Global Initiative
on Food Loss and Waste Reduction

Case Studies in
Small-scale
Agriculture and
Fisheries Subsectors

FOOD LOSS ASSESSMENTS: CAUSES AND SOLUTIONS

Kenya

BANANA
MAIZE
MILK
FISH

GLOBAL INITIATIVE
ON FOOD LOSS AND WASTE REDUCTION
- SAVE FOOD -

Food Loss Assessments: Causes and Solutions
Case Studies in Small-scale Agriculture and Fisheries Subsectors.

KENYA
Banana
Maize
Milk
Fish

FOOD & AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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INTRODUCTION

Food losses refer to the decrease in edible food mass throughout the different segments of the food supply chains – production, postharvest handling, agro-processing, distribution (wholesale and retail), consumption. Food losses and their prevention have an impact on the environment, food security for poor people, food quality and safety, and economic development. The exact causes of food losses vary throughout the world and are very much dependent on the specific conditions and local situation in a given country.

During the recent decades numerous studies have been undertaken to assess the quantities of food losses and food waste in many countries of the world. Most of these studies were conducted at national level, and based on literature review, statistical data, and stakeholder interviews.

The research revealed the knowledge gap: we have quantitative estimations of food losses, we know the causes of food losses, and we know that food loss reduction will be of great benefit to all actors in the food production and supply chains, to food security for poor people, and to the environment. However, we don't know yet which causes of food losses are the most important, what is the impact of solutions and which solutions are viable and cost-effective, in economic, environmental and food security terms. Meaning: the solution to food loss should not be more expensive than the food loss itself, should not place a higher burden on the environment and greenhouse gas emission, should make more food available to the people that need it most, and should be socially and culturally acceptable.

Therefore the 'food supply chain' case studies have been designed, for the most important food subsectors in developing countries. In these case studies primary and empirical data will be generated for the different causes of food losses, and solutions for food losses will be analysed for their feasibility.

A case study is just a one-moment recording of what is happening in a specific food supply chain in a specific season; next season and in a different location the situation can be very different again. Therefore it is important that many case studies in many different locations can be undertaken, so that the multitude of study results provide significant trends and solutions. Further, the strategy aims at using the results of the case studies to target opportunities for investment programmes and interventions, during which formulation a wider geographical scope and the seasonality will be analysed.

> *The objective of this study is the identification and quantification of the main causes of food losses in the selected food supply chains, and the analysis of the measures to reduce food losses on their technical and economic feasibility, social acceptability and environmental impact, leading to concrete proposals to implement a food loss reduction programme.*

Implementation methodology[1] of the field studies.

1. Selection of countries and subsectors.

   Countries and subsectors are based on existing and on-going programmes to work with, and collaboration with partners in the field. Subsectors are chosen from the important food commodities in the country: cereals, roots & tubers, fruits & vegetables, oilseeds & pulses, animal products (meat, milk, eggs), fish & seafood.

2. Identification of consultants.

   The field work will be done by a team of two or three national consultants: one subsector specialist, who could be an actor in the food supply chain, one agricultural economist, and one rural sociologist.

3. Selection of Food Supply Chains.

   - based on smallholder producers;
   - significant scale of food production;
   - preferably including agro-processing and urban market;
   - if possible, included in an on-going support programme for the subsector.

4. Uniform Methodology.

   The methodology of the case studies need to be uniform for all countries, so that the results are comparable and extrapolation is possible. The methodology has been developed specifically for this purpose and will be published and promoted among other Save Food partners. It is based on four ('S') elements:
   1. Preliminary Screening of Food Losses ('Screening').
   2. Survey Food Loss Assessment ('Survey').
   3. Load Tracking and Sampling Assessment ('Sampling').
   4. Monitoring and Solution Finding ('Synthesis').

   The consultants will physically follow the product during 4 weeks, from production site to final retail outlet, make direct observations and measurements, and discuss with supply chain actors the causes and solutions for food losses. The consultants draft a proposal for a food loss reduction strategy or plan.

5. Stakeholder Validation

   In a one-day workshop with stakeholders from public and private sector the study results and proposed food loss reduction strategy are being discussed and endorsed. A concept for a programme to finalize and implement the food loss reduction strategy or plan is prepared.

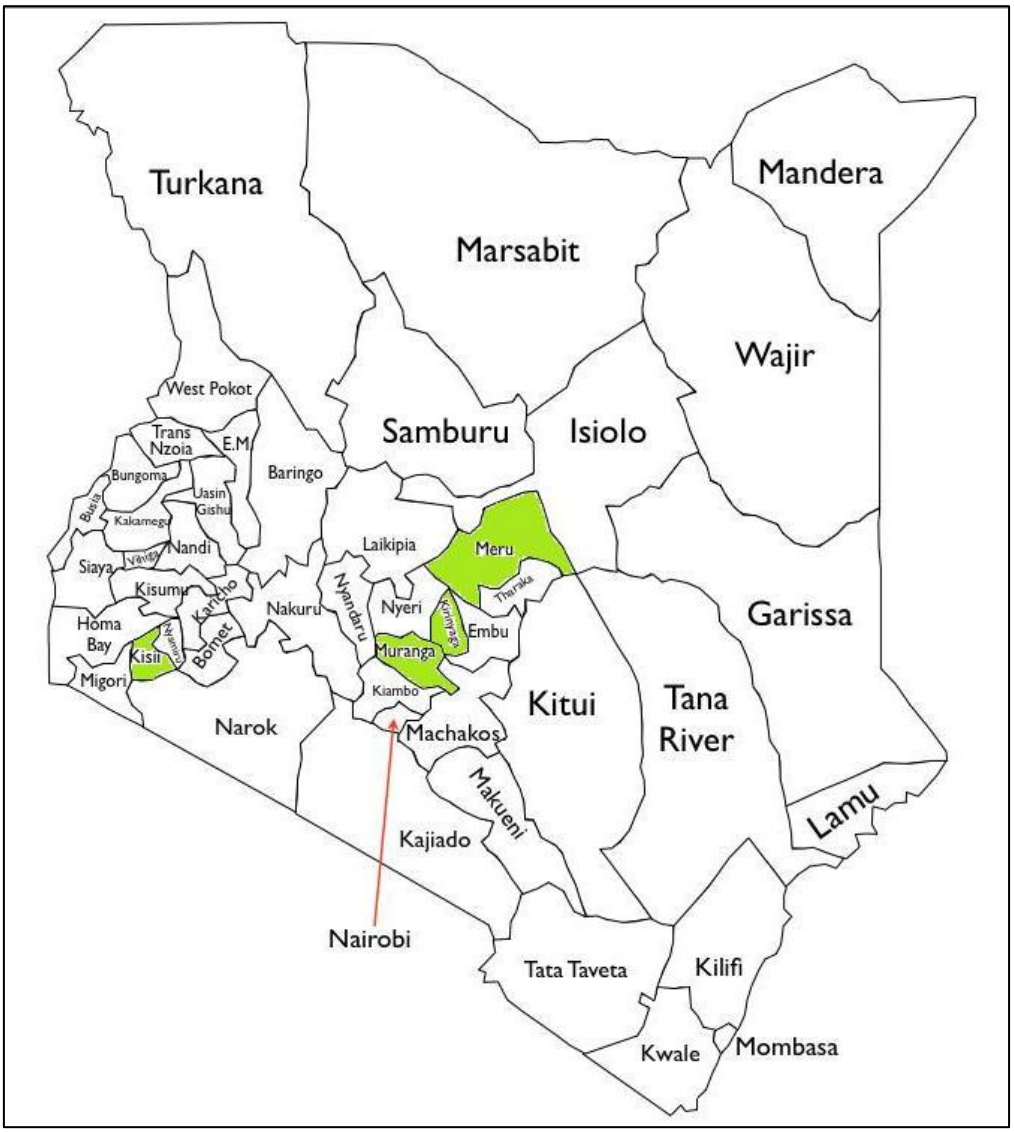
[1] Based on: Post-harvest fish loss assessment in small-scale fisheries. FAO Fisheries and Aquaculture Technical Paper 559. FAO 2011.

I.

BANANA

Field studies in Murang'a, Kirinyaga, Meru, Kisii Counties

August – October 2012



Josephine Natecho Simiyu

James Paul Kamau Njugu

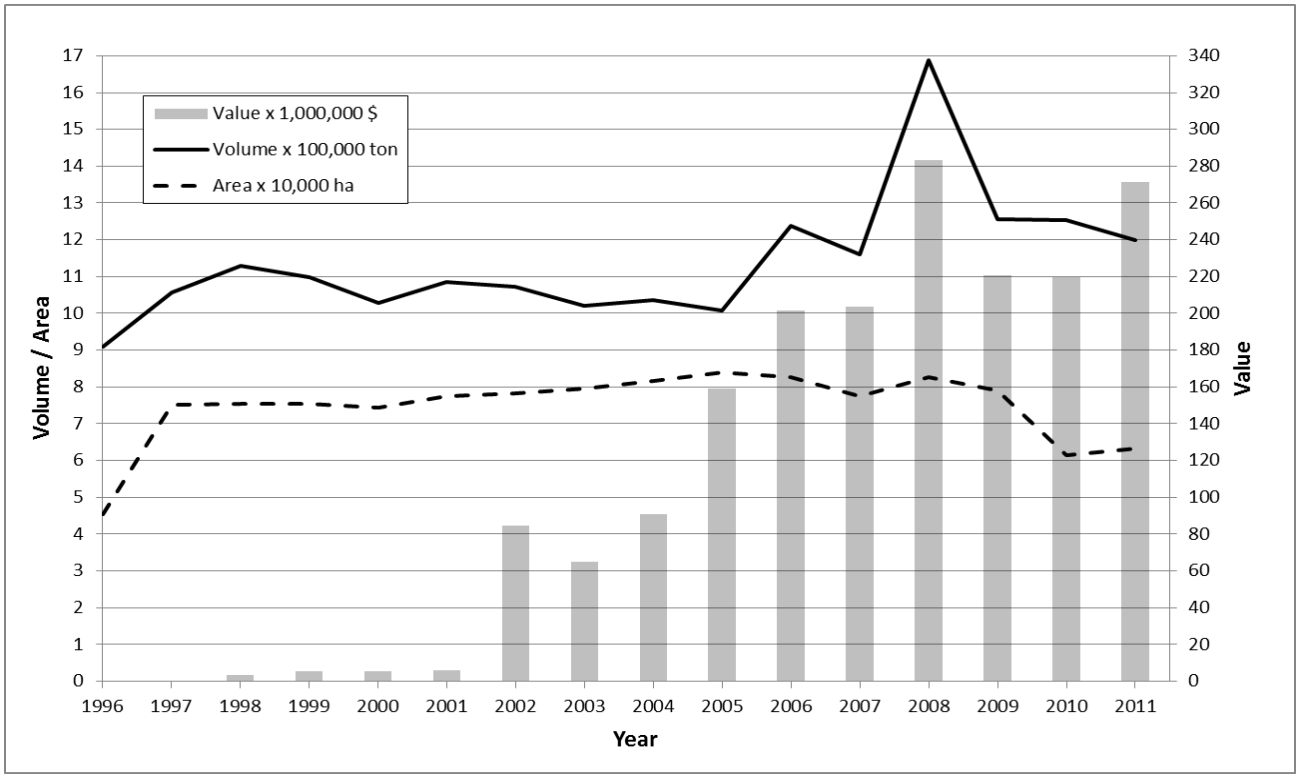
Horticultural Crops Development Authority

1. The Banana Subsector- Introduction and Background.

1.1 Status and importance of the subsector.

Small scale farming dominates the banana sub-sector with an estimated 390,000 farmers grow bananas, the majority of whom are women and 500,000 are believed to be directly involved in the business. Bananas occupy an average 0.21 hectares under a mixed cropping pattern. Mixed banana varieties are grown mainly under rain fed conditions. Prices are lowest in October, November, January and February when demand shifts to mango and avocado (October-December) and highest in August and September. The banana supply chain in the country is complex and inefficient and it is estimated that 95% of the bananas sold are grade two bananas, handled by street vendors and retailers in residential areas with 5% sold to supermarkets and other institutions (Kinyua 2008).

Figure 1. Banana production: cultivated area, volumes and value.



The area under bananas has remained relatively steady over the last 14 years (Fig. 1) after recovering from a sharp decline in 1996 due to a Panama disease outbreak. Value of production has steadily risen since 2007 whilst production has ranged from 0.9-1.6 million tons over the period. Available data lumps cooking and dessert bananas together but TechnoServe (TNS) estimates that 60% of banana production is the cooking variety and 40% are dessert bananas with Gros Michel accounting for 5% of the dessert bananas. The major production areas are Meru, Tharaka Nithi, Kirinyaga, Embu and Kisii counties.

In Kenya, annual postharvest losses in fresh horticultural crops like bananas are estimated at more than 50 % by IITA (2010) and at 18-45% by Kitinoja and Cantwell (2010), due to poor storage and handling (Mashau *et al*, 2012); however, there is a general lack of data on losses at specific points in the value chain. KARI estimates losses of bananas to be 25% attributed to diseases, harvesting and post-harvest handling though quantification of the specific causes was not done (Muchui *et al*, 2010).

There are two main banana products in Kenya- dessert or fruit bananas and cooking or plantain bananas, with different geographic origins; desert bananas originate in the central provinces viz. Kirinyaga, Murang'a and Meru, whilst plantains are mainly produces in western Kenya e.g. Kisii.

Bananas are important as both a source of income for farmers, and cooking/ plantain bananas are a basic staple food crop for many communities, especially in western Kenya and in many urban centres. Dessert/ fruit bananas are a major fresh fruit consumed by all population groups. . Bananas account for 36% of the fruit produced in the country, and 11.1% of the total value of domestic horticulture. Farmers earn USD 148 per year, contributing to 30-70% of house hold income. The subsector employs approximately 500,000 people. Foreign exchanges earnings by export however is not significant.

Table 1. Production information of the banana subsector.

NATIONAL – from small scale producers	**Figures**	**Remarks**
Nr of small scale producers	390,000	
Plantain banana volume (ton/year)	781,000	The estimated percentage of plantains is 60% (TNS). The volume is determined on this premise. The figures are an average over the last 10 years.
Plantain banana value (USD/year)	154 million	
Dessert banana volume (ton/year)	520,000	The estimated percentage (TNS) is 40% with Gros Michel Variety being 5% of this value.
Dessert banana value (USD/year)	117 million	
Level of processing operations (S, M, L)	small	Based on consumer demand and lack of awareness on processed banana products, processing is very low. The main products available are crisps
Level of trading/ wholesale operations (S, M, L)	small – medium	Exact numbers of traders is not known.
Level of retail operations (S, M, L)	small – medium	Retail operations are done by hawkers (ripened bananas), hotels, makeshift kiosks, supermarkets

1.2 Inventory of activities and lessons learnt from past and on-going interventions.

Produce handling facilities.

There have been several farm level projects funded by government and donors to construct produce handling facilities to minimize post-harvest losses. However, almost all facilities are idle as the target farmers never expressed interest in using them . Several traders have been approached to use the facilities but they cite the high cost of handling as outweighing the expected benefits. It is clear from traders' responses that post-harvest losses are not experienced at the farm level as is claimed by many authors. Post-harvest losses are mainly experienced by traders as they transport horticultural produce from the farm level to their sales points where the produce is held.

There are other handling facilities initiated by donors at the farm level or in urban centres in production areas that are later given to farmers groups to run with a pre-set model from the sponsors. Most

of these models increase the cost of produce making the produce handled at the facilities too expensive to compete in the same markets with produce handled using traditional methods. After some time in operation, the farmers realize lower margins than their neighbours using roadside markets/ bulking centres. Farmers face a dilemma on whether to sell to traders offering better prices and paying cash on the nail, or to their groups who offer lower prices and delay payment.

Processing is cited in many studies as a way to minimize post-harvest losses and as a means to increase farm income. There have been efforts by government programs to promote processing facilities at the farm level; these facilities are underutilized with most farmers citing lack of raw materials. Processed products have a very limited market and are expensive compared to competing products which are often of higher quality. It is evident that farmers in most production areas have not bought into the idea of processing. The quest for value addition is futile when the economics of the operation are doubtful.

Most post-harvest losses are experienced at the selling points mainly in urban centres where there are inadequate produce handling facilities to maintain a reasonable temperature for optimal shelf life, and as a result produce that was of good quality ends up deteriorating and eventually being thrown away.

Post-harvest training.

There have been many initiatives at farm level by various parties to build the capacity of small scale farmers to improve post-harvest handling. Due to these efforts, very good produce leaves the farm but unfortunately these same practices are not followed by traders who handle the produce in large volumes, for longer periods. There should be shift of focus from capacity building of farmers on post-harvest techniques to the traders who take the highest risk of bulking, transporting, ripening and selling the produce in urban areas.

1.3 Policy framework or national strategy.

Horticulture Policy in Kenya.

In November 2011 a national Horticulture Policy was put in place with promotion of domestic horticultural marketing as a major thrust. The policy interventions that are relevant to food handling but not specific to bananas which may minimize food losses are: i)the management and regulation of markets will be harmonized and streamlined; ii) relevant ministries, local authorities and other public institutions will enforce laws and regulations that ensure adherence to safety, hygiene and other standards; iii) government will facilitate training in recommended best practices in pre- and post-harvest handling, packaging and transportation; iv) government will improve wholesale and retail outlets for fresh produce; and v) involve private sector in provision of appropriate transport for fresh produce.

1.4 Relevant institutions and their roles.

The Kenya Agricultural Research Institute (KARI) is the national research organisation that develops research programmes and technologies for food crops, industrial crops and livestock. In 1996, KARI together with ISAAA, introduced tissue culture technology in response to the decline in banana production due to Panama disease. It introduced Farmer Field Schools for TC technology dissemination and transfer to address the lack of clean planting material and enhance farmers' capacity on the technology. KARI also introduced a ripening chamber to reduce losses farmers incurred during ripening attributed to bruising and prolonged ripening periods.

Technoserve (TNS) is an international organisation focusing on developing entrepreneurs, building businesses and improving the business environment. Under its Agribusiness and Agriculture Programme, it works with rural communities to develop their business skills and their access to mar-

kets. Their involvement with the banana supply chain began in 2003 with the adoption of TC bananas in Kenya and ended in 2010. TNS began a project to improve the quality and supply chain of bananas in Eastern and Central Kenya. They mobilised banana producer groups and conducted training with the objective of shortening the supply chain and getting better prices for farmers. They set up 6 strategic market centres with facilities for handling bananas in Meru, Embu and Murang'a counties where farmers would bring their produce for traders to collect and transport to the market. Although the centres were meant to link buyers and farmers directly, the facilities still remain under-utilised; farmers are still selling to middlemen who bulk by the roadsides because they say the centre prices and farm gate prices are the same yet they have to meet transport costs to the centre.

The Ministry of Agriculture (MoA) has identified the banana supply chain as a priority crop for intervention under the SHOMAP programme which began in 2007, financed by a loan of USD 23 million from IFAD. The seven year programme covers eight of Kenya's 35 horticultural districts. In the implementing districts, banana were identified as a priority crop. The districts conducted a value chain analysis on bananas and identified losses in the cooking and dessert supply chain, although quantification of losses was not done. Based on the analysis some farmer groups have been funded to start small scale processing of banana products. However, the volumes handled by the groups are small. The project also intends to upgrade market stalls to improve the handling of bananas. The stalls are meant to integrate the banana value chain and create direct linkages.

The Kenya Industrial Research and Development Institute (KIRDI) is mandated to undertake research and development in all industrial and allied technologies among them food processing technology. The institute has set up a KES 23 million modern processing plant as a pilot project for processing banana products among others as a way of transferring technology to farmers. The facility can process raw materials into flour, crisps, juice, and wine. A group called Nyangorora banana processor is currently using the facility to process bananas into crisps and flour. Although the facility has the capacity to process approximately 2.6 tons per day, the group processes only 300 kg per day because the supply the raw material from their members is low.

The Banana Growers Association of Kenya was officially launched in December 2009 by the Kenya National Federation of Agricultural Producers with support from TNS and the Alliance for a Green Revolution in Africa (AGRA). It was formed as a platform for banana farmers to improve adoption of modern technology, influence policy, and for information sharing and networking. However, the Association has been inactive due to lack of administrative infrastructure and funds to drive the recruitment process..

The Horticultural Crops Development Authority (HCDA) is a regulatory agency mandated to develop, coordinate, and promote the horticultural sector. In order to give direction to the industry, HCDA spearheaded the development of the Horticulture Policy to provide a regulatory framework under which all horticultural crops are grown and marketed. In a bid to reduce post-harvest losses in horticultural crops, the Authority with funding from the Japanese Government put up seven produce handling facilities to be used by small scale farmers in handling fresh fruits and vegetables. However, farmers have shied away from using the facilities even in the banana growing zones. For example, there is a roadside banana collection point about 100 meters from the Kariene depot in Meru.

