is currently being produced in Busia, Kabondo and Siaya counties, the individual farmer case study responses suggested the OFSP yields per cycle are 2.2-4.5 t/acre, 2.5t/acre and 1t/acre respectively. These calculations have been made by multiplying the quantity of bags harvested by their approximate capacity, and given the variable size of the bags and the over-packing practices common, these figures are likely to be an underestimate of the current yields.

3) Washing and peeling

Fresh roots for use in puree processing have to be washed using clean, uncontaminated water. The washing of the fresh root could occur at either the collection centres or the processing facilities, although the quality of the washing may be more easily monitored if done at the processing facility. Moreover, it has been reported by numerous stakeholders that the fresh roots are more easily damaged during transportation and handling when washed, so leaving the washing till later in the chain may help reduce maintain root quality . Washing a flat-sized sack of fresh roots needs approximately 30-50 litres of water. The cost of water can vary from 50 to 250 Ksh/cubic metre. The washing time for fresh SP roots is typically 30 minutes for 100kg of roots (approximately a flat bag). The root washing equipment includes washing bowls, knives, plastic sheets, rakes and storage sacks.

The peeling is done manually: a bag of 100 kg can be peeled in 1-1.5 hours by 3 persons. Trials are being conducted for mechanized peeling to help reduce the losses to <10% (the peel removed would then be a layer less than 1 mm thick). The mechanised peeling machine does not grate but brushes the fresh roots irregularly, peeling them at a rate of 5 kg/1.5 minutes. The cost of the machine is not yet determined.

4) Boiling

For puree making, peeled roots need to boil for ~30 minutes and not be left in the water after the boiling process is completed.

Boiling the peeled OFSP roots in a pressure cooker on a gas stove, is suggested to help maintain a better product quality particularly regarding beta-carotene retention. Product consistency is important particularly for beta-carotene content, and also to facilitate product labelling with the Kenya Bureau of Standards. Boiling using firewood brings more product quality concerns. Firewood use if indoors can cause health problems.

The estimated investment for a gas powered pressure cooker is around Ksh 830,000 in total (~9,000 USD). The quantity of fresh roots (in kg) that can be boiled per hour will depend on the dimensions of the pressure cooker. The cost of gas is around 3,070 Ksh/13-kilogramme cylinder.

Firewood costs are estimated at ~1,500-2,000 Ksh/tonne; the energy intake to boil 1 litre of water is 2.6MJ and the amount of MJ provided by 1 kg of firewood is approximated at 19[27]. Therefore boiling 1 litre of water would require around 140 grams of firewood at a cost of ~0.25Ksh.

[27] The cost is underestimated because it is assumed that 100% of the energy is transferred to the water without any loss.

5) Mashing OFSP boiled roots

Puree mashing can be done manually, but for large quantities and high quality products it is likely be done mechanically. The puree mashing machine has a theoretical capacity of 300kg/hour. The mashing cycle lasts 2 hours, and the machine then needs a 30 minute break to cool down. Tests on the same machine working in a high temperature environment (i.e. in absence of air conditioner), indicate that the current production rate per day can reach ~0.5 tonnes of OFSP puree.

The cost of the root mashing machine is Ksh 466,973 (~5,000 USD). The estimated lifespan of the machine is 15 years. The major problems are linked to excess heating and overloading or under-loading of the machine. The energy consumption is estimated at 1Kwh in 1 day (price of KWh ~9-14 Ksh).

6) OFSP puree packing

There are currently two options for packing OFSP puree: using reusable plastic containers or packing in a vacuum pack. The cost of the container varies by dimension and can be estimated around 3 Ksh for a container of 10kg capacity. The price of the vacuum packing machine is estimated at ~130,000 Ksh (excl. VAT) for a capacity of 4 cubic metres/ hour.

High standards of food quality management are crucial at this stage, to avoid the puree becoming contaminated. Strict food safety and hygiene training is required for all staff involved in the puree processing.

7) Transportation

Labour and transport are required to bring the roots from the fresh root collection centres to the processing facilities on either a daily basis or several times per week. Depending on the quantity, distance from the collection centres and vehicle availability, the fresh OFSP roots bags can be transported on a motorbike or small truck. Transport by bicycle, donkey and motorcycle is likely to be used from the farm level to the collection centre. The estimated cost reported by the farmers is ~100 Ksh/ bag by donkey or motorbike.

The onward transport of the OFSP puree from the processor to Nairobi can if necessary be done using a cooling/refrigerated truck, with the puree packed in plastic containers or vacuum-sealed packs. The transport could be daily or a few times per week if the puree can be safely preserved between trips. The approximate cost for transport from Homa Bay to Nairobi using a cooling/refrigerated truck is indicated at 10-30 Ksh/kg.

8) Fresh OFSP root buying costs and OFSP puree sales price

The price to be paid to the farmers for fresh OFSP roots has to take into account the fixed price of 14 Ksh/kg currently received from the Kabondo Cooperative. The farmers are likely to have to bring their sacks of fresh roots to a collection centre paying on average 100 Ksh/sack to rent a donkey. This will cost them about 0.6 Ksh/kg.

The expected OFSP puree sales price to the supermarket chain is ~60 Ksh/kg.

9) Labour costs

The labour for washing and peeling the roots is estimated at 300 Ksh for 8 hours of work. After having received proper training, one worker can be dedicated to the processing/mashing machine and paid 300Ksh/8 hour shift. Skilled labour and technicians are also needed; a manager, an accountant and a food technologist will be required to supervise all the OFSP puree processing activities. An estimate of Ksh50,000/ month can be used for each skilled worker.

10) Overhead, storage room and other costs

The rent of the building is estimated at 70,000 Ksh/month, and the cost of security at 20,000 Ksh/month. About 20,000 Ksh/month should be budgeted for electricity costs, and Ksh30,000/ month for secretarial staff. A 5% contingency can be included to cover those and other expenses, such as phone calls, maintenance, etc.

A storeroom with cooling and a maximum capacity of 5 tonnes will have a fixed capital cost of 733,492 Ksh (8,000 USD) and operational costs of ~20,000 Ksh/month (250 USD). Weight loss of fresh roots is estimated at 6% during an up to 4 month storage period.

5B. Main value chain findings of relevance for fresh OFSP root supply to processors

Kabondo

Kabondo is well-known as an important SP producing area of Kenya. It is expected that ~50 acres of OFSP will be harvested by the Cooperative members in March 2015. Using just the 50 acres of Cooperative members OFSP, the total production could reach 100-130 tonnes of OFSP roots per cycle (2-2.5 tonne/acre per cycle)[28] which would be sufficient for a total of 3-4 months provision of OFSP fresh roots to the processor for puree making and delivering to four of the supermarket chain's stores. Good management will be required to help schedule and stagger the planting/harvesting seasons to avoid gluts which could lead to serious wastage. This had already been experienced by one of the OFSP processors when planting materials were just given out to farmers. They have now partnered with the Anglican Development Society who will focus on seed bulking and staggering the production. Feb-March are the peak months for the supply of OFSP to the local processor for OFSP flour. Care also needs to be taken to minimise disruption to existing OFSP value chains, particularly in case the market for the OFSP puree does not take-off or grow as anticipated.

Traders are aware how important it is that the freshly harvested SP roots reach the market within 1 or 2 days, as otherwise they start rotting and are vulnerable to rodent attack. Whilst the buying and selling prices for the traditional SP trade fluctuate by 60-70% during the year based on root supply, at present there is no seasonal fluctuation in the price of OFSP fresh roots, a flat and guaranteed price is offered all-year round (14 Ksh/kg by Kabondo Cooperative). Although given the limited OFSP flour market at present, farmers supplying OFSP roots to Kabondo cooperative have to wait to harvest them until there is a known flour buyer and order and the Cooperative has informed them they are expecting their roots.

Busia

Sweetpotato is an important food and cash crop in Busia county. Peak SP supply is Jun/Jul & Jan-Mar in Busia, SP production can occur almost all year round as they do not have >1 month without rain. OFSP varieties have been grown in Busia for >10 years, and many development organisations have been involved in promoting them. Service providers estimate that 50% of HHs in Busia grow SP and 1/3rd of HHs may grow OFSP, planting two crops of it/year. The OFSP crop can be produced twice per year, or more if in wetlands. The OFSP processor confirmed that OFSP root yields in Busia range from 4.5t/acre in Feb/Mar and Jun/Sep to 2.2t/acre in Apr/May and Nov/Jan harvest periods. The production, promotion and processing of OFSP has been and is still the focus of several joint NGOs/ Government/ donor projects. As a result production of OFSP vines has become highly profitable for

[28] It is based on the data collected from the field visits. Currently there is no much production of OFSP, and this data can be easily underestimated considering the yields data received in Busia (~4.5 t/acre per cycle).

farmers, particularly as they also sell the roots they obtain during the vine multiplication. The OFSP vines are typically being bought by NGOs (e.g. One Acre Fund) and taken to other parts of Kenya.

