Food and Agriculture Organization of the United Nations

University of Nairobi

Food Quality Management in Supply Chains Linking Smallholder Farmers to the Home-Grown School Meals Programme

STUDY REPORT

AUGUST 2022

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Executive Summary

School meals are considered an important safety net for vulnerable children from food-insecure households and communities. Therefore in 1980, the Government of Kenya initiated school meal activities in collaboration with development partners. In 2009, the Kenya government launched the Home-grown School Meals Program (HGSMP) implemented by the Ministry of Education. Under the HGSMP, schools are required to purchase foods from local suppliers and provide hot and nutritious meals to school children. Apart from providing meals to the school children, the HGSMP aims to link school meals and local smallholder farmers. By offering a favorable market, home-grown school meals offer opportunities to strengthen smallholder and community capacities and improve their income, ultimately improving livelihood opportunities. Since its inception, the HGSMP has faced some challenges which have hampered realization of the program goals. Some of the challenges relate to the capacity of the smallholder farmers to supply the required quantity and quality of foods to the schools. In addition, quality management and postharvest losses in value chains linked to HGSMP is a major challenge. There is need to understand the challenges and opportunities in the HGSMP to ensure targeted interventions to improve the implementation and outcomes of the program

Therefore, this study was designed to develop and share knowledge on the understanding and practices on food quality management among stakeholders of the HGSMP. Specifically the study sought to i) develop and share knowledge on the understanding and practices on food quality management among stakeholders of the home grown school feeding programme ii) conduct an assessment of food losses in two supply chains (grain and vegetable) to the homegrown school meals program in two Counties in Kenya iii) formulate recommendations for enhancing food quality management and food loss reduction in the selected supply chains linking farmers to the school feeding programme.

The study was conducted in two Counties that are implementing the HGSMP, namely Kitui and Kajiado Counties. The study focused on the bean value chain which is linked to HGSMP in both counties. The focus counties and commodities were identified through stakeholder consultative workshops conducted in both counties. The study employed the FAO case study methodology. The methodology entails planning followed by 3-pronged data collection process that includes screening (desk review), survey compounded by field observations and interviews with key actors, and load tracking. For the survey, a detailed actor-specific questionnaire was developed for producers, traders/transporters and teachers. The survey was complemented by focused group discussions and key informant interviews. Load tracking in the beans value chain targeted a bean trader who supplies beans to most schools in Kitui and Kajiado Counties. Load tracking for the cowpeas short value chain targeted a local trader who sources from a farm in the rural areas of Kitui and supplies to Kitui town. A trader who sources for cowpeas from Kisii County to for sale in Nairobi was targeted for the long chain.

This report presents the findings of the study. The report starts by providing a general critique of the HGSMP highlighting the positive impact on school enrollment and attendance. It highlights the dilemma that while HGSMP provides a ready market for farmers, they lack capacity to supply the quality and quantity of beans demanded by schools. Ultimately it is the traders who supply the schools hence defeating the original goal of the program. The report highlights the funding challenge that hampers the realization of regular and nutritious meals for learners throughout the school term. The second part of the report highlights the extent, causes/drivers and critical loss points for quantitative and qualitative losses for different actors in the bean value chain. These include producers, traders and schools (consumers). Further, the report provides the total economic losses accruing from quantitative and qualitative losses for the different actors. Finally, the report provides recommendations to improve the implementation of the HGSMP in order to realize greater impact as originally envisioned. The implantable and context-specific recommendations provided are guided by the observations made during the field surveys and stakeholder engagements. The recommendations are specifically targeted to various actors and stakeholders in the HGSMP.

1. Introduction

1.1.Background and Rationale

Kenya's constitution (2010) article 53b and c states that 'every child has the right to free and compulsory education' and 'Basic nutrition, shelter and healthcare' respectively. Therefore, the government of Kenya adopted free primary education as a government policy in 2003. Despite significant strides towards achieving free primary education, some regions especially in arid and semi-arid counties still lag behind in education due to a combination of factors including food and nutrition insecurity. The arid and semi-arid lands, cover 80% of Kenya's land area and host a third of the population. Net enrolment and primary school completion rates in arid counties average 34% and 35%, respectively, compared to national rate of 87% 2and 78%, respectively. School meals are considered an important safety net for vulnerable children from food-insecure households and communities. Therefore in 1980, the Government of Kenya initiated school meal activities in collaboration with development partners. Since their initiation, school meals have remained a core development intervention to support the country's achievements in the education sector. In 2009, the Kenya government launched the Home-grown School Meals Program (HGSMP) through which the Ministry of Education transfers cash to schools. Under the HGSMP, schools are required to purchase foods from local suppliers and provide hot and nutritious meals to school children.

The program which targeted arid and semi-arid has seen the number of children supported by the program grown from 540,000 in 2009 to 900,000 in 2016 and more than 1.5 million to date. The numbers are expected to continue to grow with support from national, county and community resources. The Kenya government is committed to strengthen the National School Meals and Nutrition Programme and coordinate similar efforts to ensure that all children in pre-primary and primary schools receive at least one nutritious meal per school day.

1.2. Strategic Objectives of the Home-Grown School Meals Program

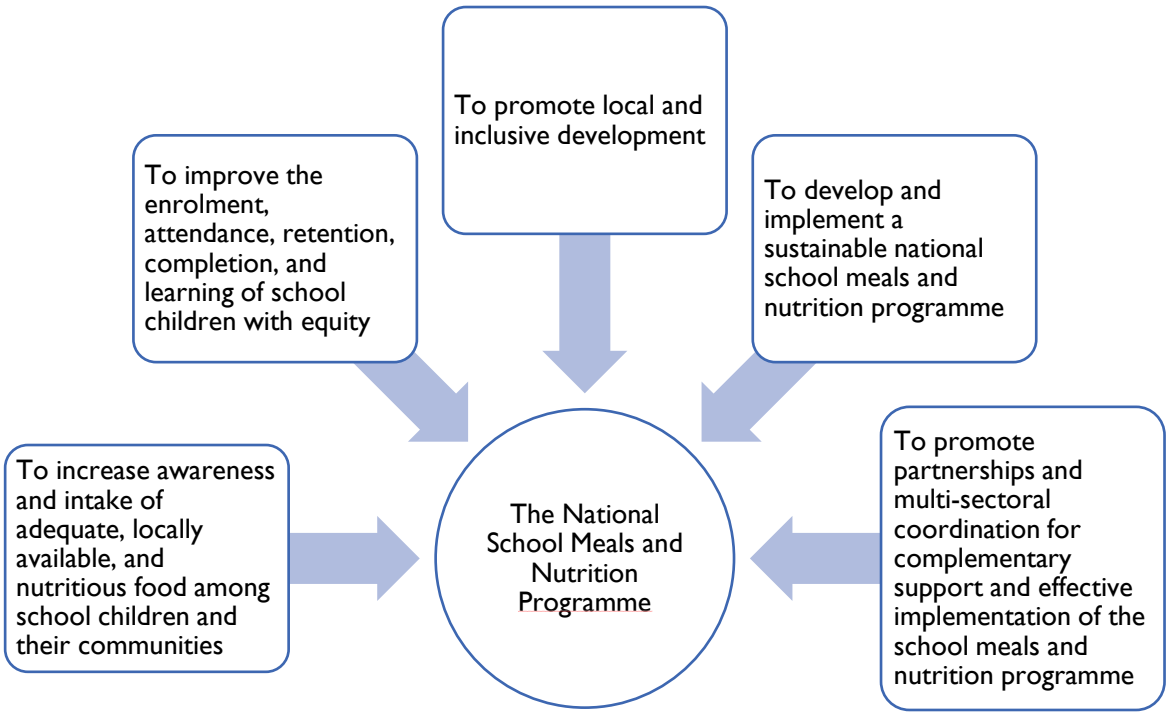


Fig. 1.1. Depiction of the Strategic Objectives of the Home-Grown School Meals Program

Apart from providing meals to the school children, the HGSMP aims to link school meals and local smallholder farmers. By offering a more favorable market, home-grown school meals provide opportunities to strengthen smallholder and community capacities and improve their income, ultimately improving livelihood opportunities and sustainable and inclusive development. Homegrown meals can be more supportive of school meals that are both nutrition sensitive and culturally sensitive, thus respecting local dietary habits. This approach ensures multiple positive outcomes for all including school children, farmers and communities. The envisaged positive outcomes under the HGSMP include:

- Bolstering efforts towards children's universal access to free education
- Strengthening food and nutrition security of children and their households and communities, especially amongst the most vulnerable groups
- Facilitating smallholder farmers' access to public procurement and capacity-building opportunities
- Encouraging governments to integrate education, health, social protection and agriculture policies
- Improving cross-sector coordination mechanisms towards global goals such as tackling hunger and poverty and spurring inclusive development

School feeding programmes normally pursue educational, social protection and nutrition goals, or a combination of these. HGSF programmes also generate additional benefits, not only for schoolchildren and their households, but also for the farmers who provide the food, for local communities and for other stakeholders

1.3.Counties targeted by the HGSMP

The homegrown school meals program (HGSMP) has been rolled out in several Counties in Kenya. A total of 26 out of the 47 Counties in Kenya are covered by the HGSMP as shown in Fig. 1.2. The program targets regions with limited access to education, low net enrolment rates, low attendance rates and low completion rates. It also targets regions which are chronically food insecure, high prevalence of malnutrition & regions with high food insecurity. Most of the Counties that have benefitted from the HGSMP are in arid and semi-arid regions of Kenya. In addition, schools from the informal urban slums of Nairobi and Mombasa have also benefited (Espejo 2009).

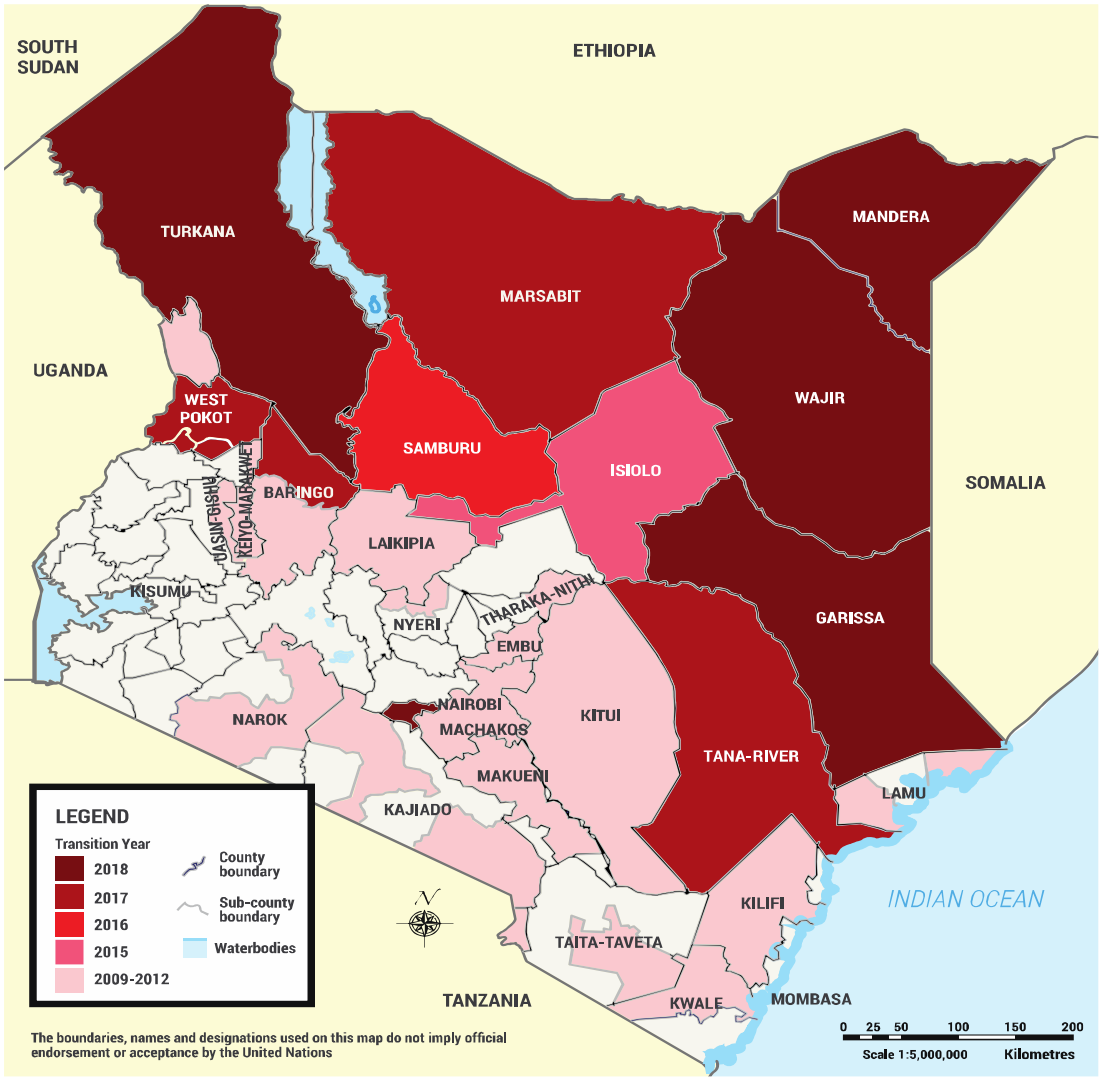


Fig. 1.2. National School Meals Programme Coverage

1.4.Modalities of Implementation of the HGSMP in Kenya

There are four modalities of implementing the school meals program. These include:

1.4.1. The community-based modality

This is mainly implemented in regions with agricultural potential where the parents make food contribution and the food is prepared in school. In the National School Meals and Nutrition Strategy 2017- 2022, it is expected that the school meals programme can be up scaled to high potential areas (Central Regions, Western and Nyanza) by encouraging parents to make food contribution in school and food is prepared within the school compound. The Ministry of Agriculture (MOA) through its programme Njaa Marufuku Kenya (NMK) introduced school meals programme in different parts of the country including Murang'a and Kakamega East. School meals programme was funded by NMK for 3 years on a reducing scale. (1st year 100%, 2nd year 75% and 3rd programme 50%).

1.4.2. The In-Kind modality

This modality involves centralised procuring of food commodities at the National level or any other food source then food is transported to the Sub-Counties. The Ministry benefits from economies of scale through bulk purchase of food. This modality is implemented in all the 10 total arid Counties which have minimal agricultural activities (Baringo (Tiaty East and East Pokot), Garissa, Isiolo, Mandera, Marsabit, Samburu, Tana River, Turkana,

Wajir, West Pokot (North Pokot). Currently the food basket include: cereals (rice, maize), Pulses (beans, peas, pigeon peas etc.), fortified vegetable oil, iodized salt, Corn Soya Blend (CSB). The ministry introduced CSB form 2021 as part of an intervention to mitigate the effect of COVID – 19. The product is meant for the pupils in grade 1,2and 3.

1.4.3. Outsourced catering services

In this modality, the supply and provision of meals is outsourced. Catering services may be contracted by schools or governments for food supply and delivery. Another option is for a government to contract a partner to manage the entire programme, including food procurement and delivery to schools, payment of the cooks, monitoring and accountability of the programme to its funders.

1.4.4. The Cash Transfer to Schools (CTS)

In the CTS modality, cash is wired directly to the school accounts and then the school management procures the food using the procurement guidelines developed by the Ministry. This is mainly covered by schools in Semi-arid regions which includes 17 Counties (Baringo, Elgeyo Marakwet, Embu, Kajiado, Kilifi, Kitui, Kwale, Laikipia, Lamu, Machakos, Makueni, Narok, Nyeri, Taita Taveta, Tharaka Nithi, West Pokot). Termly allocation per school is based on the total verified enrolment at the end of the previous term and the number of school days in the term. The transfer value is therefore rated at per child per day minus bank account balances and food carry-over stock from the previous term. The cash sent to schools is based on the Unit cost of Ksh.10 per child per day. Procurement of food under the CTS is done by the School Meals Programme Committee (SMPC) and follows the following process outlined in fig. 1.3 below:

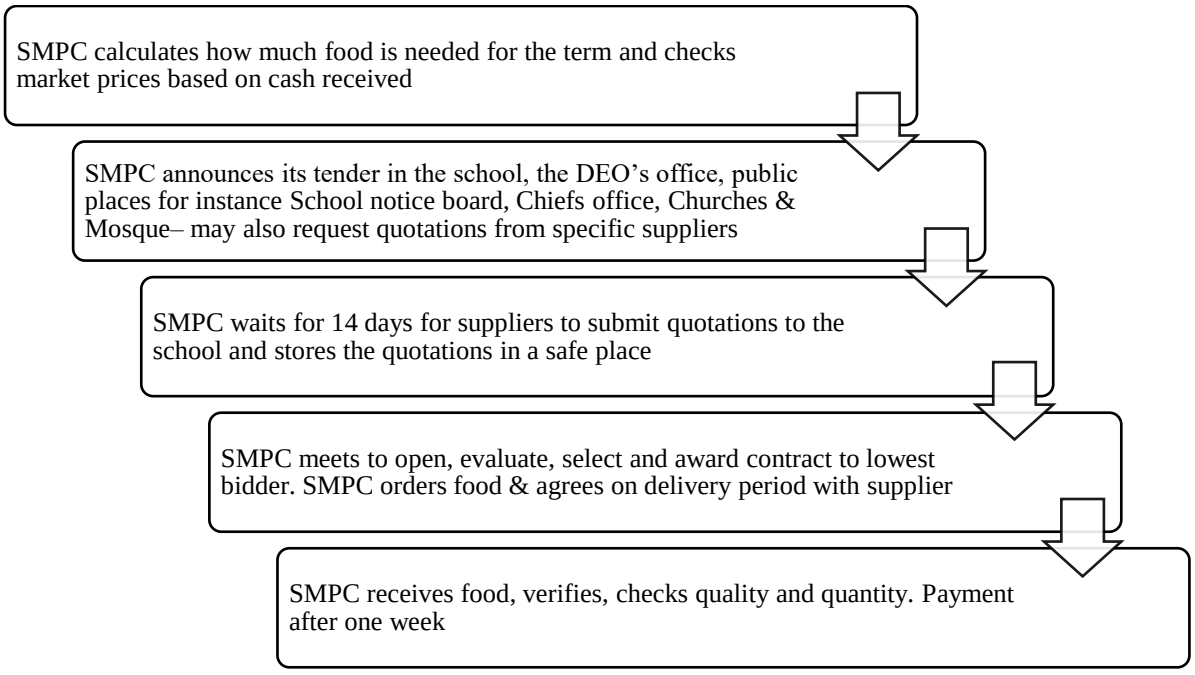


Fig. 1.3. A depiction of steps in procurement of food under the cash transfer to schools (CTS) program

Farmer groups or traders from within the County can compete to supply the schools. All the suppliers are required to provide stipulated tender documents to qualify as suppliers. The SMPC scrutinized that document to ensure that the supplier has the capacity and experience to supply food to school.
Outside the quotation there are no additional costs to schools such as transport, packing etc. The supplier is responsible for arranging delivery and the delivery time must be specified in the contract. The delivery must be during working hours and days.

1.5.The structure and operationalization of HGSMP in Kenya

(Implemented through the Cash Transfer to Schools Modality)

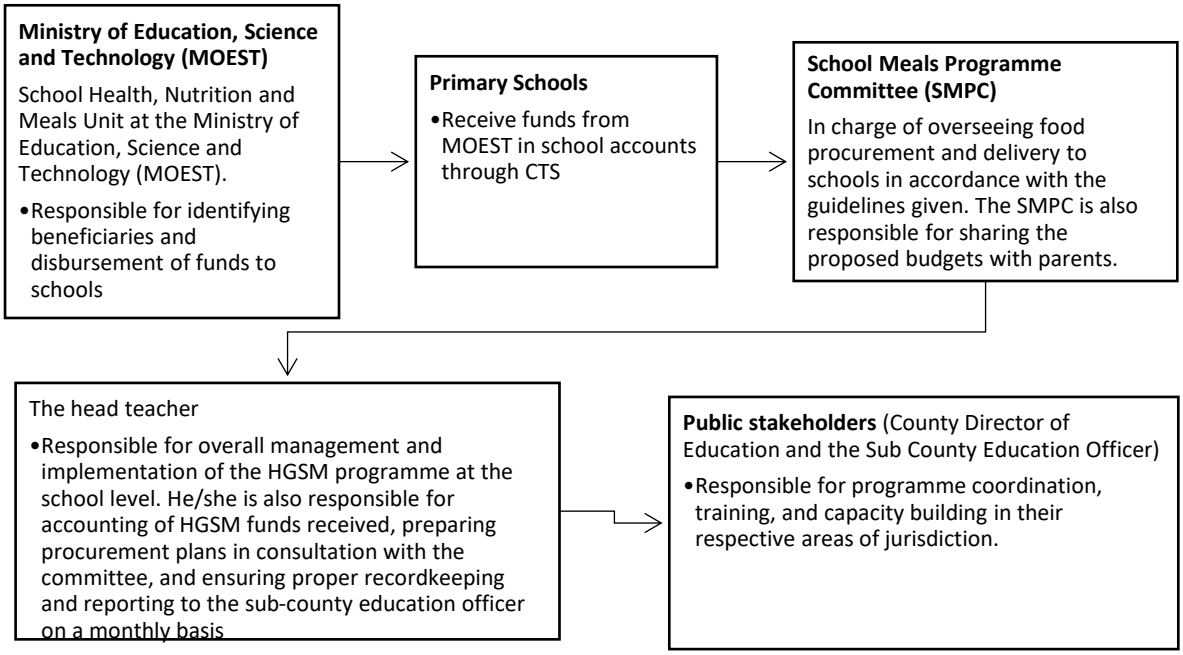


Fig. 1.4. Structure and operationalization of HGSMP in Kenya

1.6. Food groups supplied, quality attributes and requirements,

As earlier indicated, schools receive KES 10 per child per day depending on the declared enrolment. This amount is appropriated to cater for various ingredients of the meal as tabulated below (table 1.1).

Table 1.1: Food groups supplied in schools and their recommended ratios

Food group	Recommended ration
Cereals and root crops (energy foods): cassava, maize, rice, sorghum, millets, sweet potato, yams, Irish potato, bread and chapatti	~150 grams per child per school day
Protein sources and possible substitutes: eggs, pulses (beans, lentils, pigeon peas, cow peas etc.), meat, milk, ground nuts	~40 grams per child per school day
Dairy	½ cup to 1 cup
Vegetable oil	~5 grams per child per school day
Iodized Salt	~3 grams per child per school day
*Complementary rations of fresh fruits (1 cup) and vegetables (½ cup cooked or 1 cup fresh) should be provided as often as possible.	

This amounts to ~30 percent or one third of the daily energy requirements and the dietary diversity needs for a child

The children are provided the food served in school as a meal or snack. National School Meals and Nutrition Strategy (2017–2022) requires that the following requirements are adhered to when designing school meals

- The number and duration of school sessions (half day/full day)
- Age range of the target children
- Prevalence of nutrition-related conditions/ deficiencies
- National nutrition guidelines
- Food safety standards
- Locally available foods, food habits and preferences
- Range and quantities of available food, and their sources
- Price of commodities that provide similar nutritional values and can be substitutes
- Cash resources available for local purchase
- Fuel and water availability
- Community participation
- Local fortification capacity

The strategy recommends that the meal ration should be relevant in three interrelated aspects depicted in fig. 1.5 below:

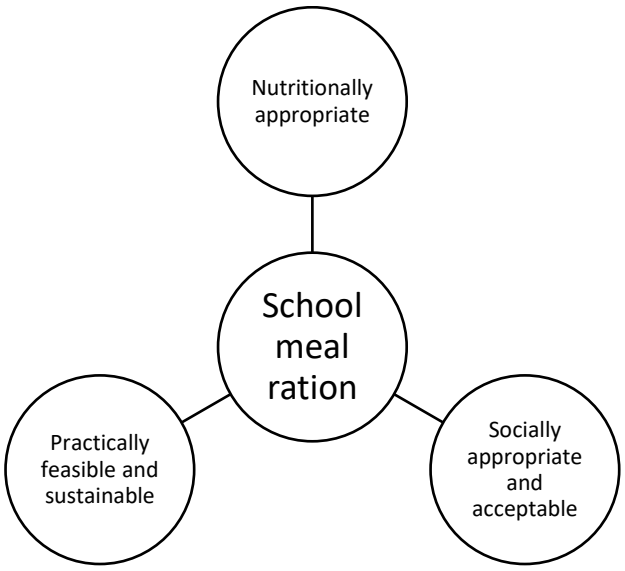


Fig.1.5. Aspects of school meal ration

According to the strategy, the food served to learners should be nutritionally appropriate. Therefore, the meal ration is required to include commodities that provide the recommended nutrient intake for macronutrients. School meals should strive to provide adequate sources of micronutrients through consumption of micro-nutrient rich foods. This includes fruits and vegetables and other sources. The school meal rations should also provide adequate amounts of fats, carbohydrates and proteins, which, when combined, are expressed as a percentage of total energy provided.

Since inception, the HGSMP in Kenya has recorded commendable success with respect to enhancing enrollment and retention of children in school especially in arid and semi-arid areas which are faced with a perennial problem of insecurity and malnutrition (MoALFC, 2021; WFP, 2022). However, the program faces many challenges related to procurement of the foods from local farmers as they lack capacity to supply the quality and quantity of food required by the schools. Similarly, management of the quality of food procured by the schools

remains a major challenged as significant quantitative and qualitative losses are reported (Langinger, 2011; WFP 2018). To understand the challenges faced by stakeholders in the implementation of the homegrown school meals program and possible interventions to address the challenges, the Food and Agriculture Organization commissioned a study to "Develop and share knowledge on the understanding and practices on food quality management among stakeholders of the home-grown school feeding programme. The study also sought to assess the occurrence and magnitude of food losses and formulate recommendations to reduce it in selected supply chains linking farmers to the school feeding programme.

1.7.Objectives of the study

1.7.1. Overall objective

To develop and share knowledge on food quality management practices among stakeholders of the HGSMP and conduct an analysis of postharvest losses in studied value chains.

1.7.2. Specific objectives

1. To develop and share knowledge on the understanding and practices on food quality management among stakeholders of the home-grown school feeding programme
2. To conduct an assessment of food losses in two supply chains (grain and vegetable) in the homegrown school meals program in two Counties in Kenya
3. Formulate recommendations to enhance food quality management for food loss reduction in the selected supply chains linking farmers to the school feeding programme.