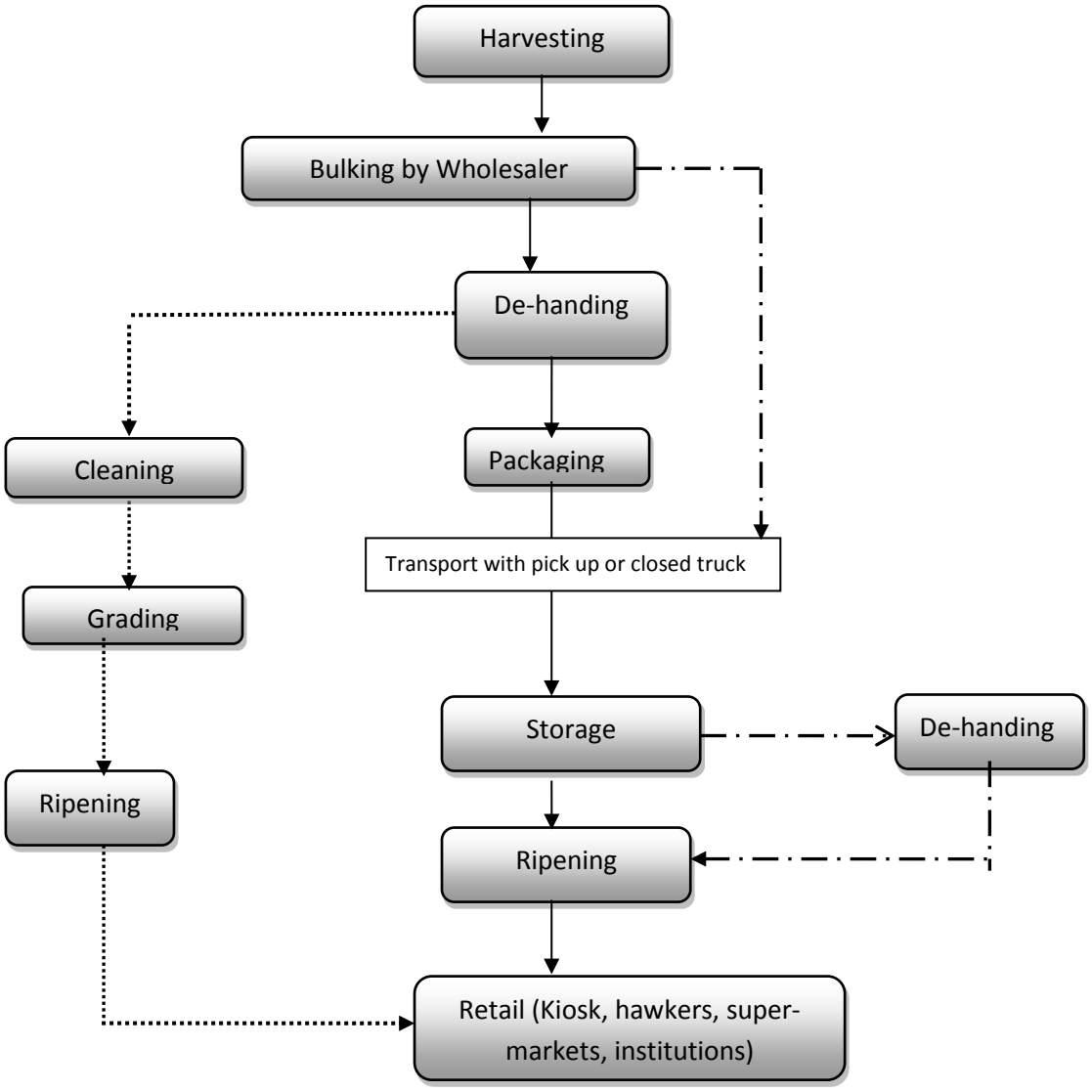
2. The Banana Supply Chains - Situation analysis.

2.1 The selected banana supply chains.

Four FSCs have been selected in this study, which are three dessert banana chains in the Meru, Murang'a and Kirinyaga counties, and one plantain banana chain in Kisii county.

Dessert Banana.

Figure 2. The dessert banana supply chain.



The supply chain selected handles on average 12 tonnes per week during low season and 20 tonnes during peak season. The chain is involved in bulking, transportation, storage ripening and wholesaling bananas. The chain was selected based on the quantities handled and its involvement in many steps along the supply chain as well as the wholesale trader being in business throughout the year.

Harvesting

Banana bunches are selected on the farm and bought by the trader or broker prior to harvesting. Therefore the harvesting operation is arranged by the buyer who usually hires two people to harvest.

Harvesting is done in the evening before, or early in the morning of a market day . The harvesting is pre-arranged and payments to the farmer or middleman are made in advance.

Bulking

Harvested bunches are bulked as follows: a trader moves round the farms collecting enough bunches to fill his vehicle, or the banana bunches are taken to the roadside by an oxcart, motorbike or carried on the shoulder. They are picked up from the roadside by a vehicle or motorbike and taken to the bulking centre or straight to the market.

De-handing

De-handing with a small sharp knife takes place at the farm, at the bulking centre or at the trader's premises. The de-handed bananas are packed in plastic woven sacks that are lined with banana leaves on the sides and at the bottom of the sack. Sometimes the banana hands are wrapped solely on leaves to make a heap of up to 120 kg.

Cleaning and grading

Cleaning and sorting is done by traders supplying the supermarkets. Those that operate at the wholesale market do not clean the bananas but grade bananas at the point of sale.

Transportation

Transportation from the farms and mini bulking sites to the bulking site is done by wheel barrows, motorbikes, oxcarts or small vehicles. Up to six bananas bunches wrapped with banana leaves are strapped onto the saddle of the motorbike. Oxcarts carry at least 50 bunches and are very handy during the rainy season when roads are impassable. Motorbikes are preferred because they are fast and inexpensive.

Transport mode to urban wholesale markets is hired and at times shared by a group of traders. The transport is by dry closed trucks or pickups. Trucks that are used, normally ferry hardware or animal feed to the towns where bananas are grown and are hired to carry bananas on their return trip. Before loading, the truck floors are lined with banana leaves. Due to the weight of the wrapped bananas, the rush to load many trucks and the fatigue experienced by loaders, the bananas are dumped and dragged without care. In addition, stepping and sitting on bunches while arranging them inside the truck is common. Transportation is done in the evening when the temperatures are low. At the market end, push carts are used.

Truck loading at bulking centre

Storage and Ripening

Except for the county council facility at the Wakulima market in Nairobi, storage and ripening facilities of wholesalers are made from corrugated sheet and lack electricity, water and produce handling infrastructure. Traders rent rooms or stalls that they use for storage, ripening and display. Offloaded bananas arrive at the market from 3:00 am in the morning and are taken directly to storage, or sometimes are left on the roadside to be picked in the morning by the trader. Ripening parameters (temperature, ethylene and humidity) are unregulated. Ripening is done by placing bananas on a polythene sheet lined with banana leaves. The hands are arranged systematically together with whole avocados on the sheet. Avocados being climacteric are used as a source of ethylene during the ripening operation. The sides of the sheet are used to wrap the arranged hands without leaving any space. The heap is uncovered after two days when the texture of the bananas is soft. The colour 'breaks' on the third day, and by the fourth day the bananas are ready on display for sale. The bananas are stored underneath the display area.

Tables 2a-c provide more details on the dessert banana chains.

Ripening

Table 2a. Detailed description of the dessert banana supply chain – Murang'a.

FSC stage	Location	Months of the year	Nr of actors	Products	Volumes (ton)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of production	Value of products
Primary production	Farm	Throughout		Whole bunches	95,400	Hand hoe, machete, wheel barrow		Manure, banana suckers, irrigation water, labour		15- 20 KES/kg
Harvest	Farm	Throughout		Whole bunches		machete		Harvesting services	2 KES/kg	
Post-harvest handling	Farm Whole sellers premises	Throughout		De-handed bananas or whole bunches		Knife, banana leaves, gunny bags.	10 km to Maragua, about 30 minutes.	De-handing services Removal of flower stalk Packing banana hands	0.66 KES/kg	
Storage/ ripening	Wholesaler premises (Maragua)	Throughout		Semi-ripe bananas at Maragua		Semi-permanent structures, banana leaves, circular bags 2.5 x 1.2 m holding 55 bunches (600-720 kg)	Ethylene induction using avocado is done for 2 days.	Ripening services Avocado for ripening Rent	2-3 KES/kg	28-30 KES/kg
Transportation	To the traders premises and the market	Throughout		De-handed and whole bunches		Wheel barrows carry offloaded bananas from the offloading point to the wholesalers premises	10 km to Maragua, about 30 minutes. Machakos about 2-3 hours	Delivery Loading, offloading Packing	1.25 KES/kg	
Market sales	Machakos and Murang'a	Throughout		De-handed bananas that have turned colour		Open air market		Cleaning the market Garbage collection	20 KES/day	
Agro-processing	Sabasaba	Throughout		Crisps and flour		Dry bananas in the open, milling of flour done at the local mill		Training by MoA and TNS. Market linkage Inputs	80 KES/kg 25 KES /500 g of crisps	100 KES/kg banana flour KES 50 for 500 g of crisps
Storage/ ripening area	Maragua market	Throughout		De-handed ripened bananas		Knife, rented room		Avocado for ripening and banana leaves	2.25 KES/kg	20-30 KES/kg
Wholesale	Machakos									
Retail	Murang'a									

Table 2b. Detailed description of the dessert banana supply chain – Kirinyaga.

FSC stage	Location	Months of the year	Nr of actors	Products	Volumes (ton)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of production	Value of products
Primary production	Farm	Throughout		Un-ripened banana	181,920	Hand hoe, machete, wheel barrow	On farm	Manure, banana suckers, irrigation water, labour Extension services Supply of TC suckers		20-25 KES/kg
Harvest	Farm	Throughout		Whole bunches of Un-ripened banana	181,920	Machete, banana leaves	On farm	Harvesting services	2 KES/kg	
Post-harvest handling	Kutus and Kagio market	Throughout		De-handed bananas		Knife, banana leaves, gunny bags.	10-15 km. around 1 hour	De-handing services Removal of flower stalk Packing banana hands. Loading on tracks	Dehanding 0.66 KES/kg Loading 0.2 KES/kg Council cess 0.125 KES/kg	
Storage/ Ripening										
Transportation	Transport to the market and from the market	Throughout		De-handed bananas. Whole bunches		Open space at the market. No equipment for loading and offloading	Nairobi (3-4 h), Nakuru (8 h), Naivasha (6 h)	Delivery Loading, offloading Packing	1.30 KES/kg	

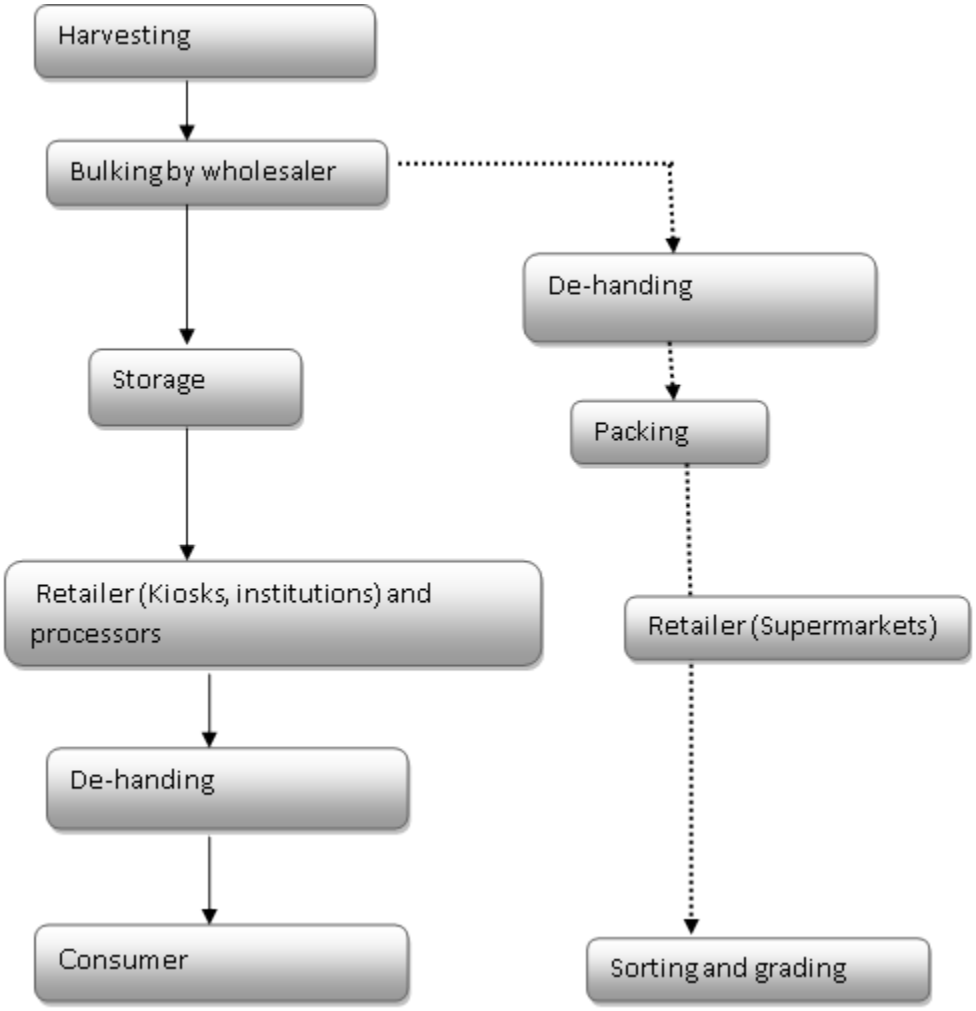
Table 2c. Detailed description of the dessert banana supply chain – Meru.

FSC stage	Location	Months of the year	Nr of actors	Products	Volumes (ton)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of production	Value of products
Primary production	Farm	Throughout		Un-ripened whole bunches	150,500	Hand hoe, machete, wheel barrow	On farm	Manure, banana suckers, irrigation water, labour		
Harvest	Farm	Throughout		Un-ripened whole bunches		machete	On farm	Harvesting services	Harvesting 2 KES/kg	17-23 KES/kg
Post-harvest handling	At the bulking site (Kariene and Ntharene) Wholesalers premises	Throughout		De-handed bananas or whole bunches		Knife, banana leaves, gunny bags.	Radius of 20 km from the farms to Ntharene and Kariene market.	De-handing services Removal of pistil Wrapping and Packing banana hands	de-handing 0.66 KES/kg, Council levy 0.5 KES/kg	500 KES per bunch (30-40 kg)
Storage/ripening	Wholesaler premises (Githurai market in Nairobi	Throughout		Semi ripened and ripened bananas		Semi-permanent structures, banana leaves, circular bags 2.5 x 1.2 m holding 55 bunches (600-720 kg)	On site. Ethylene induction using Avocado is done for 2 days. Shelf-life is 5 days	Ripening services County council levy Storage	Ripening 2 KES/kg Council levy 0.625 KES/kg Storage 0.25 KES/kg	
Transportation	To the traders premises and the market	Throughout		De-handed and whole bunches	8.2 tons.	No facilities for offloading at the traders premises.. Area for storage is the same place for ripening.	285 km from Kariene to Githurai market. Took 9 hours	Delivery Loading and offloading Packing	Loading 0.2 KES/kg Transport 1.66 KES/kg Offloading 0.2 KES/kg	Value added to bananas 5.60 KES/kg
Market sales	Githurai market Both wholesale and retail.	Throughout		De-handed bananas that are at different stages of ripening.		Open air market	At the traders premise	Cleaning the market Garbage collection	100 KES /day Rent is 2,000 KES /month	28-32 KES/kg
Retail	Estate Kiosks, Bus parks and Hawkers	Throughout		Ripened de-handed bananas		Push carts, kiosks		Display/ hawking of bananas	Buying 28-32 KES/kg Transport 0.5 KES/kg	Selling 30-40 KES/kg

Cooking - Plantain Banana.

The plantain supply chain in Kisii produces about 112,000 ton, which is sold at supermarkets, hotels, hospitals, schools, as well as by hawkers on the local markets.

Figure 3. The plantain banana supply chain.



Harvesting

Harvesting is done by the farmer or broker who hires the harvesters. If it's the farmer harvesting, the banana is taken straight to the bulking site by foot or motorbike. The broker goes round farms harvesting until the desired quantity is achieved and may use a vehicle or a motorbike to ferry to the bulking site depending on the quantity.

Bulking

The bulking centres are found at established markets where traders from wholesale markets await the produce. In Kisii, the main bulking sites are Nyakoe, Suneka and Keumbu markets. Brokers are present at the bulking centres mainly assisting traders negotiate prices with brokers and farmers coming from the farms due to language barriers.

Transportation

Transportation from the farm to the bulking site is done by wheel barrows, motorbikes or small vehicles. Up to six bunches are strapped onto the motorbike.

Transport mode to the market is hired as dry closed vans which are shared by several traders. The hired trucks are on return trips from delivering various goods to Kisii town and other towns beyond. The bananas are transported as whole bunches and no packing is done. The loading is done roughly into the truck so that they stick to each other and can fit. Here no lining of the truck is done. The trip from Kisii to Nairobi takes approximately 6 hours to travel a distance of 280 km. Transportation is done in the evening when the temperatures are low and trading is finished.

Off-loading at the market

De-handing, cleaning and grading

Wholesalers transport whole bunches to the market without any processing and deliver the bananas in that state to retailers and processors. De-handing takes place at the retail end when purchases are made. Traders such as 'Fresh and Juicy' that supply supermarkets de-hand, clean and grade bananas, although this market segment is small. A handful of commercial banana crisp processors exist and the operation is carried out in conjunction with potato crisp processing.

Storage

The only facility with proper storage in Nairobi is Wakulima market, while other traders use stalls made of corrugated sheet. This is also the sales point. The rooms hold the bananas for a few days while selling continues. At times, bananas are already sold before they arrive at the trader's premises and are in the hands of the trader for less than 24 hours.

2.2 Marketing systems.

Dessert Banana

Farmers - The sale of bananas is done by individuals or a group of farmers at either the farm or the bulking site. Where farmers are organised in groups, direct linkages with traders or brokers occur though individual farmers harvesting small quantities deliver directly to the bulking centre. There have been initiatives by both private and public sectors to support farmers improve on quality and marketing of dessert bananas. KARI and Africa harvest have been instrumental in promoting tissue culture bananas, while MOA and HCDA provided extension and training services to improve farmers' management practices. Technoserve has worked with farmers to improve farm prices by linking them directly to buyers and establishing banana handling facilities where buyers and farmers would

transact. SHOMAP is working with farmers to develop their entrepreneurial skills and promoting banana value addition technologies, however the adoption and change towards commercialization of these enterprises is still low.

Brokers - The existence of brokers in the banana supply chain particularly at the farm end is due to lack of cooperation among farmers to aggregate produce at a single point where wholesalers can purchase. Brokers move around individual farms to collect harvested bananas that are piled by the roadside. They are then delivered to the bulking centres or markets. Meru has around 9 bulking centres along the Meru Nairobi Highway with each centre having a specific day set for wholesalers purchasing. The brokers have information on (1) farms that have harvestable bunches and (2) traders who require stocking up of bananas since they are in constant communication with both parties. The brokers normally come from the same locality as the farmers and are provided with money by traders prior to the day earmarked for collection.

Wholesalers - The largest dessert banana wholesale markets are in Nairobi and Mombasa though other markets exist in smaller towns. Wholesalers arrive a day prior to the markets days allocated for each of the bulking centres that they buy from and contact with their brokers and farmers to make arrangement for advance purchases. Some wholesalers working directly with farmer groups, arrange for transport to go round farms to collect bananas that have been bulked besides the rural roads. Those that lack direct engagement with farmers wait by the bulking sites for brokers or farmers to bring the product. SHOMAP have begun intervening in setting up permanent bulking sites in Meru while Technoserve had set up similar structures which use has not lived up to the intended purpose i.e. creating direct linkages between farmers and wholesalers. Wholesalers make transport and loading arrangements from the bulking sites to the wholesale market where the ripening process is done. More often groups of wholesalers pool transport thereby sharing the cost transport and municipal levy charged for the produce.

Wholesale market

Retailers - Retailers consisting of supermarkets, kiosk owners, hawkers and green grocers buy bananas at various stages of ripening (from green to full yellow) from wholesaler. Supermarkets such as Uchumi, Tuskys, Naivas and Nakumatt purchase bananas at green stage from agents who are registered by HCDA or directly from wholesalers. They account for 5% of the total dessert bananas consumed, mainly grade A and maintain a cold chain from storage to display on the shelves. Hawkers, estate vendors and kiosk owners on the other hand sell to the low end of the market segment that constitutes 95%. Bananas sold to this end of the market are ripened without observing proper

hygiene conditions and are of mixed grades. Hawkers on the other hand are found selling full yellow bananas at bus parks and along the high way when traffic is at standstill. Hawkers and estate vendors sell between 100 to 150 banana fingers per day with margins of 3 to 5 shillings per finger with most of them making margins of KES 350-500 per day.

Retail - hawker

Plantain Banana.

Farmers/ Farmer groups - The farmers may or may not be organised into marketing groups, but they sell through brokers. KARI established Farmer Field Schools for purposes of disseminating tissue culture technology while banana loss reduction initiatives came from the Ministry of Agriculture through introduction of value addition technologies. During the rainy season the farmers are faced with poor roads from the farms to the market which contributes to quality loss.

