

## RESEARCH ARTICLE

# Determinants of postharvest losses among high moisture content vegetables traders in Kenya

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Received: 05.09.2016

Accepted: 17.01.2017

## ABSTRACT

Food losses occur in the agricultural value chain due to internal and external factors. The study sought to identify the effects of some of these factors in contributing to postharvest losses of vegetables in the traders component of the value chain. Both primary and secondary data were utilized; the former was collected from retail and wholesale traders in 14 markets in four counties of Kenya. The selected counties were: Kakamega and Kisii for indigenous vegetables, Kirinyaga for tomato and Kiambu for cabbages and kales. Age, urbanization, population, female gender, use of appropriate infrastructure, value adding to produce through grading and sorting, access and use of market information, had a negative relationship to losses. Losses were highest with cabbage, followed by tomatoes, Kales and lastly indigenous vegetables. Vegetable sourced from the market had highest losses, followed by that from farmers groups, middlemen and the least being for that sourced at farmgate. Large batches, and longer times to sell and transport the produce led to high losses. Highest losses during transportation occurred with the use of vehicles, followed by cycling, manual, draught and least with motorcycle. The study recommends detailed study of the effect of individual factors and their interrelation in contributing to food losses.

**Keywords:** Vegetables, traders, postharvest losses, factors, quality.

**Citation:** Ndirangu, S.N., Kanali, C., Mutwiwa, U., Kituu, G., Kamwere, M. and Mung'atu, J. 2017. Determinants of postharvest losses among high moisture content vegetables traders in Kenya. *Journal of Postharvest Technology*, 5(2): 37-46.

## INTRODUCTION

Kenya's Agricultural Sector Development Strategy (Kiome et al., 2010) indicates that modern technology absorption along the agricultural value chain activities is a limiting factor to agricultural production in Kenya. It also isolates pre and postharvesting crop losses as a major limiting factor in an improved agricultural sector: with the strategy calling for an effective marketing value chain as one way to improve the sector. There has been high levels of waste due to pre-harvest and postharvest losses occasioned by a number of factors. An effective marketing value calls for reduction of losses at a trader's level; this will not only increase the quantity and quality of produce but also reduce energy, water and land use.

Crop losses are a major limiting factor in the realization of optimal agricultural production. According to Gustavsson et al. (2013) food losses refer to a decrease in food quantity or quality in the early stages of the food supply chain, before the food products reach their final stage, reducing the amount of food suitable for human consumption. Both quantitative and

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qualitative losses occur in horticultural commodities between harvest and consumption. The losses in developing countries are estimated to vary from 5 to 50%, with an overall average of 22% (Kader, 2006)

Vegetables are important crops produced and consumed around the world. Kenya is a major producer of vegetables with the country producing about 6 million tonnes of vegetables in 2012; this production being valued at about US\$ 1 billion and being equivalent to 48% of the total value of horticultural production (HCDA, 2013). Vegetables unfortunately are perishable and are subject to major losses

Losses occur at different stages of vegetable value chain and according to Gustavsson et al. (2013) this is in agricultural production, postharvest handling and storage, processing and packaging, distribution, and consumption. The traders value chain mainly endures the distribution and post harvest handling and storage losses. At distribution, these losses include losses in the market system; at wholesale, supermarkets, retailers and wet markets; while postharvest handling losses include spillage and degradation during handling, storage and transportation between farm and distribution. The other causes of losses also could spill over to the marketing value chain; for example mechanical damage during harvesting.

A number of factors influence the levels of food losses. These factors include human related factors, crop factors, environmental factors and technological factors. Kiaya (2014) categorized these factors into internal and external factors; with internal factors defined as occurring at all stages in the food supply chain from the moment of harvesting, to handling, storage, processing and marketing. The external factors being those outside of the food supply chain and likely to cause significant postharvest loss; these factors being grouped into two primary categories: environmental factors and socioeconomic patterns and trends.

There has been no documented study in Kenya to identify the external and internal factors influencing vegetable losses within the traders value chain. The broad objective of this study was to identify internal and external factors influencing vegetable losses at the trader's level in Kenya. Specifically the study had the objectives of identifying the likely factors that would affect losses and the direction of these losses. The study covered the trader's upstream and downstream activities as well as traders' activities.

## **MATERIALS AND METHODS**

The survey was carried out from the end of March to early April, 2015 using multi-stage sampling. The study adopted a variety of tools to collect information. Market level data were collected through structured quantitative questionnaires, expert opinion from the Directorates of Agriculture in the respective counties, as well as by observation on how vegetables are handled at the markets. Secondary data was collected from available literature and documents. Trader and market specific structured quantitative questionnaires were developed and used to collect information on various aspects affecting the market and postharvest losses; postharvest handling, marketing, and technologies used by traders for postharvest management of vegetable. Data was collected from individual market group members and focused group discussions.