2.0 METHODOLOGY – APPROACH, STUDY LOCATIONS AND DESIGN

2.1 Overview of FAO food loss analysis case study methodology

The FAO food loss analysis case study methodology was applied in the collection of quantitative and qualitative data from producers, trader/transporters and teachers. The FAO case study methodology integrates four tools including:

- **Screening:** This entails preliminary screening of food losses. Screening is based on a desk review of secondary data including published reports and expert consultations. Screening is used to have a rough idea of the range of losses and some main causes for those. Screening was done by a team of research assistants with expertise in Agricultural economics, Food science and Technology, Nutrition and Horticulture between January 2021 to June 2021. Expert consultation through telephone conversations was conducted between January and March 2021. This was followed by further face to face expert consultations during a stakeholder consultative workshop in March 2021.
- **Survey:** This entails food loss assessment through a survey. The survey used a questionnaire which is differentiated for various actors in the target supply chain including producers, transporters, traders, consumers etc. The survey may also include other knowledgeable persons of the supply chain being assessed and is complemented with keen observations of value chain activities. The survey was conducted during the months of January to March 2022
- **Load tracking:** This entails load tracking and non-representative sampling assessment. Sampling entails quantitative and qualitative analyses of a sample of produce and could cover any at any step in the supply chain. Load tracking for one bean trader and two

cowpeas traders (long supply chain and short supply chain trader was conducted during the month of March 2022.

- **Synthesis:** This entails finding appropriate solution to food loss and includes development of recommendations for reducing food losses, based on the previous assessment methods.

The data collection process must take cognizance of social and gender dynamics in the supply chain and hence need for collecting basic and descriptive social-economic and sex disaggregated data. This entails descriptive analysis of the differences in access to resources and services of men and women; cultural practices and social positions of men and women regarding assessed agricultural and post-harvest activities, all of which affect their participation and influence on the value chain activities. Similarly, environmental and economic considerations are key to support context-specific recommendations for food losses reductions along the supply chain. Figure 2.1 below depicts the flow of the various components of the FAO case study methodology

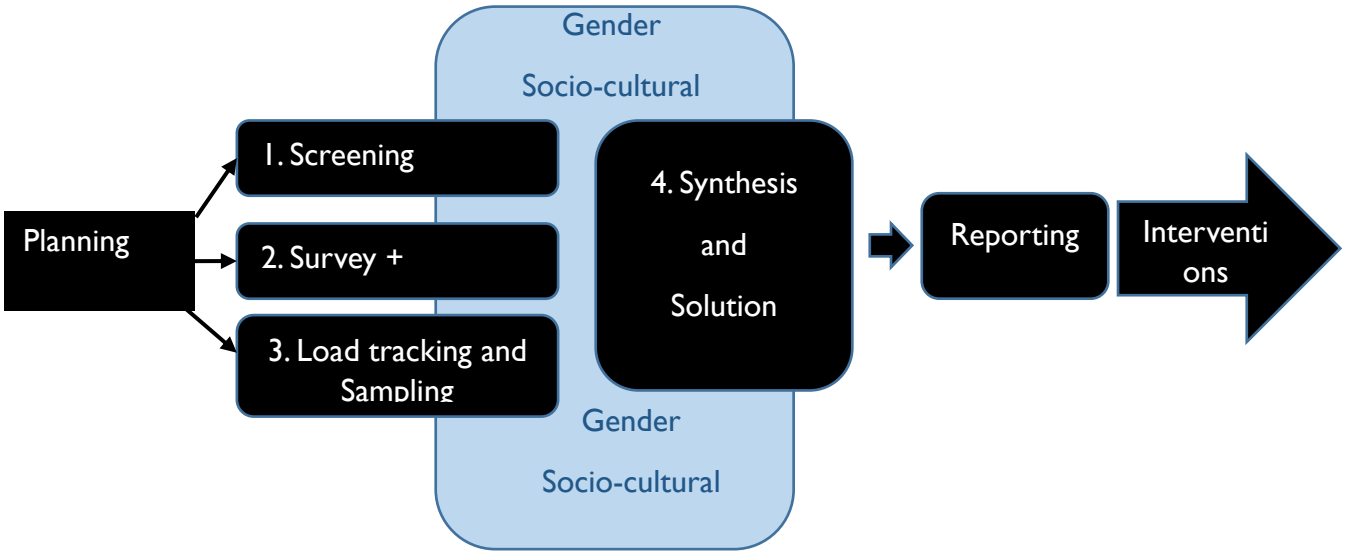


Fig 2.1: Flow of the various components of the FAO case study methodology

2.2 Key definitions and concepts adopted in the conduct of the FAO food loss analysis case study methodology

- **Food loss** is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retail, food service providers and consumers.

- **Quantitative food loss** (also referred to as physical food loss) decreases the mass of food destined for human consumption as it is removed from the food value chain. As such, quantitative food loss refers to the decrease in the mass of food destined for human consumption from decisions and actions by food suppliers in the chain.

- **Qualitative food loss** refers to the decrease in food attributes that reduces its value in terms of intended use. It can result in reduced nutritional value and/or the economic value of food because of non-compliance with quality standards. Qualitative food loss refers to the decrease in food attributes that reduces the value

of food in terms of its intended use – it results from decisions and actions by food suppliers in the chain.

- **Critical loss points (CLP)** are those points in the selected food supply chain where the most significant losses occur - both quantitative (i.e. volume, mass) and qualitative (e.g. visual changes and other quality attributes), the greatest impact on food security and the largest economic impact.

- **Produce damage and spillage ("symptoms of food loss")** result from improper or inadequate management of food quality along the food value chain. These can be categorized into three main types of interlinked damages and spillage.

    - Physical damage refers to the impacts of organisms on the produce, such as bacteria, fungus, insects or rodents. Physical damage is linked to processes of decay, rotting and weight loss owed to consumption of produce by such organisms.
    - Physiological and metabolic changes causing damage are triggered or linked to inappropriate temperature or water loss of produce. For example, it includes over-ripening, wilting, chilling injury in fruits, discoloration, browning and yellowing in vegetable leaves, adverse flavors, moisture loss, discoloration and shriveling of grains.
    - Mechanical damage is caused by physical forces applied to the produce. It includes abrasions, cracking, punctures and bruises in fruits, and breakage of grains.
    - Spillage can occur along the food value chains when containers, packaging, or storage rips or malfunction due to different causes, such as an infestation by pests.

- **Causes of food loss** differ widely along the food value chain, depending on the type of produce, the agro-ecological and climate conditions and how produce is cultivated, harvested and handled. Some critical causes of losses include harvesting at improper maturity stages, inadequate time of harvest, exposure of harvested produce to adverse weather conditions, improper practices applied at harvest and handling, inadequate and improper packaging, cooling, chilling, drying, inadequate storage conditions and challenges in marketing. Post-harvest losses can be linked to decisions made at earlier stages of the value chain. For example, improper hygiene of milking equipment and facilities increases exposure to contamination by various milk spoilage microbes, predisposing harvested produce to shorter shelf life.

2.2 Choice of study location and value chains linked to HGSMP

A stakeholders' workshop was organized to share knowledge and understanding of the HGSMP in Kenya. A minimum criterion to select priority counties for the study and the focus commodities linked to HGSMP in the respective Counties was provided for the stakeholders.

2.2.1 Minimal criteria for selection of the 5 Counties

- The HGSMP in the County recently undertook procurement of food from smallholder farmers and their organizations (last two to three years);
- County-level stakeholders demonstrate commitment towards implementing the HGSMP by the good performance of procurement from smallholder farmers and their organizations – demonstrated success of the program
- There are documented or reported challenges related to post-harvest management in supply chains linking smallholder farmers to the school meals programs and for food quality management (from farm to storage at schools);

- Ongoing or past (last two to three years) support programs for post-harvest management improvements targeting commodities and/or supply chains of interest for the HGSMP.

2.2.2 Minimal criteria for listing 5 commodities

- Food crops must be selected from the current food basket of the homegrown school meals programme;
- Selected crops must be relevant in smallholder farmers' production systems and commercialization, including sales to the HGSMP;
- Reported relevant level of losses in the supply chains of listed commodities;
- The list should include two crop categories: grain and horticultural vegetables;
- The list should not include crops and supply chains already assessed by previous comprehensive or systematic studies (e.g., Banana and Maize).

Based on the above criteria, Kajiado and Kitui Counties were selected as priority Counties for the study. Subsequently beans and green grams were selected as the priority grain value chains in Kajiado and Kitui Counties respectively. Vegetable value chains selected in the two Counties were Cowpeas and kales respectively for Kitui and Kajiado Counties.
County level inception meetings with stakeholders in the two Counties were conducted to confirm the importance of the prioritized value chains in the HGSMP. Following the County level consultative workshops, the beans value chain was selected in both Kitui and Kajiado county as the key grain commodity linked to HGSMP. In both Counties, no vegetable commodity was linked to the HGSMP. However, schools in Kitui County occasionally provided Cowpeas in schools meals through in-kind arrangements with the parents.

2.3 Data collection process

2.3.1. The study design and sampling process

The study design was both qualitative and quantitative. Data collected through qualitative methods not only informed the sampling of respondents from which quantitative data was collected but also interpretations of the results. The study targeted respondents from among the main supply chain actors, enablers and supporters. The main supply chain actors were producers, traders and school headteachers. The enablers were mainly the county education officers, county administrators and non-governmental organizations. The main supporters were transporters, who in some most cases were also trading in grains. Consequently, traders and transporters were not analyzed singly but as trader-transporter.

The study selected Kajiado and Kitui purposively because of being in the arid and semi-arid areas (ASALs) and have many schools benefiting from the Home-Grown School Meal Program (HGSMP). As expected, the two counties may not be fully representative of HGSMP ASAL counties due to the diverse ethnic, socio-economic and agro-ecological conditions prevailing in the ASALs. All the schools implementing the HGSMP programme in the two selected Counties were targeted for the study. These were 147 in Kajiado County and 397 schools in Kitui County (Table 2.1). However only 125 and 300 schools in Kajiado and Kitui counties, respectively, were involved in the study due to poor road network (schools were unreachable) and non-responsiveness (schools refused to participate in the study).

Due to the relevance of beans as one of the staples of the HGSMP and the fact that currently no procurement of vegetables is done by assessed schools, the data collection followed an in-depth assessment of bean value chains in Kitui and Kajiado. This was achieved through a survey targeting various bean value chain`s stakeholders followed by a load tracking carried out through non representative sampling, observations and interviews with key stakeholders.

For loss assessment in the cowpeas value chains, the data collection followed load tracking carried out through non-representative sampling, observations and interviews with key stakeholders.[1]

Table 2.1: Respondents interviewed in Kajiado and Kitui counties

	KAJIADO	KITUI
Total number of schools under HGSMP	147	397
Head teachers reached to provide lists of traders	125	300
Sources of Quantitative Data and Numbers Interviewed		
Bean traders	41	89
Head teachers	27	38
Bean farmers	35	15
Transporters	19	19
Sources of Qualitative Data and Numbers Interviewed		
Head teachers	6	9
School committee members	2	2
Farmers	3	2
Suppliers	2	2
Transporters	1	1
Food handlers (cooks)	2	3
Teachers in charge of meals	2	2
Other stakeholders (Ministry of Education, Teachers Service Commission, Sub- County Education Officers, County Education Officers)	14	12
Other relevant government ministries (Ministry of Agriculture, Ministry of Health), Extension Agents, National Cereals and Produce Board, (NCPB), Department of Irrigation, Non-Governmental Organizations	7	5
NGOs	2	2

The quantitative survey involved interviewing beans producers, traders and transporters, using a structured questionnaire which was fully digitalized. All the available bean traders (41 in Kajiado and 89 in Kitui) were interviewed. It was found that multiple schools had the same suppliers and hence the low number of traders interviewed. In addition, all the transporters (19 in each county) linked to traders were interviewed to provide data on losses during transportation. Similarly, the population of bean producers linked to traders provided data for the losses at the farm-level.

It was not possible to reach all the headteachers of the selected schools due to remoteness and the fact that the study was done towards the national examinations period when visitors are barred from visiting schools. Thus, the study targeted all the reachable schools in both counties to provide information on losses taking place in the school stores and when handling grain to prepare meals. The reachable schools included those which were accessible by car or motor bicycle and those where the head teachers or teachers in charge of the school meals were accessible and willing to meet with the research team.

For the qualitative survey, focus group discussions (FGDs) and key informant interviews (KIIs) were conducted with school heads and those assisting them to administer food (cooks

[1] As per guidelines stablished in Letter of Agreement (LOA) signed with FAO.

and teachers responsible for school meals). Qualitative data was also collected from Ministry of Education officials, county administrators, NGO representatives, among other groups as shown in table 2.1. These respondents were selected purposively from the schools and administrative areas where the schools are located. A check list of issues was used to guide the discussions and interviews.

2.3.2 Load Tracking in bean and cowpeas value chains

A load tracking study was designed targeting one of the bean traders who supplied schools in Kitui County. The objective of the load tracking was to measure quantitative and qualitative losses in the bean load as it moved from the farm in Oloitoktok to the trader's store in Kitui town (280 KM). Three bags out of the total load were market for tracking. The quantitative losses for the marked bags were established at various stages including cleaning (before loading), loading, off-loading, sieving (cleaning) at the trader's store, weight at the beginning of storage, weight after 3 months of storage.

A similar study was designed for the cowpeas value chain. In this case two studies were conducted targeting a short value chain (10 KM from the farm to the market) and a long value chain (325 KM from the farm to the market). In the short value chain, the load of cowpeas was tracked from the farm to a local market in Kitui town. In the long value chain, the cowpeas load was tracked from Kisii County to an urban market in Nairobi city. In each value chain, freshly harvested cowpeas were divided into batches which were subjected to various pre-packaging treatments and packaging options. These included hydration/wetting (or not) before packaging. The packaging options included polythene sacks or crates which were either lined with wetted newspapers or not lined as described in figure 2.2 below:

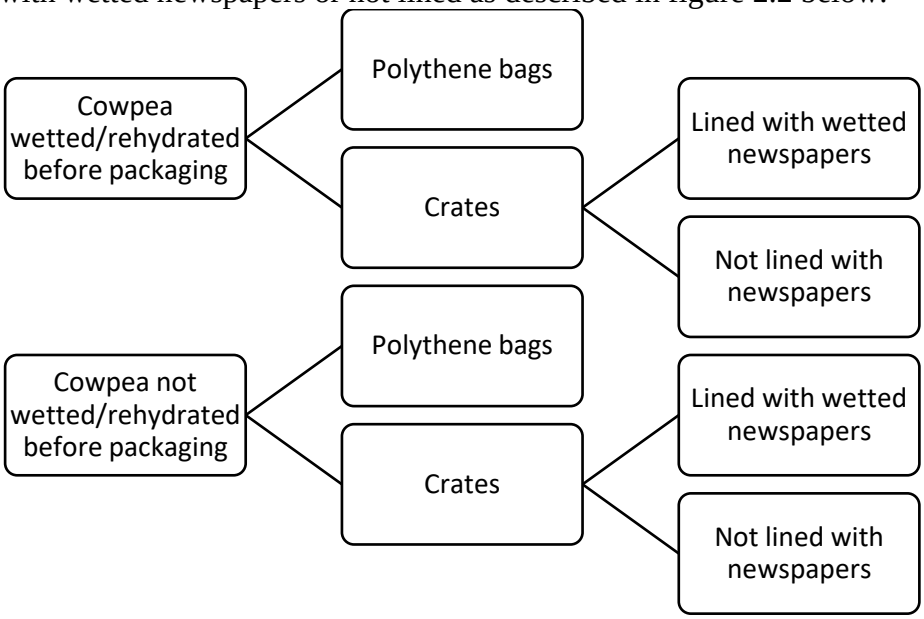


Fig.2.2. Pre-packaging treatments and packaging options

The cowpeas loads were tracked from harvesting, loading, off-loading at the market. At the market, the load was observed for qualitative and quantitative losses until the cowpeas was either sold or discarded.

2.4 Data cleaning and analysis

The data collected using an open-source mobile data collection platform (ODK) was first cleaned for ease of analysis and to remove outliers. STATA statistical analysis software was used for analysis of means with standard deviations.

2.5 Challenges and limitations of the study design

The study was significantly affected by the restrictions occasioned by the Covid-19 pandemic. The restrictions hindered full execution of some aspects of the FAO case study methodology such as key informant interviews and expert consultations.

Scheduled interviews with head teachers and teachers in charge of school meals were disrupted by sudden closures of schools by the government to mitigate against the spread of the Covid-19 virus

In the initial design of the study, based on the stakeholders' views, target commodities were identified for each County as beans and kales (Kajiado County) and green grams and cowpeas (Kitui county). Subsequently desk reviews were conducted for these commodities and tools for data collections developed accordingly. However, upon further stakeholder engagement through county-based consultative workshops, it was realized that green grams are not included in the HGSMP in Kitui County. It was also revealed that none of the schools included it as vegetable commodity in their feeding program except on occasional instances. Therefore, the study focused mainly on beans as a staple in school meals for both Counties. In the beans value chain, the survey and load tracking consultation were undertaken to collect the data. In the cowpeas value chain only load tracking of the traders was conducted and complemented with observations and expert consultation. A survey was not conducted because of the limitation of time and resources.

There was also a major challenge in randomly selecting representative schools in the two Counties because of the vast distances between schools and poor access to the schools.

3.0 STUDY FINDINGS

3.1. Overview of homegrown school meals program operations and smallholder agriculture in Kitui and Kajiado

3.1.1. Kajiado County and Its agricultural potential

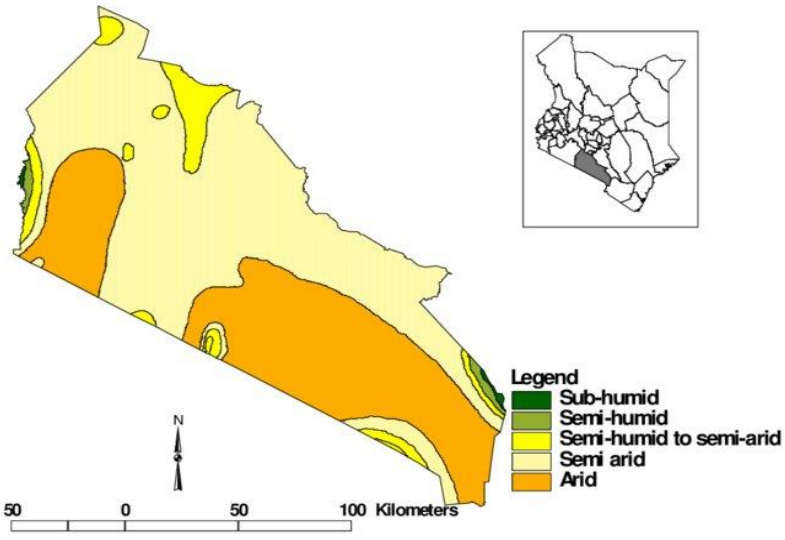


Fig. 3.1: Agro-ecological map of Kajiado County

Kajiado County covers an area of approximately 21,293 square kilometers. The cosmopolitan county borders Nairobi County (city) and to its south it borders Tanzania. The County is predominantly semi-arid and experiences a bi-modal rainfall pattern with short rains between October and December and long rains between March and May (Fig.3.1). The rainfall amount ranges from as low as 300mm in the Amboseli basin to as high as 1250mm in the Ngong hills and the slopes of Mt. Kilimanjaro. The temperatures vary significantly across the county

depending on the altitude and season. The highest temperatures of about 34°C are recoded around the Lake Magadi. At the same time, some regions like Loitokitok and the eastern slopes of Mt. Kilimanjaro experience significantly low temperatures up to 100C. July and August are the coolest months while November to April is the hottest period.

Livestock farming is the predominant agricultural activity in Kajiado. The dominant residents of Kajiado County are Maasai who derive their livelihoods from pastoralism. However, there is also small and medium scale crop farming in the high potential regions of the County including as Loitokitok, Ngong and Nkuruman. The main food crops produced are maize, beans, Irish potatoes, tomatoes, capsicum, water melon, cow peas, vegetables and bananas. Kajiado South Sub County is the main producer of maize for both subsistence and commercial purposes. In Kajiado south sub county, the area under maize production is 25,950 Hac annually, while the area under beans is 40,650 Hac annually. Tomato farming is also common in the county with 1,510 Ha across the county and Kajiado South leading with 940 Ha under cultivation. The total acreage under food crops and cash crops is 52,775 Ha and 17,354 Ha respectively. The average farm sizes for small scale is 0.5 Ha and 10 Ha for large scale farming.

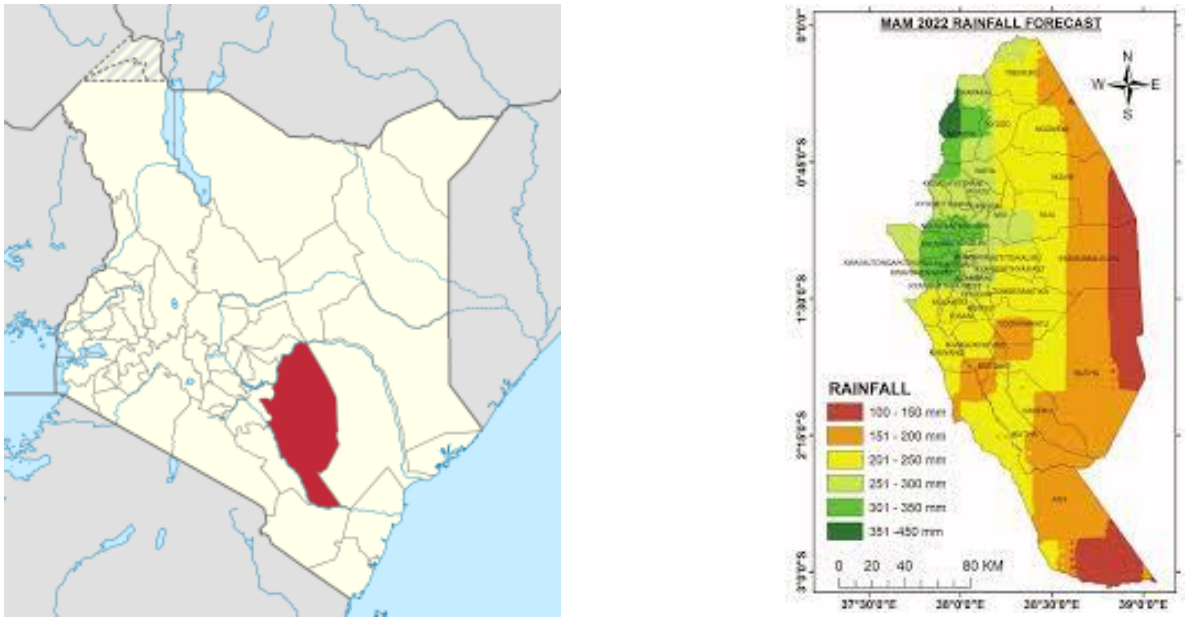


Fig 3.2: Location of Kitui County in Kenya and the Agro-ecological Map of Kitui County

Kitui County is among the Arid and Semi-Arid (ASAL) counties in Kenya which characterized by relatively high levels of poverty (Fig. 3.2). The level of absolute poverty is estimated at 47.5 percent compared to the national average of 36.1 percent in 2016. About 522,000 persons or 3.2 percent of the Kenyan poor live in the County. Food poverty is estimated at 39.4 percent compared to the national average of 32 percent. About fifty percent of the population does not have access to improved water sources and 57.6 percent of households spent thirty minutes or more to fetch drinking water.

The rainfall distribution in Kitui is erratic and unreliable. However, the highland areas namely, Migwani, Mumoni, Kitui Central, Mui and Mutitu Hills exhibit a sub – humid climate. The lowest annual average temperature is 14°C and the highest annual average temperature is 32°C. The main food crops grown in the County include cereals such as maize, sorghum, and millets; pulses such as green grams, beans, cowpeas and pigeon peas; root crops such as cassava, sweet potatoes and arrow roots; industrial crops such as cotton, sisal and sunflower, and horticultural crops represented mainly by fruits such as mangoes, pawpaw, and water

melons as well as vegetables such as tomatoes, kales, onions and bullet chilies. Agriculture in the County heavily relies on rainfall which is not only inadequate but erratic thus necessitating the use of irrigation to augment food production.

Table 3.1 shows a summary of socioeconomic characteristics of households involved in the study. Majority of the households in both Kajiado and Kitui Counties had approximately four family members headed by married middle aged men with primary level of education. Producers in both Counties had experience in production of beans but those in Kitui County received higher incomes from supplying beans to schools. Higher number of producers in Kitui were members of agricultural groups and also accessed credit. However, producers in Kajiado had higher access to infrastructure such as water, roads, markets and schools. Producers in both Counties had access to an average of one acreage for farming.

Table 3.1: Socioeconomic characteristics of households

Variable	Kajiado	Kitui
Household Characteristics		
Age (years)	42.02	44
Gender of Household Head (% Males)	54.76	76.92
Marital status (% Married)	88.09	100
Education of household head (% Primary)	47.62	53.85
Experience in farming (Years)	13.79	12.77
Household size	3.86	4.23
Household income from supply of produce (beans) to school (KES)	39,201	100,296
External support services		
Group membership (% Yes)	26.19	61.54
Access to credit (% Yes)	16.67	38.46
Access to infrastructure		
Access to water source (Kms)	2.72	3.75
Access to roads (Kms)	1.96	4.08
Access to markets (Kms)	6.20	6.69
Access to transport to school (Kms)	2.39	1.79
Access to school (Kms)	3.54	20.93
Farm characteristics		
Total land size (acres)	1.16	1.15
Involvement in postharvest activities		
Storage (% Males)	58.49	66.13

Loading (% Males)	81.82	83.33

3.1.2 Linking smallholder farmers to the school meals program

Although the original goal of the HGSMP is to link smallholder farmers to the ready market available in schools, the local farmers face challenges to produce the quantity and quality of food commodities required by the schools. Kitui County is categorized as semi-arid with low productive capacity owing to low/erratic rainfall and high temperatures. Despite the unfavorable conditions, some producers in the County still plant maize and beans. However, the crops yield sub optimally owing to the unfavorable climatic conditions (MoALFC, 2021). During the period of the study, fields of maize and beans with climate related agricultural damage and loss were evident (Picture 3.1).