Brokers - There exist two levels of brokers at the cooking banana marketing system. The first level are brokers who go round farms to collect bananas until the required quantities are met depending on the money or orders available. The second level is that of a master broker who has contacts with wholesalers at the bulking centre or markets in urban centres. The master broker is stationed at the bulking centre and buys bananas from other brokers as well as farmers. The brokers are well informed on the market prices and have knowledge on where to obtain products due to their established contacts on the ground. The main work of brokers is moving products from one point in the supply chain to the other with short time ownership.

Wholesalers - Wholesale traders operate from the bulking centres and have little or no contact with farms. The bulking sites are located by the roadside or market centres and have specific days for operation. The wholesalers rely on farmers and brokers to bring products to the bulking site. Besides choice purchasing at the bulking site, there is minimal communication and feedback mechanism between the trader, farmer and broker on quality. Communication is price based. Wholesalers of cooking bananas supply to processors, greengrocers and sometimes consumers directly. Those operating at a bulking site and sell in one urban centre like Nairobi, pool transport together which is usually a closed dry truck to share costs.

Wholesale market

3. The food losses - Study findings and results.

3.1 Critical Loss Points: type and level of food losses.

Dessert Banana.

The types of losses associated with dessert banana were both quantitative and qualitative with the critical loss points occurring at wholesale and retail level. The losses were as follows:

Table 3. Quantitative and qualitative losses occurring in the dessert banana supply chain.

Point in the FSC	Quality reduction (%)	Quantitative loss (%)		
		% handled	% losses	% of weighed losses
Transportation	10			
Ripening	20			
Storage	10			
wholesalers	5	100	3	3
hawkers		40	7.5	3
streetside vendors		30	10	3
kiosks		20	8	1.6
supermarkets	10	10	6	0.6
Total				**11.2**

Plantain banana.

The types of losses associated with plantain banana were both quantitative and qualitative with the critical loss points occurring at retail level. The losses were as follows:

Table 4. Quantitative and qualitative losses occurring in the plantain banana supply chain.

Point in the FSC	Quality reduction (%)	Quantitative loss (%)		
		% handled	% losses	% of weighed losses
Transportation	30		0	0
wholesalers	10	100	0.2	0.2
streetside vendors	20	45	4	1.8
kiosks	20	50	5	2.5
supermarkets	10	5	2	0.1
Total				**4.6**

3.2 Causes of losses.

Dessert banana - Quality losses.

Quality losses occurred during transportation, loading and offloading. 70% of the bananas on bunches at the bulking centre had bruises due to poor transport particularly from the farm and rough handling when loading and offloading. Loaders were paid according to the number of items or trucks loaded and so in an effort to load as many items and trucks as possible, handling was rough and when not supervised, banana bags were thrown onto the truck. Loads are dragged into the truck and produce was piled one on top of the other inside the truck resulting in further damage. The only cushion was the lining of the plastic woven sacks with banana leaves. The bottom of the truck was lined with the banana leaves but the sides of the truck were bare and came into direct contact with the bananas causing abrasion.

Twenty per cent of bananas had mechanical damage due to parts of the motorbike piercing the fingers or during de-handing. Banana thrips which suck sap from banana fingers lowering the quality was prevalent in 30% of the bananas sold by farmers. The damage resulted in a loss in value at the farm gate of 33% due to poor appearance and the traders use it to buy bananas at a lower price although there is no quantitative loss. However, after ripening, the value was the same as the insect free damaged bananas of the same grade. 10% of the bananas at the bulking site were immature which resulted in a loss of value by 33%. The harvesting of immature bananas is driven by financial need of the farmer and is also common during periods of low supply (December and January). The result is a product with low weight attracting a low price.

15% of bananas had fingers decaying at the pedicel where signs of splitting off from the crown occurred. The rough roads caused constant shaking of the hands that loosened some fingers. A tear occurred at the pedicel which resulted in rots or drying up that reduced it to a thin strip. The spread of the rots was exacerbated by storage and market conditions. Temperatures of between 24-36 ^{o}C were recorded at the sales point where the product was exposed directly to the sun.

Dessert banana - Quantitative losses.

The causes of quantitative losses are similar to those for qualitative losses only that the extent of the damage makes the fruit unmarketable. The placement of wrapped bananas on motorbikes and trucks caused physical injuries which affected the fingers on the outer row of the hands. After ripening the bruised area becomes hardened and creates avenues for entry of pathogens. Since bananas are climacteric, injury to the fruit causes ethylene production, increases respiration and water loss thereby shortening postharvest life. Additionally, decay caused by pathogenic agents' sets in at the point of injury.

Poor display and storage facilities - Bananas at the wholesale and retail markets with the exception of supermarkets are stored and displayed at ambient temperatures. The display area is open and is covered with a woven plastic bag providing inadequate shade and maintaining high temperatures. More so, hawkers and some roadside traders expose produce to direct sunlight which increases enzymatic reactions hastening senescence.

The market structures at the Githurai and Gikomba wholesale markets are made of iron sheet roofing and serve as the storage, ripening and de-handing area with inside temperatures ranging from 24 to 36 ^{o}C during the day. High temperatures in storage and on display hasten deterioration as respiration and water loss is high particularly for injured fruits. Whilst dessert bananas stored at 13-14 ^{o}C have a shelf life of 1-2 weeks (IITA, undated), bananas stored and sold under the aforementioned conditions had a reduced shelf life of 5 days.

Poor transportation and handling - Pathogens gain entry through injuries created by severing the crop from the plant during harvesting, among them crown rot. (Coates and Johnson, 1997). Mechanical injuries associated with poor transport and handling in addition to poor hygienic conditions

in the field and handling are the main causes of rots. The effects are seen after ripening, with traders stating that it can contribute up to 100% losses.

Lack of ripening facilities - The ideal ripening conditions for bananas is a temperature of 20 ^{o}C and a relative humidity of 80% (Mohapatra *et al*, 2010). The method used for ripening by wholesalers is under uncontrolled conditions. Inherent field heat is not removed initiating the senescence process even before artificial ripening is done. Temperatures during ripening vary from 27-35 ^{o}C and although ripening occurs it is uneven, with failure to de-green and softening of the flesh occurs. Spoiled fingers are removed and thrown away. Those that fail to change colour are re-ripened again or sold at a lower price. Traders rely on the texture of the banana to tell whether the ripening process is complete since the bananas are removed from the ripening facility while still green.

Plantain Banana – Quality losses.

Rough handling - Bananas transported to Nairobi were thrown into the truck and compacted to minimise movement. Also, offloading from vehicles at bulking points is done without care and bananas are dumped on the ground causing bruising.

Hailstorm damage -. Bananas affected by hailstorms had surface injuries that had healed. However, the colour of the banana was affected as they had a yellow tint. The quality loss as a result reduced the value of the banana by 25%. Uganda green variety was not affected by hailstorms

Cigar end rot – This affected 10% of the load and contributed to 11% loss in value. The disease is spread by poor management practices.

Immature harvesting - Contributed to 30% loss in value at the wholesale market.

Plantain Banana – Quantitative losses.

Moisture loss - Loss of moisture was due to lack of a cold chain in the supply and storage of bananas. Except for supermarkets, bananas at retail are displayed under ambient conditions. Though bananas were displayed as whole bunches to retain moisture, bunches were exposed to high temperatures causing softening and shrivelling of the peel and loss of firmness thereby making the banana unmarketable and wasted.

Mechanical damage - The detachment of hands and fingers from the crown in addition to exposure to high temperatures contributed to moisture loss resulting in the bananas losing firmness and eventually the peel and flesh dry up. Bruising, often flesh deep, leads to secondary infection, moisture loss and loss of appeal. Mechanical damage hastens senescence with the pulp softening and the peel becoming black.

Transportation and storage - Is often done in combination with ethylene producing products like avocado, passion fruit and kale. This initiates softening and ripening of the bananas and reduces shelf life. Since consumption of green ripened banana is not popular, the softened bananas end up being wasted. Softening is also caused by injuries that cause ethylene production.

Table 5. Summary result matrix of food losses.

Type of loss	Cause of loss	Percentage lost	Stakeholders affected	Impact of loss	Reduced market value	Time/ season	Details	Suggested solutions
Quality loss Dessert bananas	Bruises caused by poor transport, handling and insect damage. Poor storage and display facilities. Uneven ripening.		Retailers and wholesalers	Reduced income	30-50%	Throughout the year	Some consumers prefer immature bananas. Poor ripening is caused by banana variety. Exposure of ripened bananas to sun affects its shelf life. Poor handling is the biggest contributor to quality loss	Better facilities at the market. Encourage commercial ripening chambers. Training traders on produce handling.
Quantitative loss Dessert bananas	Rots (at point of bruising and crown rot). Over ripening. Competing products like mangoes and oranges.	Ripening 3% Hawkers 7.5% Supermarkets 5.5% Kiosks 8% Roadside vendors 10%	Farmers, wholesalers and retailers.	Loss in income	Reduction in value is very subjective to the type of market.	Jan to March and July to August. Loss more pronounced during the hot season.	Crown rot is caused by over-fertilization. Harvesting was a major cause of losses. Poor ripening methods resulted to losses. On season of mangoes in the market reduces sales of bananas.	Shelter at the point of sale. Training of transporters. More supervision during loading. Shorten the supply chain. Provision of mobile cooler boxes.
Quality loss Plantain bananas	Hailstorm damage. Mechanical damage. Immature bunches.		Farmers, wholesalers and retailers.	Reduced income.	20-30%	Throughout the year. Hailstorms occur March - April, September- November	Hailstorm and insect damage doesn't affect the flesh of bananas. Broken and bruised bananas are given away. The quality varies each time the bunches are supplied. Squeezing of bananas is because of limited space.	Consistent quality by regulating what is being sold. Proper transport designed for bananas. Training traders on produce handling
Quantitative loss Plantain bananas	Softening of the bananas. Breakages and bruises.	7 %	Farmers, wholesalers and retailers	Loss in income	20-30%	During drought period there is minimal losses	When bananas overstay they become soft. Bruises are an entry point for pathogens. The long supply chain contribute to losses.	Shorten the supply chain. Encourage value addition for the low quality bananas. Shelter at the point of sale.

4. Food Loss Reduction Strategy - Conclusions and Recommendations.

4.1 Food loss reduction measures for dessert and plantain banana.

The interventions suggested need a thorough analysis of their economic feasibility, environmental impact as well as social acceptability and way they are going to be managed, before they can become actual recommendations.

1. *Training of trainers* who in turn will take charge of training traders, loaders and off-loaders on proper handling of bananas at their points of operation. Trainers will be representatives of traders and loaders picked from bulking centres and wholesale markets.
2. Introduction of *improved practices* such as:
   - de-handing and initial packing in the field;
   - bagging of bunches and lining of hands with fibreboards at the farm, to minimise drying and injury before the point of ripening;
   - boxes for transporting bananas with motorbikes and ox carts;
   - improved shade structures/ sheds with stands at collection points and bulking sites so as to lift produce off the ground and protect it from exposure to the sun;
   - charcoal cooling to remove the field heat from the bananas;
   - umbrellas and cooler boxes used by hawkers and kiosks that are under the open air.
3. Improve and expand banana ripening *methods and infrastructure*, by developing ripening chambers at the markets as a (commercial) service to the traders (dessert bananas only).

Table 6 shows a rough assessment of the economic feasibility of the most critical measures to reduce banana losses. It shows that training and awareness raising has the highest potential and impact. Capital investments in pre-cooling facilities and ripening chambers however need a more thorough analysis of the commercial feasibility.

Table 6. Summary of food losses, causes and solutions.

Critical Loss Point	Magnitude of losses		Economic loss (USD)	Cause of loss	Intervention to reduce losses	Loss reduction % / USD	Cost of intervention (USD)
	weight (ton)	%age					
Transportation from bulking centre to market	Quality loss produce from Meru, Kirinyaga, Murang'a, Kisii	10	13,000,000	Improper handling by loading and off-loading, over-loading and insufficient protection in the truck.	Training of Trainers on proper handling of bananas and monitoring quality maintenance, through government extension program.	40% 5,200,000	158,000
Retail of dessert banana at street sides and kiosks	1.9 per trader	8-10	460	Bananas kept at too high temperatures, leading to spoilage.	Cooler boxes mounted with umbrella shades for street side traders and kiosk operators.	50% 230	120
	19,000 produce from Meru, Kirinyaga, Murang'a	8-10	4,600,000			50% 2,300,000	1,200,000
Collecting and bulking of bananas at road side	11,000	2	2,600,000	Soil contamination and sun heat.	Construction of collection shed on the road side.	1,300,000	610,000
Handling of dessert banana at wholesale market	13,000	3	3,100,000	Bananas retain field and transport heat, leading to spoilage.	Construction of pre-cooling facilities at the main wholesale markets.	50% 1,500,000	6,000,000
Ripening of dessert banana	Quality loss produce from Meru, Kirinyaga, Murang'a	20	20,500,000	Ripening at too high temperature and oxygen level.	Construction of ripening chambers.	50% 10,300,000	11,200,000

4.2 Food loss reduction plan and strategy.

The following elements of a strategy are being presented:

1. **Training** / capacity building, to add on social capital, especially for traders, processors, wholesalers, retailers. Strengthen the supply chains downstream (post-farm), because that is where the losses occur. Especially the *dissemination and extension of the various technologies* through demonstrations to women who are the majority at wholesale and retail and thus most affected by losses.
2. Minimise handling of produce in storage and distribution systems, by integrating the supply chain approach and appropriate sequencing in the development of infrastructure that will ensure shorter supply chains, with fewer intermediaries. Mobilisation of farmers in each locality to form marketing organisations through which traders can directly access their produce.
3. Investigate the potential (market and viability) of **value-added processing** in the banana chains by specialized processing enterprises, as well as **quality improvement** through improved handling and ripening. However, currently in many FSCs better quality bananas don't have access to better markets or fetch a higher price.
4. **Market development**, for diversified and value-added banana products, as well as for better quality bananas, and promoting the consumption of these products.
5. Develop and introduce a postharvest **pest/ disease management** plan.
6. Introduce, improve and expand **technology**, structures and equipment, at trader and wholesale level, where it has more potential than at farm level. Especially market facilities for fresh-produce, ripening and cold chains.
7. Finalize the national banana **policy**.
8. Establish a **monitoring mechanism**, to estimate food losses at any particular time, sampling of banana traders at various stages along the supply chain and taking account of their practices in the trade.

The main national institutions should take the lead. The Plan should involve research, government, NGOs and private entrepreneurs.

ANNEXES

i. Acronyms

FSC	Food Supply Chain
HCDA	Horticultural Crops Development Authority
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
ISAAA	International Service for the Acquisition of Agri-biotech Applications
KARI	Kenya Agricultural Research Institute
KES	Kenyan Shilling
KIRDI	Kenya Industrial Research and Development Institute
MoA	Ministry of Agriculture
SHoMaP	Smallholder Horticulture Marketing Programme
TC	Tissue Culture
TNS	TechnoServe

Currency exchange rate

USD 1.00 - KES 85

KES 100.00 - USD 1.18

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iii. List of experts consulted.

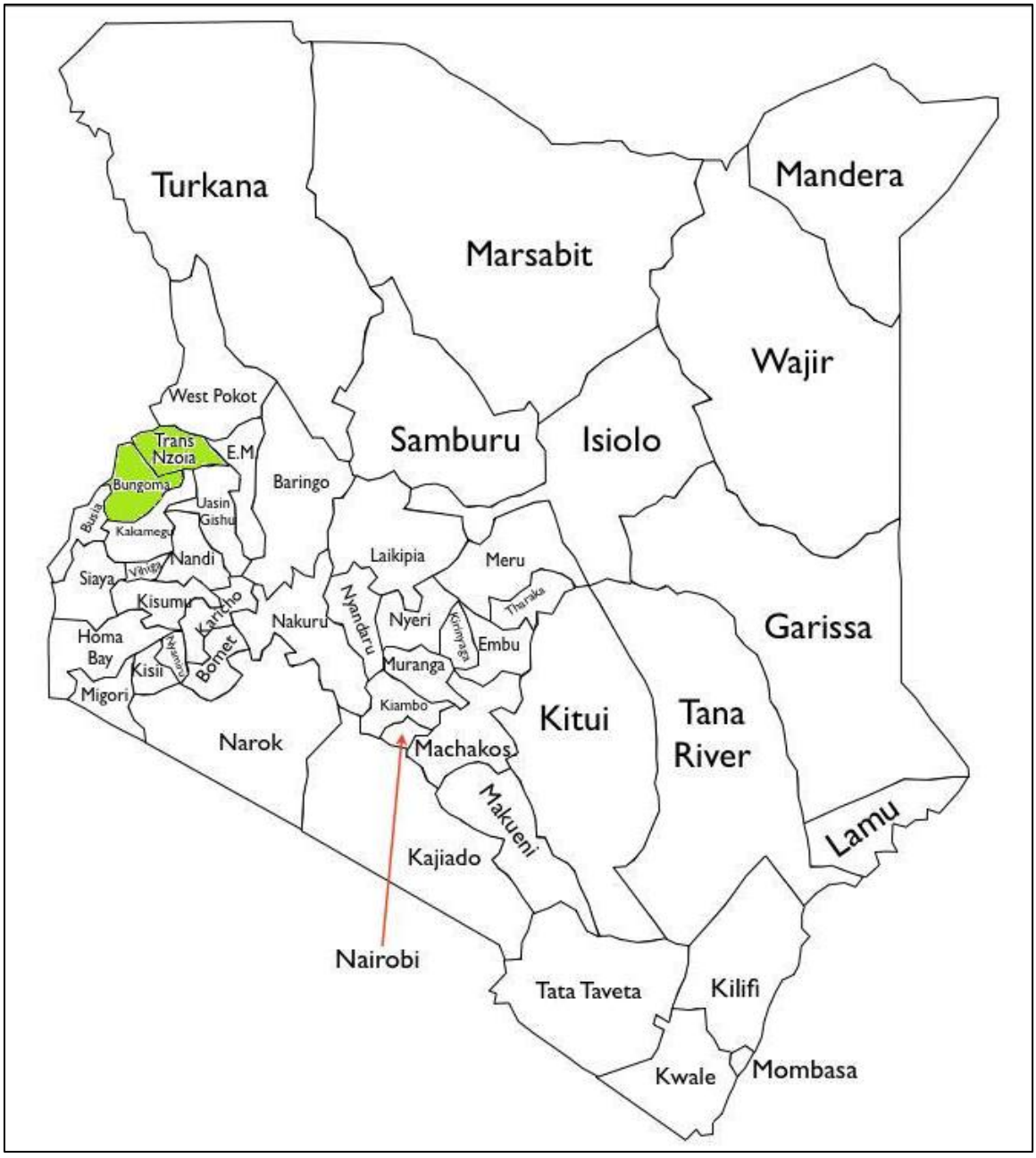
Expert name	**Title/ position**	**Institution**
Margret Muchui	Dr/ Researcher	KARI
Henry Kinyua	Senior Business Advisor	Technoserve
Arim Ogolla	General manager	HCDA
James Njoka	Trader	Kangemi market
Enkay Shah	Operations Manager	Amigo Processors
Wangare Kiragu	Ms/ Programme officer	Africa Harvest
Patrick Onchieku	Mr/ Senior Agricultural Officer	Ministry of Agriculture-Headquarters

II.

M A I Z E

Field studies in Trans-Nzoia-West and Lugari Districts

November 2012 - January 2013



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1. The Maize Subsector - Introduction and Background.

1.1 Status and importance of the subsector.

The Kenyan agricultural sector is highly complex. The complexity arises from the existence of a traditional subsistence sector alongside a commercial sector that includes both large-scale and small-holder production systems. Maize production in 1963 was 2.3 million ton from an area of approximately 701,000 hectares, with yields of about 3.3 ton per hectare. Annual production increased by about 11% per annum to reach an average of 3.1 million ton in 1989. This rapid growth was mainly attributed to both yield increases - estimated at 7.9% per annum - and expansion of the area under maize. Until the early 1990s, Kenya was self-sufficient in, and even exporting maize. Annual maize production in 2004-2008 ranged from 2.5 - 3.3 million ton cultivated on 1.7 million hectares. During the last five years, yields have averaged around 1.6 ton/ha. Recent data (2007-2011) indicate an oscillating production trend between 2.9 million ton and 3.4 million ton with the highest production of 3.4 million ton in 2010. This trend is attributed to variations in yield and the acreage under maize.