Siaya

Sweetpotato production has been recently revitalized as both a cash and food crop in Siaya. There is limited knowledge about OFSP amongst farmers, although vines of the OFSP variety, Kabode have been sold, especially by relief organisations such as UCRC (Ugunja Community Resources Centre), at Ksh500/sack. The Kabode variety matures 3MAP; is high in vitamin A; can be used for making chapatis, juice, mandazi, crisps, cakes; and has good yields. The farmers report ~1 ton/acre per cycle but this value is likely to be an underestimate of the current yields. For the OFSP variety, the supply remains quite flat during the year, mostly due to its short maturity period (3 months) that makes the OFSP roots virtually available all year-round.

The OFSP roots are mainly sold to schools and orphanages at 2,000 Ksh/bag all year round. Household consumption is not common as the people do not like the taste of the boiled Kabode root, although they do like it when it is incorporated into processed products such as mandazi, chapati and flours.

6. Improving the year-round supply of sweetpotato: a feasibility study on the potential role of fresh root storage facilities

6A. Crop storage

Historically the demand for storage of agricultural produce follows a route from necessity to market-based manipulation. In equatorial areas, even if the possibility of continuous all-year round crop production exists, which is often limited by the rainy seasons, storage facilities may help to guarantee a smooth food supply during the year and, can keep surplus crops safe and retain their quality. For crops which are seasonal, but can be produced during different times of the year in different climatic zones within a region, there can still be a financial incentive for storage due to transportation, price fluctuation or fluctuating demand issues. Moreover, as production areas and yields increase, both on-farm and more commercial (i.e. at village or county) storage structures may be necessary. Storage structures can be useful not only to farmers and final consumers but also to other actors along the chain, for example the processors that need to have a reliable supply of agricultural commodities to carry out their economic activities, or traders who want to have more control over buying and selling prices and supply.

When produce is to be stored, it is important to begin with a high quality product that does not contain damaged, diseased or pest infested units, or debris. The quality of the product will be influenced by the seed, production practices, growing conditions, timing of harvest, harvesting and postharvest handling methods.

Sweetpotato roots are perishable, and even if undamaged their quality can decline rapidly after harvest as they lose water and weight during storage which can adversely affect their taste and texture, they can also be attacked by diseases such as root rots, and existing insect pest infestations can cause serious damage[29].

Curing (pre[30] and/or postharvest[31]) can play an important role in helping the roots to heal any wounds thus protecting them against disease, reducing shrinkage and extending storage life, or toughening the skin to help protect them.

The storage facility needs to be proofed against rain, rodents, birds and thieves. The storage environment ideally needs to be maintained under conditions that are sub-optimal or lethal for pests such as fungi and insects, while not affecting the quality of the produce being stored. The key variables are temperature and relative humidity; adequate ventilation and space are also important. There are various options for manipulating the temperature and humidity of a store. As different commodities have different optimal storage conditions, mixing the commodity types being stored in one unit is not advisable.

This section of the report focusses on the potential role of fresh SP root storage facilities to improve the year round supply of sweetpotato. Fresh SP storage could offer various advantages to different agents along the SP value chain.

The advantages for the farmers are mainly related to:

- the increased ability to extend the availability of SP roots, thus allowing more crop to be produced and sold;

[29] Stathers *et al*., 2013 – Everything you ever wanted to know about sweetpotato. Topic 8: Harvesting and postharvest management. CIP, Nairobi.
[30] Preharvest curing typically involves removing the foliage 2-4 days before harvesting
[31] Postharvest curing through exposing the harvested roots to moderate temperatures of 25-30C and high humidity (90-95% relative humidity) for 4-7 days

- harvesting the roots at the optimum time for yield and root quality, and maintaining higher root quality levels than if the roots are harvested either prematurely or late;
- maintenance of markets/continuity of supply, keeping out the competition;
- buffering mechanism against low prices, so they don't have to sell when the price is low if the land needs to be used for other crops, or the roots have already been harvested;
- targeting more of their sales to occur during periods of low supply/high price.

From the point of view of the processor/buyer of fresh SP roots from the farmers, storage offers various advantages, such as:

- access to a supply of fresh SP roots (and perhaps from particular locations where root processing characteristics are good) during periods of the year when low amounts of SP are being harvested;
- buffering against high root purchasing prices;
- reliable and timely supply of raw material for the processing activities;
- utilization of transportation means at their full capacity for cost-saving practices;
- improved root quality and lower fresh root in bag losses, if the harvesting is done in a more optimal way due to having access to a storage facility;
- timely planning of the processing activities as the fresh roots do not have to be processed immediately after they are harvested.

Traders and retailers could also benefit from SP storage helping them manage peak and low supply issues and price variation (see Box 6.1 which includes their comments).

6B. Stakeholder perspectives of the potential advantages and problems of a fresh SP root storage facility

During the SP value chain field study, the potential usefulness of a sweetpotato fresh root storage facility was discussed with sweetpotato stakeholders (farmers, extensionists, NGOs and a few traders and processors). It was assumed that such a facility might help smooth SP root supply and prices during the year. Stakeholders were asked in an open question to suggest what advantages might occur as a result of having a fresh root storage facility, and then what problems might occur. They were also asked what price farmers might pay for storing SP roots for 2-3 month, whether similar storage arrangements existed for SP or other commodities, and what the most strategic location for a fresh root storage facility would be.

SP root supply trends in different locations: In the former provinces of Nyanza and Western in Kenya, SP is typically grown twice per year, thus SP roots are available throughout most of the year, and SP planting materials are easily obtained from existing crops still in the field. Although SP roots are available throughout most of the year, the supply still fluctuates during the year (Table 6.1), usually peaking ~ 3-4 months after each of the two rainy seasons start. There are usually a couple of months per year where SP root supply is low or non-existent in each location.

Table 6.1 Overview of sweetpotato root supply during the year in different locations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Busia	***	***	***	*	*	***	***	**	**	*	*	**
Kabondo	***	***	***	**	*	**	**	**	**	*	*	*
Migori	**	**	***	***	***	*	*	***	***	**	**	**
Siaya	**	**	***	***	***	***	*	*	***	***	***	*
Kericho	***	***	***	*	*	*	***	***	*	**	***	***
Key: *** = Peak supply; **= Medium supply; * = Low supply												

Source: Information from stakeholders and own elaboration

Perceived advantages of a fresh SP root storage facility: Stakeholders felt a fresh SP root storage facility could bring a diverse range of advantages to their SP value chains (Box 6.1), particularly regarding: opportunities to bulk and store SP roots in order to access larger markets and better

prices; motivation for and access to facilities for improved postharvest handling (e.g. careful washing, curing) of SP roots to help access quality sensitive markets and avoid losses during storage; change from volumetric per sack sales to per kg sales of SP roots; ability to ensure a constant supply of roots to a processor; more organised and cooperative farming and marketing of SP roots by farmers; enable farmers to rotate their crops and use their land more as they would not need to store SP roots in-ground; enable fresh SP roots to be available for sale and consumption all year round; ensuring local food security; avoidance of mole rat or weevil damage and root quality deterioration which occurs when mature SP roots are left in the ground; helping traders manage price fluctuations and price reductions which occur if sacks of SP roots are not sold on the day they arrive, but the store would then need to be at the market place.

Perceived problems for a fresh SP root storage facility: Despite these perceived advantages of fresh root storage, stakeholders also foresaw plenty of possible problems (Box 6.2), including: the additional storage costs making the roots too expensive; no/low market demand for stored fresh roots; weak store management resulting in root quality deterioration and losses or theft; weak management capacity leading to fund embezzlement and disputes; short shelf-live characteristics of some SP varieties (e.g. OFSP Kabode and Vita) making them difficult to store for >1 week; farmers need for instant cash as SP crop matures making them unlikely to use a SP storage facility; unscrupulous traders trying to disrupt root supply to farmers store as it might threaten their profits and power relations; additional transport costs involved in delivering roots to the store.

Relevant commodity aggregation and storage examples: Stakeholders suggested that there might be a need for satellite collection centres linked to a central SP root curing and storage facility. Similar set-ups already happen for grain (e.g. Millennium Development villages), cassava (e.g. EAAPP Teso South Simba Chai program), bananas (e.g. KAVES program), tea (e.g. KTDA collection centres), sweetpotato (e.g. Kabondo SP cooperative organises its OFSP into 8 collection centres), French bean (e.g. temporary storage in charcoal walled storage unit in Kabondo. However, most of these examples help in aggregating perishable commodities with very temporary storage arrangements.

The Kericho County Government have put aside Ksh25million for the design and construction of a SP root packhouse to feed a new SP root export to UK business opportunity. The Nakuru County Government are investing Ksh35million in an Irish potato cold storage facility to help smooth supply and reduce the serious price fluctuations.