Picture 3.1: A typical farm in Kitui County during the period of the study

One of the grain commodities that has potential to perform well in Kitui County is green grams. Contrary to the initial stakeholders' assertion that green grams was one of the grains in the HGSMP, none of the schools included it in their school meals. According to the stakeholders in Kitui County, non-use of green grams in the school meals was attributed to the cost and incompatibility with maize in making the main meal served in schools – locally known as Githeri. It was also noted that although cowpea (grains) was a major pulse grown and consumed by households in Kitui County, the same was shunned in school meals. The teachers indicated that learners were prejudiced against cowpeas in school meals because they ate it at home.

Because of the smallholders' individual limited production capacity, all the schools in Kitui and Kajiado Counties purchase the food items from traders. All the schools surveyed in both Counties have a criterion that is used to qualify suppliers. The highlighted requirements for suppliers in both Counties include: ability to supply food consistently (even during off-season); ownership of a physical store; evidence of being a registered business with a trading license; ability to deliver/transport the food to schools. In the case of Kitui County, the supplier/trader must be within the Sub- County in which the school is located. The criteria do not limit the traders to sources from within the County, in any sub-County, and from other

Counties. Therefore, the traders are at liberty to source for the food from local producers and from any outside County. The study revealed that some of the grains were sourced from as far as Tanzania in which case the feeding program did not in any way benefit the local producers. For example, one of traders who was linked to many schools in Kitui indicated that he sourced for beans from as far is Tanzania.

A few local farmers with children enrolled in local schools often supply food items in-kind to the schools to offset school fees and other payments demanded from the teachers. Although the in-kind supplies help to complements the inadequate food purchased from the CTS from the ministry of education, it somewhat compromises the food quality specifications set by the schools. The teachers in charge of school feeding have no control of the quality of beans (and maize) delivered in-kind by the parents (Picture 3.2 and 3.3).

Picture 3.2: Sample of maize and beans delivered by parents in-kind

Picture 3.3: Sample of maize and beans with the recommended ratio of bean: maize

It was also noted that during the rainy seasons when vegetables are in plenty, some parents supplied the schools with vegetables such as cabbage and kales (Kajiado) and cowpeas (Kitui).

3.1.3 Roles and overall challenges associated with each value chain stage

Figures 3.3a and 3.3b show gender roles in critical loss points (cultivation, storage and loading) in both Counties. In both Kajiado and Kitui Counties, preharvest activities are mainly conducted by women while storage activities are mainly conducted by men (Figure 3.3a & 3.3b). Men are also actively involved in loading activities.

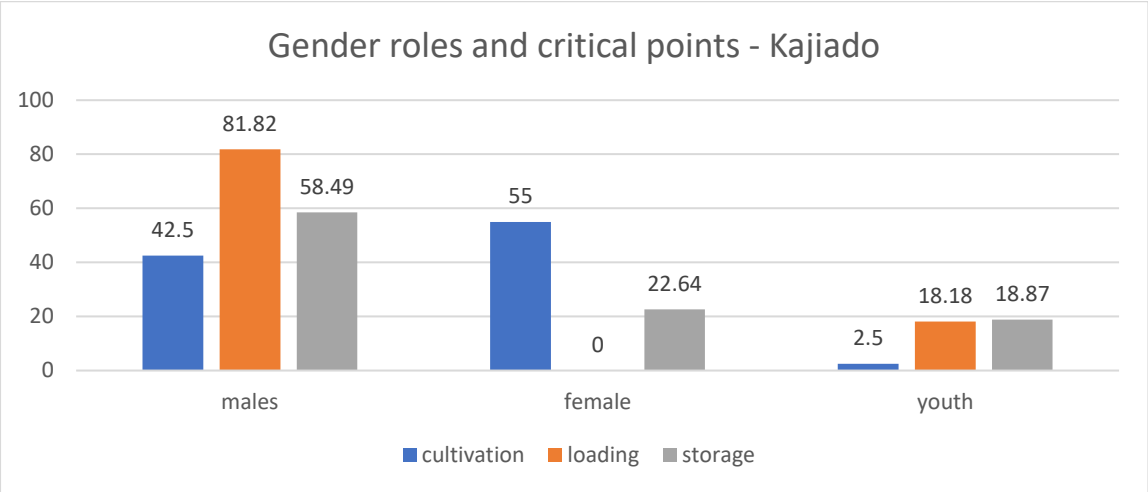


Fig. 3.3a: Gender roles in critical loss points of beans – Kajiado

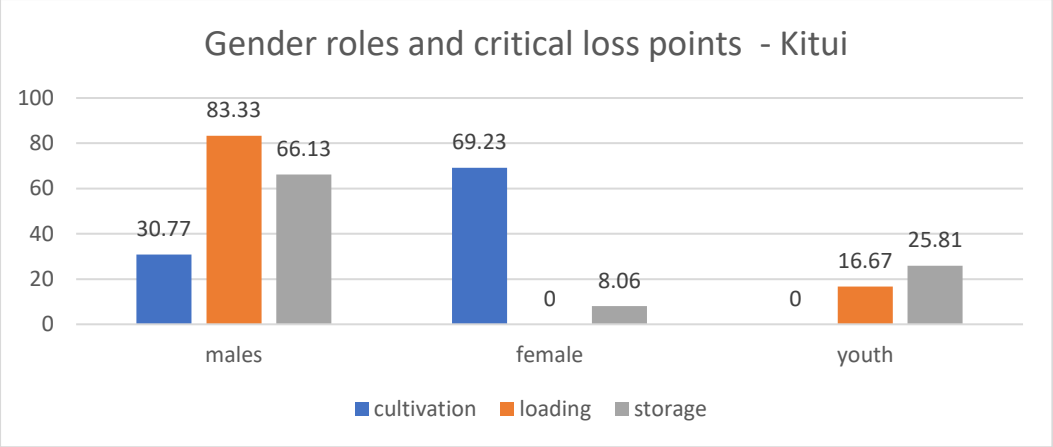


Fig. 3.3b: Gender roles in critical loss points of beans -Kitui

The main challenge during cultivation in Kajiado County is the fact that all the value chain stages are conducted manually by women (Figure 3.3a and 3.3b). Kitui farmers observed that their main challenge during cultivation of beans is the fact that rural advisory services on agronomical practices are scarce (Figure 3.4).

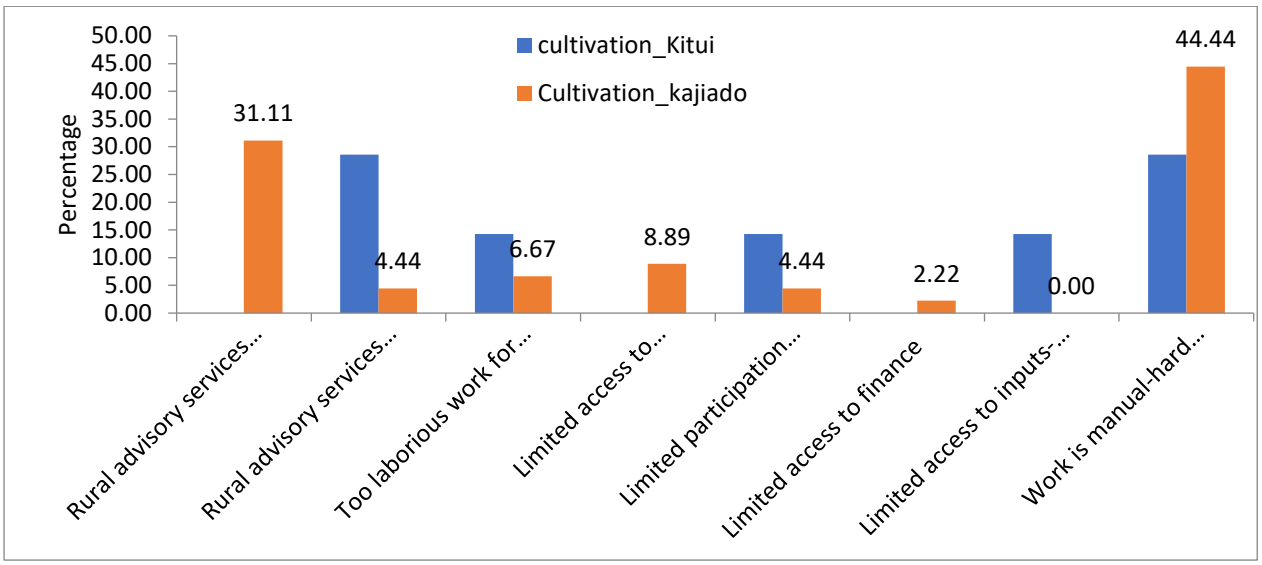


Figure 3.4: Challenges during cultivation of beans

The main challenge during storage in Kajiado County is the lack of rural advisory services on storage issues and limited access to inputs, technologies and resources, while in Kitui, farmers find the manual nature of storage activities laborious (Figure 3.5).

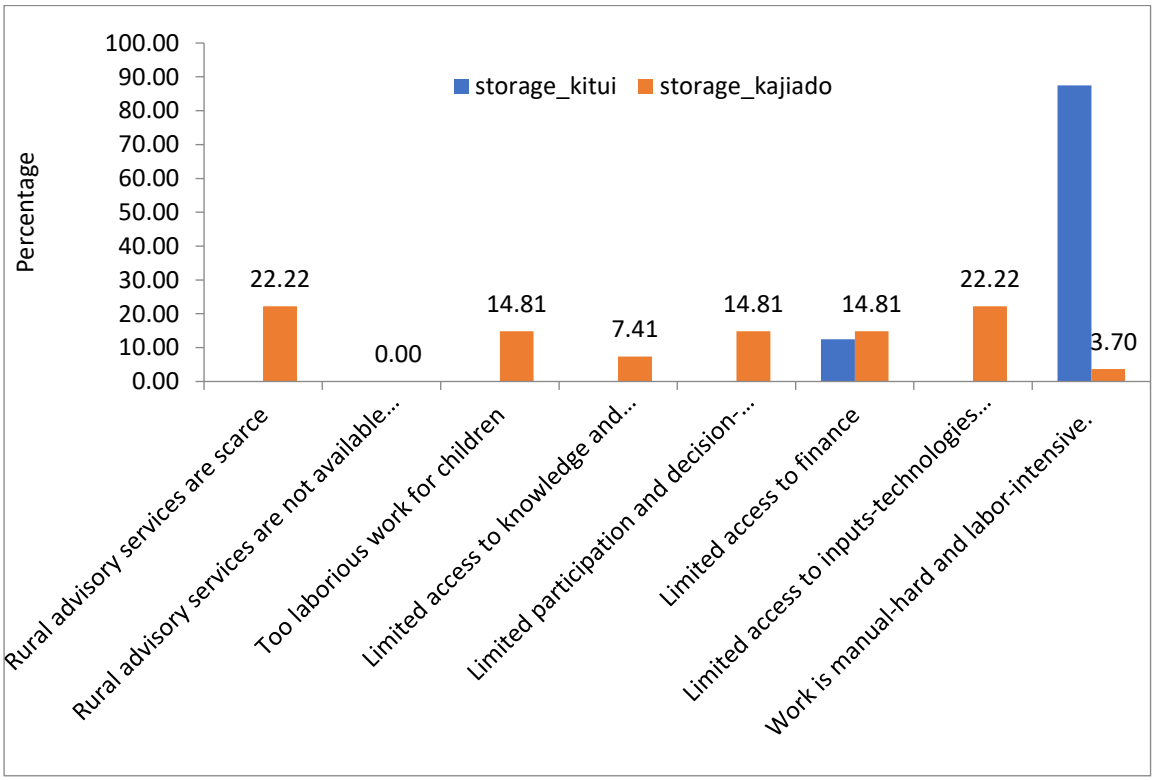


Figure 3.5: Challenges during storage of beans

The main challenge during loading of beans from the field to the aggregation point for farmers in both Counties is the laborious nature of the task which is done manually (**Figure 3.6).**

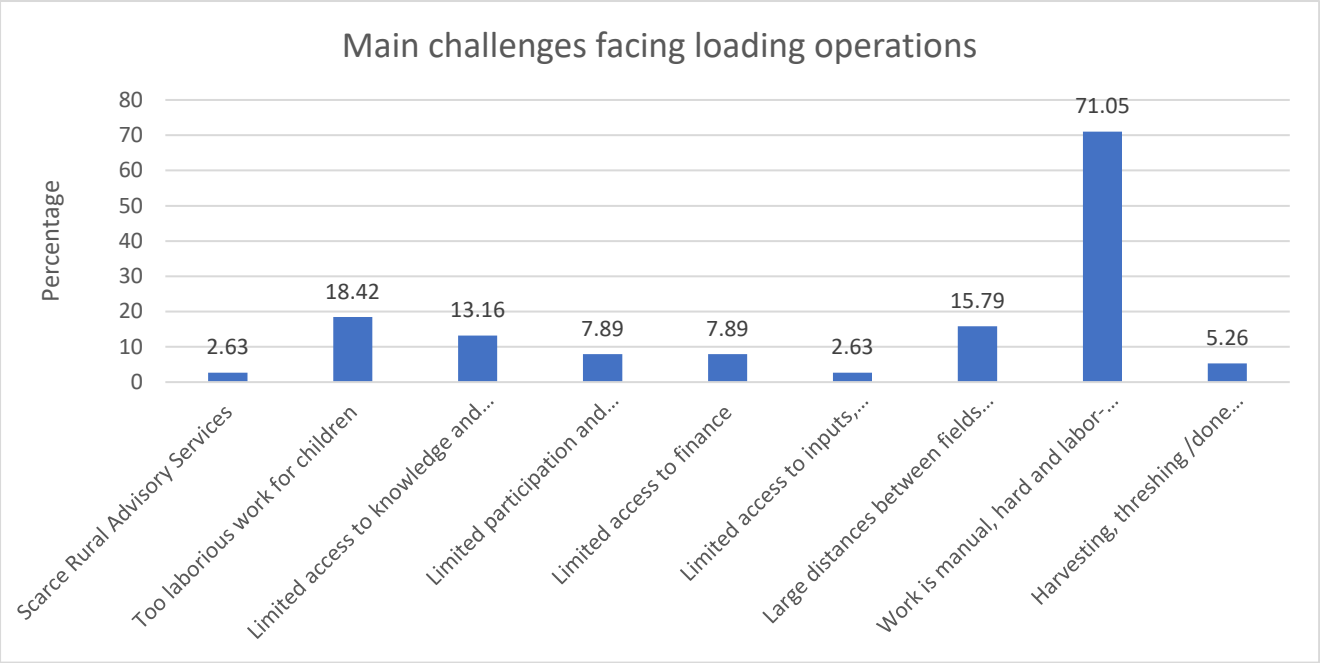


Fig. 3.6: Challenges during loading of beans from the field to the aggregation point

3.1.4 Food quality management in schools

The teachers in charge of school meals confirmed that they followed quality standards and requirements for procurement of the food from traders. The food was required to meet the quality standards listed below which are anchored on the guidelines from the ministry of education regarding quality of food materials included in the school meals. followed the checklist presented below, which the suppliers are expected to abide:

- Dry and with the right moisture content
- Free from dust and stones
- Not be infested with weevils
- Of exact weight as requested
- Kept in proper sacks that are not torn or old
- Supply at once

Beans should be dried to a moisture content of 13-14% for safe storage. Although the teachers who were interviewed alluded to the fact that the beans delivered to their schools adhered to the set quality standards, they indicated that they did not have any measurement tools/equipment (e.g., moisture meter) to ascertain the required quality standards described above. Apart for the weight, other quality parameters were subjectively determined through observation.

These are high standards which the traders endeavor to abide by in order to access the ready market in schools. However, upon delivery to the schools, if the food is not handled and/or stored appropriately, qualitative and quantitative losses occur. One of the challenges observed in most schools was the lack of appropriate storage for the food procured for the school meals. Four storage options were observed including: Head teacher's office (picture 3.4); a dedicated classroom (picture 3.5); part of a classroom; a make-shift store that is also used to store non-food items.

Picture 3.4: A head teacher's office doubling as a store for food items for school meals

Picture 3.5: A dedicated store that is used to store food and non-food items

In most schools, the grains (beans) were stored in the re-used bags in which grains were delivered by the traders/suppliers. Most of the teachers interviewed indicated that they stored the grains for a short period (< 3 months) and therefore the stored grains were not prone to agents of deterioration including pests that contribute to qualitative and quantitative losses during storage. As a measure to mitigate against storage challenges, some schools had adopted the piece-meal mode of procurement where small amounts of grains were procured based on weekly or monthly requirements.

In the few schools where vegetables were served in the school meals, there was no provision for separate storage of the highly perishable commodities. In fact, in the schools where vegetables, they were found to be stored in the kitchen (picture 3.6). These storage conditions for vegetables are not only unhygienic but predispose the perishable produce to fast deterioration leading to qualitative and quantitative losses.

Picture 3.6: Cabbages and tomatoes stored in the kitchen (Kajiado County)

One commendable good practice which was observed in nearly the schools was the use of pallets in the storage areas to avoid direct contact of the polythene bags with the floor. Pallets are recommended in storage areas for food commodities as they reduce the likelihood of contact of food with contaminants that may be present on the floor. It facilitates circulation of air in the store thereby contributing to reduce the likelihood of buildup of heat and stuffiness in the store. In addition, well organized pallets facilitate ease of stock movement from the store. It was noteworthy that even where pallets were not used, there was an effort to improvise (e.g., by use of stones) in order to achieve this requirement.

Another challenge that was reported and observed in some of the schools was lack of a reliable and adequate supply of clean water. In some schools, especially in Kitui County it was reported that preparation of food for the learners was hampered by lack of water. The teachers in charge of school meals noted that lack of clean water could lead to quality compromise during meal preparation. In addition, it was observed that in most schools there was no provision for hand washing before meals and the learners used their unwashed to eat. This situation posed the risk of hygiene-related ailments (picture 3.7).

Picture 3.7: Learners enjoying their lunch in one of the schools in Kitui County

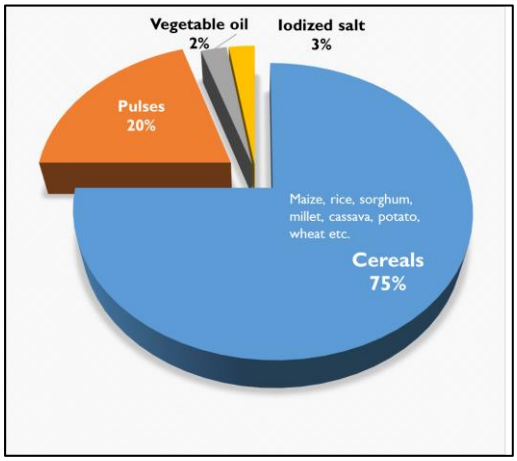
It was notable that some schools had installed water storage tanks to address the problem of lack of access to clean water. This was made possible through partnership with non-governmental organizations operating in the County (picture 3.8).

Picture 3.8: Rainwater harvest and storage systems installed in Kikuuni Primary School to address the perennial water shortages

3.1.5 Funds available to schools impacting food quality management and losses

In the period of the study, all the schools in the two Counties received funds that **catered for only 22 days of the school term**. The funds received were calculated depending on the enrolment and each pupil was allocated KES 10. This amount was proportionately used to procure maize, rice, beans, salt and oil (picture 3.9). In Kajiado County cabbages were occasionally procured.

Regarding the food quality management and food loss, the limited available funds to procure the adopted food basket is a barrier preventing schools and concerned authorities to set more specific grain quality and packaging specifications. For example, procurement specifications could require suppliers to deliver beans in hermetic bags and specific requirements could set limits of acceptance for broken grains and presence of weevils in delivered food. This requires procurement prices to internalize costs of higher quality grades for beans and packaging. Additionally, as per discussion in section above, in complementarity to funds to purchase commodities, schools need investments on proper storage management and facilities.



Picture 3.9: Proportion of food procured

3.1.6. Additional stakeholders' considerations on the impact of HGSMP on children enrolment and retention in schools.

The general sentiments from all stakeholders in the HGSMP was that the program had greatly contributed to enrollment and retention of children in schools. The stakeholders confirmed that the HGSMP had achieved its intended objectives of increased enrolment in schools, improved performance as well as motivation of both the students and teachers.

The stakeholders indicated however that the fact not all schools are currently operating the HGSMP had resulted in substantial transfers of pupils to those schools that benefit from the program. This had also contributed to poor performance from non-benefiting schools. The criteria currently used in selection of schools included absenteeism rates, dropout rates, success of past projects, geographic location, economic situation and performance in the national exams. The stakeholders indicated that the criteria for selection or the HGSMP operations should be revised to ensure equity.

3.2. General Description of Value Chains Linked to the School Meals Program in Kitui and Kajiado Counties

3.2.1. The Beans Value Chain

3.2.1.1.General production and consumption information in Kenya

Common bean (*Phaseolus vulgaris L.*) is the world's most important edible grain legume (Murube, 2021). It is also the main staple pulse consumed in Kenya. In 2019, Kenya produced 747,000 MT of beans, making it the largest producer of dry beans in the sub-Saharan Africa (FAOSTAT, 2021). Dry bean is mainly produced in the Rift Valley, Eastern, Lake Victoria zone, Western and Central regions of Kenya (Duku, 2020). Slightly over 1 million households allocate about 1 million Ha of land annually for the production of beans in Kenya (Figure 3.7). Between 2010 and 2019, bean production has been on the rise in Kenya, reaching a peak (846, 000MT) in 2017. Since then, the area under dry bean production has stagnated at 1.2M Ha. The productivity of beans in Kenya has been steady, at an average 6,367 MT/Ha.

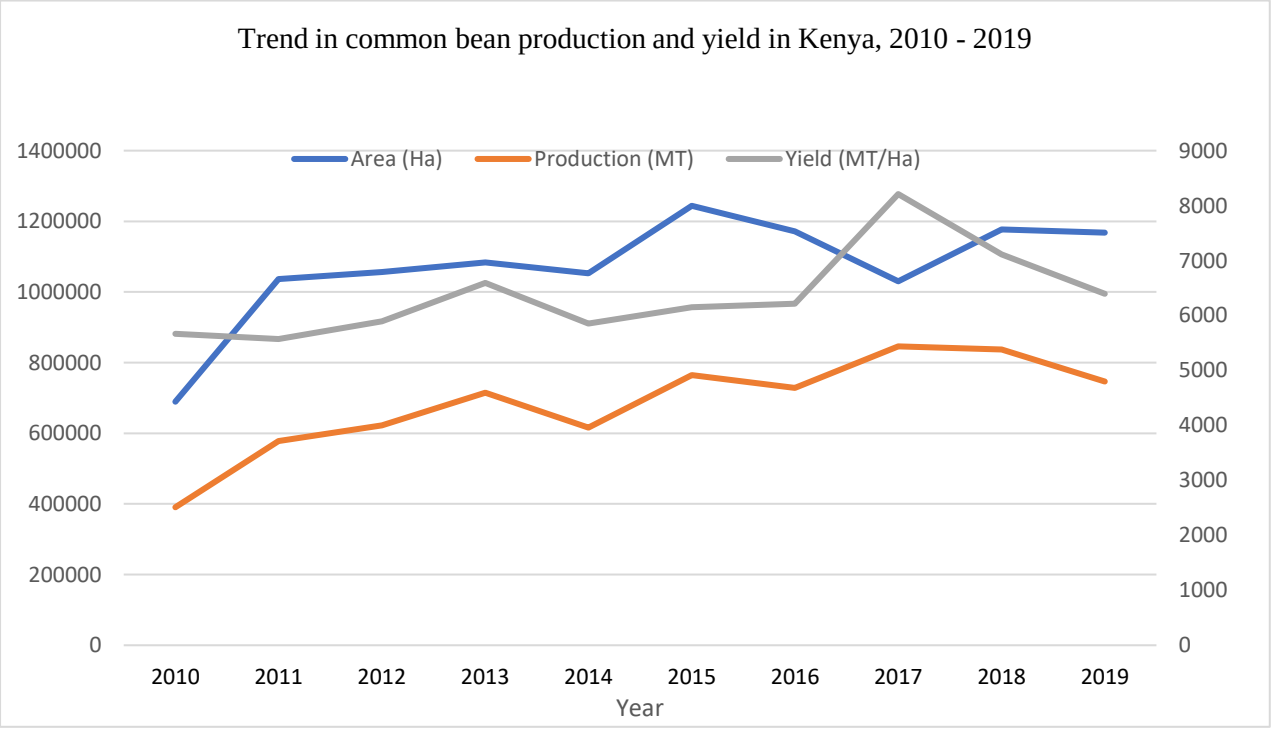


Fig 3.7: Trend in common bean production and yield in Kenya, 2010 – 2019Source: FAOSTAT, 2021

About 755,000MT of dried bean is consumed in the country annually (KenInvest, 2020) against an average production of 684, 467 MT a year. The consumption deficit is countered through imports from neighbouring countries such as Ethiopia, Tanzania and Uganda. In the last five years, imports have accounted for about 7% of consumption despite a consumption gap that is greater than 20% (KenInvest, 2020). In Kenya, the consumption and contribution of common beans to food security is relatively high with the per capita consumption estimated at 14 kg per year, but this can be as high as 66 kg/year in western parts of the country (Duku 2020).

3.2.1.2 The Main Actors and activities in the bean supply chain

3.2.1.2.1. Farmers

The primary actors in the bean supply chain are smallholder farmers who are involved in the production, harvesting, drying, threshing, winnowing and storage of the produce (Figure 3.8). Production of dry beans in Kenya is mainly undertaken by about 1.5 million smallholder farmers using family labour (KenInvest, 2020). The crop is usually intercropped with maize, but also with other crops like bananas and coffee. There is minimal use of commercial inputs such as fertilizer, improved seeds and agrochemicals. Several varieties of beans are produced in Kenya, with the most widely produced including *Wairimu, Mwitemania, Rosecoco, Nyayo* and *Mwezi Moja*, and recently the KT bean types that are more adapted to drought and with better productivity. Approximately 40% of total annual beans production is marketed and the rest is kept for household consumption.