Table 1. Production information of the maize subsector from 5 million small scale producers[2]

	Volume ton/year	**Value USD/year**	**Remarks**
Raw material dry maize grain	3.4 million	1 billion	Ministry of Agriculture. Economic Review of Agriculture, 2012
Maize grain	628,000	247 million	Formal markets. Food security situation report as at 30 September 2012.
Green maize on cob	419,600	84 million	Meant for cooking. Ministry of Agriculture. Economic Review of Agriculture, 2012
Whole meal - formal	374,000	119 million	-Economic Abstract 2011: Kenya National Bureau of Statistics -The figure indicates the formal milled maize (large and medium processors). Based on prevailing product prices (MoA, 2012)
Whole meal - posho	1.1 million	582 million	Based on domestic grain retention/year (MOA 2012) . Based on prevailing product prices (MOA, 2012).
Sifted maize meal	300,000	177 million	Maize Millers Association- Kenya Based on prevailing product prices (MoA, 2012)
Imports	360,000	132 million	Often through illegal border entry points from Uganda and Tanzania
Export	12,000	5 million	Especially to South Sudan
Level of processing operations (S,M,L)	S,M,L		Large - >150 ton/24 hr Medium - 50-150 tons/24 hr Small – hammer mills which process on the go. Posho mills.
Level of trading/wholesale operations (S,M,L)	Large		Wholesale shops and large aggregators
Level of retail operations (S,M,L)	Large		Kiosks, formal shops, supermarkets

[2] Ministry of Planning and National Development: Kenya Integrated Household Survey (KIHS) 2005/2006

1.2 Inventory of activities and lessons learnt from past and on-going interventions

The UN World Food Programme market linkage initiative 'Purchase for Progress' (P4P) links smallholder farmers to markets using WFP's procurement capacity as an incentive. Seventy farmer organizations and 30 small scale traders have been formed with the support of WFP and partners through food procurement, training and market linkage forums. The programme provides an incentive of USD 7,000 on a cost sharing basis for the construction of storage facilities for farmers' organizations. Some farmers' organizations in Uasin Gishu and Trans Nzoia Counties have already constructed stores and are preparing for warehouse receipt certification. This is expected to contribute greatly to food loss reduction especially losses caused by rats, weevils and poor store sanitation.

The One-Acre Fund project has been in the frontline in the provision of postharvest handling services including smallholder equipment like hand shellers for hand stripping of maize. The project is yet to upscale the technologies.

The National Agricultural Accelerated Inputs Access programme (NAAIAP) run by the government in partnership with FAO, AGRA, Equity Bank Ltd among others has attempted to work with farmers' groups to build and manage cereal banking systems for communal grain storage, preservation and marketing. The programme also includes provision of input subsidies to smallholder maize producers who are resource constrained. The efforts have generally been successful and are still under implementation.

The concept of the Warehousing Receipt System is being widened to serve small scale producers. Privately owned warehouses generally accept grain from owners in minimum lots of 100 ton. Efforts are being made to get both private and public warehouses to accept deliveries as low as 10 ton for one to qualify for a receipt. Policy guidelines to this effect are underway.

Continuous research on various aspects like variety improvement, have been undertaken to improve maize yields. Seed varieties suitable to various agro ecological zones have been developed, tested and released. Storage structures (cribs fitted with rat guards) have been developed in the past (1990s) to reduce grain damage by rodents and rats. However, these storage structures were not popular as they exposed produce to thieves and excessive borrowing. This lesson prompted further research to recommend mini-silos and hermetic bags for grain kept for domestic use.

Grain preservation by fumigation is an initiative where the National Cereals and Produce Board (NCPB) assists farmers to preserve their grain at a cost in the board's premises or on farm, if storage structures are suitable and safe. The same concept is now being explored under the warehouse receipt system among farmers associations and marketing groups. About 809 marketing groups are being prepared to store and market grain for their members although storage structures and management skills are still a challenge.

Capacity building and improvement of storage facilities. The USAID funded Kenya Maize Development Programme (KMDP) has, from 2002, been committed to increasing production and marketing efficiency in Kenya's small holder maize subsector. This has specifically been through improving agricultural markets and trade, increasing access to business support services and effectiveness of smallholder organizations, and building capacity of local service providers. Due to the growing concern on maize losses by pest damage resulting from the farmers' inability to protect the crop, farmer managed storage facilities are being constructed in various parts of the country.

Mobile grain driers have been introduced by the government but capacity on how to operate the units is limited.

1.3 The process of policy making and current policy framework

Over the years, the government has enacted policies for food production and agricultural development. Sessional Paper No. 4 of 1981 formulated a National Food Policy which was necessitated by the realization of

government's inability to ensure food security after or during drought, following the famine of 1980. With the implementation of stabilization and structural adjustment policies in the early 1990s, policy was revised to facilitate production in a liberalized environment and Sessional Paper Number 2 of 1994 - National Food Policy was introduced. The central theme running through these policies has been the need to achieve broad-based food self-sufficiency and produce adequate surpluses for export. However, these policies have not realized their objectives due to structural and operational weaknesses and a discernible lack of commitment on the part of government to ensure success.

The Agriculture Sector Coordination Unit (ASCU) formed in 2002 has been involved in the formulation of policies favouring smallholder agriculture such as the National Agricultural Sector Extension Policy (NASEP) which liberalized service delivery to farmers and enabled the emergence of farmers associations like the Cereal Growers Association (CGA) which provides a voice for cereals farmers.

2. The Maize Supply Chain - Situation analysis.

2.1 The selected maize supply chain.

The supply chain selected (maize and its two products i.e. sifted flour and unsifted or whole meal flour) was that found in Trans-Nzoia-West and Lugari districts. Maize is harvested, dried and shelled. No maize is sold on cobs. The shelled grain is either sold to village traders and consolidators and/or to urban traders. Village traders move around the villages to source grain from farmers. The consolidators source the grain in the same way but they have identifiable points where they can be found such as their homes or at rural centres. Grain from village traders and consolidators is then sold to urban traders though some grain may be sold to non-farming households who need maize for domestic consumption.

Small scale millers are commonly referred to as *posho millers* and are mainly located in rural areas where they offer milling services to clients who come with their already dried and winnowed maize grain. They are a mixture of electricity and diesel propelled units with capacity ranging from 10 to 50 bags per day. No de-hulling is done and the quantity put in the hopper is equal to the quantity received. Some mill owners stock grain for sale to their customers. These stocks however do not last long to warrant serious protection against weevils and other pests. Posho mills are estimated to mill 0.2 million ton annually.

The urban traders sell their grain to local institutions and large millers after carrying out some sorting, drying and weighing. Urban traders sell their stocks to large millers within the district or beyond. The large storage facilities that receive the grain from the study districts include, the National Cereals Board in Moi's bridge, Eldoret and Turbo. There are also private storage facilities such as Mama Miller's depot in Matunda market.

Kenya has 19 large scale millers with a total milling capacity of 1.6 million ton per year. These mills actually mill 1.4 million ton, while medium scale operators achieve 0.2 million ton annually in sifted flour.

Grain received by both large stores and millers undergoes further drying, if necessary, cleaning and storage. The grain is protected against weevils by fumigating the stores. The large millers produce sifted flour sold through formal and well organized distribution channels.

2.2 Marketing system.

Since trading in maize and maize products is fully liberalized in Kenya, producers are allowed to sell maize to buyers of their choice at the time they want. The price is highly influenced by the time of the season. At the time of harvesting, prices are lower because of temporary oversupply of maize. Most of the maize that reaches the traders is conveyed through the above channels (Figure 1).

Most actors don't have formal networking relationships and they come into play at different times during the harvesting period. Occasionally an influx of maize can be experienced from outside the districts adding to the existing merchant stocks. The demand for rural milling services ('posho') lasts throughout the year as grain retained for domestic use can take the families that long.

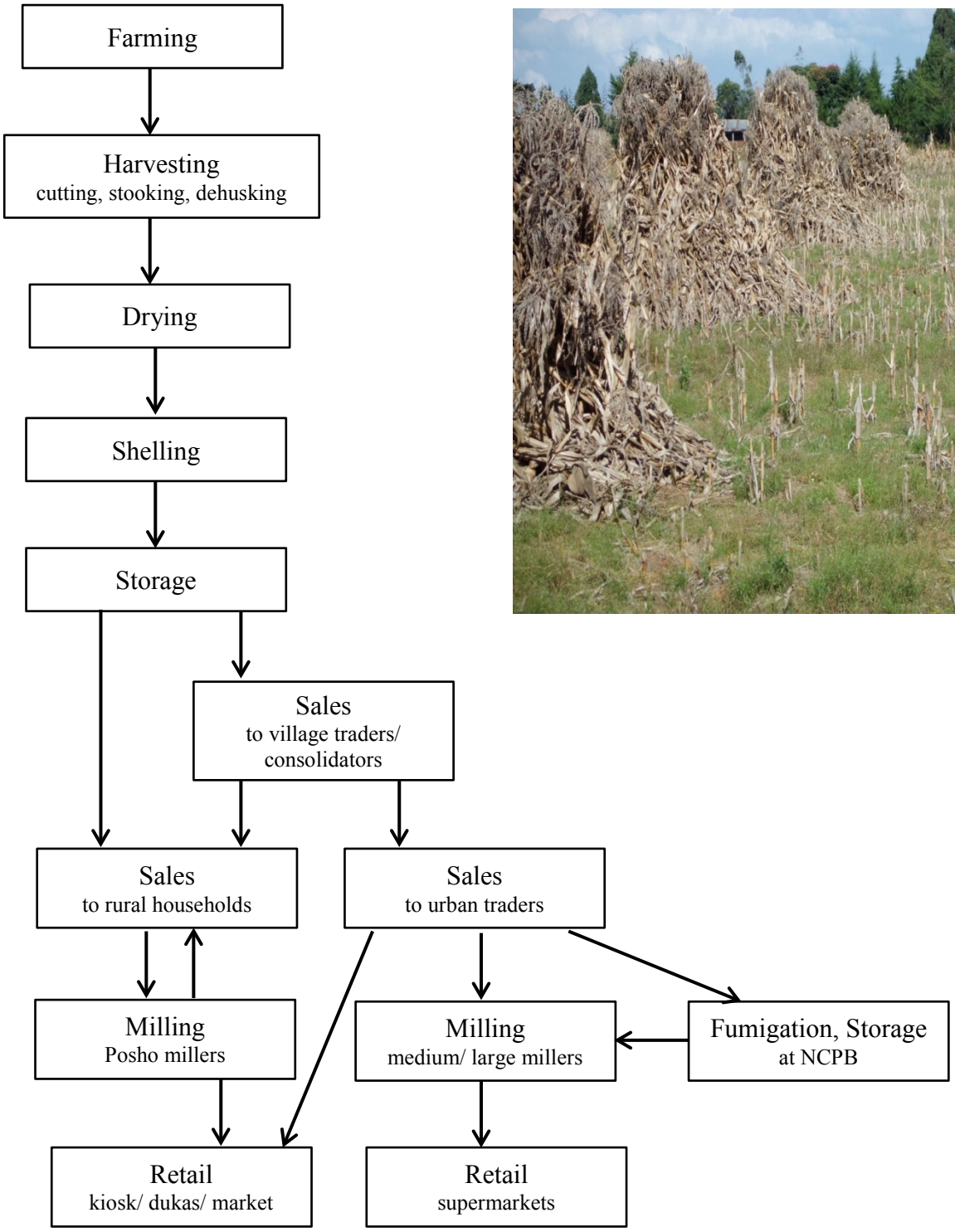
Some farmers store some grain to speculate on rising prices as the supply reduces, and only sell a fraction of their harvest to meet the cost of immediate family needs. Traders transport maize from anywhere in the country at a time of their choice and at prevailing market prices. The maize can then be resold to any other buyer immediately or weeks later.

A period of two months when maize harvesting goes on is when maize prices are lowest. Some traders operate for only six months a year, when maize is in abundance and can be sold at prices

that they consider they can make good margins. Unshelled dry maize is never sold as a consumable product, with shelled maize being the most commonly traded product.

For those who transport maize to the market, their grain is sold at the prevailing price. They never struggle to recover the cost of marketing, and often are negligent in choosing the type of measuring unit that is to be used to determine their quantities.

Figure 1. Maize supply chain.



Maize stooks[3]

[3] Stooking: cutting of the maize plants and placing them in a conical shape (stooks) against each other.

Table 2: Detailed description of the maize supply chain.

Lugari District.

FSC stage	Location	Months of the year	Nr of actors	Products	Volumes (ton)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of production KES	Value of products KES
Primary production	Lugari	April-Nov	21,500	Maize grain on cob	36,000	Ploughs Planters	8 months	Extension services Fertilizers Seed Labour	56,000/ha	
Harvest	Lugari	Nov-Dec	21,500	Maize grain on cob	36,000	Tractor & trailer Tarpaulins Bags	2 months	Labour	9,000/ha	25/kg
Post-harvest handling	Lugari	Nov-Jan	21,500	Maize grain	36,000	Tarpaulins Bags Driers Shellers	1 month	Labour	Drying: 1,300/ton Shelling: 1,300/ton	
Storage	Lugari Farmer stor-age	10 months	21,500	Maize grain	11,000 (30%)	Farmers store-in the house or grain stores	All year round	Storage chemicals	550/ton/yr	
	NCPB stores (Moi's Bridge de-pot)	Throughout the year		Maize grain	25,000	-Stores (silos) with conveyor system -Driers	Throughout the year	Drying, cleaning, fumi-gation and storage.	1,200/ton	27/kg
Transporta-tion	Lugari	All year round	Varied	Maize grain	23,000 65%	Donkeys Pick ups Motor bikes Bicycles Lorries	4 – 100 km	Labour, Hiring of transport	50-100/bag 1,100/ton	
Market sales	Lugari dis-trict town and shop-ping centres	Throughout the year	varied	Maize grain	23,000	Temporary stores Weighing scales Market facilities	All year round	Cleaning, drying, consol-idation Re-bagging Storage	Offloading: 110/ton market cess (tax): 220/ton	27/kg

FSC stage	Location	Months of the year	Nr of actors	Products	Volumes (ton)	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Cost of production KES	Value of products KES
Milling	Posho mills in Lugari district	Throughout the year	84	Whole-meal maize flour	22,000	Diesel propelled posho mills	1 days to mill a ton of maize	Worker-(labour)	2,400/ton	50/kg
	Large mills in Eldoret, Kisumu, Kakamega, Mombasa, Nairobi	Throughout the year	19	Sifted maize flour		Hammer mills Plate mills	10 minutes/ton			60/kg
Storage	Major towns	All year round		Flour		Stores and ware houses	All year round	Labour Running costs		
Transporta-tion	Major towns	All year round		Flour		Lorries			500/ton	
Wholesale	Country wide	All year round		Flour		Warehouse whole sale shops		Transport, labour	2,500/ton	
Retail	Country wide	All year round		Flour		Retail shops		Transport and labour		60/kg

Trans-Nzoia-West District.

Farmers: 14,500.

Production: 135,000 ton.

The roles and characteristics of the supply chain actors are described below:

Smallholder producers

- Usually sell part of their maize to traders or neighbours with food shortages. The amount sold varies by size of maize fields, amount harvested, and food requirement of household.
- Sell maize in small amounts mainly in the period 2-3 months after harvest, depending on the household's cash needs.
- The grain sold is not graded nor dried to achieve a lower moisture content.
- Selling is done at home (farm gate) or at the village markets to vendors or small traders and sometimes to large traders.
- Usually have no access to marketing information on prices and transportation costs.
- Bargain by comparing the previous prices offered by small traders or neighbouring farmers.
- Do not make any pre-arrangement with vendors or traders in selling their maize.

Farm storage at home

Rural grain consolidators/ vendors

- Are numerous and widely accessible throughout the maize growing zones; mainly buy at the harvest period and are not organized.
- Operate on an individual basis like farmers; this category of traders could be maize growers too.
- Buy direct from farmers, handling only small quantities such as 50 kg to 100 kg per trip for 2 to 5 days of selling.
- Are limited by capital and processing technologies, such as grading and packaging methods.
- Major transport means include bicycles, donkeys and motorcycles or hired handcart or pushcart/ ox-carts.
- Number is estimated to be less than 5% of the maize producers.
- Mainly buy maize direct from farmers while in the process of drying; also involved in buying other products like beans and finger millet, depending on information they have on product prices in urban markets.
- Buying units are tins or bags, but sell per kg in urban markets; do some cleaning of the produce and packing in bags.
- Sources of capital are mainly own savings, loans given by friends, or Savings and Credit Societies (SACCos).
- Major information sources are established media (radio and newspapers), friends, customers and own observations.
- Usually hire transport.
- Can identify markets before buying the produce by asking the big traders.

Urban grain traders

- Are mainly located in cities and big towns.
- Have informal arrangement with small traders re collection of maize, payment mode and transportation.
- Buy maize mainly from small traders and sometimes directly from farmers.
- Buy and accumulate large quantity of maize ranging from 25 to 600 90kg bags per month.
- Mainly sell (retail and wholesale) to ultimate urban retailers through a broker on commission; they also sell to millers depending on the prevailing prices.
- Some know how to access production and marketing information through telephones, sms and emails including buying other crops such as sorghum, finger millets and beans.
- Own drying tarpaulins and weighing scales; own or rent premises used as stores.
- Employ casual labour to carry out sorting of the grain to achieve the qualities desired by various customers; rotten or de-germed grain is sold at lower prices to specific customers.

Urban storage during drying and selling

Large storage facilities - NCPB and warehousing receipt practitioners

- Store grain from other depots or buy/ collect directly from growers.
- Store bagged grain in large volumes and are strict on standards.
- Warehousing receipt practitioners offer storage service for a fee and even market the grain on behalf of their clients. Their stores are relatively good to guard against losses caused by spillage, rodents and rot. They however tend to store grain for too long and may suffer quality losses through discoloration.
- Own transport or are able to contract vehicles for transportation of grain from one depot to another or to milling facilities.
- Some have drying facilities.

Small-scale processors - posho millers

- Are either individuals or a group of persons engaged in maize milling for those who consume whole meal flour. Some do this after de-hulling the grains while others grind the grain directly.
- Milling equipment has limited capacity ranging from 100 to 500 kg per hour.

- Sometimes buy grain to sell to their customers. This grain is dried to 12-15% moisture content depending on how and for how long it has been stored. Customers are advised to clean (winnow) the grain before milling.

Posho mill

Large millers

- Own large milling equipment with capacity ranging from 10 to 45 ton/day and are located in major urban centres.
- Package their products in different sizes and sometimes brands to target different market segments and distribute their products to retailers.
- Their main product is sifted flour with by-products like maize germ and bran sold as cattle feed or ingredients to feed manufacturers.
- Buy their grains from large traders who are contracted, or from suppliers under specific arrangements.
- They insist on quality supplies and have strict grading standards.
- Storage and grain handling facilities are elaborate.
- Some have grain sourcing deports/ stores located a distance away from the mill.

3. The food losses - Study findings and results.

3.1 Critical Loss Points: type and level of food losses.

An overview of food losses is provided in tables 4a and 4b. The Critical loss points are summarized in Table 3.

Table 3. Critical loss points in the maize supply chain.

Critical Loss Point	Product	% loss Lugari	% loss Trans Nzoia
Harvesting	Maize on cobs	3.3	1.0
Shelling	Grain	1.6 - 3.2	0.4 - 2.0
Drying on farm	Grain	3.0	
Storage: weevil damage	Grain	8.0	10.7
Storage: discoloration (quality loss)	Grain	8.8	8.5
Posho milling	Whole meal flour	3.5	

3.2 The causes of losses and identified (potential) loss reduction measures.

Higher losses in the maize supply chains take place among the less skilled chain actors, who operate inefficiently and unhygienicly, and lack awareness of the importance of the losses and what can (easily) be done about them. In many cases adequate supervision of unskilled labour would reduce losses. However, the cost of supervision is an obstacle for small-scale farmers and rural traders.

Farmers. They undertake various activities that if not done well contribute to high losses of grain: harvesting, shelling, drying, packaging, transport and storage. Choice of seed varieties, timely harvesting and proper drying are among the techniques farmers apply to reduce losses. However, high losses occur in situations of:

- maturity of the crop coinciding with the rains;
- excessive wind at maturity;
- outbreaks of insect pests (LGB) and weevil attack;
- rotting and discoloration due to open cob tips and poor drying.

Harvesting losses in Trans-Nzoia district are significantly lower than in Lugari. The reason being that commercialization in Lugari is still low, while in Trans-Nzoia most farmers rented land hence they had to maximize returns. The ability to own tractor trailers (Trans-Nzoia) that collected maize cobs during harvesting at the pace of the harvesters contributes to the difference noted. Lugari farmers mainly hired trailers which normally worked faster than the pace of the harvesters.

Rural traders. The main causes of losses are:

- buying grain that is not well dried (15-19% moisture content);
- spillage due to torn bags and rough ground that prevents recovery as they move from one village/ household to another and grain was sold at the roadside;
- wet product due to rains
- lack of roadside shelter;
- unreliable means of transport.

Sorting out rotten cobs before shelling

Urban traders. They have storage facilities and use preservatives like malathion and actellic super dust. They normally keep grain for some time to build stock for their target markets. They have relatively reliable networks to their suppliers and buyers. Losses at this level are low as they could recover spillages by drying the grain on flat ground where spilled maize could be swept and sieved. The main activities of urban traders were purchase of grain from the small rural traders, drying and sorting, weighing and packaging. The grain held in their stores had varied moisture content depending on the number of days the grain had been dried. On average 14-15% moisture content was common among the traders visited.

- Their main losses are caused by storage pests like rats.

Posho millers. The losses are mainly caused by:

- Careless operating, leading to large spilling of flour on the floor.
- Lack of hygiene of the mill and the room, leading to contamination of the flour with dirt.