Root supply smoothing: In areas where there is not a prolonged dry season and where SP is typically grown twice or more during the year, a fresh root storage facility is likely to help smooth supply and prices as opposed to playing a major role in providing fresh roots during times of year when there are none available in the field. For a SP root processor this could be very useful in ensuring a constant supply of raw materials. However, due to the regular and well-distributed rainfall in much of the Nyanza and Western Kenya SP producing areas, the organised staggering of planting among farmers could also be an effective way of smoothing root supply. Kabondo SP cooperative organises their OFSP producing members amongst their 8 collection centres and ensures the farmers do not harvest until the processing centre has confirmed they are expecting the OFSP roots. However, they are only operating at a small-scale currently and these challenges would increase if they needed to supply a large and regular market.

Current SP postharvest handling practices and challenges: Traditional postharvest management of SP roots for sale is fairly rough currently, with roots being tightly packed into large sacks for transport on donkeys or motorbikes to roadside collection points where they are poured out onto the ground or into metal drums of water and then trampled on roughly by the root washing women to clean off the mud (often leading to abrasions and removal of some of the skin of the roots). They are then poured onto the ground for further sorting and re-packing into extremely large sacks, which are then heaved and roughly thrown into the back of container trucks for 6-8 hours road transport. These well-established rough postharvest handling methods would need to be changed to obtain

high quality undamaged roots which could be successfully stored for up to 2-3 months. The Kabondo SP cooperative and Kericho SP cooperatives have begun to implement improved washing facilities to reduce root damage and scratching. Store managers and SP producers, brokers and handlers would require training on root quality requirements and fresh root storage management. Farmers, consumers and retailers are already well aware that washing the roots shortens their shelf-lives, but it also makes it easier to visually check that one is not buying insect damaged or rotting roots.

OFSP shelf-life and in-ground storage characteristics: OFSP varieties are reported by farmers and processors to have both short shelf-lives and poor in-ground storage characteristics (as they are said to be heavily damaged by weevils and mole rats once mature). Further study of the shelf-lives and in-ground storage ability of the different OFSP varieties may be required to aid OFSP production, marketing and processing.

Influence of fresh root storage on fresh root and processed product consumer acceptance: Traders, retailers and consumers in Nairobi, Nakuru and Kisumu markets explained that the freshness of the SP roots influences their value. Sacks of SP roots which are not sold on the day they arrive in the market, and thus lie in the hot sun all-day and then have to be placed in an overnight store or kept at the retailer's market spot overnight are then sold at a cheaper price the next day – as consumers prefer the fresher roots. It would therefore be important to evaluate the sales appeal of SP roots kept in a fresh root storage facility for different lengths of time (e.g. 2 days, 1week, 2 weeks, 1 month, 2 month) to understand consumer acceptance of such stored roots. For SP roots intended for processing an evaluation is also needed of whether the characteristics of the processed SP products and end products are altered when produced from roots which have been stored for different lengths of time.

Cost of storing SP roots: Given all the unknowns surrounding fresh SP root storage in Kenya, stakeholders found it difficult to suggest what root storage should cost. If the root storage was being done by farmers the storage cost would need to be related to the sales price and profit margins. If the fresh root store also had a food security focus stakeholders found it difficult to imagine a commercialised fee for root storage being implemented although they realised that management and infrastructure of the store would have costs. The Kericho SP co-operative currently take Ksh3/kg for every kg of SP roots sold to the exporter in order to cover electricity, washing costs etc. They are currently not envisaging their SP packhouse performing longer term root storage than 1 week, and once the packhouse is finished a new fee will be calculated to include management and security costs. Study of commercial storage service charges for other commodities and the costs of operating a SP storage facility and consumer acceptance of SP stored roots and products could help determine these charges. If the storage facility was being managed by a SP processor, the root storage costs would form part of their processing costs, and farmers would just receive the fresh root sales price. If the fresh root storage facility was being used by traders in a major urban market, the store running costs and root sales price stabilisation amount would determine the per sack storage charges.

Strategic location for a fresh SP root storage facility: Stakeholders felt that the strategic location for a fresh root storage facility needed to take ease of access and transport links into consideration as well as SP production figures, but that a public participation exercise (including processors, transporters, traders, researchers and farmers) should be done to agree on the location and decide whether the facility would be just for SP or also for other products. Some felt it may be necessary to have one storage facility per s/c, as farmers would not trust their SP roots to be stored in someone else's s/c. SP root transport is expensive due to the bulky nature of the roots, and so it would be important that the store position didn't exacerbate farmers transport costs. In Busia, service providers suggested that Matayo s/c or Busia town might be sensible locations as they could cater for the N, S & East areas of the county and Busia town is regularly frequented for banking etc. In Migori, it was suggested that the focus should be on the 3 s/c which produce the most SP - Kuria West, Kuria East, Uriri s/c.

The traders in Nairobi's Muthurwa market felt that a fresh root store would need to be located in Muthurwa market to be of use to them so that when the sacks of roots were delivered they could store them immediately there until they wished to sell them.

The debate as to whether storage facilities should be located closer to the surplus producers or the end-users is an on-going one surrounding strategic food reserves, there are pros and cons for both options. A study of relevant lessons which could be applied from strategic grain reserves and community grain banks would help avoid re-inventing the wheel for several aspects. It is possible that many of the management issues could be reduced if the fresh root store was located at and managed by a specialist SP processor or exporter, this would avoid farmers or traders incurring additional transport costs and could help in maintaining strict quality management systems.

Given the existing ability of traders in urban centres to source from different geographical areas during the year in order to maintain a smooth supply or roots and the value consumers place on root freshness, it would seem unlikely that a fresh root store could currently play a role in the domestic fresh SP root trade. If a fresh SP root storage facility is to be successfully developed within the SP value chain, all the issues raised above and in Box 6.2 need to be thought about, discussed and plans made in advance for addressing the likely problems which will arise.

Box 6.1 Stakeholders' perceptions of the ADVANTAGES of having a fresh sweetpotato root storage facility

- easier aggregation of larger quantities of SP roots from small producers which would help with marketing to buyers who want large quantities, and sharing the costs of transporting roots to urban centres
- act as a buffer against price and supply fluctuations, allowing farmers to hold their roots while surveying the prices and buyers, and avoid having to sell roots when prices were low
- reduced wastage of SP roots during production gluts
- quality criteria of the storage facility would sensitise producers about improved postharvest management of SP roots to prevent them deteriorating so rapidly
- could help ensure a constant supply of roots to a processor, e.g. a puree processor
- opportunity to introduce measuring unit standards and switch to a per kg payment system for roots (instead of selling in volumetric bags) this will incentivise farmers to produce high quality SP roots
- increased farming of SP as prices and market became more stable due to storage
- create a more cooperative approach to SP production and marketing
- it would help farmers rotate their crops and make more use of their land by storing the mature roots out of instead of in-ground, and free up their land for planting other crops
- would enable fresh roots to be available throughout the year
- would help ensure food security by lengthening the shelf-life and availability of SP roots, (particularly an issue in warm areas of Siaya county, where some varieties shrivel if not sold the day they are harvested, which results in trading of small quantities to reduce the risk of losing the roots to shrivelling).
- a community could buy SP elsewhere and stock their store with it as food security. Farmers would not need to buy so much bread as they could purchase cheap SP from the store
- whenever traders came there would be SP roots to sell, and farmers would not have to accept poor prices for fear that otherwise their roots would perish
- buyers would come directly to the store so transport costs for farmers could be reduced
- some employment would be created for those managing the store
- reduced SP theft by humans and animals, which occurs when harvested roots are just kept in a shady space
- reduced mole rat/weevil damage and quality deterioration which occurs when SP roots are left in-ground after maturing
- enable retailers or farmers to sell their mature roots slowly over time
- provision of a central location where SP roots can be cleaned carefully without scratching them which will help farmers meet buyers with high quality criteria, and raise awareness of how to reduce postharvest loss
- the facility can be an information centre too
- traders in Nairobi felt a fresh root store that enabled them to store roots for 2-3 months at the market place could help them with price management. The traders recalled a MoA plan to build a 100 acre trade complex at Kasarani including a market storage facility; but they felt the store needed to be at the market otherwise it would increase transport costs
- traders in Nairobi also suggested that a fresh root store would mean they would not have to harvest every other day, and could instead harvest roots once a week then store them until they needed them
- consumers who are concerned about poor hygiene standards in the SP retailing areas of the market might prefer to buy roots directly from the store

Box 6.2 Stakeholders' perceptions of the PROBLEMS that might occur with a fresh sweetpotato root storage facility

- the additional storage costs may make buyers perceive the roots as being too expensive
- if store management was not good, roots may rot, or their quality may deteriorate in other ways, or they may be damaged by rodents, who would be responsible for these losses?
- if security was insufficient roots may get stolen
- some farmers need cash urgently at harvest (i.e. they plant with a project in mind that will be funded by the SP sales 4 months later) and would not be willing to store their roots, so store would be under-utilised
- the OFSP varieties (Kabode and Vita) being grown in Kabondo are reported by farmers and processors to have a short shelf-life of <1 week, compared to local SP varieties which can last for 2 weeks after harvest
- no market for stored roots might be found, and if farmers became lazy in looking for buyers due to feeling their roots were secure, they might leave their roots stored so long that they rot or are sold at a low price during the peak SP supply
- unscrupulous traders would not like the idea of fresh root storage as it would help stabilise the VC which works against their profit margins, they would compete for the roots making it difficult to estimate quantities and flow of stored roots
- payment systems/ charges would need to be clear and well-managed otherwise they would be problematic
- there are likely to be management issues and squabbles amongst the farmers storing their roots, requiring a lot of group dynamics type training
- the group might be handling large amounts of cash and embezzlement may arise. Training on cooperation will be needed (the trade and industry (co-op devt.) department can do this)
- unexpected policy changes – such as the ban on use of extended bags, could influence SP root storage
- some rural communities may take a long time to adopt commercial fresh root storage systems
- the cost of transporting SP roots to the store could be a problem if farmers are harvesting 30-40 bags/ acre. Some farmers felt the store might have to have a transport fund.