3.2.1.2.2 Local traders (Assemblers)

There are various assemblers who consolidate the beans for sale to wholesalers (KenInvest, 2020). Resident farm gate assemblers handle small volumes and move from door to door to collect beans, either in cash or credit depending on level of trust. Non-resident assemblers buy large volumes either from farmers or resident assemblers. Large-scale assemblers and traders buy from farmers, agents and other assemblers.

3.2.1.2.3 Transporters

Transporters transport beans from the farmgate to local market centres where they are assembled for sale to wholesalers (KenInvest, 2020). Resident farm gate assemblers, transport beans to local urban centres and sell to regional traders. Non-resident assemblers transport beans to the local market centres, where regional traders purchase from them. Large-scale assemblers and traders transport beans to local market centres, where they bulk and transport to markets in major urban centres and cities.

3.2.1.2.4 Wholesalers

Beans wholesalers are traders who buy and sell solely in bags as the lowest transaction volume. These types of traders undertake wholesaling as individual business entities or institutional entities, like the National Cereals and Produce Board (NCPB). They work at various levels of the bean supply chain: at the regional level (long-distance wholesaler or assembler), at consumer level and at rural assembling level (KenInvest, 2020). Full-time beans wholesaling is rare and well-capitalized traders work solely as bean wholesalers when beans are moving fast in an active market, which is mostly during harvest time. In the off-peak season, these actors combine retailing and wholesaling or go completely out of the bean business.

Figure 3.8 below describes the organization of actors and their respective activities in the bean value chain.

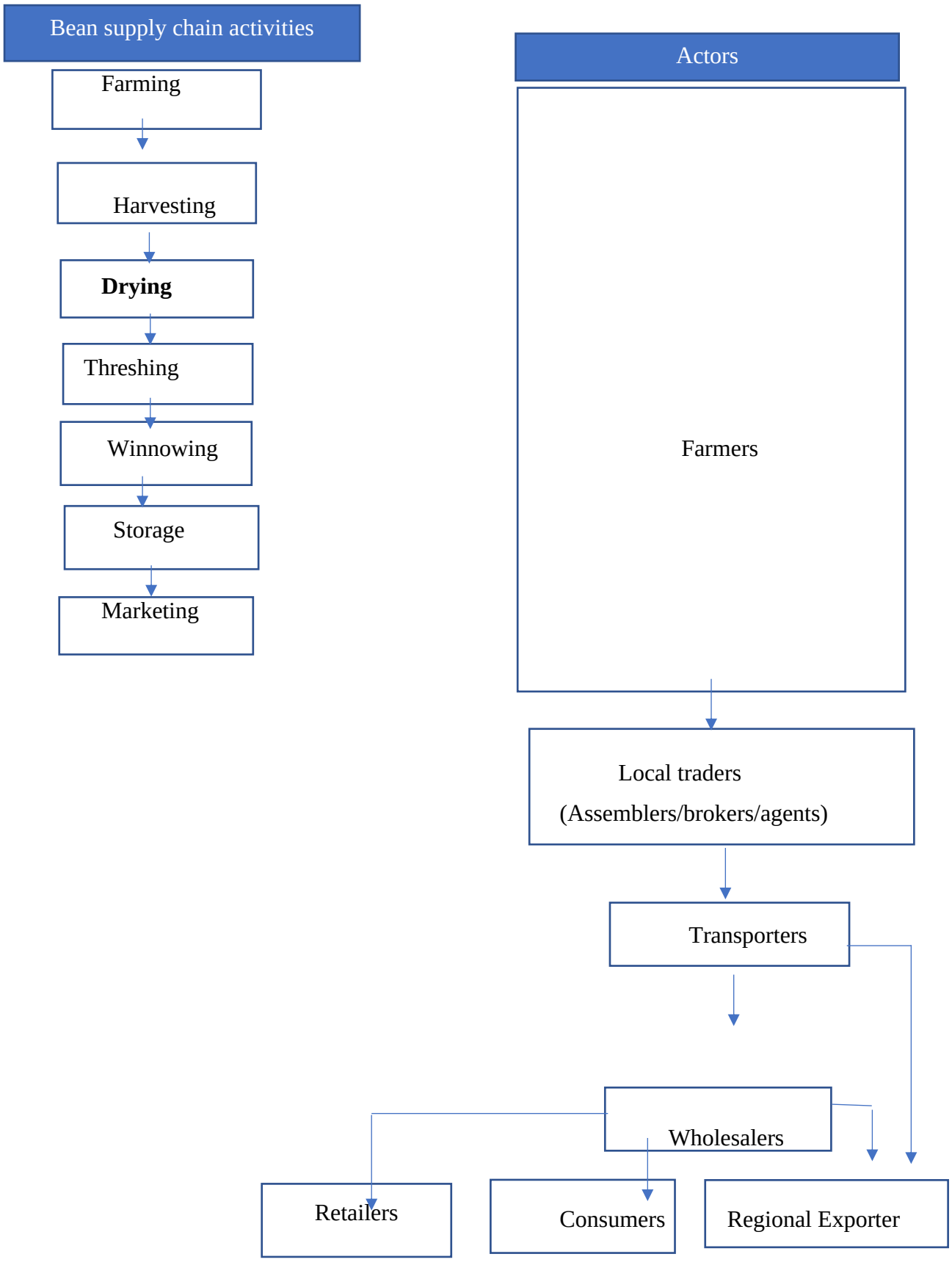


Fig 3.8: Organization of actors and their respective activities in the bean value chain. Adapted from KenInvest, 2020

3.2.1.3. Postharvest losses in the bean value chain – extent, critical loss points and causes of the losses

According to the KNBS (2021) approximately 20% of beans worth Kshs. 15.2 billion (120 million USD) is lost annually postharvest in Kenya. Overall, up to 42% postharvest losses have been reported in beans mainly due to inappropriate storage structures (USAID, 2012). Insect pests attacks causing physical damage are considered the most important cause of postharvest losses responsible for huge losses (20% - 42%) in beans from pre harvest to the storage stage (USAID, 2012; Njoroge et al., 2019). Most farmers store their beans in a room in the house exposing them to biological contamination. A large amount (25%–40%) of cereals and legumes are contaminated by the mycotoxins produced by storage fungi world-wide (Kumar et al., 2007). Figure 3.9 describes common grains damage and causes of losses at the various stages of the bean supply chain

Preharvest	Harvest	Transportation from the field	Threshing and winnowing	Drying	Storage
• Atacks by pest and diseases	• Unharvested produce due to ... • Pod shuttering and spillage	• Scattering and spillage	• Breakage from hitting with sticks • Spillage • Beans left in pods	• Pre-drying of beans in the field during rainy seasons leads to rewetting of dried beans • Improper drying on uncovered ground subject beans to fungal infestation	• Poor storage conditions (house and in traditional storage structures) predispose beans to rotting • Postharvest pests including bean bruchids, weevils, rodents

Fig 3.9: Produce damage and causes of losses at the various stages of the bean supply chain

3.1.2.4 Current mitigation measures to reduce losses in beans value chains

To address the losses resulting from poor harvest and immediate processing at the farm level, there have been efforts to introduce threshing equipment. The Pan Africa Bean Research Alliance (PABRA) is promoting the Multi Crop Thresher (MCT) in Kenya to minimize post-harvest grain loss and contamination of the beans grain. The thresher is powered by a petrol engine, making it 75 times faster than manual threshing. The machine can thresh up to eight different crops: beans, maize, millet, sorghum, pigeon pea, green grams, sunflower, and wheat. The machine has been enhanced with a winnower to improve the grain cleaning process and the grain quality thereof. The machine threshes eight bags of beans per hour, consuming one litre of petrol with a maximum of three people operating it. Normally, it would take the 3 people at least ten days to beat the beans with sticks and sort eight bags of beans (CGIAR, 2021).

To address drying challenges, some farmers are using the EasyDry M500 which is a mobile portable dryer targeted at servicing smallholder farmers (Walker & Davies, 2017).

Better storage technologies such as hermetic bags including the Purdue Improved Crop Storage (PICS), GrainPro, and AgroZ bags are used to minimize postharvest losses during storage (Foy & Wafula, 2016).

Some of the farmers who use the ordinary polypropylene bags apply Actellic Super to avoid pest infestation for a few months of storage (Mutungi et al., 2014). Some farmers have adopted traditional (non-chemical options) such as application of ash on the beans before storage (Wambugu et al., 2009).

3.2.2. The Cowpeas Value Chain

3.2.2.1 Production, Consumption and Marketing of Cowpeas

Cowpea (*Vigna unguiculata* (L.) Walp) is a dual-purpose food crop that is grown for both subsistence and commercial use in the local market. Mono-cropping and intercropping (with maize, millet, and sorghum) are production strategies that have been used in the cultivation of the crop [1]. The leaves, locally referred to as *Kunde*, were the most produced African Leafy Vegetable (ALV) in Kenya in 2016, accounting for 43% of total output.

Cowpeas are produced primarily for the domestic market as a leafy vegetable for local consumption. Cowpeas are a drought-tolerant crop that is mostly grown in arid and semi-arid regions. Makueni, Kwale, Machakos, Kitui, Siaya and Bungoma are among the top producing counties. The marketing system of the cowpea has no distinct organization, as the crop is also not a known export product from the country.

In Kitui County, a large proportion of the cowpeas (leave and grain) are traded in the rural markets in the county or used for subsistent consumption. The marketing of the cowpea (both grains and leaves), in Kitui County are done in weekly markets that are located in the urban trading centres[15]. A generalized marketing structure for cowpeas in Kenya is presented in Fig. 3.10 below.

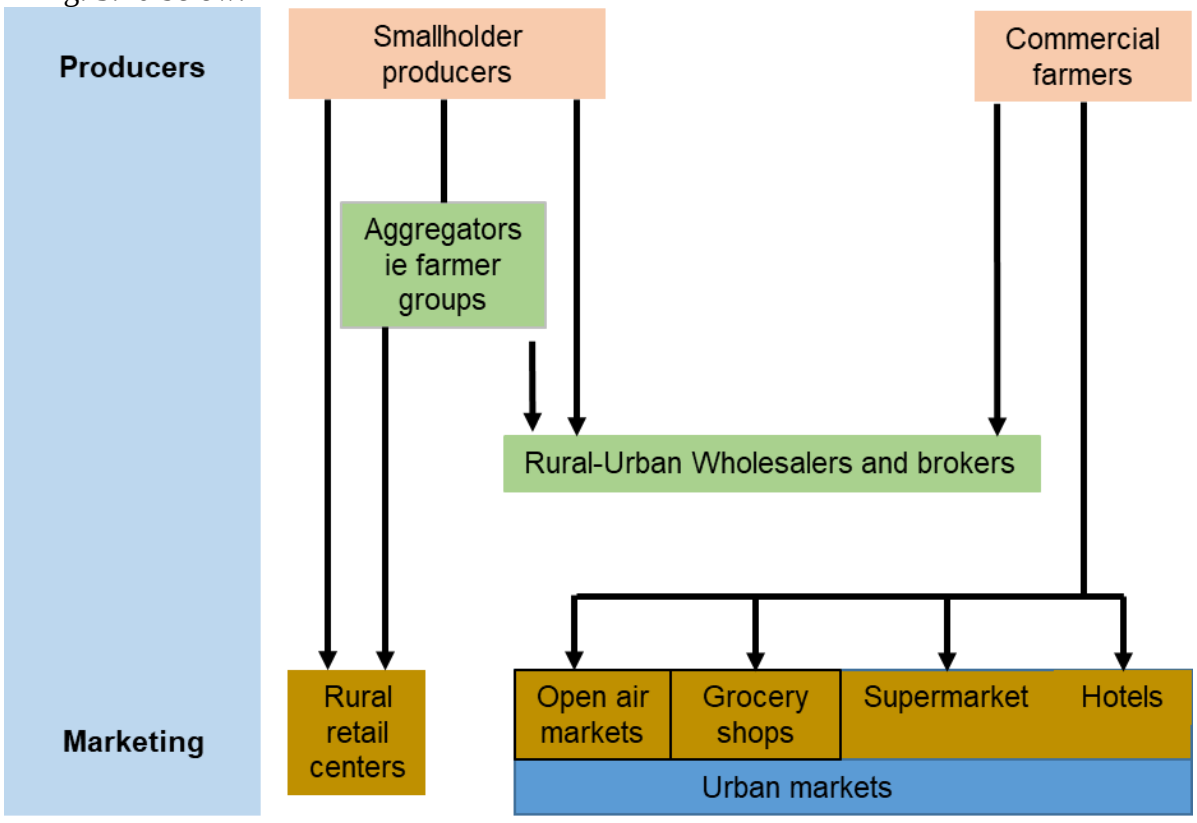


Fig. 3.10. Marketing structure of cowpea leaves in Kenya

Kitui County is one of the leading producers of cowpeas accounting for 10.8% of the total national production (Figure 3.11). Since the County has erratic and low amounts of rainfall, cowpea leaves are largely cultivated as a fast-growing crop that can be harvested within a short period. The crop is also drought tolerant and can be grow under low moisture [5]. Its cultivation has two cropping seasons among majority of the producing households who rely

on rainfed production.[1]. In Kitui county, the crop is not only grown for the leaves but also the grain, both for domestic consumption and trade. The leaves have a high content of beta-carotene, ascorbic acid, zinc, calcium and iron [6], micronutrients whose deficiencies among the Kenyan population are rampant. Moreover, the Kenya Demographic and Health Survey and the Kenya National Bureau of Statistics, KNBS (2014) reported that the rural areas such as Kitui have higher prevalence of micronutrient deficiencies, despite these areas constituting the highest production of these vitamin-rich vegetables. The region is also characterized by frequent incidences of famine resulting from frequent droughts that are experienced in the area. This further exacerbates their preference of the crop due to the short-maturity season and the need to diversify their diet.

According to the Horticultural Crops Directorate (HCD) data, the area under cowpeas in the country in 2018 was 36,745 Ha, yielding 119,326 Tons valued as Ksh2.5Billion. In comparison to the 2017, this was a rise in area, volume, and value by 17%, 50%, and 7%, respectively.

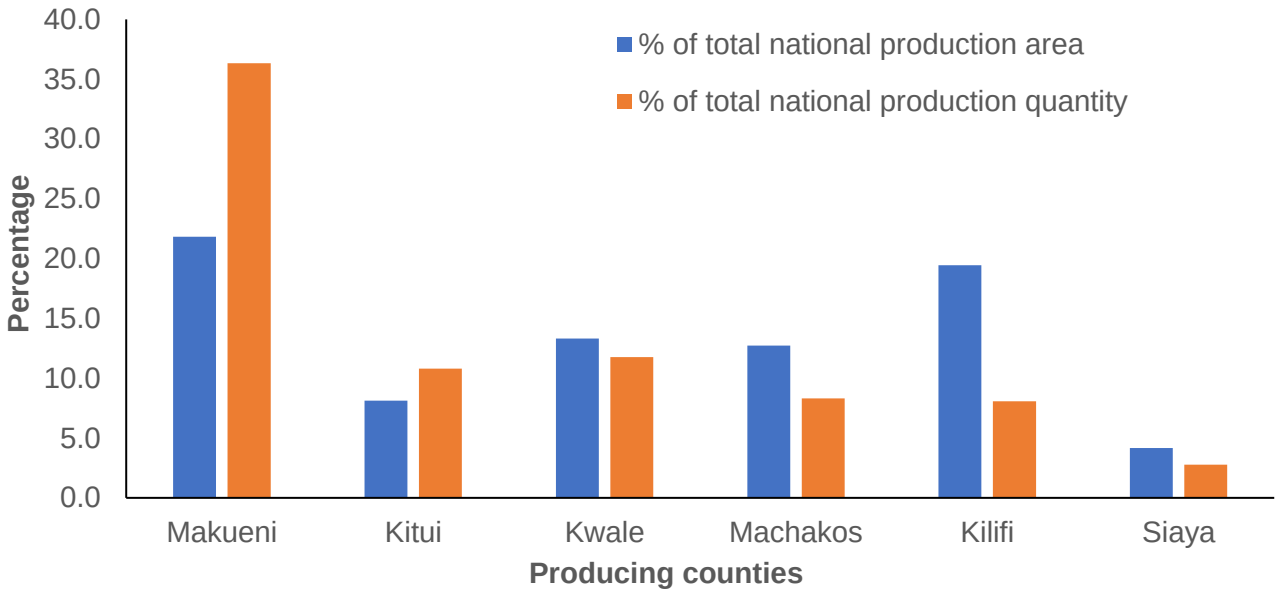


Fig 3.11: Production trends of cowpea leaves in Kenya (Horticultural Crops Directorate, 2018).

The total value of trade of cowpea leaves nationally stood at KES. 2.4 billion in 2016. Kitui is among the leading producers of cowpeas and trade in cowpeas has had a progressive increase in value since 2012 (figure 3.12). This trend has not been replicated in other cowpea producing counties. The marketing of the cowpeas (both grains and leaves), in Kitui County is done in weekly markets which are located in the urban trading centres [8].

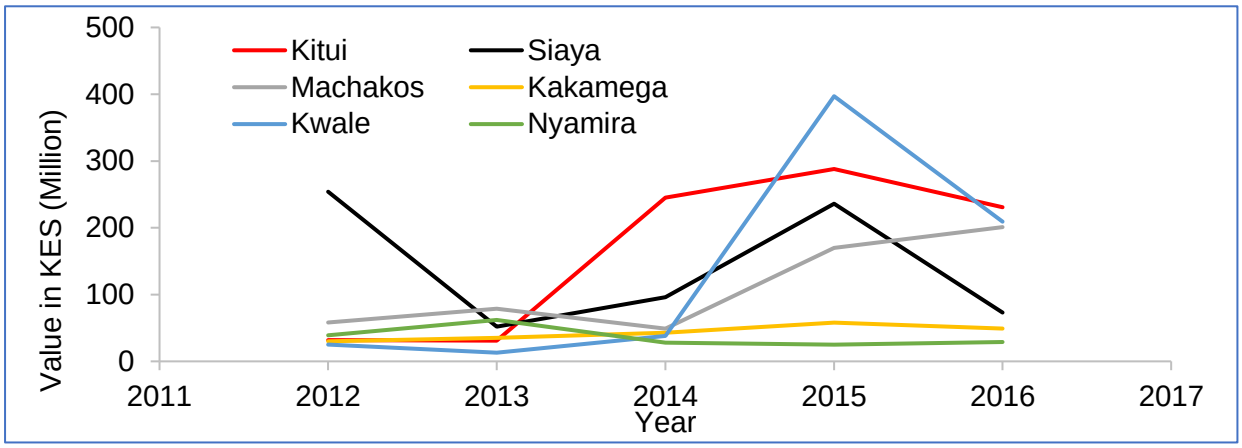


Fig 3.12: Value of cowpea leaves produced in Kitui County and other cowpea producing counties. Sourced from USAID and AFFA[9] and Horticultural Crops Directorate

3.2.2.2 Postharvest losses in the cowpeas value chain – extent and causes

It is estimated that up to 50% of the annual production of cowpeas leaves is lost [6]. These losses occur pre-harvest, harvesting, storage, transportation, and marketing staged of the supply chain. There are no studies to quantifying the losses at the various stages of the supply chain, which precludes the identification of critical loss points based on the assessed literature. The losses are attributed various factors including poor harvest and postharvest handling practices, high perishability of the leaves, lack of processing practices, lack of and inefficient postharvest storage facilities. There is limited value addition through small-scale processing because most householders prefer to consume the fresh leaves. Moreover, Okello et al. (2015) reported a lower demand for these value-added products, resulting in minimal value addition which could address the high postharvest losses. Production is seasonal with a limited availability of less than one month. This has resulted in the households having scarce supply of the vegetable in the off-season. During the season there is oversupply of the vegetables leading to glut and subsequent losses. The figure 3.13 below describes common causes of losses at the various stages of the supply chains.

Preharvest	Harvest	Storage	Transport	Processing	Consumer attitudes and preference
•Pests and diseases •Varieties that are susceptible to pests and have poor keeping quality •Seasonality of the crop - High postharvest losses during the high season with oversupply	•Poor harvesting practices – time of harvesting and handling of harvested leaves •Lack of field shades to reduce deterioration •Poor harvesting and field packaging containers	•Poor storage conditions – hot and dry conditions that exuberate deterioration •Lack of appropriate storage facilities for the perishable leaves – cold storage.	•Lack of reliable transportation and poor rural road infrastructure leads to qualitative and quantitative losses •Poor handling and packaging during transport leading to quantitative and qualitative losses	•Lack of value addition capacity •Inadequate knowledge, and additional costs associated with value addition and have thus resulted in less practice of value addition for the cowpea leaves	•Preference for fresh leaves to dried cowpeas •Misconception regarding dried leaves as being less nutritious leading to low uptake of value-added cowpeas products

Fig 3.13: The causes of losses at the various stages of the supply chains

3.2.2.3 Current mitigation measures to reduce losses in cowpeas value chains

The households involved in the cultivation of cowpea leaves in Kitui County and other producing areas has largely been using landrace varieties. However, there are other improved varieties presenting various agronomic advantages including high yields, drought tolerance and pest and disease resistance that have been grown. Kenya Agricultural and Livestock Research Organization (KALRO) is the leading research institute that has undertaken research on the crop resulting in the release of the improved crop varieties for cultivation in different agro-ecological areas in the country. Uptake of improved varieties with high yields and better pest/disease resistance could contributes to efforts towards commercialization. Most of the cowpeas is produced by smallholder farmers who depend on rainfall. The vegetable is therefore abundant following the rain season and scarce during the dry season. To enhance availability during the low/lean season, drying and other preservation methods have been recommended as possible ways of extending the shelf-life and increasing availability (Owade et al. 2020). However, consumer acceptance of the dried vegetables remains low (Okello et al. 2015). Therefore, there is need for continued efforts to raise awareness on value addition of cowpeas and the nutritional benefits of the value-added products. Such efforts are geared towards addressing the seasonality challenge where seasonal gluts have contributed to high postharvest losses.

3.3. Postharvest Losses in bean value chains linked to the Homegrown School Meals Program

3.3.1 Description of losses at the producer level - beans

3.3.1.1 Quantitative losses

According to the bean farmers in Kitui and Kajiado Counties, 18.37% and 6.61% of the beans are lost in the supply chain. The critical loss points were reported is the harvest, threshing and

drying stage (on-farm processing) where 8.73% and 2.93% of the losses occur in Kitui and Kajiado Counties respectively (Figure 3.14). High losses at this stage can be attributed to over drying which leads to shattering of the pods and subsequent spillage in the farm during harvesting. The relatively higher losses (5.18%) reported at the storage in Kitui county could partially be attributed to inadequate and poor storage facilities as observed during the survey.

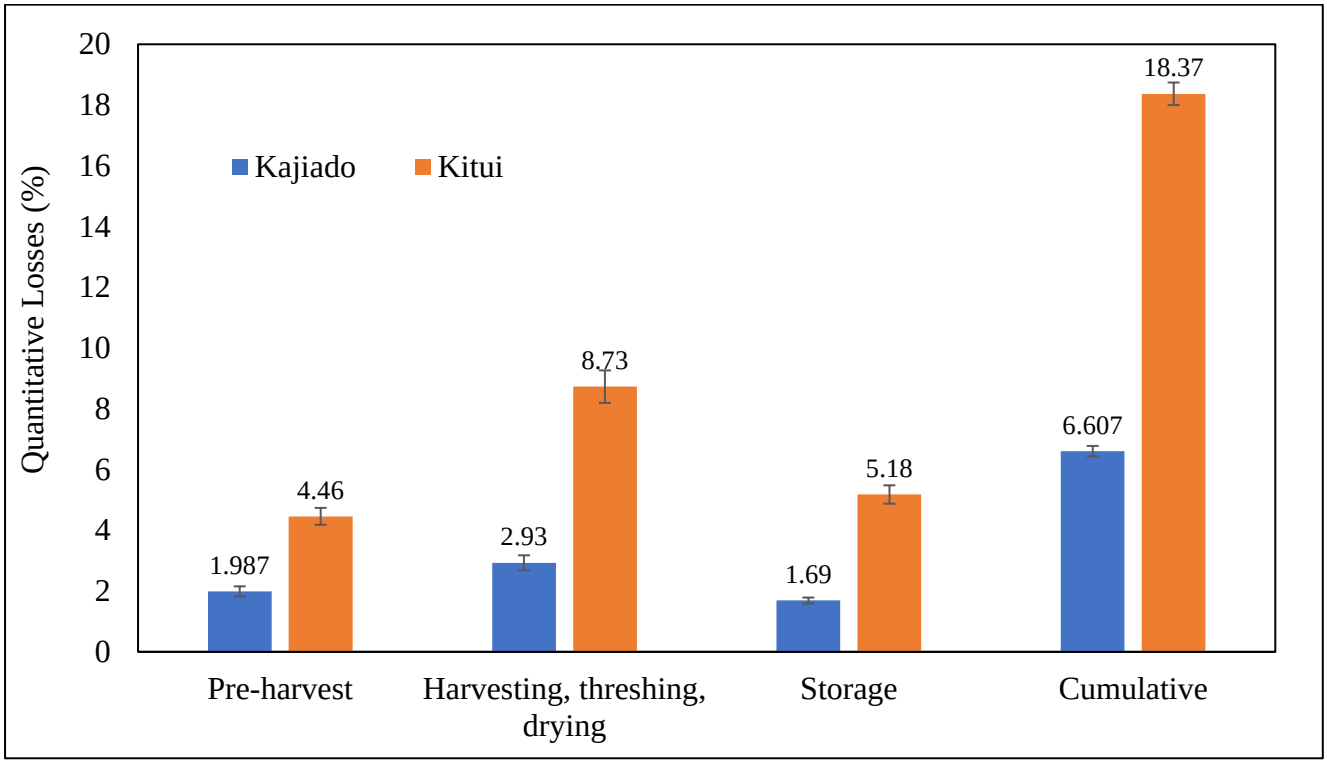


Fig 3.14: Quantitative losses at the producer level. Vertical bars represent standard error of means, n=42 (Kajiado); n=13 (Kitui).

3.3.1.2 Qualitative losses and causes at the producer level

Qualitative losses were estimated to be 3.55% and 10.14% respectively for Kajiado and Kitui Counties. The harvesting, threshing and drying stage had the highest qualitative losses estimated at 2.19% and 7.52% for Kajiado and Kitui counties respectively (Figure 3.15). The lower losses at the storage stage, 0.19% and 0.54% respectively for Kajiado and Kitui Counties could be attributed to the fact that the farmers do not store the beans for long because of the low volumes produced and the high demand for the produce.