Tractor shelling

Table 4a. Summary result matrix of food losses - Lugari District

Type of loss/ Location in fsc	Cause of loss	%age lost or low quality	Stakeholders affected	Impact of loss	Reduced market value	Trends	Time/ season	Perception of stakeholders	Suggested solutions
Qn / Field - harvesting	Leftovers during stooking	1.6	Farmers	Reduced farm output			Nov-Dec	Ignored as no one has ever quantified how much is left in the farm and the value lost	-Capacity building -Strict supervision during harvesting
	Leftovers in stook trash	1.5							
	Shattered grain	0.2							
Qn / Field - transporting	Spilling	0.04	Farmers	Negligible			Nov-Dec	Ignored	Capacity building Strict supervision Sorting out rotten cobs before shelling Change of farmers perception and attitude
Qn / Posthar-vest - Tractor shelling[4]	Spillage/ shattered grain	0.7	Farmers	Reduced farm output		Spent cobs are used as fuel for cooking Reduced quality if rotten grains proceed in the FSC	Nov-Dec	Ignored as no one has ever quantified how much is lost and the value lost. Hand shelling is more efficient but is time consuming and costly. Farmers prefer tractor shelling which is fast.	
	Grains left on spent cobs	1.6		Reduced farm output					
	Rotten grain	3.2		Reduced quality					
Qn / Posthar-vest – Hand shelling	Spillage/ shattered grain	0.2	Farmers	Reduced farm output					
	Grains left on spent cobs	1.7		Reduced farm output					
	Rotten grain	6.7		Reduced quality					
Qn / Posthar-vest – Strip shelling	Spillage/shattered grain	0.02	Farmers	Negligible					
	Grains left on spent cobs	1.7		Reduced farm output					
	Rotten grain	4.4		Reduced quality					

[4] Tractor shelling: a shelling machine is connected to the tractor engine.

Type of loss/ Location in fsc	Cause of loss	%age lost or low quality	Stakeholders affected	Impact of loss	Reduced market value	Trends	Time/ season	Perception of stakeholders	Suggested solutions
Ql / Postharvest - Drying	High moisture content due to insufficient drying: penalty of 1 kg maize per bag for each 1% mc above 13.5%	3	Farmers	Economic loss: 3% of product for free to trader	3%		Nov-Dec	When the weather is unfavourable during drying, farmers sell their maize to avoid more losses (moulds) and costs incurred during drying	Organize farmers into business groups to run improved drying technology
Qn / Farm - Storage	Weevil attack	8	Farmer Traders	Economic loss	65%		Storage	Poor storage in inappropriate bags Temperature and humidity variation Poor aeration Inappropriate use of storage preservative Poor sanitation in stores	Use of gunny bags and insecticides Cereal banking Warehouse receipt system Better storage facilities
Ql-Qn - Farmer storage	Discoloration	8.8	Farmer Traders		65%		Storage		
Qn / Traders - Drying and Sorting	Spillage	0.1-0.3	Traders and Millers	Economic loss				Ignored by traders	Replacement of torn tarpaulins Own drier and storage facilities Formal business agreements
	Rotten grains	0.5							
Ql - NCPB Storage	Broken grain	1	NCPB	Reduced quality	10%			Very low moisture content in grain leaving the silos Inefficient system	
	Discoloration								
Ql - Warehouses and milling storage	Broken and discoloured grain	0.01		Negligible				Privately owned system is efficient	
Qn – Posho milling	Spillage Contamination	3.5	Households	Financial loss					Good Manufacturing Practices

Qn = Quantitative; Ql = Qualitative

Table 4b. Summary result matrix of food losses – Trans-Nzoia-West District

Location in the FSC	Cause of loss	%age lost or low quality	Stakeholders affected	Impact of loss	Reduced market value	Trends	Time/ season	Perception of stakeholders	Suggested solutions
Qn / Field - harvesting	Left overs during stooking	0.3	Farmers	Reduced farm output			Nov-Dec	Ignored as no one has ever quantified how much is left in the farm and the value lost	-Capacity building -strict supervision during harvesting time
	Leftovers in stook trash	0.2							
	Shattered grain	0.5							
Qn / Field - transporting	Spilling	0.04	Farmers	Negligible			Nov-Dec	Ignored	
Qn / Posthar-vest - Tractor shelling	Spilling	0.7	Farmers	Reduced farm output			Nov-Dec	Ignored	Changing farmers perception and atti-tude.
	Grains left on spent cobs	2.4							
Qn / Posthar-vest – Hand shelling	Spilling	0.6							
	Grains left on spent cobs	1.7							
Qn / Posthar-vest – Strip shelling	Spilling	0.2							
	Grains left on spent cobs	1.3							
Qn / Farm – Storage	Weevil attack	10.7	Farmer Traders	Reduced quantity and quality Rejection of the product		Late harvest hence attack by weevils while still in the field. Lack of treat-ment before storage attack increases		-Poor storage in inap-propriate bags and other vessels -temperature and hu-midity variation - poor aeration -inappropriate use of storage preservative -poor sanitation in stores	Use of gunny bags and insecticides Cereal banking Ware house receipt system Proper storage facili-ties
Ql / Farm – Storage	Discoloration	8.5	Farmer Traders	Reduced quantity and quality Rejection of the product		In large quanti-ties it's used as animal feed			
	Broken grain	2.9							

Hand shelling

3.3 Good Practices and Low Loss Points.

The low losses noted (Table 5) at the various points were due to the business orientation of the actors and their putting in place systems that reduce losses e.g. contracting services at agreed terms and conditions, carefully selecting reliable transport, minimizing storage periods and recovering of spilled grain.

Table 5. Low loss points in the maize supply chain.

Low Loss Point	Product	% loss Lugari	% loss Trans Nzoia	Good Practice
Formal milling	Sifted flour	-	1	Profit driven systems
Transportation and marketing	Grain	0.03	-	Appropriate transport, profit driven actions
Trader (rotten grains)	Grain	0.4	-	Commercial orientation
Trader (spillage)	Grain	0.1	-	Commercial orientation

4. Food Loss Reduction Strategy - Conclusions and Recommendations.

4.1 Food loss reduction measures.

The interventions suggested need a thorough analysis of their economic feasibility, environmental impact as well as social acceptability and way they are going to be managed, before they can become actual recommendations.

1. Mobile grain driers and improved storage at community level. When farmers can't properly dry their grain (<13.5%), they incur penalties at the point of sales, and/or the grain is at risk of getting spoilt during storage. Mobile grain driers operating in an area could provide a solution. Farmers need to be organized into business groups to be able to run and manage these driers. The driers can be positioned in rural centres equipped with sieves and tarpaulins that can be borrowed or rented at agreed terms. Driers need to be accompanied by hermitic bags and spacious storage facilities in the farming community. An additional benefit would be that farmers can delay selling until prices get higher.
2. Small metal silos for grain storage. This would address losses by individual farmers resulting from poor storage conditions such as leaking roofs, poor palleting and torn packaging materials. The smallest silo has a capacity of 500 kg and costs KES 3,750 (USD 44).
3. Mechanized harvesting. This practice has been tried in Narok County, but requires further research to determine the feasibility in terms of cost-benefit.
4. Producer sensitization and training. Sensitize smallholder maize growers on harvesting at the right maturity period of maize that varies with the varieties. Show them advantages and disadvantages of the stooking practice vs. direct harvesting and promote the practice with lower losses. Sensitize farmers on the value lost as a result of spilling, shattering and incomplete shelling. Further, the use of adequate shelling and drying materials like bags and tarpaulins is critical in reducing losses resulting from shattering and spillage. It is necessary to carry out the operations in designated locations where spilled or shattered grain is recoverable.
5. Equipment calibration. Regular calibration of shelling equipment would reduce quality losses from kernel breaking, shattering and grain unstripped from the spent cobs.
6. Grain drying centres. Urban traders need designated grain drying centres where recovery of spilled grain is possible and where sieving, grain cleaning, drying, weighing and packaging facilities are installed for use by the traders.
7. Grain consolidation centres. To reduce the losses incurred at small farmer and trader level, it would be necessary to establish formal grain bulking centres for farmers to store and sell their grain. This will encourage buyers to carry grain in adequate quantities using sound transport. It will also reduce losses through spillage observed at several roadside points where currently the small traders exchange with individual sellers.

4.2 Food loss reduction strategy.

1. Awareness raising combined with training and organization of smallholders.

   The strategy approach is to build capacity of supply chain actors to recognise the effect of food losses on food security and on their economic benefits, and the need for upgrading and developing the supply chain for better business performance. The target groups are small commercial maize farmers, traders and small millers. Sensitization and mobilization of these actors has to be carried out to change attitudes and perceptions regarding the impact of losses on their margins.

2. Value chain development and organization.

   For enhancing food quality along the supply chain it is important to take collective action in grain sorting, cleaning drying and storage. Putting in place practical interventions for reducing both quality and quantity losses requires partnerships and collaboration. For example, to make storage effective and viable the quantity of grain to be stored, storage period and location of stores has to be coordinated. The following elements are essential:

   - *Inclusiveness:* including all actors – particularly smallholder farmers – in the supply chain processes to ensure development, where different interests are negotiated while providing freedom for innovation and entrepreneurial forces.
   - *Performance evaluation* of each actor in terms of gains, loss reduction achievements. Continuous monitoring mechanisms need to be designed and internalized by all the actors
   - *Roles assigned* to allow those actors who are best suited to play them. A continuous assessment of traditional and non-traditional actors will identify those who are best placed to lead. In many cases this might be new partnerships (public - private) which can best deal with the complex issues involved in agribusiness. The issue is not people or institutions, but performance.
   - *Systemic approach:* the strategy aims at developing functional systems that enhance each actor's performance through its interventions. It does not encourage single activities that have no impact on the functioning of the systems.
   - *Transformation:* the present situation is largely influenced by the status quo of institutions, attitudes and people. The strategy aims at transforming people's attitudes and that of institutions and organizations to unleash the potential that they have.
   - *Quality management systems,* especially Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) need to be promoted and implemented.

3. Centralisation and contract services.

   Farmer managed facilities adequate to dry grain, weigh, pack and store will be required in designated rural areas. The supposedly motorized driers that are tractor drawn and can operate within short distances should cover at least 3-4 neighbouring centres where storage sheds will be located to hold dried grain before it is sold.

   Entrepreneurs will be introduced to initiatives to enhance value adding services. One such initiative is to establish grain bulking centres that are located within the reach of growers. The centres will obtain their revenues from the provision of drying, grading and packing services. This will improve grain quality and provide sustainable sources of revenue for Grain Bulking Centres (GBCs)/ Village Aggregation Centres (VACs), and provide equipment on a rental basis to farmers who otherwise couldn't afford it. Eventually, these centres, individuals and other traders will be encouraged to go into partnerships, alliances and networking and be in a position to qualify for funding from commercial financial agencies for further development.

   There will be possibilities of establishing other business wings through expanding to privately run mechanization services, establishment of mobile grain driers and measuring/ weighing/ grading equipment. Further, an option would be contracting maize growers on behalf of large processors which, in turn, would encourage grain buyers to offer differentiated prices to smallholders based upon different quality grades, thereby increasing incentives for improved handling.

   This approach will require strong linkages to be promoted by buyers' presence in frequent match making forums.

   Helping warehouse managers and grain buyers to utilize moisture meters and other crop conditioning equipment would pay measurable and lasting dividends. This will be expected to trans-

late into higher farm gate prices, lower product losses during storage and improved sales revenue for traders and grain storage centres.

For this the following is required from the public sector:

- Infrastructure development (roads, electricity) at grain dealing centres to be able to provide harvesting, transport, shelling, drying and bagging services in rural areas.
- Incentives for private investments and management capacity for the centres.

ANNEXES

i. Acronyms.

ASCU	Agriculture Sector Coordination Unit
CGA	Cereal Growers Association
FSC	Food Supply Chain
GBC	Grain Bulking Centres
GMP	Good Manufacturing Practices
KES	Kenya shilling
KMDP	Kenya Maize Development Programme
LGB	Larger Grain Borer
MoA	Ministry of Agriculture
NASEP	National Agricultural Sector Extension Policy
NCPB	National Cereals and Produce Board
SACCo	Savings and Credit Society
USAID	United States Agency for International Development
VAC	Village Aggregation Centres
WFP	World Food Programme

Currency exchange rate

USD 1.00 - KES 85

KES 100.00 - USD 1.18

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iii. List of experts consulted

Expert Name	**Title/Position**	**Institution**
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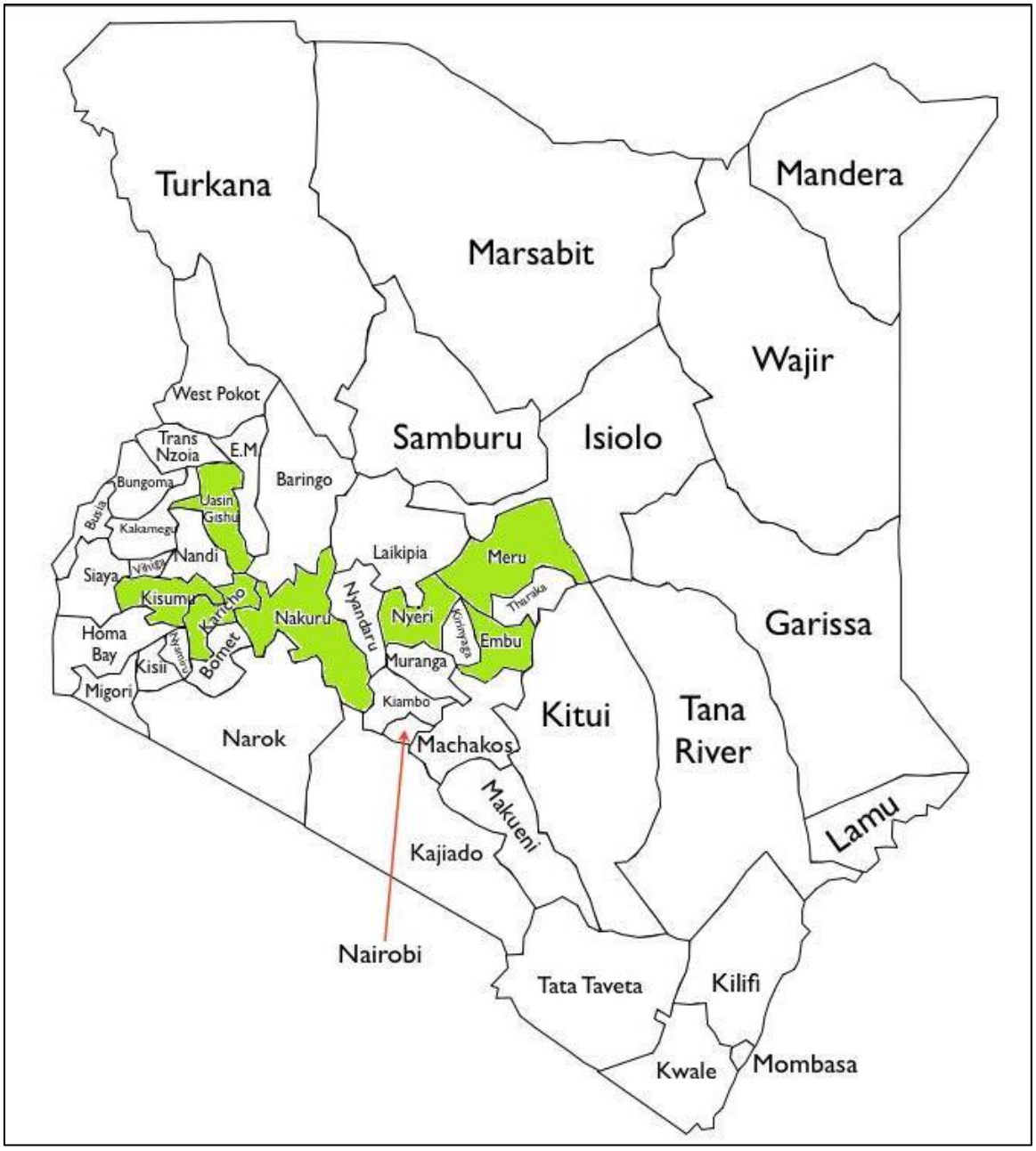
Nyaga	SADA/PH	MoA –Crop Protection Division

III.

M I L K

Field studies in Embu - Meru - Nyeri - Nakuru - Uasin Gishu - Kisumu - Kericho Counties

November – December 2012



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1. The Dairy Subsector - Introduction and Background.

1.1 Status and importance of the dairy subsector.

Kenya has about 3.4 million head of dairy cattle composed of approximately 50% pure dairy breeds and 50% crosses, 14.1 million head of zebu cattle (local breeds), 3 million head of camels, about 200,000 head of dairy goats and 27 million meat goats (KNBS, 2009). Milk from the dairy cattle herd contributes the bulk of the marketed production although milk from the other dairy animals is important for rural and home consumption.

Table 1. Estimated population of dairy animals and the percentage contribution to annual milk production (based on KNBS, 2009 census results).

Species / breed type	Number of heads	Milk production (ton/year)	Milk production (% contribution)
Improved dairy cattle	3,400,000	2,500,000	60.3
Zebu	14,100,000	640,000	15.4
Camel	3,000,000	750,000	18.1
Indigenous goat	27,600,000	250,000	6.0
Improved dairy goat	200,000	7,000	0.2

Milk production in Kenya is rain-fed. Production increases during the wet seasons resulting in surplus milk being produced, while milk scarcity is reported during the dry seasons resulting in increases in milk imports to meet market demand.

Until the late 1970s, Kenya was a net exporter of dairy products. Since then, Kenya oscillates between net exporter and importer of dairy products but can be considered as self-sufficient in milk and dairy products with a potential to be a net exporter.

Annual milk production from all dairy animals combined (Table 2 and 3) is reported to be between 3 and 5 billion litres. This is more than 10 million litres a day from all species or over 6 million litres a day from the dairy herd alone. Over 80% of the 6 million litres a day is from the smallholder dairy producers, who are also the main suppliers of the marketed portion.

Agriculture and forestry contribute slightly more than 20% of Gross Domestic Product (GDP). Livestock contributes about 30% of agricultural GDP and about 10% of total GDP. Dairy products (excluding live animals) contribute 30% of livestock GDP and more than 22% of livestock's gross marketed products.

According to Omore, Lore and Staal (2004), the number of smallholder dairy farms is about 1.8 million (ILRI, 2004) which is much higher than the official estimate of 650,000 at the time. The recent Kenya Dairy Board (KDB) estimates are lower at 1 million households (KDB, 2010). Each smallholder dairy farmer has about 3 dairy cows. There are also about 200 large-scale farmers with an estimated 250,000 head of grade cattle between them. The over 1 million smallholder dairy farms represent 35% of rural households and 26% of total households in Kenya (KNBS, 2009). Most of the farmers combine dairy production with maize, or other cash crops. The International Livestock Research Institute (ILRI,) estimates that 40% of the smallholder dairy farmers' income is from dairying. Income from dairy is the only year-long recurrent revenue from agriculture, though revenue flows fluctuate seasonally.

Table 2. Production information for the dairy subsector.

Total national production	**Volume ton/year**	**Value USD/year**	**Remarks**
Raw milk - all animals	5.2 million	1530 million	90-95% of the milk produced in Kenya is produced by 1.8 million small scale dairy farmers
Raw milk – dairy cattle	2.5 million		
Domestic milk products in 2011 marketed through formal channels	**Volume ton/year**	**Value USD/year**	**Remarks**
Fresh pasteurized milk	373,000	307 million	Accounts for 68% of total milk intake Sold mainly in the local market
UHT white milk	84,000	178 million	- Produced by Brookside, New KCC and Sameer & Agriculture - Over 90% sold in Kenya and rest exported - Accounts for 15% of manufactured dairy products
Cultured milk	38,400	59 million	Accounts for 7% of manufactured dairy products
Yoghurt	36,800	113 million	- Accounts for 7% of manufactured dairy products - Consumed mainly in Nairobi and Eastern provinces
UHT Flavoured milk	14,800	31 million	Accounts for 3% of manufactured dairy products
Powder milk	1,200	6,212,000	Produced by New KCC
Cheese	54	508,000	
Export in 2011	**Volume ton/year**	**Value USD/year**	**Remarks**
Milk and cream, not concentrated or sweetened	7,600	6,727,000	Over 95% exported to the EAC region
Milk and cream, concentrated or sweetened	2,500	5,707,000	Exported mainly to COMESA and EAC region
Butter and other oils derived from milk	900	3,165,000	Exported to Arabian countries such as Egypt, UAE and Asian countries such as Malaysia
Buttermilk and yogurt	376	486,000	Exports to EAC region account for over 87%
Cheese and Curd	61	423,000	Exported to the EAC region, Sudan and Ethiopia
Level of processing	**Fraction of produce**	**Value**	**Remarks**
Small: 1200 actors	15%		- Handling less than 5,000 litres per day - Milk bars, cottage industries and mini dairies
Medium: 33 actors	27%		- Handle between 5,000 and 100,000 litres per day - Mini dairies and medium scale milk processors
Large: 2 actors	58%		- Handling over 100,000 litres per day Brookside and New KCC
Level of trading/ wholesale	**Fraction of produce**	**Value**	**Remarks**
Small dukas and kiosks	70%		
Middle size stores	20%		
Self service stores	10%		

1.2 Inventory of activities and lessons learnt from past and on-going interventions.

The Eastern Africa Agricultural Productivity Project (EAAPP) is a World Bank supported programme for the period 2010 - 2014 implemented by ASARECA with KARI as lead institution in Kenya. The project focuses on the dairy sector and has plans to set up a regional Dairy Centre of Excellence (DCoE) because of Kenya's relative comparative advantage in the dairy industry in terms of superior genetics, feeding technologies, animal health technologies and organization of farmer producer units. The goal of the DCoE is to improve the livelihoods of smallholder dairy farmers within the Eastern Africa region through development, testing and dissemination of tech-

nologies, knowledge and information that will assist in building a globally competitive dairy industry in the region. Priority areas of research include animal genetic improvement, feed resource utilization covering fodder and pasture, processing and value addition and socioeconomics which includes farmer oriented socio-economic studies, policy analysis and impact assessment studies.