6C. Feasibility assessment of different scenarios for SP fresh root storage facilities at processor level

Reasons for having an OFSP fresh root storage facility at the OFSP puree processor's level include:

- continuity of supply of raw materials (buffering against poor harvest or transport issues);
- avoidance of, or lessening the need to pay high root purchasing prices during the low supply seasons;
- increased control over the quality of fresh roots;
- improved flexibility to increase or decrease puree production quantities if market demand fluctuates.

Freshly harvested sweetpotato roots are cured and stored in large-scale stores in North Carolina, USA for periods of more than 6 months. Large-scale fresh sweetpotato storage is also practiced in South Africa. Traditionally in Sub-Saharan Africa (SSA) some communities have stored fresh sweetpotato roots for various lengths of time in underground pits, or in covered mound stores (e.g. clamp stores) to extend the fresh root consumption period of the year and occasionally the market period, or in piles which are typically kept moist and covered with vines or other foliage to help extend the marketing period by a short period. However, there has been limited if any, medium or large-scale commercial storage of fresh sweetpotato roots across the rest of SSA (excluding South Africa).

Key issues to be considered during fresh sweetpotato root storage include:

- ensuring that the roots to be stored are of a suitable quality (the variety, growing conditions, harvesting method, postharvesting handling, and transport distances will influence this);
- establishing a curing regime (which may include pre and postharvest steps) to help reduce root damage during handling and access of bacterial or fungal diseases through wound sites;
- access to a secure storage facility in which the necessary temperature and humidity conditions for long-term storage of sweetpotato roots can be maintained;
- ensuring the store is managed by a competent, well-trained, committed manager who understands the importance of: only accepting roots which meet the quality standards; careful handling of roots; good store hygiene and maintenance, regular monitoring of stored roots; strict loading, un-loading and avoidance of over-loading protocols; careful record keeping.

These issues can be addressed through: careful store design to work within the specific environmental conditions in which it is located; training and subsequent support of the store manager and workers.

Several different scenarios for the processor's requirements, supply management and OFSP fresh root storage could be used to meet the OFSP puree requirements of the supermarket chain's bakeries. The proposed figures should only be considered preliminary, as the contract negotiations are still on-going. Nevertheless these scenarios can be used as starting points for further future development as more precise data becomes available and the OFSP puree processing activities becomes more established.

The proposed scenarios are the following:

- **Scenario 1** considers that OFSP puree will substitute 30% of wheat flour used in the bakery products. The amount of wheat flour processed for bakery products is 630 kg per day per store[32] and the initial number of stores to be supplied is 4;

[32] The amount of wheat processed for bakery products is 630 kg which correspond to 7 bags of 90 kg each.

- **Scenario 2** considers that OFSP puree will substitute 40% of wheat flour used in the bakery products. The amount of wheat flour processed for bakery products is 630 kg per day per store and the number of stores to be supplied is 4;
- **Scenario 3** considers the provision of 0.5 tonne of OFSP puree per day, without specifying the quantity of wheat used or the number of stores supplied;
- **Scenario 4** considers that OFSP puree will substitute 30% of wheat flour in bakery products. The amount of wheat processed for bakery products is 630 kg per day per store and the number of stores to be supplied is 52.

The coefficients and fresh OFSP roots quantities required (per day, week, month and year) are illustrated in Table 6.2.

The first three Scenarios are discussed initially, as one processor could provide the amount of OFSP puree required for the 4 shops in Scenarios 1 and 2 or the 0.5 tonne/day of puree required for Scenario 3. Scenario 4 is discussed at the end of the section.

Table 6.2 OFSP puree and fresh roots requirements for meeting the supermarket chain's demand

	Scenario 1	*Scenario 2*	*Scenario 3*	*Scenario 4*
Wheat utilization without OFSP puree per day per shop (kg)	630	630	NA	630
Quantity of OFSP puree in enriched bread (wheat substitution in %)	30%	40%	NA	30%
OFSP puree for wheat substitution per day per shop (kg)	189	252	NA	189
Number of shops to be supplied	4	4	NA	52
OFSP puree for wheat substitution per day for all the shops (kg)	**756**	**1,008**	**500**	**9,828**
Conversion rate OFSP roots: OFSP puree	1.35:1	1.35:1	1.35:1	1.35:1
OFSP root requirements per day for all the shops (including 5% in bag root losses) (kg)	**1,072**	**1,429**	**709**	**13,931**
Number of days per month	30	30	30	30
Number of days per year	365	365	365	365
OFSP root requirements per week for all the shops (including 5% in bag root losses) (tonnes)	**7.50**	**10.00**	**4.96**	**97.52**
OFSP root requirements per month for all the shops (including 5% in bag root losses) (tonnes)	32.16	42.87	21.27	417.93
OFSP root requirements per year for all the shops (including 5% in bag root losses) (tonnes)	391	522	259	5,085
Acres of OFSP crop required needed per year (assuming an average yield of 3.6t/acre/cycle and 2 cycles per year)	54.3	72.4	35.9	706.2

Source: Information from stakeholders and own elaboration

1) Fresh OFSP root supply

The fresh OFSP root supply areas likely to be targeted are Busia, Homa Bay (Kabondo), Migori and Siaya Counties. At the current stage of the activities, Kericho County is not a supply area of fresh OFSP roots but it may be included in the future, as the supply of fresh roots required increases in response to the larger demand for OFSP puree from the supermaket (Scenario 4 in Table 6.2).

An overview of the SP supply seasonality in different areas, mostly for white and yellow fleshed varieties is provided in Table 6.1. Considering the months of peak and medium supply (coloured in green), accessing fresh SP roots throughout the year is not difficult if they are sequentially sourced from different areas. During the value chain study, traders explained how they also source from Tanzania through the Sirare border post to help ensure sufficient supply of fresh SP roots all year round. Most of the OFSP varieties mature 3-4 MAP, and it would therefore be possible in many of the focal areas to produce 3 cycles of OFSP per year which would further enhance fresh root availability throughout the year.

Therefore, in order to constantly obtain fresh OFSP roots throughout the year, the processor (or an intermediary) has to carefully schedule the OFSP planting and harvesting times of farmers in the different production locations, and to set-up contracts to secure the required quantities.

The OFSP yields reported by selected farmers interviewed during our field visit are shown in Table 6.3. In Kabondo and Siaya the OFSP varieties are relatively new, and currently cultivated by only a few farmers, the yields reported may therefore represent an underestimation of their potential. In Busia, various OFSP varieties have been grown for >10 years, and the yield estimates may therefore be considered more realistic.

Table 6.3 OFSP yields reported by stakeholders in Busia, Homa Bay and Siaya Counties of Kenya

County	Yields (sack/acre per cycle)	Bag type	approx kg per bag	tonnes/acre per cycle (est.)	peak season (t/acre)	low season (t/acre)
Busia	40	flat	90	3.60	4.5	2.2
Kabondo	14	prim	165	2.31	NA	NA
Siaya	9	flat	95	0.86	NA	NA

Source: Information from stakeholders and own elaboration

Considering the yield range in Busia between the peak and the low seasons, Figure 6.1 shows the quantity of acres to be harvested per month to cover the whole monthly requirement of fresh roots for the different puree supply scenarios (as described in Table 6.2). With average yields of ~3.6 tonnes/acre/cycle (taking into account ~7.5 months of peak season and ~4.5 months of low season[33]), the acreage requirements per year are: ~55 for Scenario 1, ~75 for Scenario 2, and ~35-40 for Scenario 3.