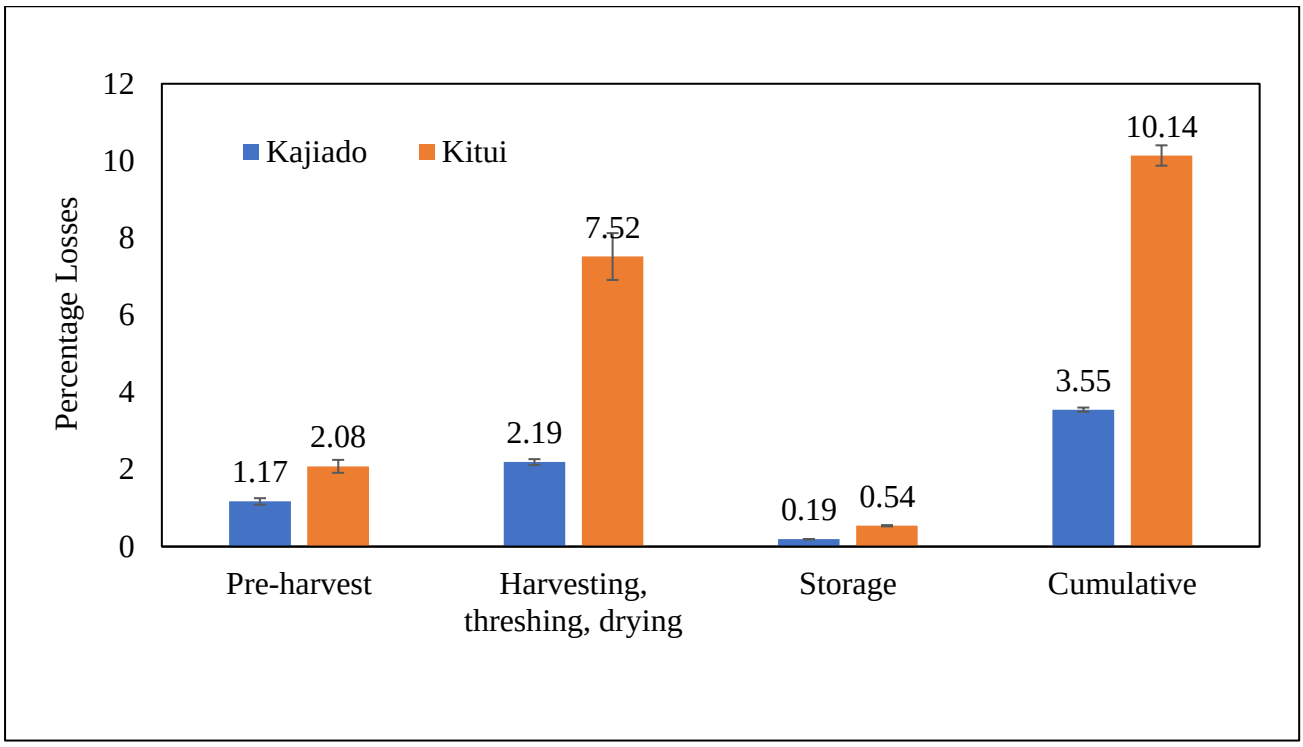


Fig 3.15: Qualitative losses at the producer. Vertical bars represent standard error of means, n=42 (Kajiado); n=13 (Kitui)

3.3.1.3 Direct causes of losses at the critical loss point (producer level - beans)

The critical loss point for quantitative and qualitative losses at the producer level is the harvest, threshing and drying stage which constitutes the on-farm processing stage. Broken beans accounted for most of the losses according to 75.61% and 61.54% of the interviewed respondents in Kajiado and Kitui respectively. Other issues associated with qualitative losses included dirt, molds and sprouting (Fig. 3.16). The breakages of grains could be attributed to excess mechanical impact applied during manual threshing. During winnowing, much dirt/chaff is left due to incomplete winnowing. Dirt is better removed during the warm windy days. In Kajiado County, the much dirt could be associated with cool and calm weather experienced in most parts of the county after the harvesting season. Grain winnowed on less windy days are left with much chaff. In addition, the cool weather during the harvest and on-farm processing could lead to inadequate drying. Most published reports indicate pests (mainly weevils) as the major causes of quantitative and qualitative losses during storage. However, in the current study only 14.6% and 7.7% of the respondents in Kajiado and Kitui respectively indicated pest as a major cause of losses. This could be explained by the short storage period where pest damage may not have a significant impact on the losses.

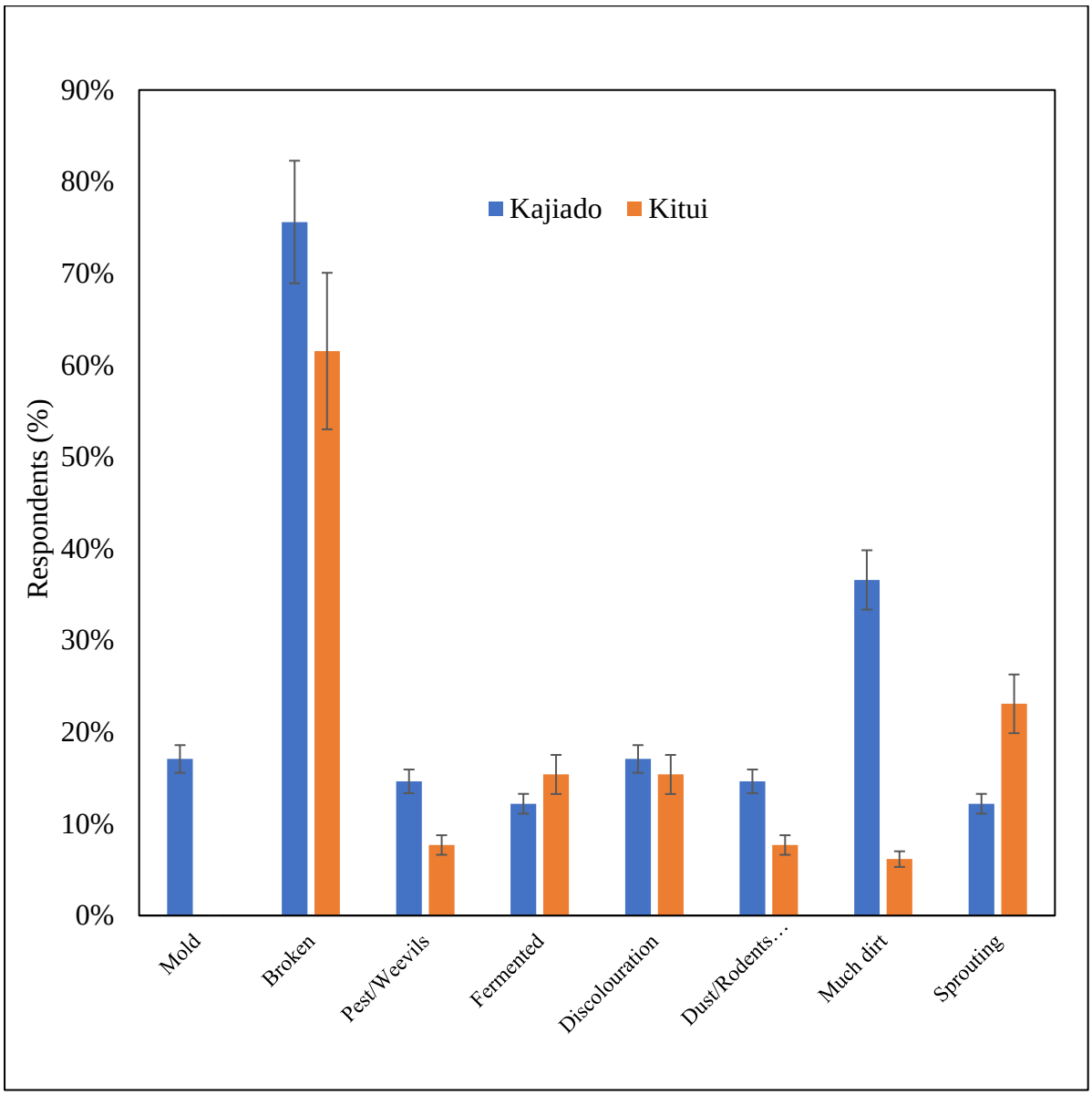


Fig 3.16: Types of produce damage at the critical loss point (producer). Vertical bars represent standard error of means, n=42 (Kajiado); n=13 (Kitui)

3.3.1.4 Economic impact of losses for Producers

The economic impact of losses was estimated by attaching monetary values to qualitative and quantitative losses. This impact is based on the starting quantity at the beginning of the value chain stage. Economic quality loss is the estimated revenue that could have been generated given best quality prices at the time of sale. Thus, economic quality losses were computed as follows:

Economic quality loss (Kshs)= Qualitative losses (kg) × (Best price per kg (Kshs)—Reduced price per kg (Kshs) [A]

Economic Physical loss is the monetary value of the weight lost from one value chain stage to the next and was computed as follows.

Economic physical loss (Kshs) =Quantitative losses (kg)×Best price per kg (Kshs) [B]

Total economic loss (Ksh) = Economic quality loss (Ksh) + Economic physical loss (Ksh)[C]

Original maximum value of food (Kshs)= Weight at beginning of stage (kg) ×Best price per kg (Kshs) [D]

Total economic loss (%) = ([C] / [D]) ×100

Table 3.2 shows the economic impact of postharvest losses for bean producers in Kajiado and Kitui Counties. Results revealed higher total economic losses at the harvest, threshing & drying stage for both Kajiado and Kitui Counties, with Kitui County experiencing higher total economic losses. This implies that farmers in Kitui County realize lower farm incomes as compared to their counterparts in Kajiado. This agrees with findings from the estimation of the extent of losses in both Counties from which harvest, threshing & drying stage was identified as a critical loss point in both Counties and strongly in the case of Kitui County.

Table 3.2: Economic impact of losses for Producer

County	Stage	Economic physical loss (KES)	Economic quality loss (KES)	Total Economic loss (KES)	Total Economic loss (%)
Kajiado	Harvest, threshing & drying	2,431.5	1,528.8	3,960.3	3.7
	Storage	601.6	760.6	1362.3	1.4
Kitui	Harvest, threshing & drying	3,033.1	1,085.3	4,118.5	6.3
	Storage	1,920.0	972.1	2,892.0	1.3

3.3.2 Description of losses at the trader level - beans

3.3.2.1 Quantitative losses

In Kajiado and Kitui counties the bean traders double up as transporters of their produce to the market. The cumulative quantitative loss for the traders was 5.79% and 12.63% in Kajiado and Kitui respectively. The critical loss point for the trader is during storage where the losses are estimated to be 1.60% and 6.61% for Kajiado and Kitui respectively (Figure 3.17). The losses in the stores result from spillage due to the poor quality of storage bags and poor storage practices in general. Loading, transportation and offloading were considered for Farm to Aggregation (FA) and Storage to Market (SM). The other three stages in order of rank from highest for Kitui were Loading FA (1.42%), transportation SM (1.10%) and transportation FA (1.09) whereas in Kajiado, lower percentages were recorded for transportation FA (1.12%), Offloading FA (1.06%) and transportation SM (0.75%).

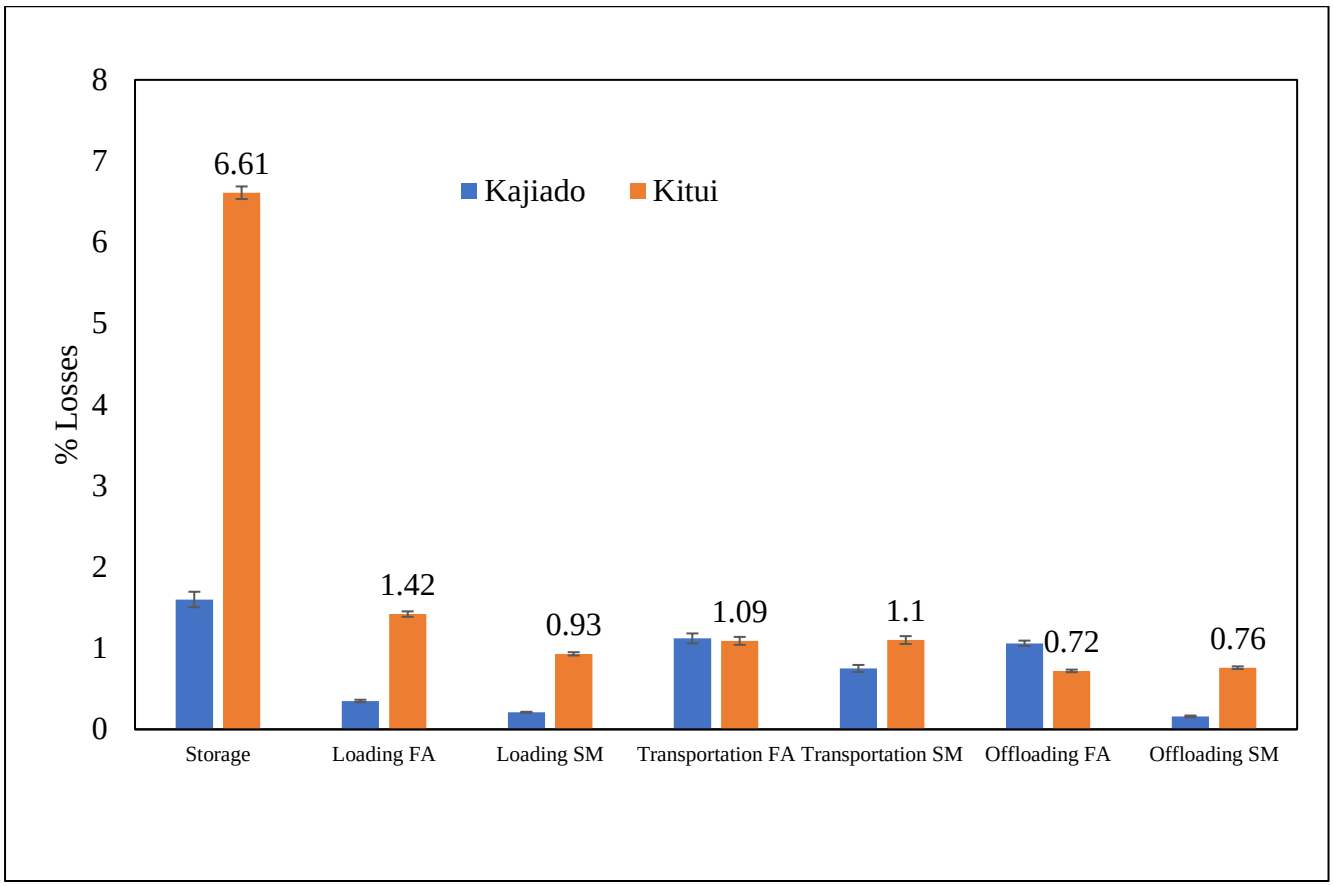


Fig 3.17: Quantitative losses at the trader-transporter stage (FA = Farm to Aggregation; SM Store to Market. Vertical bars represent standard error of means. n=40 (Kajiado); n=65 (Kitui)

3.3.2.2 Qualitative losses

The storage stage remains the critical loss point for qualitative losses among the traders. The losses are estimated to be 2.15% and 5.60% in Kajiado and Kitui respectively (Figure 3.18). Besides the critical loss point (storage), other leading loss points high qualitative losses include transportation SM (2.38%) and loading FA (1.13%) for Kitui and transportation SM (1.61%) and offloading FA (0.86%) for Kajiado county.

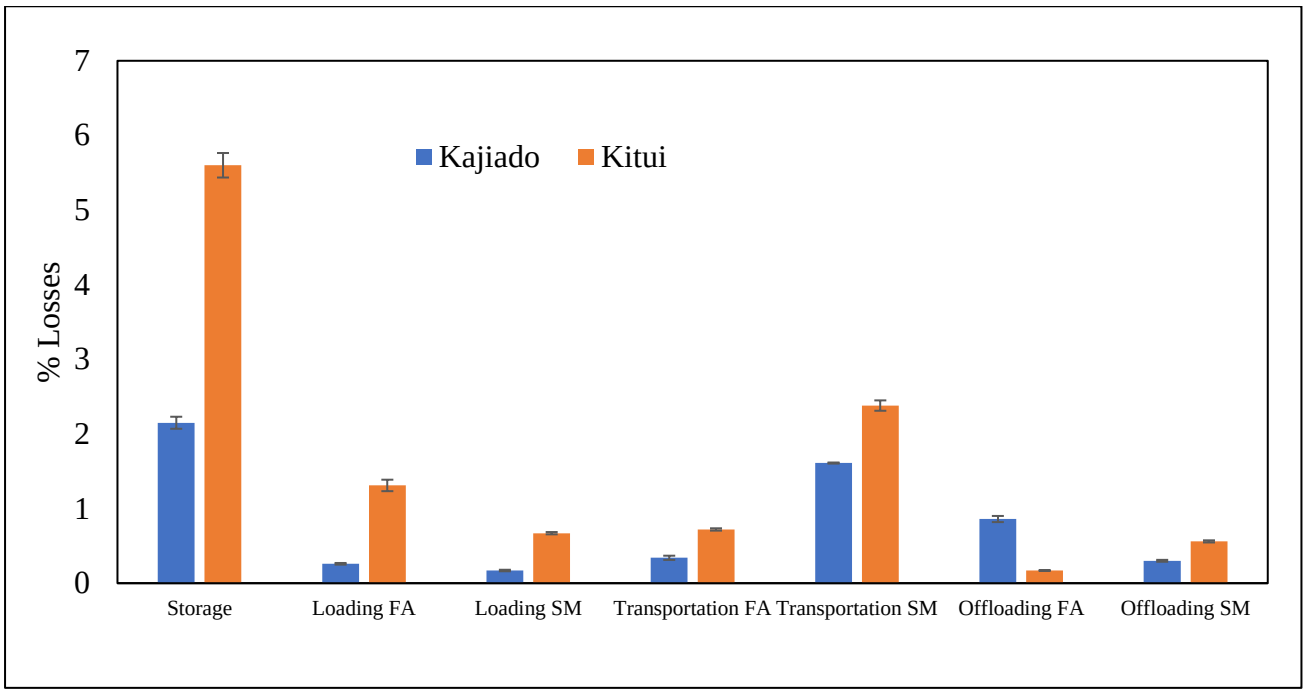


Fig 3.18: Qualitative losses attributed to damaged beans. Vertical bars represent standard error of means. n=40 (Kajiado); n=65 (Kitui).

3.3.2.3 Causes of losses at the critical loss point

The leading issue associated with quality loss at the critical loss point for traders (storage) were pests/weevils attack as revealed by 70.37% and 64.91% of the respondents in Kajiado and Kitui respectively (Figure 3.19). Other factors contributing to qualitative losses in Kitui include broken grains (45.61%), much dirt (29.82%) and discolouration (28.07%) for Kitui. In Kajiado the loss factors included broken grains (37.04%), dust/rodents dropping (29.63%) and much dirt (18.52%). It is noteworthy that some of the issues associated with losses at the trader stage were transferred from the producer (See Figure 3.19 below, with high % reports of broken grains and much dirt). Breakages in bean grains are caused by manual threshing at producer level and rough handling of packed grains in bags. Broken beans are more susceptible to attack by weevils hence the high loses. In addition, some of the varieties stored by the traders like '*Nyayo'* beans are very susceptible to weevil attack. Lack of proper store management may also contribute to the high levels of the pest attack. Unlike the producers, traders store the beans for some time as they scout for profitable market outlets. According to the traders and observations during the study, causes of quality loss include inappropriate use of packaging technology, humidity leading to fermentation and exposure to high sunshine intensity leading to bean discoloration. In most cases, traders have failed to reinforce their stores besides not opting to use/adopt appropriate packaging options. Consequently, poorly stored/packed produce are prone to insects and other pests (e.g., weevils) infestation. Further, a lower proportion of the traders in Kitui place their produce on pallets during storage, thus exposing the produce to humidity from the floor as evidenced by sprouting of up to 10.53% of respondents (Fig. 3.19). The other cause of loss in quality in Kitui is exposure to intense solar radiation which was attributed to discoloration (28.07%) when grains are dried under direct sunlight after threshing.

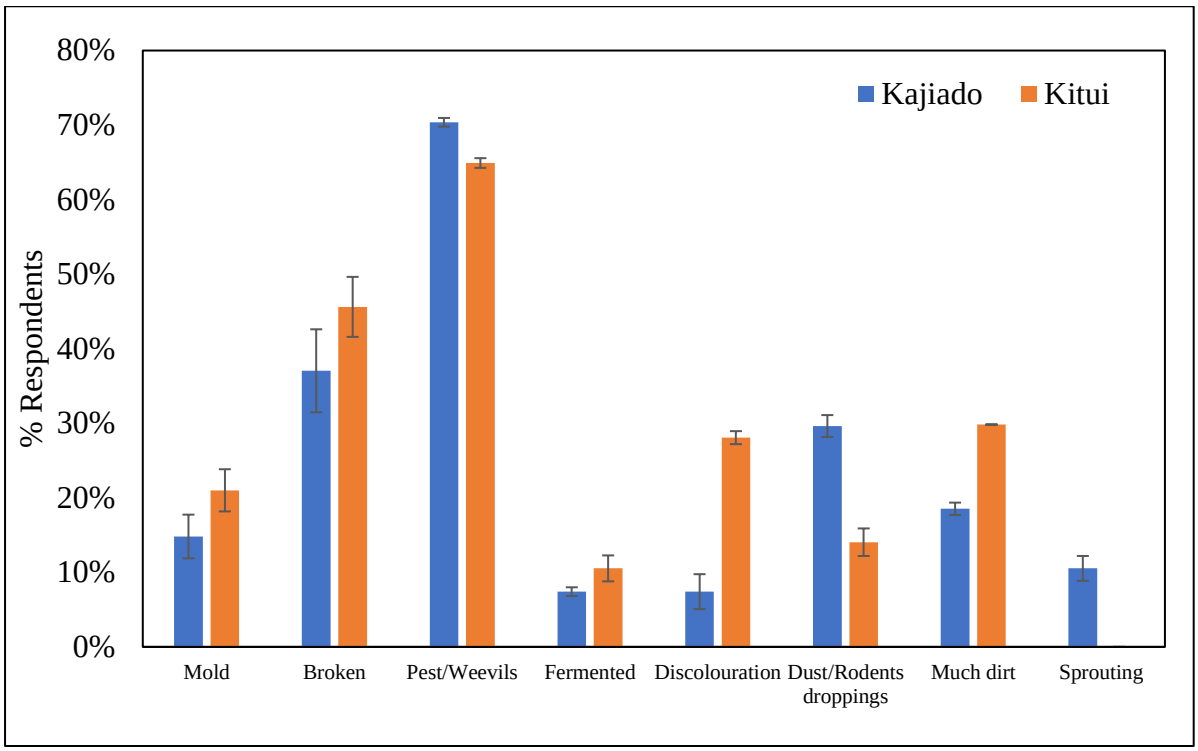


Fig 3.19: Types of damage associated with qualitative loss at the critical loss point (storage), % respondents. Vertical bars represent standard error of means. n=40 (Kajiado); n=65 (Kitui).

3.3.2.4 Load tracking of beans– Extent and causes of losses at the critical loss point for the trader (Kitui)

The stage of winnowing threshed beans was observed as the critical loss point in the bean value chain involving traders who buy the beans from the producers at farm level. At this point 7.60% of the initial weight was lost (Figure 3.20a). The quantitative and qualitative losses were attributed to spillage and mixing with much chaff/dirt respectively. Winnowing during the less windy days aggravated the problem of chaff/dirt remaining on the beans. The much dirt was observed at later stages of the supply chain including schools. The minimal losses observed during storage were mainly due to spillage in part attributed to low quality packaging materials which are mainly reused polythene/plastic bags (figure 3.20b).

Follow up of the stored beans after 3 months of storage showed that only 0.8% of the initial quantity had been lost. The quality of beans was still very good and no cases of pest damage observed because the beans were treated with storage pesticides before storage. The cumulative quantitative losses from farm to storage after 3 months was estimated to be 12%.

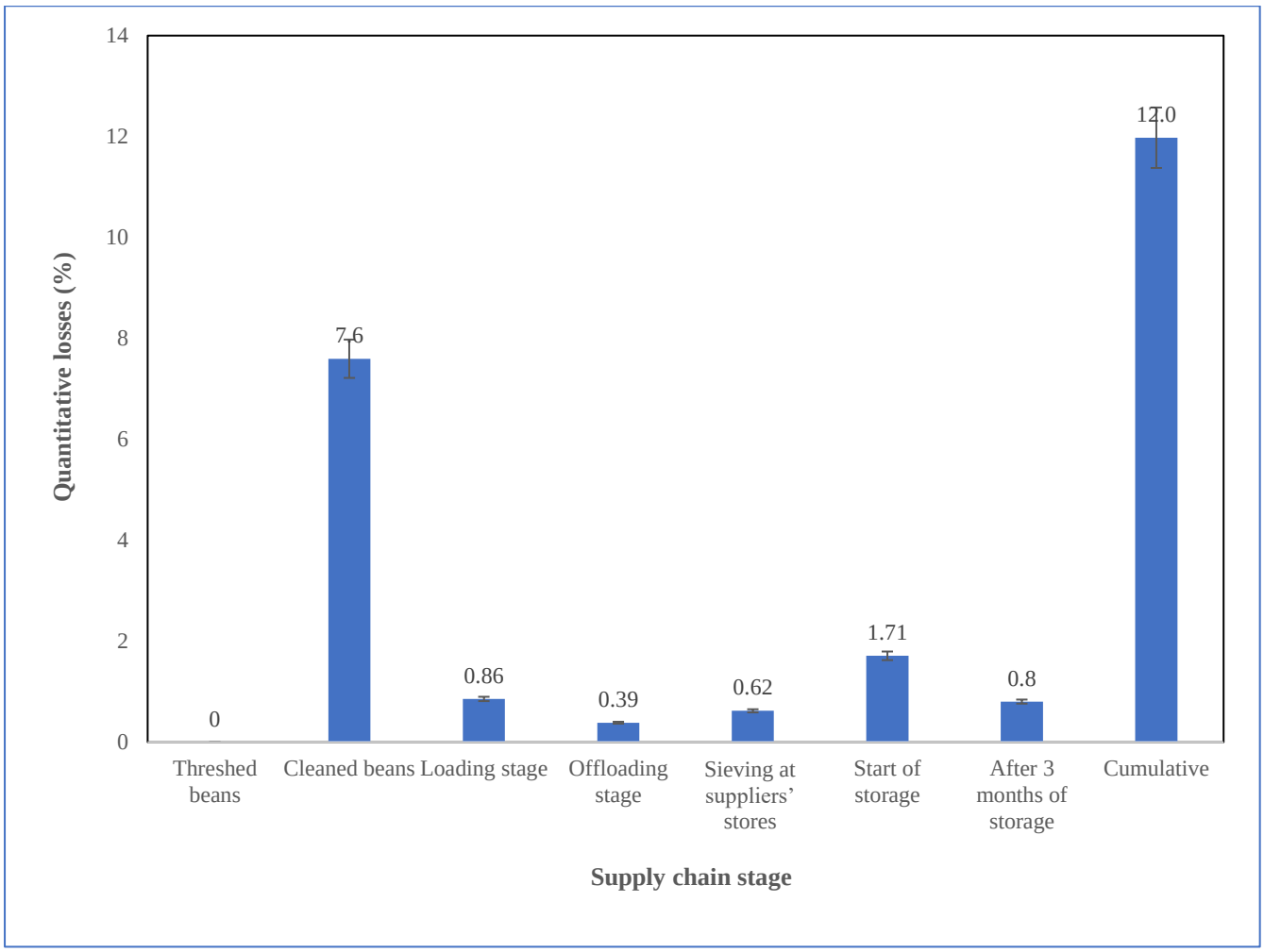


Fig 3.20a: The quantitative losses from farm to storage after 3 months. Vertical bars represent standard error of means.