The East African Dairy Development Programme (EADDP) is a Bill and Melinda Gates Foundation funded project which started in 2008 with a grant of USD 43 million. Its main objective is to increase farm level incomes in Kenya, Uganda and Rwanda. In Kenya, the project has targeted 110,000 farmers. The strategy adopted by the project is to set up co-operatives which enable farmers to bulk milk for ease of marketing and benefit from economies of scale. To address milk quality constraints which result in rejection of milk due to poor quality, the project has assisted farmer groups to set up 22 milk chilling plants. Bulking and cooling milk has helped farmers to negotiate better prices as well as curb quality related losses.

The project has a component specifically addressing post-harvest milk losses which is developing affordable milk transport containers (MTC) made of food grade plastic and a Hot Milk Holding System (HMHS). The MTC which is cheaper than the aluminium cans and easy to handle during transportation is expected to be an alternative to the ordinary plastic jerricans, which are non-food grade, currently used by small scale farmers and milk traders. The HMHS has not registered significant progress due to milk curdling when held in the hot holding system for a long time and is still on trial at the laboratory level. The innovations will be introduced on a pilot basis and if successful will be scaled up to other parts of the country.

The programme has been very active in setting up milk bulking centres. EADD II will run from 2014 to 2019. The project targets 136,000 smallholder farm families in East Africa. In Kenya EADD II will Work with 58,000 dairy farmers to strengthen EADD I hubs, pilot innovative techniques and build capacity of the Kenya dairy farmers. The funding for the second phase is USD 25.5 million.

The Kenya Dairy Sector Competitiveness Programme (KDSCP) was a five year program concluded in 2012 to improve Kenya's dairy industry competitiveness. The program which was funded by USAID employed a market driven value chain approach, utilizing a Business Development Services (BDS) methodology. The programme was implemented through the NGO Land O' Lakes. The programme is credited with initiating several farmer milk marketing groups/ federations, the development of a reader friendly code of practice for the dairy industry, a Good Manufacturing Practices (GMP) standard for small and medium scale enterprises, formulation of draft dairy regulations, technical capacity building of KDB dairy inspectors and initiating the concept of milk quality based payment systems. Some of these activities were however not fully completed by the time the programme came to an end and therefore present a potential area for support.

The Smallholder Dairy Commercialization Programme (SDCP) is a Kenya Government dairy development programme supported by IFAD (USD 20 million) with an emphasis on commercialization of dairying and dairy products through the Market Oriented Dairy Enterprises (MODE) approach. The Programme commenced in July 2006 with a completion date of 30 September 2015 and aims to increase the income of poor rural households that depend substantially on production and trade of dairy products for their livelihoods. The programme aims to: (a) improve the financial returns of market oriented production and trade activities by small operators through improved information on market opportunities, increased productivity, cost reduction, value adding and more reliable trade relations; and (b) enable more rural households to create employment through, and benefit from, expanded opportunities for market-oriented dairy activities, as a result of strengthened farmer organizations.

The programme targets 120,000 people (resource poor dairy farmers, part time dairy farmers, small-scale intensive dairy farmers, crop oriented farmers with dairy cows, small-scale milk bars and shop operators and mobile milk traders) in approximately 24,000 households through 600 groups in nine

districts. It is being implemented through four components: i) organization and enterprise skills development, ii) technical support to smallholder dairy producers to participate and benefit from market driven commercialization, iii) development of a marketing chain through which the programme plans to install three milk coolers and iv) support to policy formulation and legal frameworks. This programme has developed farmer training modules and is in the process of installing milk coolers to enhance milk marketing. It has however faced challenges of enhancing production and milk marketing in some of the target areas.

Capacity development services are being provided by the Netherlands Development Organisation (SNV), an international non-profit development organisation. It works in collaboration with both public and private players in the Kenya dairy industry to increase investments, enhance productivity and quality of milk, and enable pro-poor access to formal markets while promoting business development services to achieve greater outreach, cost efficiency and sustainability through:

- Support to 11 dairy business hubs in 3 regions to promote commercialisation of the sector.
- Increased youth participation in the dairy industry to ensure sustainability and adoption of new practices, knowledge and technology through vocational skills development.
- Feed conservation and fodder development as a service paid for by farmers to improve animal productivity.
- Dairy value chain governance to foster an enabling environment to ensure that interests of farmers are secured.

1.3 Policy framework or national strategy.

Prior to the liberalization of the Kenyan dairy industry in 1992, milk marketing in Kenya was monopolised by Kenya Co-operative Creameries (KCC) which had a chain of milk cooling centres and processing plants in the major milk producing and consumption areas. Milk supply to the cooling centres was supported by a well-organized network of dairy farmers co-operative societies.

However, by the mid to late 1990s, KCC was faced with a number of challenges among them political interference, mismanagement of resources and competition from the then emerging informal sector and small scale milk processors. By 2003 it had become evident that KCC could no longer sustain formal milk marketing in the country and the operations of the emerging small scale milk processors were too low to meet the market demands (MOLD, 2010).

This necessitated a change in the regulatory provisions through a gazette notice of 2004 to allow licensing of small scale milk traders to legally participate in the dairy trade. The small scale milk traders basically dealt in marketing raw milk to consumers, a matter that was of grave concern to the regulatory authorities. A key supporting aspect of the policy change was the development of modules for training (milk handling, processing and marketing) and certification of vendors in order to improve milk quality (SDP, 2009) and a Good Manufacturing Practice (GMP) standard targeting small scale milk traders operating milk bars, milk collection centres and processing plants. A code of hygienic practice for the dairy industry was also developed to educate players along the value chain on the requirements of hygienic milk handling practices. The Kenya Dairy Board reviewed the dairy premises inspection checklists to accommodate the operations of small scale milk traders.

As part of the on-going development and the need for pro-poor strategies for small-scale milk market development, the Dairy Traders Association (DTA) of Kenya was officially launched in September 2009. Its aims and activities included self-regulation based on the training and certification concept originally developed by SITE (Strengthening Informal Sector Training and Enterprise) and scaled up by KDB. Around 4,000 small scale milk vendors, offering employment to over 10,000 people, have since been trained, certified and licensed by the KDB through the association (SDP, 2009).

The Kenya vision 2030 (medium term plan) has identified the dairy subsector as having a huge potential in contributing to the economic development of the country, being the largest agricultural subsector in value (KES 100 billion). This potential can however only be realised if there are systems in place to curb losses both in quality and economic value.

Despite the importance and the existence of information on post harvest milk losses, there has been no apparent effort to incorporate post harvest milk losses in national policies. The only policy indirectly relevant to post harvest milk losses is a section contained in the sessional paper on National Livestock Policy which states *"To improve the infrastructure, the Government will develop and rehabilitate livestock marketing infrastructure in collaboration with the relevant stakeholders. In particular, the local county councils (government) will plough back some of the cess (levy) revenue towards the development of livestock marketing infrastructure in order to improve local livestock market ..."*.

1.4 Relevant institutions and their roles.

Liberalization of the Kenyan dairy industry in 1992, saw the milk marketing monopoly of the Kenya Co-operative Creameries (KCC) ending and the opening up of the market to other players. KCC continues to have a chain of milk cooling centres and processing plants in the major milk producing and consumption areas.

The gazette notice of 2004 allowed licensing of small scale milk traders to legally participate in the dairy trade. The Dairy Traders Association (DTA) of Kenya set up in 2009 promotes self-regulation based on the training and certification concept originally developed by SITE (Strengthening Informal Sector Training and Enterprise) and scaled up by KDB.

The dairy sector has a number of institutions involved in its activities which include: farmer groups/ organisations, regulatory institutions, input suppliers, service providers, market agents, research institutions and development organisations.

Co-operatives and other farmer groups such as self-help groups (SHG) assist farmers to acquire credit and inputs and sell their produce. There are about 300 active dairy societies (co-operatives) (CBS, 2011). Dairy co-ops have in the past significantly contributed to the development of smallholder milk marketing and provision of farm inputs and services at a relatively lower cost; however in the 1980s and 90s, they came under threat after the liberalisation of the dairy industry. But there have been efforts to revive and establish farmer groups to enhance milk marketing efficiency. Close to 400 self-help groups that deal in marketing of raw milk have been licensed. Some of the co-operatives and self-help groups have also converted into farmer owned companies. As a result, according to the major milk processors, over 90% of the milk marketed today is marketed through groups.

The regulatory institutions include the Kenya Dairy Board (KDB) which plays the lead role in dairy regulation, government ministries such as the Ministry of Agriculture, Livestock and Fisheries (MALF), Ministry of Health (MoH) - Public Health Department, Ministry of Commerce, Tourism and East Africa Region, the Kenya Bureau of Standards (KEBS), Ministry of Co-operative Development (MoCD), and parastatals such as the Kenya Agricultural Research Institute (KARI) and the Veterinary Vaccine Production Centre (VVPC).

KDB was established in 1958 under the Dairy Industry Act (CAP 336) to organise, regulate and develop the dairy industry in Kenya. The board's role is to ensure efficient production, marketing, distribution and supply of milk and dairy products while having regard to consumer preferences.

KEBS is the government's principal body that is mandated to facilitate and or/ guide the development of appropriate standardization and conformity assessment mechanisms for goods and services including those of the dairy sub-sector. Some of the activities undertaken by KEBS include among others the issuance of quality conformity marks; offer Pre-export Verification of Conformity

(PVoC), systems certification against ISO standards, quality assurance and testing, inspections, metrology and calibration services and standards development.

The main role of the Public Health Division, both under the Ministry of Health and local authorities, is to ensure the maintenance of hygiene in handling and premises that deal with food items including milk.

While in the past regulatory institutions were well known for their enthusiasm in cessing and enforcing the policing functions of their mandates, there has been effort by these organizations to be more stakeholder-friendly and relevant in recent years. The KDB relationship with stakeholders is now more service oriented. This is reflected in the Board's mission, which is: to efficiently and sustainably develop, promote and regulate the dairy industry and create an enabling environment for increased private sector entrepreneurship in milk production, processing and marketing. The regulatory bodies are however constrained by lack of resources in terms of personnel and equipment although there have been attempts to improve the situation.

Input suppliers and service providers to the dairy industry include shopkeepers at various urban centres, animal health practitioners some of whom are not qualified, extension officers, dairy NGOs and farmers' groups such as co-operatives and self-help groups. While they should offer quality inputs at competitive prices keeping pace with new technologies and ensuring proper practices and use of inputs, there are concerns particularly with regard to quality of inputs and service provision in the case of feeds and veterinary services.

There are few agricultural credit institutions in Kenya. A study of dairy farm households between 1997 and 2000 by SDP (2000) showed that only 3.8% of dairy farmers had ever taken credit from co-operative societies and commercial banks. The major limitations on accessing commercial credit are interest rates, collateral requirements and inadequate grace period in case of dairy farming. Most of the financial institutions have attempted to ease requirements for credit security by: allowing the asset procured by the credit to be the security; combining insurance with the credit package; and/or by encouraging individuals to form groups for the purpose of guaranteeing each other.

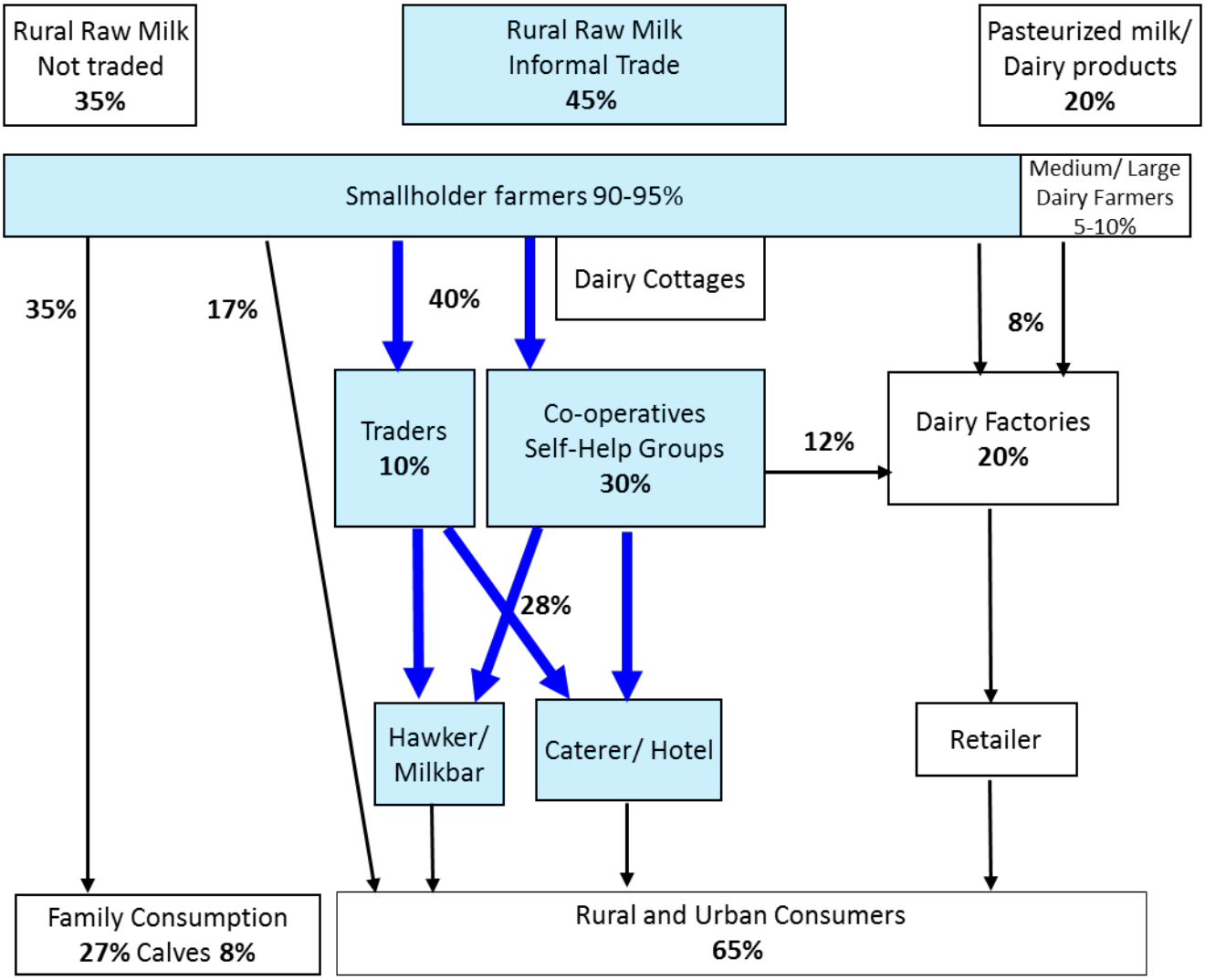
On-farm milk

2. The Dairy Supply Chains - Situation analysis.

2.1 The selected dairy supply chains.

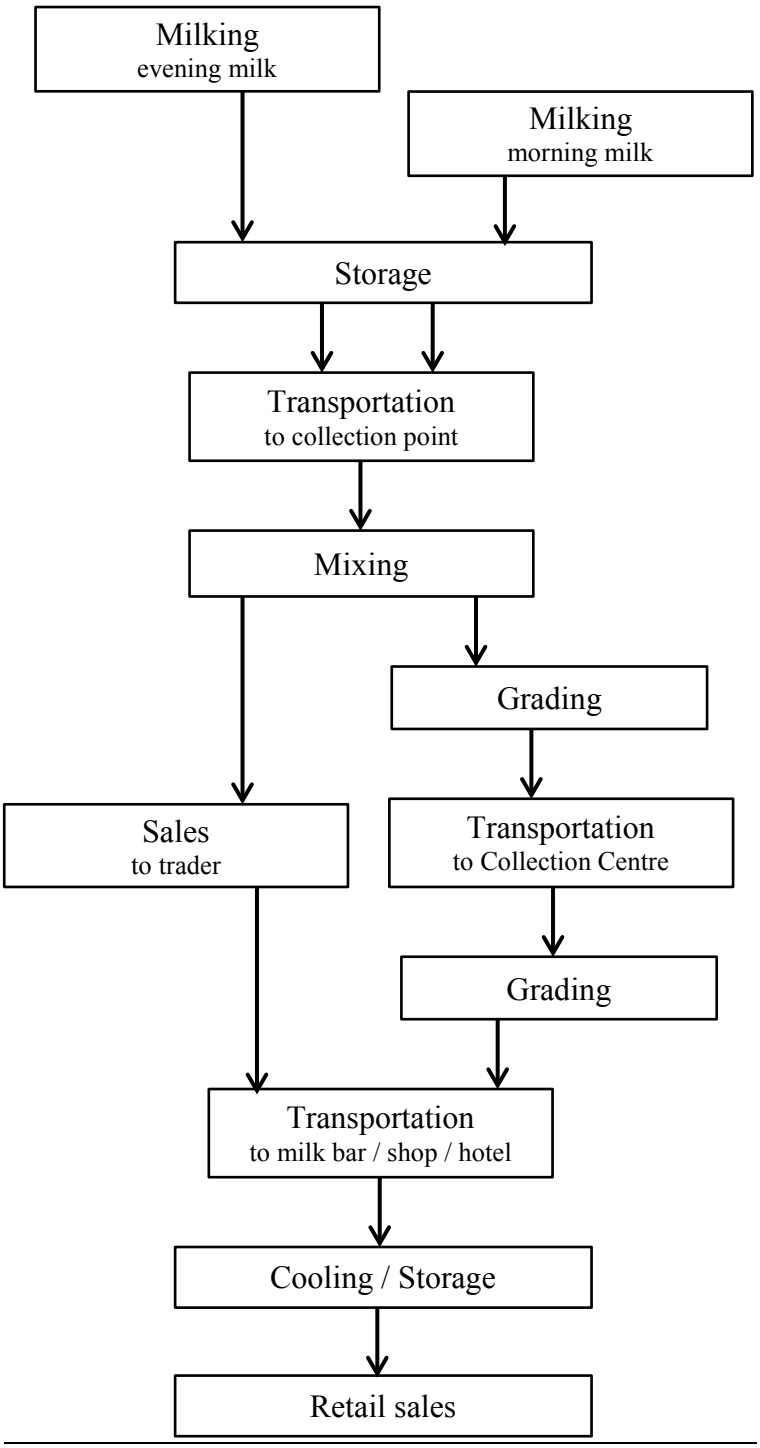
The milk supply system from the dairy cattle in Kenya is complex having both formal and informal supply chains. See figure 1. A large proportion (35%) of the milk produced is consumed in producer households, for the family (27%) and for calves (8%). Another 17% is supplied directly, unprocessed to the neighbourhood and 40% is supplied to consumers through co-operatives, shops and kiosks. Finally 8% is passing through dairy processing factories. Milk losses in supply to own family and the neighbourhood are minimal due to the proximity of the consumers.

Figure 1. Actors in the Kenya Milk Supply Chains.



The percentages indicate the fraction of milk that is produced by, or passed on to the actors. The thick blue arrows indicate the selected supply chains in the study.

Figure 2. Milk supply chain.



Most of the farmer groups and large scale milk traders handle between 500 litres and 4,000 litres per day while small scale transporters handle between 50 and 500 litres. They supply milk to processors, particularly the morning milk, and also to their own milk bars, or milk bars owned by other traders. Both the large scale traders and the farmers groups source milk from different farmers. No milk quality analysis is done during milk collection from the farmers. The milk is bulked without cooling and transported to the processors collection centre or milk bars. Where milk was delivered to the processors' milk collection centres, quality analysis was done, resulting in rejections at times.

Most of the milk is being transported through groups which have an organised mode of transport, mostly pick-ups. Small scale traders or hawkers who are now entering the business are using motorbikes for milk transport with banks availing loans to facilitate purchase of the motorbike. Other

means of milk transport include public transport vehicles (matatus and buses) for milk being transported over long distances to urban areas. This is a common mode of transport even though it is unacceptable according to Kenya Dairy Board due to the suspected potential for contamination. Farmers delivering milk on foot and bicycles are those within short distances from milk collection centres.

In both the unprocessed and processed milk pathways, milk can at times pass through many intermediaries before reaching the consumer. The supply chain of both the formal and informal market is fragmented with a large number of players at each step, and a low level of vertical integration. A major characteristic of the milk supply chain has been (and still is in many areas) the low level of cold chain utilization, which lowers the quality of milk, affects the keeping quality of processed dairy products and limits the choice of dairy processing.

There is an increasing awareness of milk quality across the milk supply chain. The quality tests done on milk delivered to the collection centres are lactometer reading and alcohol test[5] particularly for sales to the formal sector. Some collection centres have chilling plants while others do not.