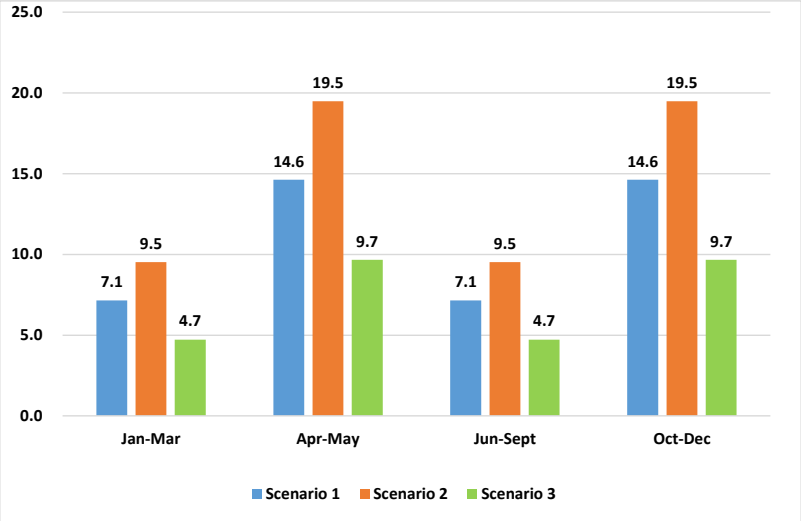


Figure 6.1 OFSP crop acreage required per month from Busia to meet the different puree demand scenarios

Source: Information from stakeholders and own elaboration

Currently in Busia County there are ~35 acres under OFSP (REFSO pers. comms., Dec 2014). In the Kabondo area of Homa Bay current estimates suggest there are at least 50 acres of OFSP being grown, mainly to supply the Kabondo SP Cooperative for producing OFSP flour. These estimated acreage results for the different scenarios will change if the supply localities and plans change.

2) Price variation

According to the data collected during the field visits, the price variation between the peak and low supply season can be summarized as in Table 6.4. It is worth noting that the figures are based on data received from various agents along the chain. The information collected at farm level in Kabondo and Migori report a sales price variation of ~70% between peak and low supply season.

[33] December is considered an intermediate month, between low and high supply season. In the Figure 6.1 is represented as a low supply month.

The traders provided broad information in geographical terms. The buying price between the peak and low supply season varies between 20% and 67% in Kabondo, Migori, Busia while the % variation of the selling price is lower, i.e. 5%-29%[34].

Table 6.4. Price variation from peak to low supply season (white and yellow fleshed varieties) (buying-selling price)

	Farmers	Traders	Retailers
Busia			
Kabondo	67%	67%-29%	
Migori	70%	31%-14%	
Siaya		20%-5%	
Kericho		NA-136%	81%
Nairobi		67%-55%	120%-~60%
Nakuru		63%-10%	23%
Kisumu		9%-13%	15%

Source: Information from stakeholders and own elaboration

To date the buying price of fresh OFSP roots has not varied during the year in the focal counties considered. In Kabondo and Busia the OFSP fresh roots are sold by the farmers to cooperatives and processors at 14 Ksh/kg and 12 Ksh/kg, respectively. The trader in Siaya pays the farmers Ksh2,000/ flat-sized bag of fresh OFSP all year round (~20Ksh/kg). Fresh roots of OFSP varieties do not currently suffer from seasonal price variation as the crop has a guaranteed market in both Busia and Kabondo.

In an ideal situation where i) the production is well scheduled, ii) the contracts between processor, farmers, NGOs and other organization are in place, iii) the farmers have a guaranteed (profitable) price, and iv) the processor receives the planned amount of fresh OFSP root supply, there is no reason to think that the price variability of OFSP will reach the level of variability seen for fresh SP roots between the peak and low seasons.

However, the following problems may arise leading to fresh OFSP root price variability:

- weak coordination;
- climatic conditions that may hamper the foreseen harvesting time or quantities in one or more counties;
- farmers that cultivate OFSP for the retailing market, and not for sales to the processor (unlikely);
- poor quality harvest, presence of too many rotten roots.

In assessing the economic feasibility of having OFSP fresh root storage facilities, one hypothesis could be that the increasing quantity of OFSP produced may induce a similar price behaviour (including high variation) to that seen for white and yellow fleshed varieties. Considering the current prices of fresh OFSP roots (ksh/kg), Table 6.5 suggests a theoretical range of price variations due to seasonality and indicates the months when there is more likely to be a reduced OFSP supply. The cells shaded in light blue indicate the likely increased price in Kabondo and Siaya if the OFSP price behaves in the same way the SP price does (in Ksh/kg).

Table 6.5 OFSP price variation between the peak and low season

	Current price (Ksh/Kg)	Price increase: <25% (Ksh/kg)	Price increase: 25%-50% (Ksh/kg)	Price increase: 50%-75% (Ksh/kg)	Price increase: >75% (Ksh/kg)	Low season months
Busia	12	<15	15-18	28-21	>21	Apr-May; Oct-Nov
Kabondo	14	<17.5	17.5-21	21-24.5	>24.5	May; Oct-Dec
Migori	NA					June-July
Siaya	~20	<25	25-30	30-35	>35	Jul-Aug

Source: Information from stakeholders and own elaboration

[34] The % of price variation per county and agents is calculated as an average of all the % variations registered per different types of sacks.

3) *Transportation*

To understand the quantity needing to be stored, it is also important to estimate the cost of transport from the collection sites at county level to the processor's facilities. The (average) road transport distances between the different counties visited are reported in Table 6.6.

Table 6.6 Average distance in km between the counties

	Homa Bay/ Kabondo	Busia	Siaya	Migori	Bungoma	Nairobi
Homa Bay/ Kabondo	-					
Busia	228	-				
Siaya	183	58	-			
Migori	73	294	238	-		
Bungoma	207	66	70	181	-	
Nairobi	358	470	403	372	408	-

Source: web maps

Considering the information received during the field visits, the overall transportation costs for a truck (~10 tonne capacity) transporting ~45-60 bags driving for ~400 km is 200-300 Ksh/bag of SP. Scaling down by half the truck capacity, i.e. considering a processor who owns a truck with 5 tonnes capacity, and calculating the price per 10 km, the transport cost per bag can be estimated at 2.5-3.75 Ksh/bag (for a distance of 10 km).
The per bag SP root transport costs from Homa Bay to different counties are illustrated in Table 6.7.

Table 6.7 Sweetpotato root transport costs from different counties to Homa Bay (per bag)

	Homa Bay/ Kabondo (km)	time (one way)	Avg costs per bag/trip* (Ksh)	Avg costs per tonne/trip (Ksh)
Homa Bay/ Kabondo	30	<1hr	7.5-11.25	45-67.5
Busia	228	4-5hr	57-85.5	342-513
Siaya	183	3hr	45.75-68.62	275-411
Migori	73	1-2 hr	18.25-27.37	110-165
Bungoma	207	4-5 hr	50-75	300-450
*considering an average 165kg/bag (prim), 1 tonne=6 bags				

Source: Information from stakeholders and own elaboration

4) *Cost of storage facility at processor level*

A range of different storage systems which could be implemented at the processor's level are reported in Table 6.8. This table considers the type of storage system (if it is a plenum chamber or an insulated tunnel), the range of storage capacities, the initial capital costs (CapEx), the maximum storage period for SP roots, their expected weight losses during the maximum storage period and the operational costs by storage period (OpEx) that includes power costs, repair and maintenance costs and labour. The CapEx figures are for the larger tonnage in the target group. The OpEx figures refer to the storage period of 4 months. The costs are expressed in USD. Key features of a plenum chamber store are shown in Figure 6.2, and insulated tunnel store types with plenum are shown in Figure 6.3.