Harvest stage	Post-harvest processing, handling and storage at farmer's level	Transportation	Processing, handling and storage at Trader's stores
• Delays in bean harvesting result in preharvest losses. • Harvesting during cool days with rains and limited sunshine – delays drying • Harvested beans placed directly on ground – they shutter and lost • Harvesting together with weeds – making the cleaning, sorting and grading hard. • Mixing varieties at harvest – additional work for sorting and grading	• Drying done in farms with no designated areas for drying - leads to losses through shuttering • Threshing done directly on the ground – Contamination and spillage leading to quantitative losses • Threshing done manually using wooden sticks – breaks the beans that are discarded • Storage of semi-dried beans due to lack of moisture meters which may ferment or rot • Lack of proper storage for processed beans - spillages, weevil attack and humid environments • Lack of pallets in stores, spillage and storing other cereals and materials in the same store • Spillage during winnowing results to quantitative losses	• Poor road networks from farms to homesteads as well as from homesteads to market thus spillage may occur • Use of polythene bags that may tear thus spilling the beans • The manual loading and offloading of the beans is frequently rough, resulting in interference with the packaging integrity and, as a result, quantitative losses • Use of open lorries and pickups that might be rained on	• Storage of not properly dried beans - associated with aflatoxins, fermentation • Spillage in the stores leading to quantitative losses • Direct placement on ground – rodent attacks and contamination • No cleaning and fumigation schedules leading to contamination • Multi-use of stores with other commodities leading to cross-contamination • Leaking roof in some stores creating humid conditions • The bags used contribute to spillages as they are of poor integrity and therefore quantitative losses

Fig 3.20b: Summary of the causes of losses at each of the stages of the supply chain as observed during load tracking.

3.3.2.5 Economic impact of losses for Traders

Table 3.3 shows the economic impact of postharvest losses for bean traders in Kajiado and Kitui Counties, majority of whom also transported the produce to schools. In tendering for the supply of the basket of goods, school committees prefer competitive suppliers who are willing to deliver the commodities to the schools at no extra cost. Results revealed that traders and transporters in both Kajiado and Kitui Counties experience much lower total economic losses as compared to producers. As expected, although the storage stage was identified as a critical loss point for traders and transporters, in Kajiado the total economic losses are slightly lower compared to other stages. This is attributable to the fact that traders procure beans around harvest time when prevailing market prices (employed in this study) at that time are much lower. However, the total economic losses at storage for Kitui County were found to be higher and this is in line with the higher extent of losses found for Kitui. In Kajiado County the highest total economic losses were estimated at the stage: loading from the field to the aggregation point. In Kitui the highest total economic losses were estimated at the stage of loading from storage to the school. However, this was higher by only 0.02% compared to the loading from the field to the aggregation point in Kitui. This indicates that for traders and transporters, higher total economic losses are incurred at the loading stage. This is attributable to poor handling while loading and poor quality of the packaging bags.

Table 3.3: Economic impact of losses for Traders

County	**Actor**	**Stage**	**Economic physical loss (Kshs)**	**Economic quality loss (Kshs)**	**Total Economic loss (Kshs)**	**Total Economic loss (%)**
Kajiado	Trader / Transporter	Storage	2,428.39	2,181.85	4,610.24	0.55
		Loading FA	5,891.11	4,616.95	10,508.06	1.16
		Loading FA	2,475.56	954.34	3,429.90	0.38
		Transportation FA	6,155.56	3,137.24	9,292.80	1.03
		Transportation SS	4,391.11	5,689.40	10,080.51	1.13
		Offloading FA	3,904.44	2,658.04	6,562.48	0.74

		Offloading SS	1,288.89	2,233.81	3,522.70	0.40
Kitui	Trader / Transporter	Storage	2,350.44	3,114.66	5,465.10	0.82
		Loading FA	910.48	412.41	1,322.90	0.16
		Loading FA	964.03	503.60	1,467.63	0.18
		Transportation FA	413.71	239.82	653.53	0.08
		Transportation SS	760.48	470.34	1,230.83	0.15
		Offloading FA	387.90	173.01	560.91	0.07
		Offloading SS	574.19	336.89	911.09	0.11

N/B: FA = Field to aggregation point

SS = Storage/farm to school

3.3.3 Description of losses at the school level - (beans)

3.3.3.1 Indicative levels of quantitative and qualitative losses

Quantitative losses at the school level are minimal because the quantities handled are small and the duration of storage is short. Most of the losses reported were qualitative in nature. According to teachers in Kitui, the leading issues associated with losses in schools were pest/weevils (47.06%) and spillages (17.65%). In Kajiado 42.86% and 28.57% of the respondents linked losses to spillage and pests/weevils respectively (Figure 3.21). The high level of pest/weevils reported could be because the schools purchase beans which are already infested. Since they do not apply any treatment to the beans because of the short storage duration, the pest multiply leading to more damage. Most schools lack appropriate storage for the beans as reflected in Figure 3.23. In most schools, the classrooms are used as temporary stores for the beans and other non-food items exposing the produce to attack by pests and rodents.

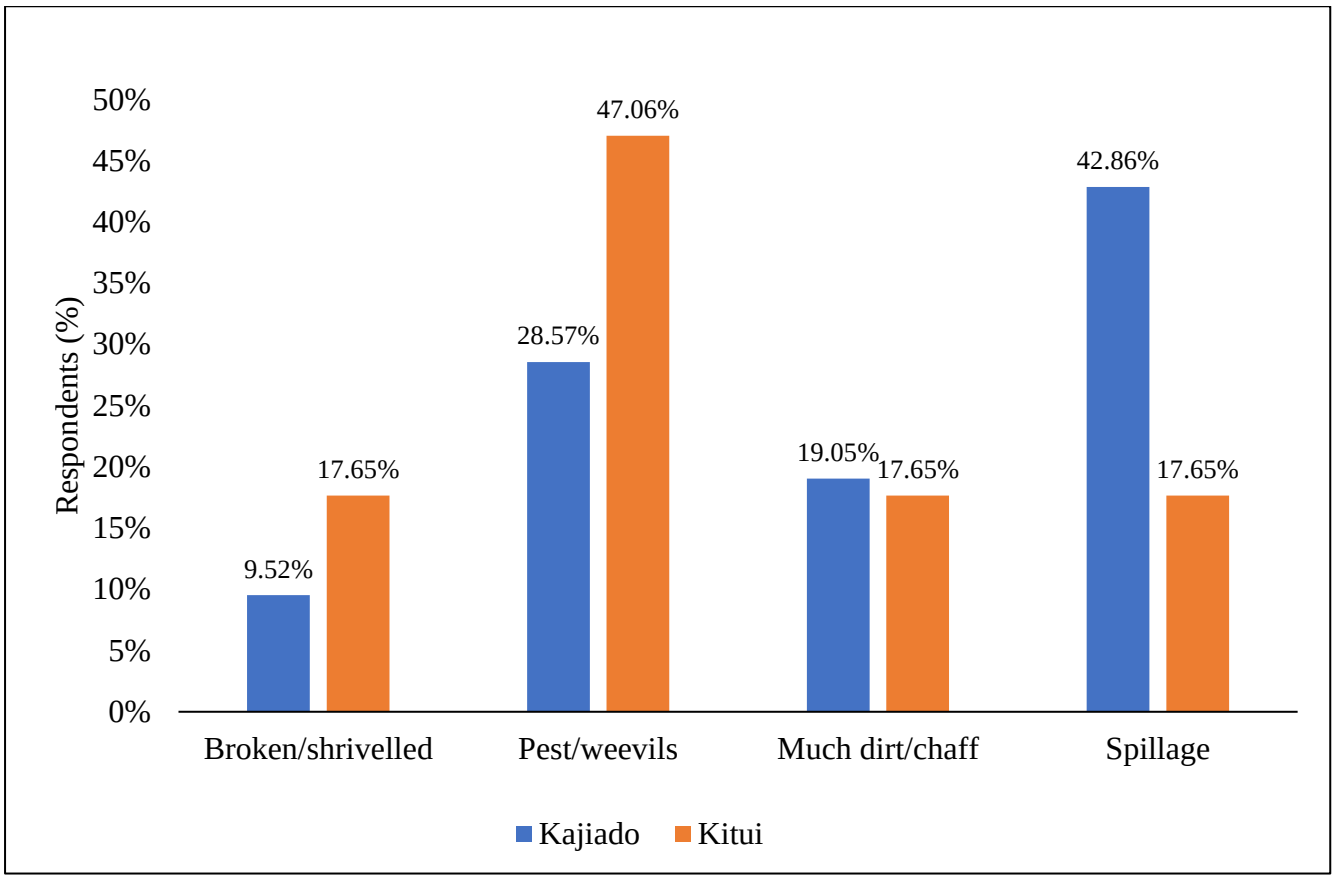


Fig 3.21: Types of damage associated with quantitative and qualitative losses of beans at schools (% of respondents). n=27 (Kajiado); n=38 (Kitui).

3.3.3.2 Causes of quantitative and qualitative losses in schools

3.3.3.2.1 Types of bags used for storage

The high percentage of spillage, 42.87% and 17.65% of the respondents in Kajiado and Kitui Counties respectively can be attributed to use of low-quality bags which easily tear and spill the beans. In Kajiado, about 52% of the teachers indicated that the beans were stored in reused bags. In Kitui, about 38% of the respondents indicated that gunny bags were used to store beans (figure 3.22a). Most schools use polythene bags which most traders use to package the beans. Traders prefer the polythene bags because they are cheap and readily available compared to gunny bags and the hermetic bags which are recommended for grains storage. In Kajiado, no school reported using hermetic bags to store beans while in Kitui, only 2.6% of the teachers reported use of the hermetic bags (figure 3.22b).

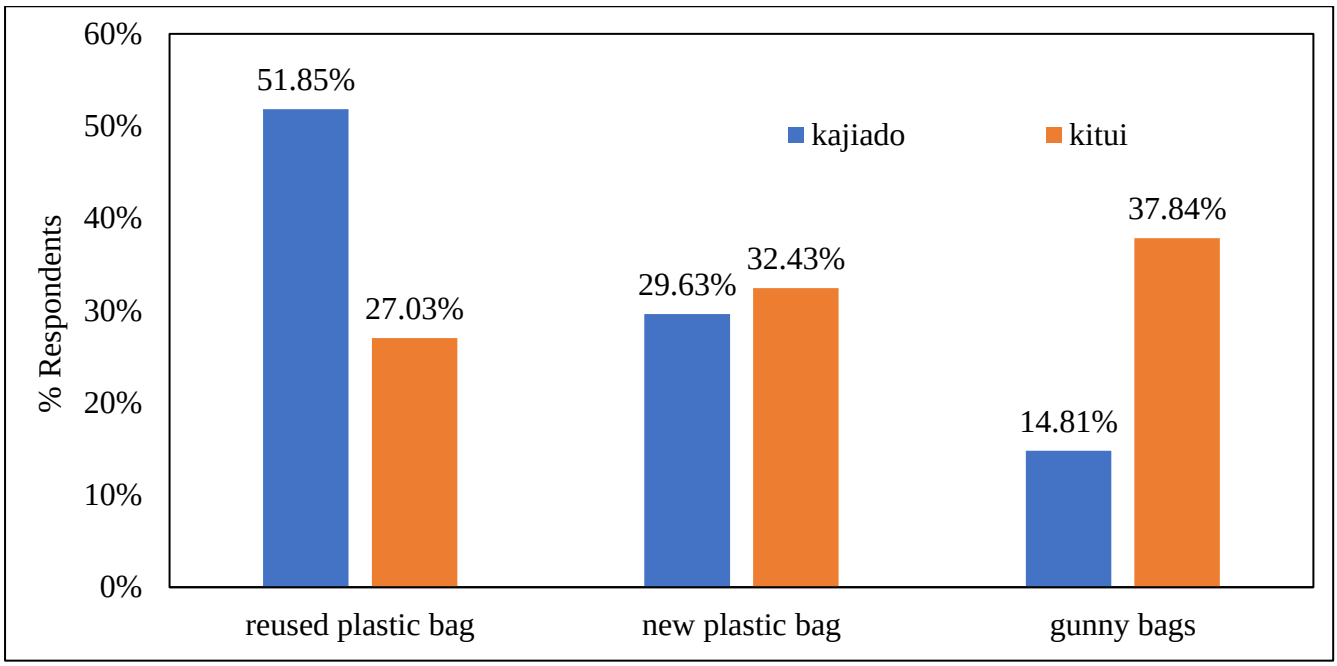


Fig 3.22a: Types of bags used to store beans (% of respondents) in Kajiado and Kitui. n=27 (Kajiado); n=38 (Kitui).

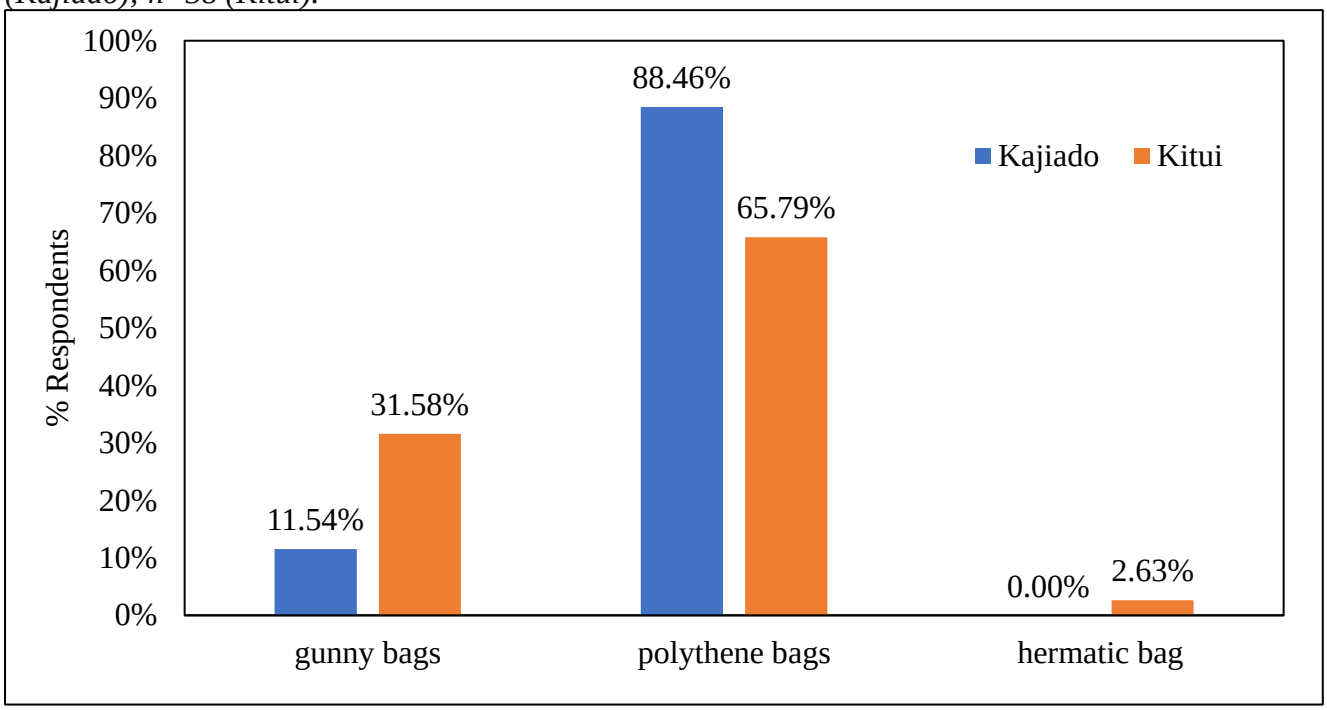


Fig 3.22b: Storage container used for storage in Kajiado and Kitui. n=27 (Kajiado); n=38 (Kitui).

3.3.3.2.2 Lack of appropriate stores

Most of the schools in both counties lack appropriate stores for food. In most schools, 50% and 46% respectively for Kajiado and Kitui there was a dedicated class room that served as a store for food. However, in most cases the same room was used to store other non-food items (Fig. 3.23). Only 19.2% and 13.5% respectively for Kajiado and Kitui of the respondents indicated that they had a proper store for beans (and other food). A very small percentage, 3.85% and 2.70% respondents respectively for Kajiado and Kitui indicated that they had improved granaries for storage of grains.

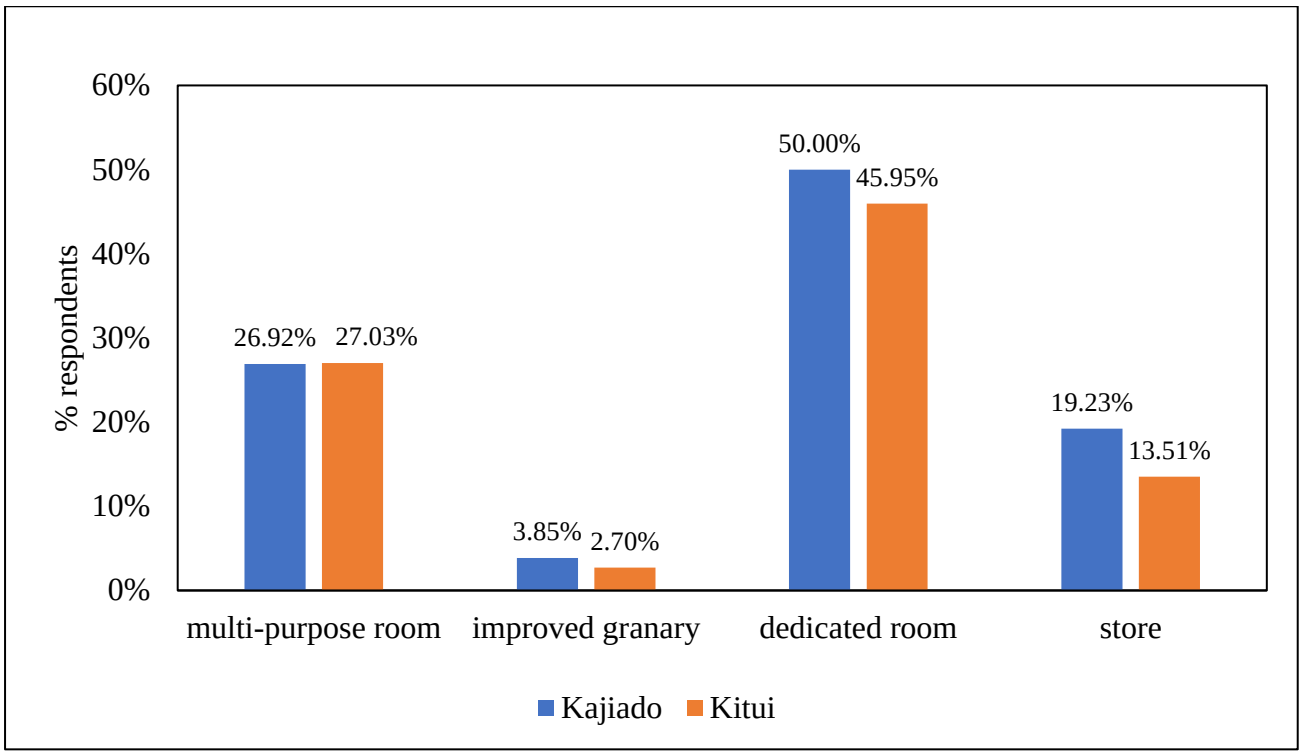


Fig. 3.23: Facilities used for storage of beans in Kajiado and Kitui County. n=27 (Kajiado); n=38 (Kitui).

3.3.3.2.3 Choice of variety

Schools in Kajiado had more varieties of beans to choose from than Kitui (Table 3.4). This could be attributed to more farming activities in Kajiado County compared to Kitui County. However, the choice of bean varieties supplied to schools is limited by the prices. The cheaper varieties were commonly stocked by traders who supplied the schools. In Kitui, all the beans consumed were purchased from other counties. The '*Nyayo'* variety is the most preferred across the 2 counties because it is cheaper, makes a thick stew and blends well with maize in the maize/bean meal (picture 3.10). However, *Nyayo* beans are highly susceptible to weevils hence the high losses reported to be attributed to pests. In both Counties, fewer schools stock/cook the 'Rose coco' and 'yellow bean' varieties because of their high price. Schools in Kitui County shun the 'Wairimu' variety because it is associated with digestive issues and flatulence.

'Nyayo' *'Yellow* *'Mwitemania'* *'Wairimu'* *'Rosecoco'*

Picture 3.10: Beans varieties commonly used in the school meals in Kitui and Kajiado Counties

Table 3.4: Varieties bought by schools in Kajiado and Kitui (% of respondents per variable.

Variety	Kajiado	Kitui
Mwitemania	14.42%	0
Nyayo	25.92%	68.42%
Rose coco	11.11%	5.26%
Wairimu	22.22%	0
Yellow bean	25.92%	2.63%

3.3.3.2.4 Challenges during purchase and storage

Teachers face various challenges when purchasing beans for the schools. These include produce availability, low quality and maintenance of roads, few reliable suppliers, long distances, price volatility, inadequate funds and procurement challenges (Table 3.5). These challenges are more pronounced in Kitui because it is far from the city compared to Kajiado County. Challenges experienced during storage are associated with the predispose to pests and rodents. In Kitui, the preferred variety (*Nyayo*) is highly susceptible to weevils and this is aggravated by poor storage facilities and practices. In addition, the challenge of rodents in Kitui is associated with the bushes around schools and low use of traps and rat guards.

Table 3.5: Challenges during purchasing and storage (% response per variable, each variable is out of 100% per cell)

Stage	Kajiado	Kitui
Purchasing		
Food availability	11.1%	-
Bad roads	7.4%	10.52%
Few reliable suppliers	11.1%	34.62%
Distance to school	-	2.63%
Inadequate funds	-	7.89%
Volatile prices/high prices	40.71%	13.15%
procurement	-	10.53%
Storage		
Ants in the store	-	2.63%
Lack of store	7.4%	7.89%
Weevils	-	5.26%
Rodents	-	2.63%

3.3.3.3 Examples of challenges and coping strategies adopted by schools to manage quality and reduce losses

Challenges at the trader-transporter are transferred to schools. High moisture, pests/weevils and rodents were reported as the major challenge at schools. To manage storage pests, traders commonly use chemical application – the treated beans are sold to schools and therefore this helps to manage the pests during the short-term storage in schools. Rodents in Kajiado are

attributed to plenty farming activities, crops residues and available grains continually in stores. It was also evident that there was spillage of food on the ground in various school stores, which is attributed to use of poor packaging bags as most of them re-used bags (table 3.6).

Table 3.6: Challenges in storage and copying measures in schools

	Problem	Copying strategy	Problem	Copying strategy	Problem	Copying strategy
County	High moisture	Redrying	Pest/Weevils	Apply chemicals	Rodents	Physical killing
Kajiado	4.76%	0%	42.86%	77.27%	42.86%	4.55%
Kitui	5.56%	6.25%	52.78%	68.75%	22.22%	6.25%

Almost all schools in the 2 counties used pallets for stacking bags of grains. However, other best practices in stores including layering of bags stacked at a good distance from the walls; and roofs and/or removing bags leaning on the wall were not adhered to (Table 3.7). This could be attributed to lack of knowledge on the best storage practices and thus need for capacity building for schools on the same.

Table 3.7: Best practices in stores in schools

county	Pallets	1m away from wall	Stacks on floor	Leaning on wall	Layers while stacks	1.5m left from roof
Reported (% of response)						
Kajiado	69.23%	3.85%	3.85%	23.08%	42.86%	7.14%
Kitui	91.67%	100%	8.33%	-	75%	-
Observed state (% response)						
Kajiado	81.48%	37.04%	3.86%	7.08%	53.85%	25%
Kitui	83.78%	35.14%	6.73%	8.11%	32.43%	5.41%

3.3.3.4 Responses on various aspects of storage practices and quality management

Table 3.8 shows a summary of storage practices and quality management of food in schools. Food in both Counties is stored for no longer than a month and both Counties have limited access to dedicated stores. Commendable effort exists in application of FIFO with Kajiado paying slightly more attention to this. Hermetic bags are hardly used for storing beans owing to the cost implication. Stores in both Counties are cleaned without paying much attention to floor, roof and cobwebs. Being learning environments, effort is made to clear bushes and to

keep the surrounding area clean. Use of traps and rat guards to control rodents was not common. Storekeepers had access to bathroom, soap and water. Ventilation was better in Kajiado but Kitui tried to avoid mixing food with non-food items. Both Counties had enough lighting in store and stable source of energy. There were signs of water leakage and cracks on floors. Slightly over 30% of the schools had damaged bags by insects and rodents and spillages on the floor of half of the schools in Kitui. Upto 40% of the schools in Kajiado County had live insects in the stores. Both Counties had stock ledger books. However, cleaning and pest control records were uncommon, with Kitui County making efforts to achieve these.