2.2 Marketing systems.

Competition for milk by milk marketers is a result of complex dynamics. Increasing demand for milk and milk products has been associated with increasing urban population and incomes (Dairy Master Plan, 2010) and neighbouring milk deficit countries present a growing market for Kenyan dairy produce. As a result, there is stiff competition for milk at the farm level amongst processors, large scale milk traders and groups that carry out processing and marketing of milk. Increasingly buyers/ processors are supporting backward linkages to secure milk supplies from farmers and farmers groups.

Most of the milk in the informal trade is marketed through co-operatives, self-help groups or farmer based companies. Milk transport to the co-operative owned milk collection centres is arranged by farmers and involves milk bulking in collection points by the road side before the same is collected by a vehicle to the collection centre. From the collection centre, the milk is then transported to the milk processing plants or milk bars in urban areas.

Individual farmers supply milk directly or via middle men to milk bars, mini dairies, processing plants or consumers. In terms of milk marketing, self-help groups and farmer milk companies operations are similar to those of milk co-operatives.

The formal milk trade is the market segment licensed by KDB. Licences are issued for, among others, milk bars (for up to 1,000 litres/day), cottage industries who deal with on-farm milk processing, mini dairies (up to 5,000 litres/day), processors (above 5,000 litres/day) and producers who deliver raw milk to milk bars in urban areas. Milk cooling plants are also licensed. Over 80% of the milk processed by the formal sector is handled by the milk processors.

There is an increasing interest in milk collection and bulking by small scale dairy farmers driven by higher returns. Farmers have established groups which are either registered as self–help groups or cooperatives or as companies. The motivation for this group formation include among others:

- To enhance negotiation capacity for better producer prices. Most of the processors and other milk traders are currently paying a premium for quantity of milk delivered where farmers supplying more than 500 litres are paid 1 KES/ltr more than farmers delivering lower daily volumes.
- To benefit from the economies of scale in milk transport to the market. Most of these small scale milk producers sell about 5 – 20 litres of milk per day. Bulking to 200 litres and more enables reduction of transport costs.

[5] Lactoscan test to identify water adulteration of the milk; alcohol test to measure microbial contamination.

As a result of increased competition for the available milk at the farm level, farmers have designed various ways of preserving the evening milk, previously consumed at home due to lack of a market outlet (forced consumption). Evening milk is now not only sold to neighbours but also to other milk outlets/ markets with the morning milk thus enhancing household incomes. Most of the self-help groups and large scale milk traders accept evening milk if it meets the basic milk quality requirements. Where it is accepted, farmers are expected to deliver and declare evening milk separately. Evening milk is bulked separately at the collection centres so that the same is promptly disposed of. Most processors do not accept evening milk and therefore most of it is sold through milk bars.

There is an increased use of the cold chain as compared to 7 - 8 years ago. This is driven by pricing premiums given by processors for delivery of chilled milk, and supported by the many programmes of development partners that enable farmers to acquire a milk cooler.

In the past, small scale milk traders operated as milk hawkers moving milk from place to place, resulting in milk losses. However, in recent years there has been an increase in small scale traders who operate milk bars licensed by Kenya Dairy Board through which they dispense their milk. One of the requirements by the Board for applicants to get a milk bar license is to have a system for milk cooling. As a result, almost all the milk bars have a freezer which is modified to work as a milk cooler. Milk bar owners however expressed concern over the high electricity bills. Based on figures presented during the study, the milk bar spends KES 2 for every litre of milk. This will rise to uneconomic levels if the Kenya Dairy Board demands that all milk marketed should be processed (pasteurized), a matter which is currently a big threat to the survival of small scale businesses.

The Case of the Mathira Dairy Farmers Society.

The Mathira Farmers Society was established in 2003. It is an umbrella body for 35 self-help groups with each group being registered and having its own officials. In total, the society has 2000 members. The society has pick-up vehicles assigned to collect milk from all the 35 groups. Each vehicle has a daily route that takes about 3 – 4 hours to run. Milking is done by 4:30 am with milk collection being starting at 5:00 am. Each vehicle is accompanied by a clerk who does weighing of the milk by each individual farmer and ascertains quality by use of the lactometer test and occasional use of the alcohol test. Evening milk is declared, tested for quality and bulked separately. Farmers are only allowed to deliver milk in aluminium cans. Milk collected from all the groups is bulked up at the collection centre.

Milk bar

Table 3. Detailed description of the food supply chain.

FSC stage	Location	Products	Facilities/ Equipment	Duration/ Distance	Inputs and Services	Value of products KES/ltr
Primary production	Farm	Raw milk	Animal housing, Milking parlour , feed troughs		Animal feeds, extension and veterinary services	30
Milking	Farm	Raw milk	Milk can, Milking bucket, milking machine		Milking salve, supplements, mastitis testing	30
Storage	Farm	Raw milk	Milk can	12 h	-	30
Transportation	Collection/ bulking centre	Raw milk	Milk cans, collections, quality test equipment, weighing equipment, transport vehicles	1 - 3 h	Testing	33
Sales	Outlets countrywide	Raw milk	Milk cooler, testing equipment	8 h	Testing reagents, cleaning reagents	35
Boiling/ pasteurizing	Major milk producing and consumption areas	Boiled milk	Pot, stove		Gas	40 - 50
Storage	Milk bars	Raw milk, boiled milk	Milk freezer, testing equipment	12 h	Cleaning reagents	40 - 50
Retail	Milk bars	Raw milk, boiled milk	Milk freezer, testing equipment, batch pasteurizer	12 h	Cleaning reagents	40 - 50

Milk collection centre

3. The food losses - Study findings and results.

3.1 Critical Loss Points: type and level of food losses.

A 2011 study of the entire marketing chain found that milk loss was mainly due to spillage and spoilage occasioned by poor access to markets, rejection at markets, poor milk handling practices and irregular power supply in milk processing plants. Rejections were higher during the wet season, when production was high and roads impassable (H.G. Muriuki, 2011). In some areas, it was possible to market only the morning milk, creating a major constraint to increased production.

The total quantitative losses in the dairy cattle milk supply chain is estimated at 7.3%. The critical points in the milk supply chain where improvements will contribute to reduced milk losses and improved quality are: i) farm level ii) collection points/ centres iii) vendor outlets i.e. milk bars. See Table 4 and 5.

Table 4. Quantitative losses in the dairy cattle milk supply chain.

Stage in the supply chain	Percentage loss	Percentage handled	Weighed losses %	Notes
Smallholder farm	6.0	95	5.7	Mainly spoilage of evening milk
Family consumption	-	35	0	
Community supply	-	17	0	Negligible spillage due to very short supply chain
Trader collection centres	1.5	40	0.6	No cooling facility
Co-op/ SHG	0.6	30	0.2	aluminium milk containers and cooling facility
Traders/ Hawkers	0.9	10	0.1	Transport 50 – 300 ltr of milk per day on motorbikes
At milk bars and others	2.0	28	0.6	With milk cooling system, but expensive and unreliable power supply
Processors' collection centres	0.4	20	0.1	Milk rejected by the processor
Total loss along the supply chain			**7.3**	

3.2 Causes of milk losses.

The causes of milk losses are: i) poor marketing infrastructure, e.g., roads; ii) inadequate/ unhygienic handling equipment; iii) poor product quality due to lack of technical know-how, lack of equipment and lack of price incentives for efforts to improve quality; iv) lack of appropriately trained personnel along the milk supply chain; v) inappropriate transport equipment and poor handling practices and vi) lack of market intelligence.

Additional factors that cause milk losses are: i) mastitis; ii) malpractices such as water adulteration of the milk. However, less milk is proportionally lost although the quality passing through the supply chain may not have improved. During earlier studies, the marketed proportion was 55% as opposed to the current 65% of total production with household retention proportionally reduced. Milk quality tests by lactoscan, milkoscan and alcohol showed cases of water adulteration being prevalent, and most milk failing the alcohol test although it passed field alcohol tests used by the majority of milk handlers other than at the dairy plant.

Farmers however still incur losses as a result of milk rejections at the collection centres mostly due to microbial quality, with mastitis, and delays before delivery of milk to collection centre being quoted as the main cause of the high microbial load.

At the collection centres and the society premises rejections were mainly due to microbial activity and water adulteration which was found to be rampant.

While some farmers are able to preserve their evening milk and deliver the same when it is of acceptable quality, others still face a challenge in this area and deliver poor quality milk which is rejected.

Rural infrastructure – water sources, roads, electricity and other sources of energy – have also been issues of concern. Road access and availability of electricity are essential for preservation of raw milk quality (cooling).

Milk is received either based on volume or on weights. Volumetric measurement was done using a five litre container or a dip stick. Milk weight was taken with an analogue weighing balance or a digital weighing scale. Some of the analogue weighing scales are inaccurate (lower weights) by about 1 - 2 kg for every 10 kg of milk. This is a potential significant economic loss for farmers if milk measurement is not done accurately and does appear to warrant action by the relevant national regulatory authorities.

3.3 Good Practices and Low Loss Points.

Various studies on the Kenya dairy sector have observed a declining trend in milk losses pointing to increasing competition for raw milk (Muriuki, 2011), due to high national and regional market demand. The reasons for loss reduction were attributed to increased competition by milk buyers, particularly processors, who had changed the way and the point at which they received milk deliveries. Previously, the processors were in most cases waiting for milk to be delivered to the factory gate but with increasing competition by new market players, they moved as near as possible to the milk producers by deploying coolers or collection vehicles near them and engaging milk collection agents. Increased collective action by dairy groups has also facilitated this process.

Farmers have devised ways of preserving the evening milk for market the following day. Upon milking, the milk is put in an aluminium ‘sufuria’ (cooking pot), among many other forms of cooling, and stored outside in a raised ground where cold wind blows lowering the temperature of the milk to less than 15 °C and hence slowing microbial activity. This enabled the farmers to deliver the milk while it was still of acceptable quality particularly to milk bars where no stringent quality assessment is done.

Milk loss through spillage or forced consumption is negligible.

Table 5. Summary result matrix of food losses.

Critical Loss Points	Cause of loss	Percentage lost	Stakeholders affected	Impact of loss	Time/ season	Perception of stakeholders	Suggested solutions
Milking and milk storage on farm	Microbial spoilage	6.0	Farmers	Reduced income	Higher in wet season	Loss not significant	Training on: - Better animal husbandry practices to prevent mastitis - Hygienic milking practices - Evening milk preservation techniques - Sensitize farmers on speedy milk delivery
Supplying collection centres	Rejection because of microbial spoilage or water adulteration.	0.6 - 1.5	Cooperative/ SHG/ Trader	Reduced income	Higher in wet season	Loss not significant	- Train on milk quality testing techniques - Use of proper and reliable testing equipment - Sensitize speedy delivery - Use of hygienic cans - Promote installation of cooling infrastructure - Sensitize on ethical business practices
Storing and vending at milk bars	Microbial spoilage	2.0	Milk bar operators	Reduced income	Higher in wet season	Loss not significant	- Train on milk quality testing techniques - Use of proper and reliable testing equipment and reagents - Promote cold chain - Train on value addition

4. Food Loss Reduction Strategy - Conclusions and Recommendations.

4.1 Food loss reduction measures.

The interventions suggested need a thorough analysis of their economic feasibility, environmental impact as well as social acceptability and way they are going to be managed, before they can become actual recommendations.

To deal with milk losses arising out of microbial quality, water adulteration and inaccurate measuring, a number of critical areas to address require the following solutions:

1. Introduce milk quality assurance at farm level: treating mastitis; time required between calving and sale of milk; knowledge of good milking and handling practices.
2. For the better preservation of evening milk, introduce improved facilities for cooling or cold storage at farm or preferably village/ group or enterprise level.
3. Introduce milk quality assurance along the supply chain, including a standard method and equipment for milk quality testing.
4. Promote price incentives for quality milk.
5. Introduce standard milk handling and transporting containers and weighing equipment.

4.2 Food loss reduction plan and strategy.

The main strategic approach to reduce milk losses concentrates on capacity building along the milk supply chain, promoting collective milk marketing and raising awareness on ethical practices. The following are the proposed strategic measures to reduce milk losses:

1. Promotion and advancement of a quality-based milk payment system.
2. Training of farmers on farm management practices that not only improve efficiency of milk production but also the preservation of milk, particularly the evening milk.
3. Training dairy industry players on hygienic milk handling and quality testing including the use of standardized equipment and reagents.
4. Enhance industry regulation to carry out quality surveillance of milk for increased compliance to standards through training of dairy inspectors, procuring of inspection tools and setting up a regulatory laboratory.
5. Promotion of cold chain throughout the supply chains.
6. Promote and improve production and commercialization of traditional and value-added dairy products. Research on food systems that make dairy products affordable for the majority of the Kenyan population.
7. Increased investments in rural infrastructure, particularly all-weather roads and reliable electricity supply.
8. Finalize the national Dairy Development Policy as internalized by the 2010 Dairy Master Plan.

The strategic intervention could be implemented in 3 components: i) campaigns and promotion; ii) research; and iii) training and capacity building. There is need to organize a nation-wide stakeholders meeting, to develop a detailed intervention program.

ANNEXES

i. Acronyms

AFC	Agricultural Finance Corporation
ASARECA	Association for strengthening Agricultural Research in Eastern and Central Africa
BDS	Business Development Services
CBO	Community Based Organization
COMESA	Common Market for Eastern and Southern Africa
DTA	Dairy Traders Association
EAC	East African Community
EADD	East African Dairy Development Programme
FSC	Food Supply Chain
GDP	Gross Domestic Product
HMHS	Hot Milk Holding System
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
KARI	Kenya Agricultural Research Institute
KCC	Kenya Cooperative Creameries
KDB	Kenya Dairy Board
KEBS	Kenya Bureau of Standards
KES.	Kenya shilling
KNBS	Kenya National Bureau of Statistics
MALF	Ministry of Agriculture, Livestock and Fisheries
MOCD	Ministry of Cooperative Development
MOH	Ministry of Health
MOLD	Ministry of Livestock Development
MTC	Milk Transport Container
NGO	Non Governmental Organization
PCPB	Pest Control Products Board
PvoC	Pre-export Verification of Conformity
SDP	Smallholder Dairy (Research and Development) Project
SHG	Self Help Group
SITE	Strengthening Informal Sector Training and Enterprise
SME	Small and Medium Enterprise
SNV	Netherlands Development Organization
USAID	United States Agency for International Development
VVPC	Veterinary Vaccine Production Centre

Currency exchange rate

USD 1.00 - KES 85

KES 100.00 - USD 1.18

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iii Experts and informants consulted.

Mr. Geofrey Bartenge	Head, Production	New KCC
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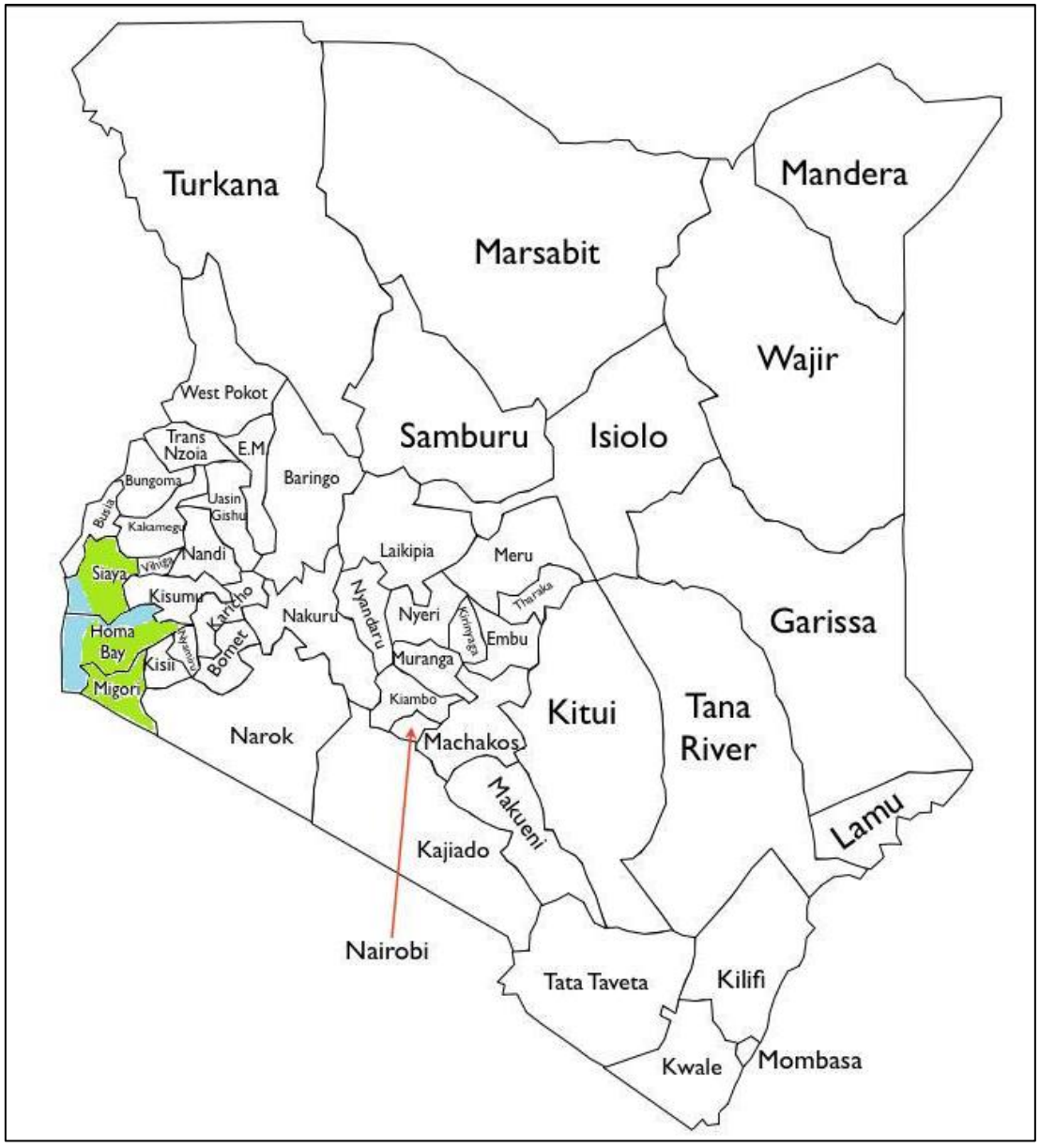
Mr. John Gethi,	Head, Milk procurement	Brookside Dairy
Mr. Gathii	Chief Executive Officer	Dairy Traders Association
Ms. Jane Maindi	Manager, Post Harvest Milk Losses Technology	East African Dairy Development Programme

IV.

F I S H

Field studies in Migori, Homabay, Siaya Counties

September – December 2012



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1. Artisanal Fisheries Sub sector - Introduction and Background.

1.1 Status and importance of the artisanal fisheries subsector.

Kenya's fisheries sector is mainly composed of freshwater (lakes, rivers and dams) and marine (Indian Ocean) fishing, with aquaculture still in its infancy. With fish production estimated at 150,000 tonnes annually, the sector contributes about 5% to the country's gross domestic product (GDP), and supports the livelihood of over 500,000 people direct or indirectly. There are at least 50,000 people working in the sector directly, mainly as fishermen, traders, processors and employees. The freshwater fisheries account for about 96% of Kenya's total fish production, with the principal water body being that of Lake Victoria. Lake Victoria production consists mainly of nile perch (*Lates niloticus*), omena (silver cyprinid - *Rastrineobola argentea*) and tilapia (*Oreochromis niloticus*). According to a government policy document on fisheries, fishing in Lake Victoria is considered to be at its maximum sustainable level and is already heading to over exploitation.

In total an estimated 111,000 Fishermen and farmers are active; fish farmers constitute 44% of the total.

Traditionally, Lake Victoria has the largest fishery in Kenya. It produced 133,800 tonnes of fish in 2011 (Fisheries Statistical Bulletin (FSB), 2011). Omena accounted for 54% (72,300 ton) of the lake's total production while tilapia contributed 17% (22,700 ton). The coastal and marine waters produced 8,900 tonnes while Lake Turkana produced 3,700 tonnes (FSB, 2011). Other major fisheries are: lakes Naivasha, Baringo, Jipe, Chala and the river Tana. Artisanal fishing is of great importance to the fishing communities along Lake Victoria and is estimated to employ some 465,000 either directly or indirectly. Fish is a major source of protein especially for low income households and provides diet diversity.

The largest species of fish processed and exported from Lake Victoria is the nile perch. Other commercially important species in the domestic market are the small sardine fish and tilapia. The nile perch is not a native species in Lake Victoria and was introduced in 1954, but did not become important until the mid-1980s, when it became popular in export markets. The catching and processing of nile perch in Kenya has grown from a local activity into a major export industry.

The domestic market commands about 70% of the total fish market. It is however not well defined or organized and involves buying fish at the beach by small scale traders and selling to various open-air markets and fish shops. Domestically consumed fish is mostly handled and processed by fish mongers and small artisans. Processing locally consumed fish involves frying, smoking and sun drying. Smoking and sun drying are normally used as long term preservation measures. Nairobi is the main destination for fish from Lake Victoria. In the urban centers fish mongers may have small private refrigeration facilities where they keep fresh fish.

Omena fishing is artisanal and omena utilization is split between the animal feed industry and human consumption, mainly in lower income households. Omena fish is mainly dried for sale. Once dried and if stored in a well-ventilated area, omena can last up to one month without serious quality deterioration. Omena is the most popular fish among the local consumers. Almost 90% of the work involved in processing and trading the omena fish is done by women. Omena fish is not only an income earner but it is also a crucial source of nutrition and livelihood for many households. Female headed households living around Lake Victoria will derive almost all their livelihood from fish related activities and are likely to be involved in the omena trade.