Table 6.8 Characteristics of potential medium to large scale sweetpotato storage systems

Storage system	Storage capacity	CapEx (in USD)	Storage period months	Losses by weight	OpEx (in USD per storage period)
Plenum chamber type with cooling	Medium - 1 to 5 tonnes	8,000	4	6%	250
Plenum chamber type with cooling	Large - 5 - 10 tonnes	13,000	4	6%	280
Plenum chamber type with cooling	Large - 10 - 50 tonnes	40,000	4	6%	450
Insulated tunnel type with plenum	Large - 10 - 50 tonnes	15,000	4	6%	750

Source: A. Marchant, NRI, pers. comms., Jan 2015

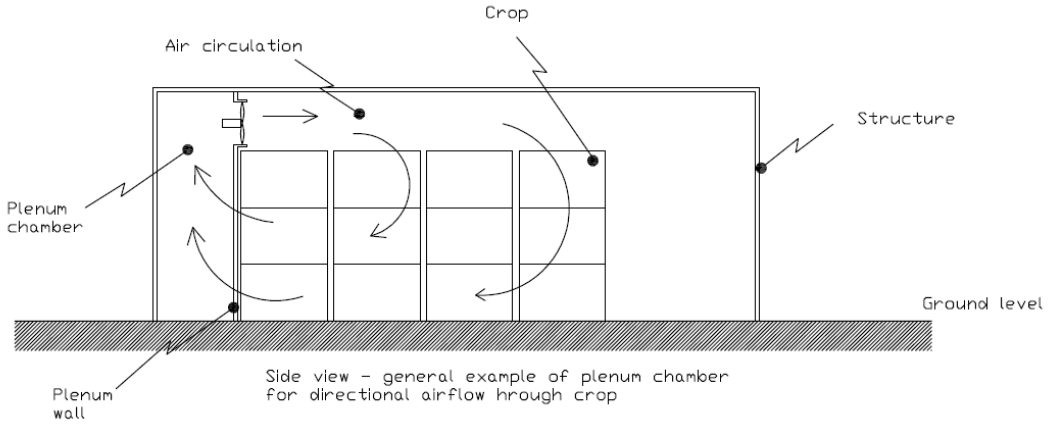


Figure 6.2 Plenum chamber store type

Figure 6.3 Insulated tunnel store types

Energy options and related prices are not analysed in detail due to the lack of information available. However, the storage facilities mainly need electricity, which may come from different sources (i.e. generator, solar photovoltaic (PV), hydro sources, etc.). As a rule of thumb, the electricity price is estimated to be 0.35times the oil price, i.e. 35c / kWh[35].

The lifespan of all the storage systems are assumed to be 15 years and the interest rate is set at 13%[36]. The annualised capital costs and operation costs per storage period are reported in Table 6.9 in USD and Ksh[37]. To ease the comparison with other type of costs, both the capital and operational costs are calculated per week. It is assumed that the storage period of 4 months is made by ~17 weeks. It is worth noting that each cost refers to the maximum storage capacity in each storage system.

[35] Estimations from Andrew Marchant, NRI

[36] The Central Bank of Kenya (CBK) has the interest rate at 8.5% while the bank interest rates on loans are higher (up to 16.5%). We have set the interest at 13% as an average between the two values.

[37] Exchange rate: 91.25 Ksh=1 USD (January 2015)

Table 6.9 Storage facilities costs

	Plenum chamber type with cooling	Plenum chamber type with cooling	Plenum chamber type with cooling	Insulated tunnel type with plenum
Storage capacity	Medium: 1 to 5 tonnes	Large: 5 to 10 tonnes	Large: 10 to 50 tonnes	Large: 10 to 50 tonnes
Equipment (in USD)	8,000	13,000	40,000	15,000
Interest costs	13%	13%	13%	13%
Life span (years)	15	15	15	15
Annualised capital cost (in USD)	1,238	2,012	6,190	2,321
Capital cost per storage period (in USD considering 3 storage periods per year)	413	671	2,063	774
Operation cost per storage period (in USD)	250	280	450	750
Capital + Operation costs per storage period (in USD considering the max storage capacity)	663	951	2,513	1,524
Capital + Operation costs per week period (in USD considering the max storage capacity)	38.98	55.91	147.84	89.63
Capital + Operation costs per week period (in Ksh considering the max storage capacity)	**3,557**	**5,102**	**13,490**	**8,179**

Source: NRI and own elaboration

To achieve the OFSP puree requirements for Scenarios 1-3, the store realistically needs to be able to hold a minimum of 1 week's root demand. Given the likely unreliability of OFSP fresh root supply during the early stages of the enterprise and the need to ensure that the processor is not let down during this critical period, it would be advisable to ensure the storage facility can hold at least 1 month's root demand.

The calculations of root storage requirement for the different scenarios is reported in Table 6.10. As for the capital costs, the calculations are assumed for the larger tonnage capacity, i.e. 5 tonnes for the first storage facilities' type, 10 tonnes for the second one, and so on. With the plenum chamber of less than 5 tonnes and the plenum chamber of 5- 10 tonnes, the holding capacity only reaches 2 weeks' worth of roots for Scenario 3. Therefore, to meet the appropriate storage capacity, the 'plenum chamber with cooling' or the 'insulated tunnel with plenum' with storage capacity of ~20-30 tonnes seem to be the most viable choices.

Table 6.10 Storage facilities and different root storage requirement scenarios

	Plenum chamber type with cooling	Plenum chamber type with cooling	Plenum chamber type with cooling	Insulated tunnel type with plenum
Storage capacity	Medium - 1 to 5 tonnes	Large - 5 - 10 tonnes	Large - 10 - 50 tonnes	Large - 10 - 50 tonnes
Scenario 1 (7.5 t/week)	0.66 week/supply	1.3 week/supply	6 week/supply	6 week/supply
Scenario 2 (10 t/week)	0.5 week/supply	1 week/supply	5 week/supply	5 week/supply
Scenario 3 (4.96 t/week)	1 week/supply	2 week/supply	10 week/supply	10 week/supply

Source: NRI and own elaboration

The analysis of the convenience of storage facility at processor level is illustrated in Table 6.11. The analysis is carried out in OFSP requirements/week.

Considering the price assumed (14 Ksh/kg) and the quantity of fresh OFSP roots needed in each Scenario, the costs of fresh roots provision per week are 105,020 Ksh, 140,026 Ksh and 69,458 Ksh for Scenario 1, 2 and 3, respectively. A price increase of 20% due to seasonality translates into an increase of the weekly costs for the processor from 14,000 Ksh (Scenario 3) to 28,000 Ksh (Scenario 2).

The storage costs per week depend on the type of storage facility: the costs for the plenum chamber with cooling are Ksh 13,490 while the costs for the insulated tunnel with plenum are Ksh 8,179. It is worth noting that the cost per week refers to the maximum storage capacity of 50 tonnes in each storage system, and is based on the assumption of a 17 week (~4 month) storage period. If the processor builds a storage facility of a smaller tonnage than 50 tonnes, the capital costs, and therefore the capital costs per week, are likely to be lower.

As can be seen from Table 6.11, even with a minimum price increase of 20% it is worth the investment in storage facilities, as the weekly cost to buy fresh roots in low supply season are higher than the weekly storage costs for both types of facility. Only in Scenario 3, the insulated tunnel with plenum has almost the same weekly costs of a 20% price increase of the supply of OFSP per week.

Table 6.11 Cost analysis of storage facilities and different puree requirement scenarios

		Scenario 1	Scenario 2	Scenario 3
OFSP requirements	OFSP fresh roots requirement per week (t)	7.50	10.00	4.96
	Price per kg (assumption) (Ksh)	14	14	14
	Cost of OFSP per week (Ksh)	105,020	140,026	69,458
Storage facility costs	Plenum chamber type with cooling per week (in Ksh considering the maximum capacity of 50 t)	13,490	13,490	13,490
	Insulated tunnel type with plenum per week (in Ksh considering the maximum capacity of 50 t)	8,179	8,179	8,179
	Losses per storage period	6%	6%	6%
Price variation range	Increase of 20% of the weekly cost during low supply (Ksh)	21,004	28,005	13,892
	Increase of 67% of the weekly cost during low supply (Ksh)	70,363	93,818	46,537
Cost of transportation per full capacity (Ksh/5 t)	Kabondo	281	281	281
	Busia	2,138	2,138	2,138
	Siaya	1,715	1,715	1,715
	Migori	688	688	688
	Bungoma	1,875	1,875	1,875

Source: Information from stakeholders and own elaboration

During the high supply season, however, this advantage can vanish considering that the processor has to continue paying the storage facility (Table 6.12).

Considering a price increase of 20% for 5 months per year, the cost of the plenum chamber with cooling with the maximum storage capacity of 50 tonnes is no longer economically viable while the costs of the insulated tunnel with plenum is still a worthwhile investment for Scenario 1 and 2. If the processor would like to build a storage facility of less than 50 tonnes, the capital costs, and therefore the capital costs per week, are likely to be lower, and therefore the economic convenience of having the plenum chamber with cooling may increase.

A storage facility could also help in reducing the processor's transport costs, as the root collection truck could travel less frequently but with a full load with any surplus roots not immediately required for processing being placed into the store.

Table 6.12 Cost analysis of storage facilities and different puree requirement scenarios per year

		Scenario 1	Scenario 2	Scenario 3
Storage facility costs	Plenum chamber type with cooling per annum (in Ksh considering the maximum capacity of 50 t)	674,505	674,505	674,505
	Insulated tunnel type with plenum per annum (in Ksh considering the maximum capacity of 50 t)	408,937	408,937	408,937
Price variation range	Increase of 20% of the annual cost of OFSP roots considering a lower supply season of 5 months (Ksh)	437,582	583,443	289,406
	Increase of 67% of the annual cost of OFSP roots considering a lower supply season of 5 months (Ksh)	1,465,901	1,954,534	969,511

Scenario 4 envisages the production of 9.8 tonne of OFSP puree per day to supply 52 of the supermarkets shops after an initial 2 year OFSP puree introductory period. Based on the calculations in Table 6.2, this requires the availability of ~14 tonnes of fresh OFSP roots per day corresponding to ~5,000 tonnes of roots per year, under the hypothesis that OFSP puree will substitute 30% of wheat flour in bakery products and the amount of wheat processed is 630 kg per day per shop.