Table 3.8: Binary responses on various aspects of storage good practices and quality management

Activity	Kajiado	Kitui
Interviewee response on binary attributes		
Experienced losses (Yes)	77.78%	51.35%
Losses during packaging (yes	53.85%	41.38%
Adopt quality standards (yes)	100%	94.74%
Storage duration	(4wks) 37.04%	(3wks) 51.35%
Store used for storage of other materials (yes)	76.19%	70.83%
FIFO application(yes)	72%	65.63%
Observed state of the stores		
Hermetic bags used	7.69%	18.92%
Store cleaned	70.37%	71.43%
Floor, roof clean without dust, cobwebs	59.26%	51.35%
Bush and surrounding clean	77.78%	81.08%
Traps used to control rodents	44%	19.44%
Access to bathroom, soap and water for store keeper	92.31%	64.86%
Rat guards on poles	7.41%	10.81%
Ventilation	65.38%	34.29%
Non-food materials not kept	44.44%	56.76%
Source of light available	74.07%	66.67%
Enough lighting in store	85.19%	72.97%
Refrigerators	0	0
Stable source of energy	66.67%	63.89%
Signs of water leakage and cracks	19.23%	22.22%
Damaged bags by insects and rodents	36%	35.14%
Spillage of grains on floor	33.33%	54.05%
Presence of live insects	40.74%	13.51%
Sufficient ventilation for easy air flow	74.07%	65.71%
Cards or boxes to keep tally	33.33%	38.24%
Stock ledger book	73.08%	75.68%
Cleaning records	29.63%	42.11%
Pest control records	25.93%	47.37%

3.4. Description of Losses in the Cowpeas Value Chain

The data presented below on the extent and causes of losses in cowpeas is based on direct observation during load tracking of the traders. The data presented at producer level is from the farmers from whom the traders source the cowpeas from.

3.4.1. Extent and causes of losses in the long value chain

3.4.1.2. Extent of losses at the producer level

The losses at the farm level were estimated to be 16.2% (cumulative). The critical loss point was the harvesting stage where 10.7% losses were reported (Figure 3.24). High losses at this stage were due limited access to knowledge. Most of the produce lost was left unharvested due to dirt, pest damage and over maturity. Majority of the producers (66.7%) cited limited access to knowledge on recommended harvesting practices and inputs as the main contributors of damage losses. In addition, most of the producers indicated that they only harvest on order from traders. Therefore, lack of consistent/regular market or delay in marketing contributed to the over maturity and losses reported at the harvest stage.

The reported losses (5.5%) at the preharvest stage were attributed to lack of information/advisory services on good production practices. Some of the producers cited lack of supplementary irrigation to sustain the crop during low rains seasons as a factor contributing to the preharvest losses.

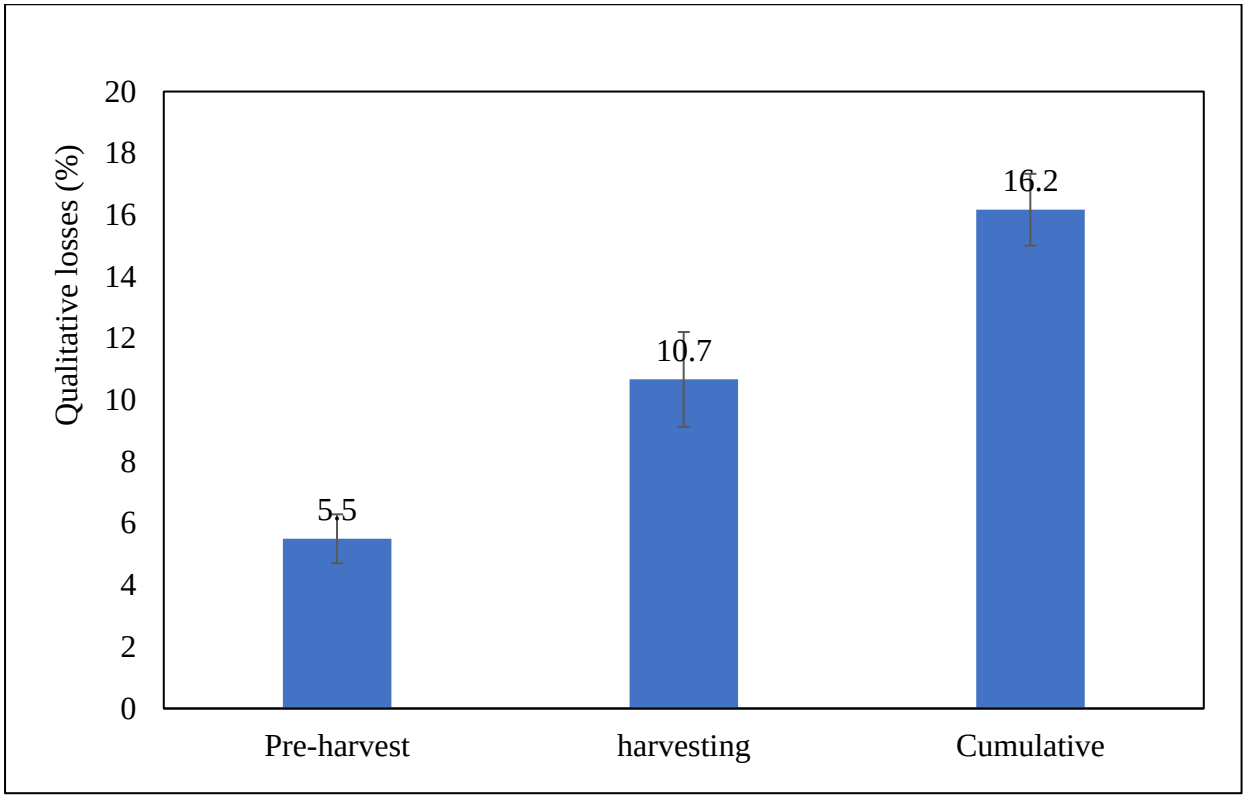


Fig. 3.24. Extent of losses cowpeas at the producer level in the long value chain. Vertical bars represent standard error of means, n = 6.

3.4.1.3. Extent of losses at the trader level (long supply chain)

The traders subject the harvested cowpeas to different pre-treatments and packaging options. These were simulated in the present study and the associated losses for each option reported. The extent of losses and the critical loss point varied depending on the various treatments (Fig. 3.25). In the case of cowpea transported and stored in crates with no wet linings and rehydrated sack, the critical loss point was transportation from farm to market (28.02% and 9.18%). For the cowpeas which were packaged in crates with wetted linings, the critical loss point was between offloading and day 1 at the market (11.82%). For the cowpeas that was packaged in un-hydrated sack, the losses were highest was during storage between 1st and 2nd day (7.99%). The high losses during transportation from farm to market was due to water loss.

Most traders rehydrated the cowpeas once the produce arrived at the market. Rehydration is done regularly as a measure to minimize wilting that results from water loss. Therefore, the produce 'gained' some weight leading to the negative values observed when the cumulative weights were computed. The cumulative losses were highest (72.73%) in cowpeas which were rehydrated before packaging in the sack (rehydrated sack). Incidentally the cowpeas under this treatment remained on the shelves much longer (3 days) compared to the other treatments. This is attributed to the fact that they remained turgid and unwilted because water loss was minimal. This scenario is common among traders as they make efforts to reduce wilting. However, such efforts are not complemented with other postharvest management practices to extent the shelf life of the produce. For example, the unclean water used to rehydrate the vegetables may contain microbial contaminants which continue to multiply leading to rotting as the vegetables remain on the shelf for longer under ambient room conditions. On the other hand, the cowpeas in the un-hydrated sack recorded lower losses (14.22%) which could be attributed to the modified atmosphere (low oxygen and high carbon dioxide) created in the sack. The cowpeas packed in open crates experienced high losses because of direct exposure to heat and intense water loss.

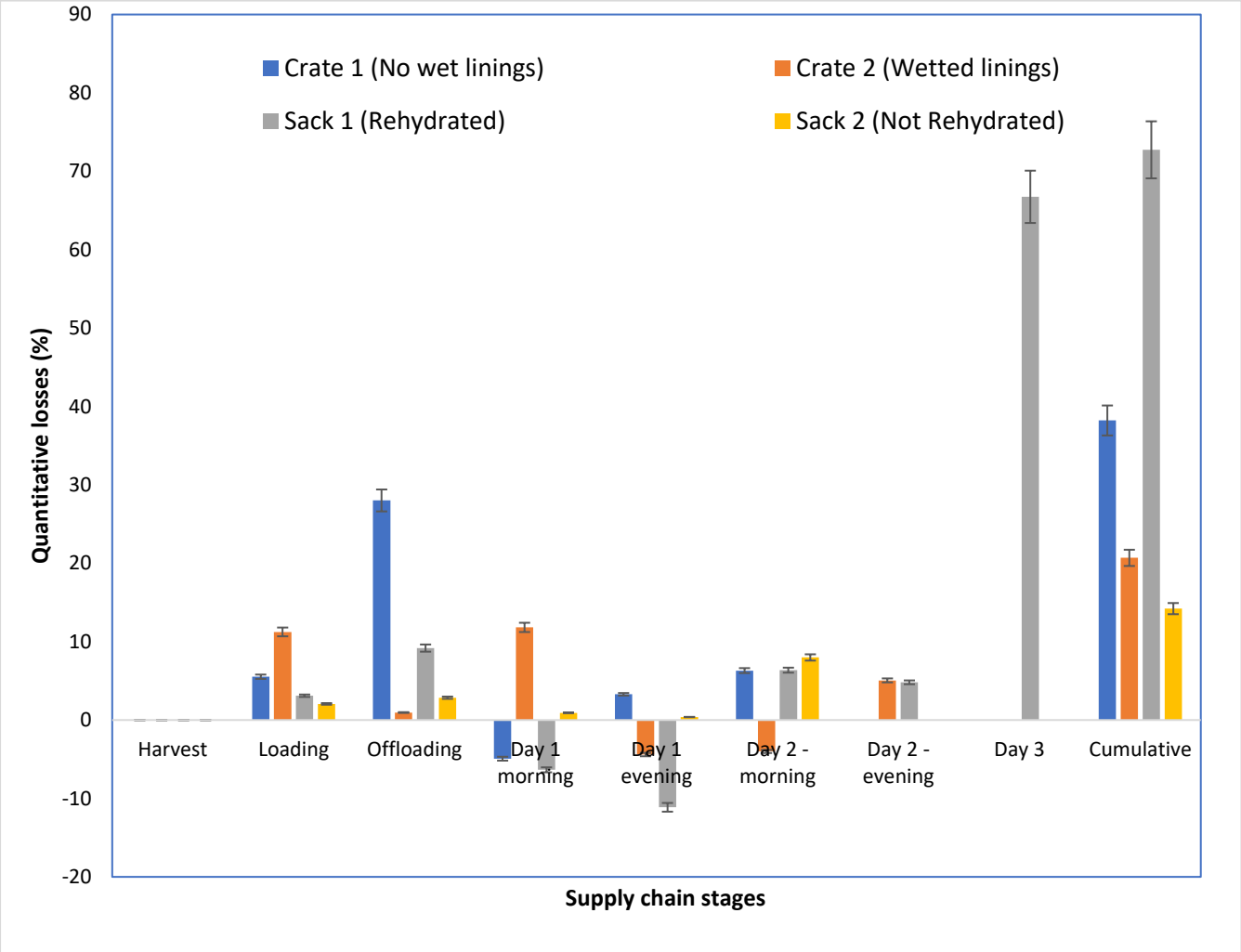


Fig 3.25. Extent of quantitative losses (%) at various stages of the cowpeas supply chain (long chain). Vertical bars represent standard error of means.

3.4.1.4. Extent of losses at the trader level (short supply chain)

Just like in the long chain, the cumulative losses and critical loss points were dependent on how the vegetables were packaged. In cowpeas packaged in crates without wet lining, the

cumulative losses were estimated to be 33.42% while for vegetables packaged in crates with wetted linings 12.55% losses were recorded. The un-hydrated vegetables which were packaged in sacks lost 27.33% while the vegetables that were rehydrated and packaged in sacks lost 4.40% of the initial weight. Rehydration of the vegetables at different stages as after harvest and at the market explains the negative values resulting from the weigh gained from rehydration (Fig.3.26).

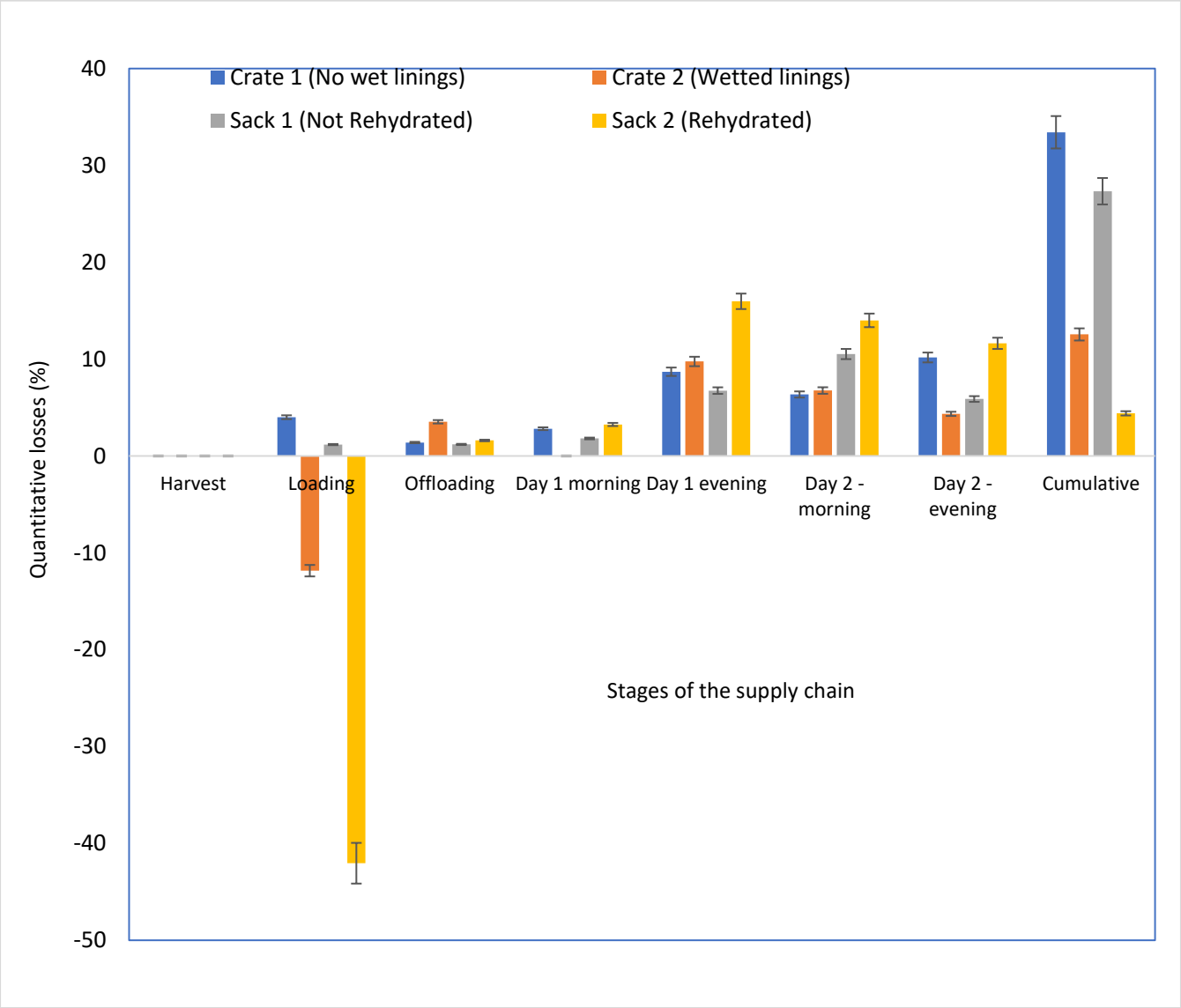


Fig 3.26. Extent of quantitative losses (%) at various stages of the cowpeas supply chain (short chain). Vertical bars represent standard error of means.

Table 3.9 presents as summary of the causes of losses (qualitative and quantitative) at the various stages of the supply chain from harvest to the market. The observed losses result from decisions made by the farmer based on reasons beyond his control and these are categorized in the table as preharvest.

Table 3.9: Causes of losses at various stages of the cowpeas value chai and mitigation measures to address the causes

Stage of the supply chain	**Causes of losses**	**Mitigation measures**

Preharvest	1. A good proportion of leaves are lest unharvested for various reasons including disease, pests, discoloration, overgrown, dirty 2. When there is no market, farmers leave the vegetables in the field	1a. Control pest and diseases that infest the vegetables 1b. Avoid harvesting during the wet days when the lower leaves are muddy 1c. Promote mulching which protects the vegetables from dirty besides contributing to weed control and moisture conservation 1d. Pruning of the overgrown leaves which can be left on the grown as mulch 2a. Better linkages to reliable markets for fresh vegetables e.g., local institutions/schools, urban markets where demand for indigenous vegetables is high 2b. Encourage value addition to preserve the vegetables e.g., through drying. This will ensure regular harvesting and no overgrown leaves that do meet market requirements
Harvest	1. Harvesting during hot times of day results in a high heat load which redisposes the leaves to fast deterioration and wilting 2. Lack of proper shading exposes harvested leaves to direct sun leading to water loss and wilting	1. Harvesting early in the morning or late evening when the temperatures are lower 2. Encourage construction of simple farm shades to hold the vegetables after harvesting
Handling after harvest	1. There is no sorting or grading of harvested vegetables 2. Handling of the produce under direct sun which enhances heat buildup and faster deterioration of the vegetables 3. Use of inappropriate packaging for the harvested vegetables 4. Poor packaging practices such as stuffing the harvested vegetables into closed sacks leading to heat	1. Encourage sorting and grading based on various quality attributes. This can guide on quality-based pricing and target markets/use of the vegetables 2. Encourage handling of harvested vegetables under the shade 3. Use of perforated sacks and crates to package the harvested vegetables 4. Loading the right amounts – no stuffing and compressing during packaging. Continuous churning of the packaged vegetables to ensure good aeration, reduce heat buildup and fermentation

	buildup, fermentation and mechanical injuries. 5. Use of dirty water to rehydrate the harvested vegetables – compromising quality and safety of the vegetables 6. Covering rehydrated vegetable with linen that is unsafe for food handling – safety is compromised	5. Use of clean water to rehydrate the harvested vegetables 6. Use of clean food-grade materials to cover the rehydrated vegetables
Transportation	1. Lack of protection during transport – vegetables are exposed to direct sunlight, wind and dust 2. Transportation during hot times of day. 3. Poor packing for far-flung markets – use of unperforated polythene sacks which enhance heat buildup and fast deterioration 4. Vegetables are mixed with other heavy produce during transportation 5. Spillage during transport to local markets	1. Ensure that the vegetables are transported in protective containers 2. Transportation during the cooler times of the day – early morning, late evening or during the night 3. Use better packaging options e.g. open crates with wetted linings, perforated sacks which are not over-stuffed 4. Vegetables should be stacked on top of other produce to minimize compression and heat buildup. Or use designated vehicles that transport vegetables only 5. Proper packaging to avoid spillage during transport. Avoid overloading on the bikes that transport vegetables to the local market
Handling at market	1. Food safety/quality is compromised by use of unclean water used to wash/rehydrate the vegetables 2. Spreading vegetables on bare/unclean ground compromises safety and quality 3. Repackaging is done under direct sunlight predisposing the vegetables to high heat load and wilting	1. Use of clean water to rehydrate the vegetables. Intervention by concerned authorities to provide clean water at the market 2. Use of tarpaulins to spread/display vegetables 3. Repackaging under shaded structures

	4. Plucking and/or cutting predisposes the vegetables to faster deterioration 5. Vegetables are not washed before cutting leading to cross- contamination 6. Unplucked, plucked and cut vegetables are repackaged in polythene bags Repackaging into polythene bags which are kept in the sun – this leads to heat buildup and fermentation from anaerobic respiration 7. Poor storage practices whereby vegetables and ripening fruits are stored together. Ethylene from the fruits hastens deterioration and yellowing of the vegetables 8. Lack of cold storage at the market place 9. Poor disposal of waste from unsold produce posed a food safety risk	4. Prevent deterioration of cut/plucked vegetables e.g. cold storage. Cut only on demand by the buyer 5. Encourage washing before cutting the vegetables 6. Use of recommended modified atmosphere packaging for cut vegetables; perforate the polythene bags to minimize heat buildup and fermentation; keep the packaged vegetables under cold storage 7. Training of traders to understand the demerits of mixing ethylene producing commodities such as fruits and ethylene sensitive commodities such as green/leafy vegetables. 8. Working with concerned authorities to build cold storage facilities at the market for traders' use 9. Work with concerned authorities to establish designated garbage disposal areas at the market

3.5. General discussion points

3.5.1. Extent and causes of losses in the bean value chain at the producer level

At the bean's producer level, 18.4% and 6.6% cumulative losses were reported in Kitui and Kajiado Counties respectively. The reported losses, especially in Kajiado County are significantly lower than losses reported in other reports as 20% (KNBS 2021); 20 – 42% (USAID, 2012; Njoroge et al. 2019). The discrepancy could be attributed to the small sample size used in the present study. The extent and causes of losses also vary significantly with season, region, scale of production and other factors (FAO, 2014). The harvest, threshing and drying stage was reported as the critical loss point for producers contributing 8.7% (47% of the total) and 2.9% (43% of the total) of reported cumulative in Kitui and Kajiado Counties respectively. A similar study in bush beans reported high losses during the harvest and postharvest handling stage (Strecker et al. 2022). The losses at this stage were attributed to various factors including delayed harvesting during dry weather which led to pod shuttering and spillage of the beans. Quantitative and qualitative losses were also associated with breakage, rotting or the beans being left in the pods during threshing. In the present study, breakage accounted for most of the qualitative losses as indicated by 75.6% and 61.5% of the respondents in Kajiado and Kitui. The breakage is attributed to poor manual threshing

practices where excess mechanical pressure is applied when using sticks to thresh the beans. Better threshing options would significantly reduce the levels of quantitative losses in beans. The storage stage has been cited as the critical loss point in grains. However, in the present, losses at the storage stage were minimal. The losses reported at this stage 5.2% and 1.7% respectively for Kitui and Kajiado. The lower % of losses could be attributed to the short storage period as most producers sold their beans soon after harvest. Qualitative losses were attributed to various factors including breakage, pests, molds, fermentation, discoloration and dirt lower the value of beans which are ultimately sold at a lower price compared to undamaged beans. In Kajiado, total economic losses (based on the volume of produce handled) were estimated to be KES 3,960 (at the harvest, threshing and drying stage) and KES 1,362 (at the storage stage). The total economic losses (KES 5,322) was estimated to be 5.1% in Kajiado. In Kitui the total economic losses were higher at 7.6% equivalent to KES 7,010. These figures are significantly small in comparison to the estimated value of lost beans at the national level, KES. 15.2 billion or 120 million USD (KNBS, 2021). However, for an individual smallholder farmer, the economic losses are significant given the volume of produce handled. For instance, the total economic losses experienced in Kajiado and Kitui represent 14% and 7% of the household income from supply of beans to schools, respectively. Therefore, efforts to address the factors that contribute to qualitative and quantitative losses would have a significant impact on the individual farmers.

3.5.2. Extent and causes of losses in the bean value chain at the trader (transporter level)

The cumulative losses at the trader level were much lower at 5.8% and 12.6% respectively for Kajiado and Kitui Counties. The critical loss point for traders was the storage stage where 6.6% and 1.6% losses were reported respectively for Kitui and Kajiado. Minimal losses (<1%) were reported at the other handling stages. Unlike producers, the traders store the beans for a significantly longer period and therefore the beans are prone to various deteriorative agents that lead to quantitative and qualitative losses. Damage from pests (mainly weevils) resulted in both quantitative and qualitative losses during storage. It is noteworthy that some of the causes of quantitative and qualitative losses at the producer level are transferred to the trader. For example, broken grains resulting from poor threshing practices are more prone to damage from weevils and rotting. Similarly poor drying at the producer level predisposed the beans to qualitative losses during storage (Tibagonzeka et. al. 2018). The interrelatedness of causes/drivers of postharvest losses is highlighted by FAO-HLPE (2014). The FAO report recognizes the food supply chain as a conveyor belt whereby action (or lack of action) by actors at one stage of the supply chain could be the cause/driver of losses at a different stage of the supply chain. However, there are other stage specific causes/drivers of the observed losses at the trader stage. Poor packaging whereby most traders use and reuse low quality polythene bags contribute significantly to spillage and subsequently the quantitative losses reported. Apart from spillage losses, poor packaging predisposes the beans to pest and rodent attacks thereby aggravating quantitative losses. Other causes of qualitative losses during storage include poor ventilation and placement of bean sacks directly on the floor (not using pallets).

Application of postharvest pesticides (mainly Actellic Super) was adopted as a mitigation measure against storage pests. Subsequently observed quantitative losses after 3 months of storage were minimal (0.8%) and no qualitative losses resulting from pest attack were observed. Judicious application of Actellic Super is highly recommended to mitigate against storage pests in grains (FarmbizAfrica, 2017; Esilaba et al. 2021).

3.5.3. Extent and causes of losses in the bean value chain at the school level

Schools generally handle very small volumes of food (beans) because of the limited funding received from the school meals program. Therefore, most schools reported minimal quantitative losses. Weevils and spillage were reported as main factors associated with qualitative and quantitative losses reported in both counties. The losses attributed to weevils and spillage are in turn traced back to different causes. For example, low quality bags that are used to store the beans predispose them to pest infestation, rodents and spillage losses. In addition to poor packaging, most schools lacked appropriate stores for the storage of food (including beans). The make-shift including classrooms, head teacher's office and multi-purpose storage rooms do not meet the minimum requirements for grain storage. A suitable storage for grains such as beans should be dry, well-aerated and meet certain specifications that minimize quantitative and qualitative losses during storage. Research has shown that apart from the qualitative losses which can be easily seen, poor storage conditions negatively influence the nutritive value and quality of many legumes (Momanyi et al. 2022). Therefore, adoption of good storage practices and improved bags such as hermetic bags could contribute to the efforts to minimize losses during storage (Strecker et al. 2022; Momamyi et. al. 2022). The variety chosen for the school meals also contributed to the reported losses. Bean variety 'Nyayo' which is the most preferred variety in both Kitui and Kajiado county because it is cheaper, cooks faster and makes a good (desirable) blend with maize. Interestingly all the stakeholders in the value chain including farmers, traders, and consumers (schools) unanimously agreed that 'Nyayo' beans are highly susceptible to weevil damage. The bean varieties that are less prone to pest attack during storage such as 'Mwitemania', Yellow beans, 'Wairimu' and others are either expensive or have low consumer preference. Therefore, efforts should be geared towards better storage practices for the preferred variety (Nyayo) to minimize storage losses.