Tilapia fishing is artisanal with only a small proportion being industrially processed. Tilapia fish are sold either fresh, sundried, or smoked. The market is affluent consumers through supermarket chains, hotels and tourism sector. Most tilapia is sold in major towns and cities; export markets are not targeted.

Table 1: Production information for the fish subsector.

Year 2011 production	Volume Ton/year	Value USD/year	Remarks
Total fish landed	167,800	229 million	
Aquaculture	20,000		
Omena	72,300	37.9 million	
Tilapia	23,100	52.1 million	
Nile perch	47,100	108 million	
Level of processing operations	Up to 80 kg/day in peak season		Dried omena
Level of trading/ wholesale operations	Up to 500 kg/day Up to 200 ton/ month		Dried omena in Migori County Tilapia wholesale traders
Level of retail operations	About 50 kg/day Up to 50 kg/day		Omena Tilapia traders

1.2 Inventory of activities and lessons learnt from past and on-going interventions.

Recently a non-governmental organization that is helping communities to export omena came up with an ideal design for drying. This consists of raised racks within a fenced area. The racks are covered with polythene covers to protect the fish from wind, dust, rain and other elements. The polythene helps to trap heat and therefore the fish will dry faster on cloudy days. In order to benefit from the intervention, traders must commit themselves to some certain hygienic standards of handling the fish and must also organize themselves in groups. This intervention is still at its infancy stage and it is yet to be adopted in most of the beaches. Much as there is need for research to establish the slow adoption rate of the technology, it appears quite simple and less complicated and more appropriate for local adoption. It is also adapted to local conditions and is cost effective. Such simple technologies are the way to go in the future.

The government with financial support from the European Union has also introduced infrastructure to reduce fish losses, although this is relatively expensive. Most of the registered beaches have an 'ultra-modern' fish landing facility that complies with EU standards for handling fish. This facility is supposed to be fitted with ice plants, storage facilities for omena, cold storage rooms, and other facilities like washrooms, offices etc. Despite the high costs of putting up such facilities, very few are functioning, and others are uncompleted and in a state of disrepair.

1.3 Policy framework or national strategy.

The Government of Kenya has a fisheries policy with the overall objective to *"Create an enabling environment for a vibrant fishing industry based on sustainable resource exploitation providing optimal and sustainable benefits, alleviating poverty, and creating wealth, taking into consideration gender equity."* Some of the specific objectives of the policy are to:

(i) Promote responsible and sustainable utilization of fishery resources taking into account environmental concerns.
(ii) Promote the development of responsible and sustainable aquaculture, recreational and ornamental fisheries.
(iii) Ensure that Kenya has a fair access to, and benefit from, the country's shared fishery resources.

(iv) Promote responsible fish handling and preservation measures and technologies to minimize post-harvest losses.
(v) Encourage value addition, marketing and fair trade in Kenya's fishery products worldwide.
(vi) Encourage efficient and sustainable investment in the Kenya fishery sector.
(vii) Promote active involvement of fisher communities in fisheries management.
(viii) Integrate gender issues in fisheries development.
(ix) Promote fish consumption in the country.

Fishery resources in Kenya are managed by the Department of Fisheries through the Fisheries Act (Cap 378) and Maritime Act (Cap 250) of the Laws of Kenya.

1.4 Relevant institutions and their roles.

The Government of Kenya has recently emphasized fisheries co-management and strengthened the previously inefficient Beach Committees into Beach Management Units (BMUs) through the Gazette Notice on Beach Management Unit Regulations in 2000. The BMUs are responsible for vetting fishermen, monitoring, security, marketing and development of the landing sites in partnership with the government and other development partners in the sector.

The Kenya Bureau of Standards (KEBS), which sets and enforces standards for manufactured goods, is also charged with the responsibility of developing standards for locally consumed fish. To improve the quality of Kenyan fish, all fish factories have instituted stringent quality control procedures like the Hazard Analysis Critical Control Points (HACCP) system. New institutions have also emerged to implement the additional regulations required for exporting fish. The fish industry is now governed directly by at least six sets of standards operated through several Kenyan agencies and European Union (EU), the latter having the most significant regulations on the fisheries sector for the export market.

The regulations are based on the HACCP principle, and define the practices governing fish production, handling, packaging, and transporting of fishery products destined for the EU. It also imposes strict standards regarding construction of buildings, equipment, purification tanks, storage tanks intended for holding fish prior to export, on-premises laboratories, strict record keeping, and accurate labelling. EU conditions also require that processors and exporters organize an industry association to ensure self-monitoring on matters of fish quality. These standards are enforced through a competent authority – the Ministry of Fisheries Development - Department of Fisheries, approved by the EU.

Other public institutions involved with fishery activities include the Kenya Marine Fisheries Research Institute (KMFRI), the Ministry of Regional Development, Ministry of Environment and Natural Resources, universities and public laboratories.

The large-scale export-oriented private sector is organized under the Kenya Fish Processors and Exporters Association (AFIPEK), which has facilitated industry self-regulation, marketing and interfacing with the Government. The small, medium and large scale fish traders are also considering the formation of an umbrella organization, comprising trader associations aimed at influencing Government policy, providing training services and facilities to accelerate efficient and sustainable trade. A major drawback is that most of the small scale traders are not organized into strong associations. Fishermen lack strong cooperatives or associations, but there are efforts by several organizations, including the newly launched Beach Management Units (BMUs) to organize this vital group. In addition to these private sector players, there are several civil society and non-governmental organizations (NGOs) working in fisheries, especially on socio-economic and conservation issues.

2. The Artisanal Fisheries Food Supply Chain - Situation analysis.

2.1 The selected artisanal fish supply chains.

Two FSCs have been selected in this study, which are omena and tilapia from several landing sites (beaches) in Homabay, Siaya and Migori Counties.

Omena.

Fishing for omena should only be done 21 days in a month when the nights are dark with no moon-light. Besides, by regulation omena fishing should be closed between the months of April to July to allow for breeding. These regulations are hardly followed, and omena fishing may go on all year round. This has contributed to over fishing and stock reduction not just for omena but also for other species. Due to low fish stock some omena fishermen are now using motorboats to go very far off-shore into areas that have not been overfished.

Drying omena on the beach is usually very basic and 'crude'. It is done by women who dry the fish on the ground. The fish is spread on fishing nets that are hired from the fishermen at a fee. The women use brooms to turn the omena.

Figure 1. Flow diagram of the *omena* supply chain

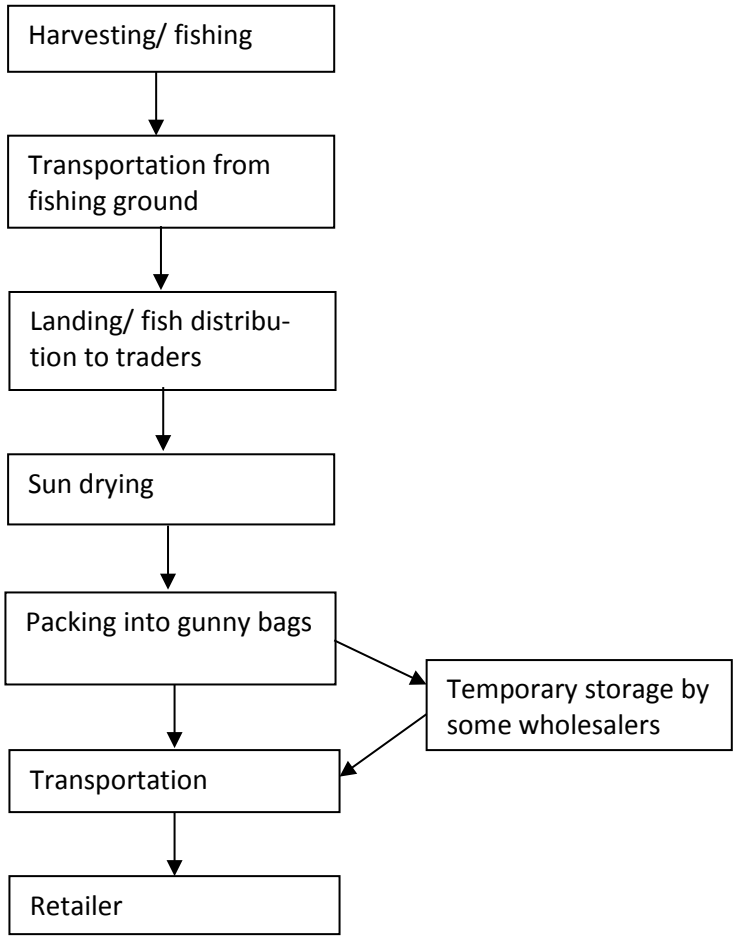
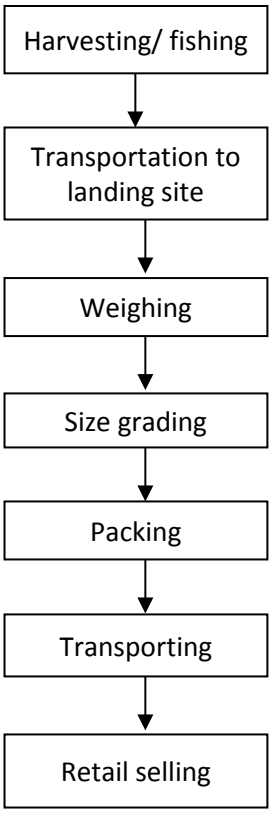


Fig 2. *Tilapia* supply chain



Omena drying

Tilapia.

Tilapia is caught in nets, and stay there under water until the fishermen come to haul it in. The fish are then placed on the bare wood floor in the boat. Because of dwindling catches, fishermen have also resulted to using illegal fishing nets in an effort to maximize catches. In one night a fishing net may catch up to 5 fish, and on a good day an average fishing net may catch up to 7 fish ranging anywhere between 0.3 and 1.5 kg. However, there are days when a fisherman can catch nothing, despite all the expenses involved in a fishing expedition.

Load tracking studies revealed that in Siaya County, at Gulmin Ougo landing site in 5 days 678 kg tilapia was landed by 10 boats, which is 13.6 kg per boat per day. In Homabay County, at Sare Beach in 5 days 465 kg tilapia was landed by 10 boats, which is 9.3 kg per boat per day. At Nyandiwa Beach during the month of February 2012 one trader was sending 6 loads of tilapia to the urban market, for a total weight of 2,400 kg. At the same beach 10 traders were operational. At Sare Beach in 5 days about 1,600 kg was sent to the Kisumu fish retail market.

2.2 Marketing systems

Women traders buy the **omena** from fishermen. After drying, the fish is packed in gunny bags and transported to the local markets for sale.

When **tilapia** fishing boats arrive at the beach, they are met by traders. Local fishermen don't have scales for weighing the fish; they depend on visual experience to determine size and price of each fish. The demand for tilapia is very high, and eventually, all fish is sold out upon landing, even though at highly discounted prices for the deteriorated fish.

Traders who sell tilapia in major urban centers need to accumulate fish from different fishermen over a couple of days before they get an economical load to transport to the market. Given the absence of functioning ice plants in beaches and other fishing towns, such traders make informal arrangements with major fish processing companies where they get small quantities of ice at a time for a fee. During the peak season an average trader will need about three to five days to accumulate an economical load for transporting to major markets. In low seasons, a trader will look for more suppliers and may require about seven days to accumulate an economical load for the market.

Most of the traders sell their fish in major urban centers through agents who are already on the ground. The fish is packed in polythene bags lined with ice and then in cartons before being transported in public transport with labels for the agent to receive at the bus stop of final destination.

On average a trader sends tilapia to a major urban centre (Nairobi) about five to seven times in a month (in a normal fishing season). Once all fish has arrived, it is inspected for freshness and quality by the agents. Three categories of fish are then established: fresh fish which will sell at 230 KES/kg, reject (fish that is beginning to get spoilt) which will sell at 100 KES/kg, and bad fish (fish not suitable for human consumption) which will sell at 50 KES/kg.

Fish transport to the market

3. Food Losses - Study findings and results.

3.1 Critical Loss Points: type, level and causes of food losses

Omena

Critical Loss Point: sundrying.

Qualitative losses for omena while still at water occur depending on how far the fishermen go to fish. Apparently omena fish which is caught far off in the deeper water is often much bigger in size, has soft belly that easily bursts before landing partly due to rough handling and a lack of preservation facilities during the long trips. Water accumulating in leaking boats promotes qualitative losses during transportation. Bigger omena takes longer to dry and during the rainy seasons, traders may suffer up to 80% economic losses especially if there is insufficient sunlight to dry the fish for more than two days. Fresh omena cannot last more than two days before it is completely deteriorated for human consumption.

Fish collected from the floor of the boat

An estimated 1-2% of omena is lost as droppings during sun drying. Omena is dried on fishing nets spread on the ground. The hygiene on the landing beaches is low. Animals can wander freely on the beach where they eat the dropped fish. In the absence of ice, larger fish will normally undergo several preservation methods in an attempt to sell them. What is not sold fresh is smoked, sun dried or deep fried depending on the level of quality.

During the rainy seasons, the lake region is prone to sudden down pours and storms which wash all drying fish offshore. Huge losses are incurred of up to 100 %, and a trader may lose up to USD 350.

Omena fish is transported to the market in airtight sacks and transported on public transport. The sacks do not allow air circulation and may cause deterioration especially if fish was not well dried.

Torn drying net

Tilapia

Critical Loss Points: harvesting, transporting to the market.

Quality losses for tilapia occur depending on how long the fish has been in the warm water before fishermen come to haul it. This is the case especially for those fish which are caught by the gills immediately the nets are set. If the fish net entangles the fish by the gills, the fish dies very quickly because of suffocation; it then begins to deteriorate. The fish are not transported in a container, but are rather placed on the bare wood in the boat. The hot tropical sun in Lake Victoria serves to further hasten the deterioration process of the already dead fish. About 22% of a tilapia fisherman's daily catch suffer some kind of quality deterioration before landing. This translates to an economic loss of about USD 1,100 per boat per year.

Quantitative losses before landing may occur when monitor lizards swim into the water and eat parts or whole fish while it is still in the net. However, such losses are minimal.

No fish is ever thrown away due to quality deterioration. The locals claim that there are special vegetables that could be eaten with smoked or dried tilapia fish of 'not so good quality'.

The way fresh tilapia is transported to the market is a cause for concern over its safety for human consumption. Fish is packed in a special bag lined with polythene papers for transport over long journeys on public transport. Should there be delays along the way, most of it becomes vulnerable to deterioration. Hence the mode of transportation for locally consumed fish may be a threat to food safety and may also trigger economic losses due to quality deterioration.

Between landing sites and retail market quality losses of up to 5.5% occur (USD 210 per month). An average trader incurs about 4.2% revenue loss (about 273 USD) in a month due to quality loss. Quantitative losses among tilapia traders was minimal.

The biggest challenge with preserving the larger fish is the lack of ice. In the absence of ice, larger fish will normally undergo several preservation methods in an attempt to sell them while fresh, such as smearing with beach mud in an attempt to preserve freshness. When all does not work, some is

smoked, dried or deep fried for human or animal consumption depending on the level of deterioration.

Early death in the net – bird attack

Tilapia prepared for transport to urban market

Table 2. Summary result matrix of food losses.

a. Omena - Sori landing site, Migoori County. The landing site has 200 omena traders

Type of loss	Cause of loss	Volume or %age lost	Stakeholders affected	Impact of loss	Trends	Time /season	Perception of stakeholders	Suggested solutions
Quantitative loss	Drying surface run off during the rain storms.	Up to 6% or 850 kg per trader / year.	150 traders May happen twice a month	Loss of operational capital.	Decreasing	Oct, Nov, March	Traders feel the problem can be controlled.	Drying area with raised racks for drying fish in the rainy season.
Quantitative loss	Spilling during drying	1-2%	traders					
Quality loss	Poor weather - insufficient sunshine hours.	16%	200 traders	Reduced profits.	Not increasing.	Oct, Nov, March	See it as a serious problem but they do not have a solution for it.	

b. Tilapia – Gul Minougo landing site, Siaya County.

Type of loss	Cause of loss	Volume or %age lost	Stakeholders affected	Impact of loss	Trends	Time /season	Perception of stakeholders	Suggested solutions
Quantitative loss	Attack by monitor lizards.	Minimal	60 fishermen 6 wholesale traders.	Minimal			Losses minimal	
Quality loss	Fish stay in nets for long hours at harvesting ground.	4.5% of value	60 fishermen	USD 1,100 per boat/year	Decreasing	April to Aug	Quality loss not taken as a serious problem	
Quality loss	Fish not kept cold awaiting and during transport to market.	5.5% of value	6 wholesale traders.	USD 2,500 per trader/year				Ice to be made available

4. Food Loss Reduction Strategy - Conclusions and Recommendations.

4.1 Food loss reduction measures.

The interventions suggested need a thorough analysis of their economic feasibility, environmental impact as well as social acceptability and way they are going to be managed, before they can become actual recommendations.

Omena.

1. Fence off fish landing beaches - To guard against contamination of domestically consumed fish, landing beaches need to be fenced off to keep animals at bay. This could be done in conjunction with the local community through the Beach Management Units. There should also be sensitization and enforcement on the importance of keeping animals off the landing beaches.
2. Drying racks - There is a need to introduce drying racks to ensure that fish is kept off the ground and that some standard of hygiene is maintained. An improved drying rack consists of raised racks within a fenced off area. The racks are covered with polythene covers to keep away wind, dust, rain and other elements. The polythene helps trap heat hence fish will dry faster on cloudy days. This intervention has also greatly reduced fish spillage and the risk of contamination. Although this intervention is still at its infancy (was only available in one beach at the time of this study) it was found appropriate and cost effective and its adoption should be accelerated. The need for raised racks was proposed by the traders.

Drying racks for omena.

Improving the quality and therefore market for the omena fish is likely to have lots of benefits to more vulnerable groups. Adopting the raised drying racks for omena is likely to have the following advantages:

- drying is very fast during sunny conditions compared to drying on the ground and hence it is possible to dry more than one batch of fish in a day within the same rack;
- improvement in hygiene conditions as compared to drying on the ground;
- the construction materials are locally available and does not require highly specialized technology;
- the absence of animals on drying grounds and no need to keep turning the fish frees women's and children's time for other chores;

- less spillage is expected as compared to drying on the ground especially if the racks are well maintained.

Disadvantages of the raised drying rack:
- requires lots of space, as the specifications require that there should be at least one and half meters distance between racks to allow adequate passage for people and good air circulation;
- to avoid blocking the perforations, fish must be cleaned to remove debris and other by-catches before drying - hence it is labour intensive;
- polythene covers are delicate and therefore require care in handling the racks.

Tilapia.

3. Fish landing facilities – Including ice plants, cold storage, cleaning basins, washrooms, offices, as well as workshops for repairing fishing gear.
4. Use recommended fishing gear - The use of illegal fish nets is a major cause of fish spoilage. When the fishing nets are of the wrong size they are likely to trap the fish by the gills and thus cause suffocation, leading to immediate death and deterioration before hauling.

Fish landing facility.

4.2 Food loss reduction plan and strategy.

The following elements of a strategy are being presented:

1) Address flouting fishing regulations.

   Use of illegal gears is rampant in Lake Victoria. Some of the gears were found to promote spoilage at the time of harvesting. The closed fishing season for omena (April to July) is also not effectively enforced. This has resulted in low fish stocks and fishermen are now moving longer distances in search of fish hence exposing fish to longer hours of ambient temperatures.

2) Livelihood diversification for fishing communities.

   The first step in resolving the problem is livelihood diversification at the level of local communities, through an economic stimulus package that includes aquaculture for local fishing communities. Income diversification will relieve pressure on fish resources in the lake.

3) Adopt demand-driven approach for capital investment in infrastructure.

   The government with financial support from the European Union has established at most of the registered beaches 'ultra-modern' fish landing facilities that comply with EU standards for handling fish. These facilities are fitted with ice plants, storage facilities for omena, cold storage, etc. However, very few are functioning due to neglect; others are uncompleted and are in a state of disrepair. The failure of these government interventions calls for collaboration with local communities in the design of interventions. Only demand driven and cost effective interventions should be established, including clarity and viability of its ownership and the position of the community.

   Public-private partnerships should complete and make use of these structures since they are needed especially for ice production for locally consumed fish.

4) Involve local communities in management of landing sites.

   Beach Management Units collect fees and other levies from fishermen that are used for day to day managing of the beaches. There should also be sensitization of local communities on the importance of enforcement of regulations.

To achieve these strategic objectives it is recommended to establish a stakeholders task-force including the county governments, to develop an intervention programme, and to mobilize resources.

ANNEXES

i. Acronyms

AFIPEK	Kenya Fish Processors and Exporters Association
BMU	Beach Management Unit
FSC	Food Supply Chain
HACCP	Hazard Analysis Critical Control Points
KEBS	Kenya Bureau of Standards
KES	Kenyan Shilling
KMFRI	Kenya Marine Fisheries Research Institute

Currency exchange rate

USD 1.00 - KES 85

KES 100.00 - USD 1.18

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