Considering as a benchmark of our analysis the OFSP average yields in Busia (~3.6 tonnes/acre/cycle (see "Fresh OFSP root supply" sub-section in 6C), the OFSP puree production for 52 shops will require >700 acres per year under OFSP cultivation.

One of the challenges of Scenario 4 is the expansion of processing activities. If the average processor's size is suitable to meet the OFSP puree demands of 4 of the supermarket chain's shops, then a total of 13 of these scale processors would be required to meet the OFSP puree demands of

52 shops. The storage facilities could be replicated for each processor, as discussed in the previous section.

Alternatively, a smaller number of processors may be required if their production capacity per unit of processing could be increased and their storage capacity accordingly, or a village or county level storage facility could become part of the system (see Box 6.3 which provides a brief overview of SP fresh root pack-house and storage facility which is being constructed in Kericho County to help farmers in supplying high quality SP roots for a small export market to the UK (see section 3F of this report)).

Considering the high transportation costs and the likely need in Scenario 4 to manage the OFSP puree supply from different locations of processors and to different locations of final shops, it may become efficient for the supermarket chain to develop in-house processing activities and storage. This recommendation is not based on calculations but on the considerations that investments in processing activities may be justified by the high volume of OFSP puree and the need for a reliable daily supply of OFSP puree, although the transport costs of the roots from producing area have to be taken into account.

At the moment, we do not have the costs for storage facilities able to contain more than 50 tonnes of OFSP. As demand increases, well-managed stores of more than 50 tonne capacity may be needed at village or county level.

Considering the calculations for the storage facility at processors' level, it can be reasonable to assume that the costs for a larger storage facility of >50 tonnes could be lower than the seasonal price increase of the fresh SP roots and that the storage facility may benefit from the 'storage fee' paid by farmers and/or processors willing to store their fresh SP roots.

Box 6.3 Brief overview of proposed Kericho SP fresh root pack-house and storage facility

The MoA (Ministry of Agriculture) in Kericho County is actively involved in different SP promotion initiatives, such as the building of a SP pack-house in Sigowet sub-county for the farmers who have begun selling SP roots to SACOMA for export to UK. Initial building design work for the structure of the Kericho county government SP pack-house facility has been undertaken (see Figure 6.4). Further work is planned for the internal items. This facility will have a capacity of approximately 6 tonnes of SP, with packing and quality control (QC) areas. Since the site will have both electricity and water it offers the potential to be a test bed for certain aspects of the storage work prior to the off-grid versions suitable for more remote areas. Ksh 2.5 million has been set-aside by the Kericho County Government for construction of this SP pack-house. It is early days for the export operation, and so it is currently uncertain how much root storage this facility will undertake and for what length of storage periods.

As the export operation progresses a relationship with the farmers/suppliers will be built up, and as output increases so will the need for root storage. This is likely to be best done close to farmers, and satellite stores operated by a well-trained producer might be set-up to act as storage hubs and help regulate root supply to the exporter.

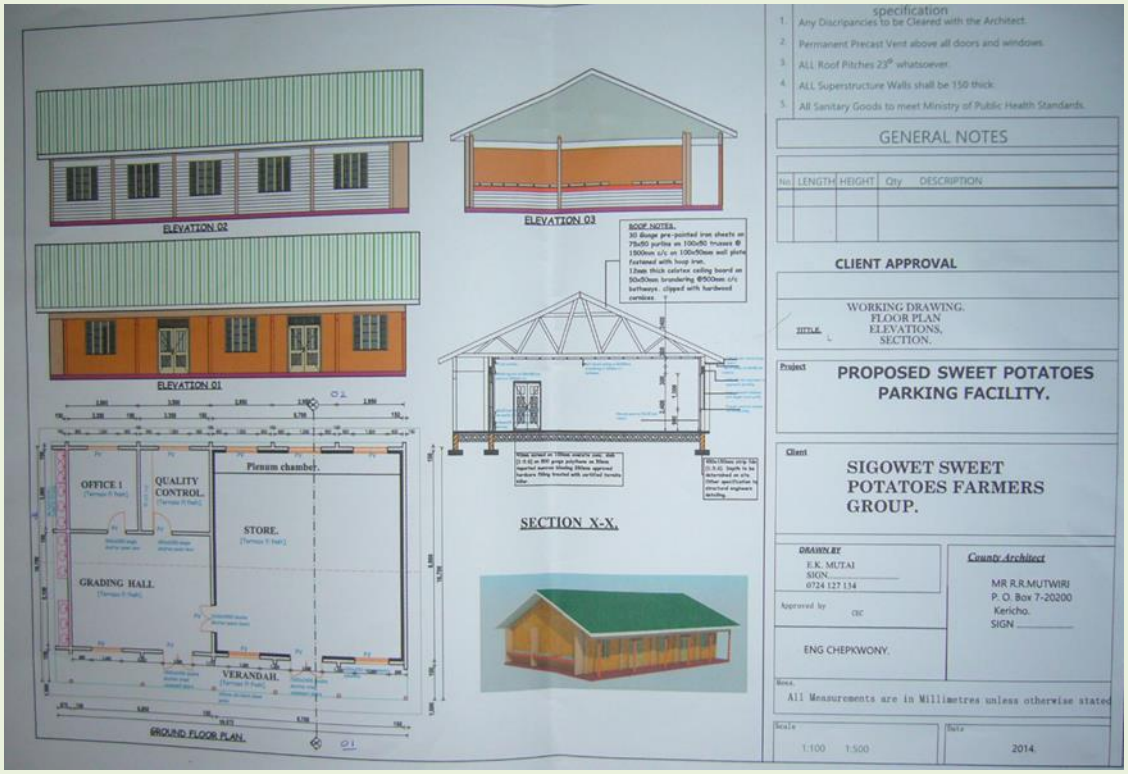


Figure 6.4 Plan of Kericho County SP fresh root pack-house and storage facility

7. Conclusions

The sweetpotato (SP) value chains have been investigated in five counties of the former Western, Nyanza and Kericho provinces, and the three major urban centres of Kisumu, Nakuru and Nairobi. There are differences between the five SP producing counties (Busia, Homa Bay - Kabondo area, Siaya, Migori and Kericho) in terms of: their climatic and socio-ecological features; the role SP plays in their food systems; the scale of SP fresh root trading which occurs; whether the farmers cultivate orange-fleshed sweetpotato varieties (OFSP) or not; and the presence of OFSP processing-related activities. In the three major urban centres, the main differences were related to their food systems and the role of SP within them, their population sizes, and the trade volumes and business margins of the traders and retailers involved in the SP value chain.

Sweetpotato roots are harvested almost all year round in the focal producing counties, where the crop is typically planted twice per year with farmers accessing SP planting materials from one of their own or a neighbour's plot, usually for free. Planting material shortages were not mentioned by farmers. The SP crop is rotated with maize, groundnuts or beans to help reduce weevil damage and manage soil fertility. The peak and low SP supply seasons occur sequentially in different locations making it fairly straightforward for traders to access fresh SP roots throughout the year. Traders also rely on sourcing cheaper SP roots from Tanzania via the Sirare border area during periods when the supply from Kabondo or elsewhere is low. Fresh SP roots with red skins and yellow flesh, produced in Kabondo are generally viewed as the most delicious SP roots by urban consumers and traders in Kenya, and fetch higher prices than similar looking roots from Tanzania. Although some urban consumers prefer to purchase SP roots which have been grown in the county they originate from.

The highest profits per acre (per cycle) for SP and OFSP roots and OFSP vines are reported in Busia (Ksh 12,800-54,000 SP roots; Ksh 32,000-45,000 OFSP roots; 22,000-48,000 OFSP vines), followed by Kericho (Ksh30,000-40,000 SP roots) and Kabondo (Ksh 10,000-20,000 SP roots; Ksh 20,000-25,000 OFSP roots; Ksh12,000 OFSP vines). The farmers in Siaya reported much lower profits and smaller production areas per farmer.

Limited amounts of OFSP are cultivated in the focal counties, despite service providers in Busia having promoted various OFSP varieties for more than 10 years. The low uptake by farmers is reported to be due to limited and often unreliable markets for OFSP roots or products, with the exception of OFSP vines which are currently highly profitable and bought by Government and NGO relief or development projects to distribute to different areas of the country. Some characteristics of the released OFSP varieties have not been attractive to farmers, e.g. poor taste, roots turning to slush when boiled. These findings suggest the need for closer work between breeders and rural consumers/producers, on postharvest characteristics such as cooking qualities, taste, in-ground storability, and shelf-life if household consumption of Vitamin A rich fresh OFSP roots is to be increased, in addition to consumption of OFSP roots in processed forms. Currently the main OFSP varieties being promoted are Kabode and Vita.