Some of the schools have adopted coping measures to minimize losses during storage. These include redrying of beans after purchase and application of storage pesticides (Actellic Supper). One of the commendable good storage practices in schools which is key to quality preservation include is the use of pallets which was reported in 70% and 92% of schools in Kajiado and Kitui respectively. The pallets remove the sacks from the floor therefore preventing dampness and re-humidification of the dried grains. Pallets also facilitate good air circulation in the sacks of grain.

3.5.4. Extent and causes of losses in the cowpeas value chain

Cowpeas is an important and nutritious vegetable that is produced widely in Kenya mainly for local consumption. It is the leading African Indigenous Vegetable (AIV) produced in Kenya (HCD, 2018). Production of cowpeas has increased gradually to meet the increasing demand from health-conscious consumers. Kitui is among the top 5 cowpeas producing Counties in Kenya. Most of the cowpeas produced in Kitui is consumed locally hence the value chain is described as a short value chain whereby the vegetables are harvested and transported within hours to the market – less than 50 Km away. The cowpeas consumed in urban areas such as Nairobi are often sourced from far flung farms in rural areas. In the present study, load tracking was conducted targeting a trader that transport the cowpeas from Kisii to Nairobi (approximately 400 Km). This value chain was described as a long value chain.

In both the long and short value chains, significant losses were reported at the farm level. The losses at this stage were mainly attributed to lack of knowledge on good crop management practices including pest/disease control and other crop husbandry practices that enhance yield and quality of the vegetables. As result low quality leaves were left unharvested leading to high losses at the farm level. The farmers lack of information on alternative market outlets and therefore they have become dependent on a few traders who buy directly from them. Subsequently the farmers only harvest vegetables when they receive orders from the few regular traders. Without these orders, the cowpeas are left to overgrow leading to high on-farm losses (preharvest and harvest stages).

The time of harvest and postharvest handling practices are key to preservation of quality of vegetables. It is well documented that the best time to harvest fruits and vegetables is during the cooler times of day (early morning and/or late evening). Vegetables and fruits which are harvested during the hot times of the day have been reported to have high level of field heat which contributed to wilting and fast deterioration. Harvesting during hotter times of the day normally raises the field heat of the produce and courses wilting and shriveling (Yahaya and Mardiyya 2019; Amwoka et al. 2021).

Just like other leafy vegetables, cowpeas leaves are high perishable because of the high-water content (>90%). Water loss results in wilting which not only leads to loss of saleable weight but the wilted vegetables fetch an inferior price or get discarded. Farmers and traders have devised handling and packaging practices to minimize water loss as the vegetables are moved from the farm to the market. A common practice by traders is rewetting (rehydration) at various stages. This practice is aimed at saturating the air around the vegetables leading to high humidity and a low vapor pressure deficit. Subsequently, wilting is minimized in the rewetted vegetables. It is important that the water used to rehydrate the vegetables is clean or portable. In the present study, it was observed that the water used to rehydrate the vegetables was drawn from stagnant ponds. This poses a food safety risk because of the contaminants known be present in stagnant pond water.

In addition, at the market, the use of polythene bags to package the plucked and/or cut vegetables is a common practice aimed at preventing wilting and deterioration at the market. However, this practice is often counter-productive if the vegetables are kept in the polythene bag under ambient temperatures for long periods. This is because the packaged vegetables are 'living' and continue to respire, taking in oxygen and releasing carbon dioxide. Therefore, the packaging bag should be permeable to these gases and the water produced during respiration. There are produce-specific packages which have been developed for modified atmosphere (MAP) of fruits and vegetables. Most traders are unaware of the produce-specific MAP packages and therefore use the ordinary polythene bags. Some traders perforate the polyethene bags to provide for some ventilation. Poor packaging coupled with poor storage conditions (temperature and humidity) results in negative results such as yellowing and fermentation which is evidenced by off-flavors. This negates the intended benefits of packaging the vegetables in the polythene bags.

Proper harvest, postharvest handling, transportation and storage practices at all the stages of the cowpeas supply chain are key to quality preservation and reduction of postharvest losses. This will require capacity building of all the stakeholders including farmers and traders on good harvest and postharvest handling practices to preserve quality while ensuring food safety.

4.0 Recommendations

Interventions to address the challenges that affect quality management and contribute to food loss require a targeted approach. Interventions should target specific actors and/or stages of the supply chain identified as the critical loss points. Below is a summary of proposed interventions for various actors in the bean and cowpeas supply chains.

4.1. Producers

To address the mismatch between what local farmers produce versus commodities demanded by schools, farmers should be encouraged to adoption of better adapted bean varieties, e.g., Mwezi moja which is an early maturing variety. This requires partnership between MoE and relevant county stakeholders and research institutions such as KALRO, ICRISAT, universities to conduct adaptive studies and introduce relevant varieties.

Water harvesting is encouraged to supplement the low and erratic rainfall especially in Kitui county. This will address crop failure that hinders the farmers from producing commodities like beans (in quantities) which are demanded by the schools.

There is need for interventions to address low yields and low quality of produce from the local farmers. This could be achieved through joint capacity building initiatives to train farmers on good crop husbandry in the field, harvest and postharvest handling practices.

There is need for interventions to ensure better and proper storage at the farm level to reduce quantitative and qualitative losses. This may include raising awareness about available storage options which are context-appropriate.

4.2.Traders

To address the problem of low-quality grain, there is need for capacity building on good post-harvest handling and encourage adoption of postharvest technologies such as tarpaulins, moisture meters, dryers, hermetic storage.

Traders should be encouraged to adopt good transport practices such as use of tarpaulins to cover grains during transport to avoid rewetting and dust contamination during transit.

To reduce storage losses (quantitative and qualitative), there is need to create awareness about applicable storage facilities and technologies (hermetic storage) and their benefits and ensure better access to these technologies.

Since all traders' action are mainly driven by profit, it is important to make business cases for adoption of the recommended technologies and practices.

4.3.Schools

The main challenge that contributes to qualitative and quantitative losses in schools is lack of proper storage for food commodities. There is need for dedicated rooms for food storage in schools. The dedicated storage areas should be complemented with suitable, context-specific storage technologies. For example, in schools where rats are prevalent, metallic or plastic silos could be promoted. While hermetic bags can be in schools where rats are not a problem.

Where possible, schools should also be encouraged to produce additional food commodities to complement the insufficient food procured from the cash received from MOE. This is especially encouraged for nutritious food commodities mainly vegetables which are not included in the daily ratio served to learners. Specifically, the schools are encouraged to promote own production activities through 4K clubs where children learn by doing. Schools could partner with technology companies to demonstrate innovative production practices and food preservation. Schools are encouraged to invest in water harvesting to support on-school farming activities. There is need to for capacity building of teachers and learners on the possibilities and benefits of own production.

There is need to build capacity of teachers (who manage the school meals) and cooks to ensure adherence to nutrition standards and good meal preparation practices.

There is need to address the negative attitude of learners towards locally produced food commodities. This requires education towards behavioural/attitude change.

Schools should be encouraged to as much as possible procure food commodities from the local farmers especially during the high season when many farmers have surplus produce but lack storage.

4.4. Ministry of Education

There is need to address the inequality in the HGSMP to ensure that all deserving schools are included. This will require an updated list of schools benefitting from HGSMP. Most of the teachers proposed inclusion of early childhood (ECD) and secondary schools in the program.

The following additional recommendations have been made to improve the nutrition goals and impact of the HGSMP.

- Increase capitation per child – revise the current allocation of 10/- per child which is > 10 years
- Make a mandatory provision for fruits/vegetables in the allocation per child (20%)
- Encourage own production of fruits and vegetables to supplement HGSMP – as recommended for schools
- Encourage local processing e.g., mangoes in Kitui into shelf-stable products like juices. Local small-scale processors get contract with schools to supply juice to schools - once or twice a week.
- Stream integration of in-kind support from parents to ensure food safety and nutrition quality
- Policy directive to encourage consumption of locally produced food commodities e.g., green grams, cowpeas, pigeon peas in Kitui
- Policy directive to encourage consumption of non-cereal energy sources – sweet potato, cassava etc.

4.5 Researchers

Since the current results are based on a single event/season, there is need to repeat the study to confirm the loss data at the identified critical loss points for various actors. The study should also be expanded to other Counties where the HGSMP is being implemented.

The present study focused only on beans (and limited observation from load tracking of cowpeas traders), it is recommended that the study is expanded to other value chains linked to school meals.

There need to conduct comparative studies on quality management and loss assessment targeting schools served by other modalities in HGSMP – other than the CTS.

In addition, a similar study targeting boarding schools which procure more food, diverse food commodities and store food for longer could be included in subsequent studies.

The above recommendations are tabulated below. The table also includes the institutions tasked with required action to address the identified challenge.

4.6 Recommendations to address challenges at the producer level

Challenge	**Proposed intervention**	**Responsibility**

Mismatch between what local farmers produce versus commodities demanded by schools	– Emphasise consumption of locally produced commodities e.g., green grams and cowpeas in Kitui – Promote adoption of better adapted bean varieties, e.g., *Mwezi Moja* – Behavioural/attitude change among learners – education	– MoE and relevant county stakeholders to work with research institutions e.g., KALRO, ICRISAT, universities to conduct adaptive studies and introduce relevant varieties
Low yields for the commodities produced	– Capacity building for producers on proper agronomic practices e.g., nutrient management, pest and disease management etc. – The use of right inputs, subsidies and credit – Water harvesting & irrigation to supplement as demonstrated in picture 3.11 and 3.12. – Dryland production technologies	– Extension & outreach agents, e.g., government, county, NGOs, seed companies, universities – Credit institutions, county governments – County government, NGOs & CBOs working on environmental management – Research institutions, universities
Low quality grain due to poor harvest & postharvest handling	– Capacity building on good harvest practices and post-harvest handling – Introduction of simple harvest and postharvest handling technologies e.g., tarpaulins, threshers, moisture meters, dryers	– Research institutions, universities, development partners, agricultural input suppliers, county extension agents
Lack and/poor storage facilities for produce - Forced to sell soon after harvest - High quantitative and qualitative losses due to poor storage	– Promote on-farm storage facilities and technologies to enable farmers to store produce and supply schools when demanded – Capacity building/training on good storage practices – Village aggregation centres – community stores, warehouses – Take advantage of excess/idle storage capacity in NCPB stores	– Research institutions e.g., KIRDI, Universities, hermetic bag manufacturers, development partners, local NGOs – County governments – NCPB officers to raise awareness and value proposition for farmers

4.7 Recommendations to address challenges at the trader level

Challenge	**Proposed intervention**	**Responsibility**

Low quality grain due to poor handling	– Capacity building on good post-harvest handling – Introduction of technologies e.g., tarpaulins, moisture meters, dryers,	– Research institutions, universities, development partners, agricultural input suppliers, county extension agents
Poor transport practices	– Use tarpaulins to cover grains during transport to avoid rewetting and dust contamination during transit – Capacity building	– Extension and outreach agents
Inadequate/Poor storage facilities	– Promote and created awareness about storage facilities and technologies (hermetic bags) and their benefits – Capacity building of traders on benefits applicable storage facilities and technologies e.g., pellets, hermetic storage technologies – Enhance access to the technologies – accessible and affordable	– Research institutions e.g., KIRDI, Universities, technology manufacturers – Extension agents, development partners

4.8 Recommendations to address challenges in schools

Challenge	**Proposed intervention**	**Responsibility**
Inadequate/poor storage facilities	– Dedicated room/store for food commodities only – Invest in durable, rat-proof storage technologies such as plastic silos, metallic silos – Where polythene bags are used – better quality should be used – Capacity building for teachers on benefits of use storage facilities and technologies	– Local leaders – MOE – School committees – Research institutions e.g., KIRDI, Universities, technology distributors/companies, development partners
Poor stock management	– Capacity building on record keeping	– MOE and other relevant institutions.
Inadequate capacity to complement/supplement the inadequate food procured under HGSMP	– Own production for schools that have land – encourage production of beans, vegetables – Promote own production activities through 4K clubs – learn by doing, partner with technology companies to demonstrate innovative production practices and food preservation	– School committees – Research institutions and technology developers/promoters

	– Invest in water harvesting to support on-school farming activities – Capacity building of teachers and learners on the possibilities and benefits of own production	
Inadequate water supply for food preparation	– Invest in water harvesting and extraction	– County government, NGOs, Development partners, Ministry of Water and other relevant institutions
Non adherence to recommended quality standards for the food; there is no quality check for food supplied in-kind by parents	– Capacity building to streamline the in-kind food supply by parents to schools	– School committee – MOE
Lack/inadequate energy saving cooking options in some schools	– Invest in energy saving jikos – Capacity building of cooks and teachers in charge of meals on optimal (energy-saving) meal preparation options	– Ministry of Agriculture, Livestock, Fisheries and Cooperatives and relevant institutions – Research institutions
Poor attitude towards local diets by pupils and parents	– Education towards behavioural/attitude change	– Ministry of Education and Relevant institutions, CBO involved in community nutrition.

Picture 3.11: Kales produced under irrigation in Kitui

Picture 3.12: Cowpeas produced under irrigation in Kitui

4.9 General recommendations to improve outcomes of implementation of the HGSMP

Challenge	Proposed intervention	Responsibility

Food quality requirements (specifications of commodity grades) and packaging specifications s not supportive of improved food quality management along with low food diversity in school meals provided	– Increase capitation per child – revise the current allocation of 10/- per child which is > 10 years – Include hermetic bags as a requirement and allocate funds to cover the costs – Invest in proper storage rooms for grain and vegetables – Policy directive to encourage procurement of locally produced food commodities e.g., green grams, cowpeas, pigeon peas in Kitui – – Policy directive to encourage consumption of non-cereal energy sources – sweet potato, cassava etc	– Ministry of Education & Ministry of Finance and National Treasury – Ministry of Education, Ministry of Agriculture, County governments, NGOs, – Universities and other relevant institutions – Ministry of Education
Inequity	– Update the list of schools that should benefit from HGSMP – Address the inequality occasioned by selective inclusion into the HGSMP – Incorporate the early childhood development (ECD)pupils into the HGSMP	– Ministry of Education and other relevant institutions – County governments

Annex 1: Knowledge, Attitude, and Practices

Annex 1: Knowledge, Attitude, and Practices

	Practice	County practice	Practice (Respondents practice)	Knowledge (Awareness of recommended practice)	Attitude (Willingness to adopt recommended practice)
Producer	Weather	Kitui	Sunny during & before harvest (76.92%)	Sunny during & before harvest (92.31%)	Strongly Agree (100%)
		Kajiado	97.56%	100%	NO OBSERVATION
Producer	Pods placement	Kitui	Placed on the soil directly & other surfaces (23%)	Should not be placed on surfaces directly (69%)	Agree (75%)
		Kajiado	60%	69.23%	Strongly agree (66.67%)
Producer	Dry grains	Kitui	Do not know (46.15%)	Yes (92.31%)	Agree (90.91%)
		Kajiado	Yes (78.95%)	Yes (84.62%)	Agree 66.67%
Trader		Kitui	Yes (37.5%)	Yes (75.00%)	Agree (100%)
		Kajiado	Yes (78.38%)	Yes (92.11)	Agree (100%)
Producer	Container for harvested pods	Kitui	New plastic bags or woven polythene (30.77%)	New plastic bags or woven polythene (46.15%)	Agree (66.67%)
		Kajiado	New plastic bags or woven polythene (57.14%)	New plastic bags or woven polythene (59.52%)	Strongly Agree (80%)
Trader		Kitui	Gunny bags & New plastic bags or woven polythene tied at (37.5%)	New plastic bags or woven polythene (75%)	Agree (100%)
		Kajiado	New plastic bags or woven polythene (60%)	Gunny bags & New plastic bags or woven polythene tied at (50%)	Agree (100%)
Transporter		Kitui	New plastic bags or woven polythene (33.33%)	Gunny bags (100%)	Agree (100%)
		Kajiado	New plastic bags or woven polythene (65.86%)	Gunny bags (100%)	Agree (100%)
Producer	Harvesting	Kitui	Manual uprooting placing in a container to transport to drying facility (38.46%)	Manual uprooting placing in a container to transport to drying facility (46.15%)	Strongly Agree (70.59%)
		Kajiado	Manual uprooting placing in a container to transport to	Manual uprooting placing in a container to transport to drying facility	Strongly Agree (42.86%)

			drying facility (27%)	(69.05%)	
Producer	Aggregation	Kitui	Move them into an aggregating point dedicated to starting drying in the same day (53.85%)	Aggregated and transported from the field in the same day of harvest for drying (100%)	Strongly Agree (61.54%)
		Kajiado	Move them into an aggregating point dedicated to starting drying in the same day (92.86%)	Aggregated and transported from the field in the same day of harvest for drying (97.62%)	Strongly Agree (66.67%)
Trader		Kitui	Move them into an aggregating point dedicated to starting drying in the same day (55.00%)	Aggregated and transported from the field in the same day of harvest for drying (76.67%)	Strongly Agree (52.83%)
		Kajiado	Move them into an aggregating point dedicated to starting drying in the same day (84.62%)	Aggregated and transported from the field in the same day of harvest for drying (75.93%)	Strongly Agree (58.62%)
Producer	Container for Transport	Kitui	New plastic or woven polyethylene bags (30.77%)	New plastic or woven polyethylene bags only for transp & harvesting (46.15%)	Agree (66.67%)
		Kajiado	New plastic or woven polyethylene bags (50%)	New plastic or woven polyethylene bags (53.85%)	Strongly Agree (69.23%)
Trader		Kitui	New plastic or woven polyethylene bags only for transp & harvesting (30.19%)	New plastic or woven polyethylene bags (35.85%)	Strongly Agree (50%)
		Kajiado	Plastic or woven polyethylene bags only used for harvesting and transporting operations (56.66%)	Plastic or woven polyethylene bags only used for harvesting and transporting operations (36.99%)	Agree (50%)
Transporter		Kitui	Plastic or woven polyethylene bags only	New plastic or woven polyethylene bags (31.58%)	Agree (66.67%)

			used for harvesting and transporting operations (36.84%)		
		Kajiado	Plastic or woven polyethylene bags only used for harvesting and transporting operations (52.64%)	Plastic or woven polyethylene bags only used for harvesting and transporting operations (42.1%)	Strongly Agree (50%)
Producer	Start drying pods immediately	Kitui	Immediately after harvest (53.85%)	Immediately after harvest (61.54%)	Agree (50%)
		Kajiado	Immediately after harvest (100%)	Immediately after harvest (97.62%)	NO OBSERVATION
Producer	Drying the pods	Kitui	Drying is….. mats, plastic sheets, clean drying yards and/or collapsible dryers (84.62%)	Drying is….. mats, plastic sheets, clean drying yards and/or collapsible dryers (100%)	NO OBSERVATION
		Kajiado	Drying is….. mats, plastic sheets, clean drying yards and/or collapsible dryers (100%)	Drying is….. mats, plastic sheets, clean drying yards and/or collapsible dryers (100%)	NO OBSERVATION
Producer	Remove leaves before drying pods	Kitui	Yes (90%)	Yes (96.88%)	NO OBSERVATION
		Kajiado	Yes (90.32%)	Yes (100%)	NO OBSERVATION
Producer	Separate grains from pods	Kitui	Hand threshing (92.31%)	Hand threshing (100%)	NO OBSERVATION
		Kajiado	Hand threshing (100%)	Hand threshing (100%)	NO OBSERVATION
Producer	Placement of grains during threshing	Kitui	Tarpaulin or mats (46.15%)	Tarpaulin or mats (53.85%)	NO OBSERVATION
		Kajiado	Tarpaulin or mats (54.76%)	Tarpaulin or mats (54.76%)	Strongly Agree (70%)
Producer	Drying the beans	Kitui	Yes (78.26%)	After threshing (69.23%)	Tie at 50% on both Agree & Neutral
		Kajiado	Yes (97.62%)	After threshing (97.62%)	Agree (100%)
Trader		Kitui	Yes (79.63%)	After threshing (87.04%)	Tie at 40% on both Agree & Neutral
		Kajiado	Yes (96.55%)	After threshing (96.67%)	NO OBSERVATION
Producer	Sun drying placement material (tarpaulin, mats)	Kajiado	Yes (97.56%)	Yes (97.56%)	No observations
		Kitui	Yes (84.62%)	Yes (84.62%)	
Trader		Kajiado	Yes (93.55%)	Yes (93.55%)	Strongly agree (100%
		Kitui	Yes (92.86%)	Yes (92.86%)	
Producer		Kajiado	Yes (97.62%)	Yes (97.62%)	Neutral (100%)

	Turning of beans	Kitui	Yes (61.54%)	Yes (61.54%)	Neutral (60%)
Trader		Kajiado	Yes (93.55%)	Yes (97.5%)	Neutral (100%)
		Kitui	Yes (83.93%)	Yes (85.71%)	Neutral (50%)
Producer	Covering beans at night	Kajiado	Yes (97.62%)	Yes (100%)	neutral (87.71%)
		Kitui	Yes (50%)	Yes (61.54%)	Agree and neutral (tie 40%
Trader		Kajiado	Yes (97.5%)	Yes (77.42%)	Neutral (87.71%)
		Kitui	Yes(69.9%)	Yes (71.43%)	Disagree (31.25%)
Producer	Knowledge of pulse is dry	Kajiado	Biting with teach (31.71%)	Moisture meter (75.61%)	Strongly agree (100%)
		Kitui	Moisture meter and pressing with figure (tie 23.08%	Moisture meter (53.85%)	No observation
Trader		Kajiado	Moisture meter (35.48%)	Moisture meter (74.19%)	Neutral and disagree (tie 50%)
		Kitui	Pressing with figure (23.21%)	Moisture meter (71.43%)	Neutral (40%)
Producer	Cleaning and grading beans	Kajiado	Remove straw, dirt, soil residue (59.52%)	Yes (92.86%)	Strongly Agree (100%)
		Kitui	Remove straw, dirt, soil residue (69.22%)	Yes (100%)	NO OBSERVATION
Trader		Kajiado	Remove straw, dirt, soil residue (38.71%)	Yes (87.10%)	Tie at 50% for both Neutral & Agree
		Kitui	Remove straw, dirt, soil residue (21.43%)	Yes (82.14%)	Neutral (40%)

Annex 2: Storage practices of beans

Activity	Practice	Producer		Trader		Transporter	
		Kajiado	Kitui	Kajiado	Kitui	Kajiado	Kitui
Storage duration	A month and less	64%	46.15%	70.37%	62.27%	83.34%	88.89 %
Store with other produce	(Yes)	65.79%	100%	67.86%	90.91%	55.56%	77.78 %
Preparation of store before storage	Cleaning	52.63%	53.84%	48.41%	69.95%	61.12%	78.94 %
	Reinforce store	97.43%	53.84%	66.64%	41.11%	55.57%	47.36 %
Construction material	masonry	63.16%	100%	64.28%	82.15%	50%	78.95 %
Container used for storing	Polythene bags	89.47%	23.08%	74.08%	60.73	61.71%	73.68 %
	Plastic bags	7.89%	69.23%	3.7%	25%	0%	10.53 %
	Gunny bags	10.52%	0%	22.22%	3.58%	23.53%	15.79 %

	Hematic	2.63%	15.38%	7.41%	19.65%	5.88%	21.04 %
Placement while storing	On pallets	57.89%	69.24%	96.27%	88.89%	75%	83.36 %
	1m away	7.89%	15.38%	3.7%	16.67%	6.25%	5.56%
	Accessible	13.15%	23.08%	14.81%	11.11%	6.25%	5.56%
Storing challenges	Insects (weevils)	56.76%	76.9%	66.64%	68.5%	52.93%	83.38 %
	Moisture	21.62%	30.76%	25.91%	18.51%	11.76%	27.79 %
	Rodents	21.62%	38.45%	44.41%	29.62%	47.04%	38.92 %
	Spillage	16.21%	15.38%	18.5%	14.81%	11.76%	22.22 %
Coping with the challenge	Applied chemicals	75.68%	38.46%	78.57%	63.46%	77.79%	77.79 %
	Re-drying	16.22%	15.38%	21.43%	9.62%	5.56%	5.56%
	Physical killing	2.7%	23.07%	0%	19.23%	0%	16.67 %
Treatment of produce	Storage chemicals	91.2%	10.28%	100%	100%	100%	No obs.
	Hematic bags	15.23%	0%	0%	20.4%	0%	No obs.

Annex 3: Attitudes on postharvest management training

Training aspects	Description	Producer		trader		transporter	
		Kajiado	Kitui	Kajiado	Kitui	Kajiado	Kitui
Would participate in training	Yes	90.48%	76.92%	70.97%	82.46%	78.95%	89.47%
Reason for non-participation	Lack of time	66.6%	No obs.	66.6%	No obs.	66.6%	No obs.
	no advice to attend	33.3%	No obs.	33.3%	No obs.	33.3%	No obs.
After training effect	Change postharvest management	71.43%	84.62%	64.52%	75.44%	73.68%	78.95%
	Influence others	64.29%	84.62%	60%	80.36%	68.42%	68.42%
	Upgrade equipment	60.98%	38.46%	70%	64.29%	78.95%	57.89%
Past postharvest management training	Past training (Yes)	23.08%	25.81%	25.81%	36.84%	42.11%	26.32%
	Training not organised	47.6%	80%	36.82%	47.83%	55.6%	35.7%
	Not invited	18.23%	23.2%	11.35%	19.21%	22.22%	7.41%
	Change of practice after training	87.5%	33.3%	62.5%	71.43%	37.5%	60%

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