Where OFSP varieties are cultivated (e.g. in Busia, Kabondo and Siaya), the farmers involved report that they give higher profits per acre (per cycle) than the traditional white or yellow-fleshed SP varieties. In Busia, the reported yields for OFSP varieties are 4.5 tonnes/acre/cycle during the peak season, and 2.2 tonnes/acre/cycle during the low season, while in Kabondo and Siaya the OFSP yields lower to 2.3 tonnes/acre/cycle and ~1 tonnes/acre/cycle, respectively.

Large quantities of yellow-fleshed red-skinned SP roots are traded from both Kabondo and Migori. Farmers may harvest and deliver their SP roots to the roadside collection area by donkey load or motorbike, or brokers may arrange the root transport from the farmer's field. The farmers are mainly paid on a per sack basis, after the broker or trader has separated the different sized roots and discarded any weevil damaged roots; a much lower price is paid for the small or cut roots than for

the medium and large sized roots. The sack sizes vary substantially by location and at different stages along the value chain, making it complex to compare prices. On reaching the roadside the sacks of roots are typically poured onto the ground or into a drum of water and then trampled on by the root washing lady to remove the soil from them. Parts of the skin are also removed during this washing process, and the roots are then tossed onto the ground to allow some of the water to evaporate while they are sorted by size and damage, and then tightly packed into the trading size of sack (usually an extended Prim size (~adult head height), or a Bao size (two and a half times the length of a 90kg capacity maize sack, and requiring 4 strong young men to lift it)). These sacks are then sewn closed, and heaved into the back of trucks headed to Nakuru or Nairobi. The trucks have delivered goods to Kisumu, Uganda or Tanzania and then use their empty backhaul space to transport the sacks of SP to the urban markets. The road journey is likely to take 6-8 hours and then the sacks overnight in the truck before being delivered at 5am to the wholesale market.

The wholesaling/trading activities in Kabondo appeared to be the most profitable amongst all the rural areas visited due both to the large volumes of sacks traded (Kabondo is well-known throughout Kenya as a major producer of SP), and the high margins per sack. The trading system in Nairobi is the most complex one, considering the numerous different sack dimensions and root types, and the various different geographical sources of SP used. The traders in the Nairobi market were also likely to gain the highest annual profits among the different traders due to the large number of sacks traded. The SP trading process is now highly dependent on mobile phones for brokers and traders to plan their requirements and dates, to link up with transporters with empty trucks, and for urban based traders to send money by M-PESA, to brokers who withdraw the funds as cash for root purchasing and washing and packing costs, or to transporters. Mobile money is also used by traders who travel from the rural areas to urban centres and back so they can avoid travelling with large amounts of cash.

On arrival in the urban market, the sacks of SP are mainly sold to retailers from nearby markets. The retailers sell the fresh SP roots to urban consumers in piles. The price per pile does not vary much during the year; what changes is the number of SP roots per pile to help the retailers maintain their profit levels during the low supply seasons. The SP trading chain functions smoothly despite the perishability of the crop, and the complexity of price variations, range of sack sizes and numerous sourcing locations; traders and retailers view it as a profitable and good business to be in and expect the demand for SP roots in urban centres to keep increasing due to urbanisation, population growth and the fact SP roots are a comparatively cheap, easy to prepare, filling and healthy food.

The price variation of the traditional yellow or white fleshed SP roots between the peak and low supply season changes by agent and county: the buying price varies by up to 9% in Kisumu and up to 67% in Kabondo and Nairobi, while the average % variation of the selling price is generally lower.

In contrast, the buying price of fresh OFSP roots has to date not varied during the year in the three focal counties where OFSP is produced. In Kabondo the OFSP fresh roots are sold by the farmers to an OFSP flour producing Cooperative at 14 Ksh/kg all year round, and in Busia to an OFSP flour and dry chip processor at 12 Ksh/kg. The trader in Siaya paid the farmers Ksh2,000/ flat-sized bag of fresh OFSP all year round (~20Ksh/kg).

Consumers select SP roots based on their size, freshness, colour, absence of damage, washed skin. Most of the consumers interviewed preferred to eat the traditional yellow- or white- fleshed SP varieties as boiled roots, mainly for breakfast. They said they provide a tasty, cheaper, healthy and more filling alternative to bread. Campaigns to encourage increased consumption of locally produced unprocessed foods such as SP roots were reported. However, despite this retailers and consumers felt that SP root consumption declines as household income rises.

In this study's focal locations OFSP consumption currently appears to be more popular when the roots are incorporated into processed products as opposed to being taken in a boiled root form (as occurs for the traditional white or yellow fleshed SP varieties). OFSP production and processing is

happening on a very small-scale, with one processor in each of Busia, Kabondo and Siaya processing the OFSP roots into OFSP flour or composite flour. A few individuals in these locations are also using OFSP roots in preparing chapatis, mandazi, onion bites, crackies, crisps and bread etc. No evidence of processing of the traditional yellow or white fleshed SP varieties was found during the study.

Building on the Rwandan Superfood project in which a private company has successfully incorporated OFSP puree into biscuits and mandazi, and is still working on producing an OFSP – based juice, similar business opportunities were being sort by the 'Scaling up sweetpotato through agriculture and nutrition' (SUSTAIN) project in Kenya. An exciting business opportunity to produce OFSP puree for inclusion in bakery products in one of Kenya's large supermarket chains has recently been agreed.

An OFSP puree processing enterprise with a guaranteed market will still face various challenges, including: access to a year-round supply of fresh OFSP roots; need for strict adherence to food safety protocols; skilled management and staff; access to stable and sufficient power and water supplies; and transport issues from the processor's site to the Nairobi area.

The high likelihood of unreliability in the constancy of OFSP fresh root supply, especially during the early stages of the enterprise, the potential risk of high root purchasing prices during the low supply seasons, and the need for control over the quality and quantity of fresh OFSP roots suggest that a fresh root storage facility at the processor's site might be strategic. Although the constancy of the OFSP supply could also be managed through well-organised staggered OFSP planting of producers (including if necessary the use of swamp/wetland areas), allowing a pre-planned quantity of roots to be purchased throughout the year. Care also needs to be taken to support OFSP producers access to other OFSP market opportunities in case the puree business dimensions do not reach the foreseen levels.

A comparison of the weekly costs of various SP fresh root store types (mainly different sized plenum chambers with cooling or insulated tunnels with plenum), factoring in the potential extra costs of having to purchase higher priced OFSP roots during the low supply seasons in various scenarios differentiated in terms of puree demand, showed the economic convenience for an OFSP puree processor of having an (appropriately dimensioned) fresh SP root storage facility. A storage facility could also help in reducing the processor's transport costs, as the root collection truck could travel less frequently but with a full load with any surplus roots not immediately required for processing being placed into the store.

Once the puree requirements and the processor are confirmed, a specific business analysis and design of each of the puree processing activities should be undertaken. This will include identifying a suitable fresh SP storage facility of the appropriate dimensions for the environmental conditions at the processor's site to optimise its economic viability.

No commercial SP fresh root stores yet exist in the study's focal counties, however the Kericho County Government is investing Ksh2.5 million in a SP pack-house for sorting, washing and packaging traditional yellow-fleshed SP roots intended for a nascent export market to the Kenyan diaspora based in the UK. In 2014, 9 tonnes of fresh SP roots were exported through this value chain. The facility's plan includes a store room but it is uncertain at this stage what level of utilisation of this store will occur, especially as root freshness is such an important characteristic for Kenyan fresh SP root consumers. If fresh SP root storage was found to work well and the stored roots were acceptable to urban Kenyan consumers, allowing fresh SP root storage to play a role in enhancing SP producers' livelihoods, it is possible that other County's would also invest in such stores. As stakeholders reported that since the devolution process a higher proportion of resources were being targeted to tangible investments such as buildings as opposed to agricultural training. However, significant harvest and postharvest handling and storage training would be required by SP producers and store managers for successful fresh root storage.

The stakeholders interviewed felt that a fresh SP root storage facility at local level might bring a diverse range of advantages to their SP value chains, in terms of: opportunities to bulk and store SP roots to help access larger markets and better prices; motivating producers, traders or processor into practicing improved postharvest handling; driving a change from the use of volumetric sacks to per kg sales of SP roots; ensuring a constant supply of roots to a processor; enhancing local food security; avoiding weevil and mole rat damage and root quality deterioration which occurs when mature SP roots are left in the ground. Perceived problems included: additional storage costs making the roots too expensive; no/low market demand for stored fresh roots; weak store management leading to root quality deterioration and losses or theft; short shelf-lives of some varieties rendering them unfit for storage of more than 1 week; farmers need for instant cash returns from SP production making storage an unattractive option to them.