The focus of the study was on postharvest losses of vegetables, namely kales, cabbages, tomato, and indigenous ones (e.g. black nightshade and Amaranthus). Four counties were selected for the study due to their specialization in the production of these vegetables, namely: Kakamega and Kisii Counties for indigenous vegetables, Kirinyaga County for tomato, and the Kiambu County for cabbages and kales. A total of 187 traders found in 14 markets in the four counties were interviewed as detailed in table 1.

The traders involved in wholesale or retail activities were randomly selected during the days of the interview. In most markets in these two types of traders normally carry their activities within the same markets, with such activities being

undertaken at the same time of the day, or at varying times. Commonly, wholesalers undertake their trading early in the morning and on specific days, and the retailers undertake their activities later in the day and in all day.

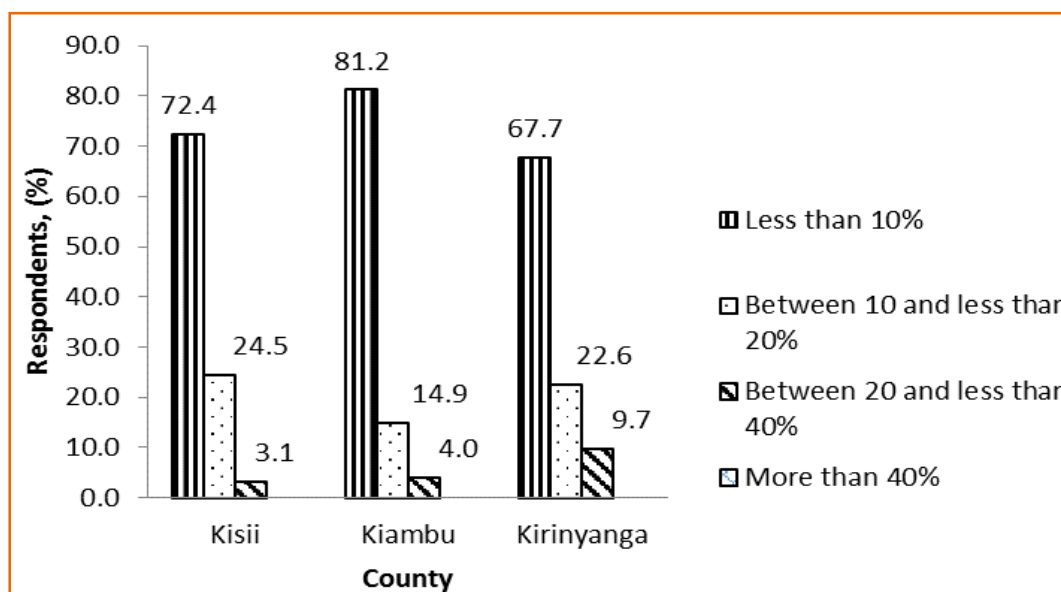
**Table 1: Distribution of respondent within the markets in the four Counties involved in the survey**

County	Market names	Interviews (n)
Kakamega	Shianda, Ekeru, Mumias, Mayoni	34
Kisii	Daraja Mbili, Suneka, Kisii Municipality	49
Kiambu	Kimende, Soko Mjinga, Nyambari, Uplands	54
Kirinyaga	Kagio, Makutano, Kutus	50
<b>Total respondents (N)</b>		<b>187</b>

## RESULTS AND DISCUSSION

Several factors would be attributed to postharvest losses amongst vegetable traders in the four counties. Initially the study differentiated the losses in terms losses occurring due to handling, losses registered after value addition and losses related to amount not sold.

Results indicate that significant postharvest losses occur in the trade value chain during handling with more than 67% of the respondents experiencing losses of less than 10% as shown in Figure 1.



**Figure 1: Level of loss attributed to handling in the trade value chain for vegetables in Kisii, Kiambu and Kirinyaga Counties in Kenya.**

Also losses are witnessed during trading after value addition (grading, sorting etc.). The proportion of damaged vegetables thrown away after value addition is mainly between 0 and 20% as indicated in the Figure 2.

Losses to trader include the unsold amount on the market. On average, the amount of lost vegetables ranged from 3.4% to 38.6% as shown in Table 2. The unsold vegetables are mainly used for livestock feed and home consumption in all the counties surveyed. Some is also disposed as well as used as compost manure.

An investigation was undertaken to find out the level of losses due to variation in the various factors as follows:

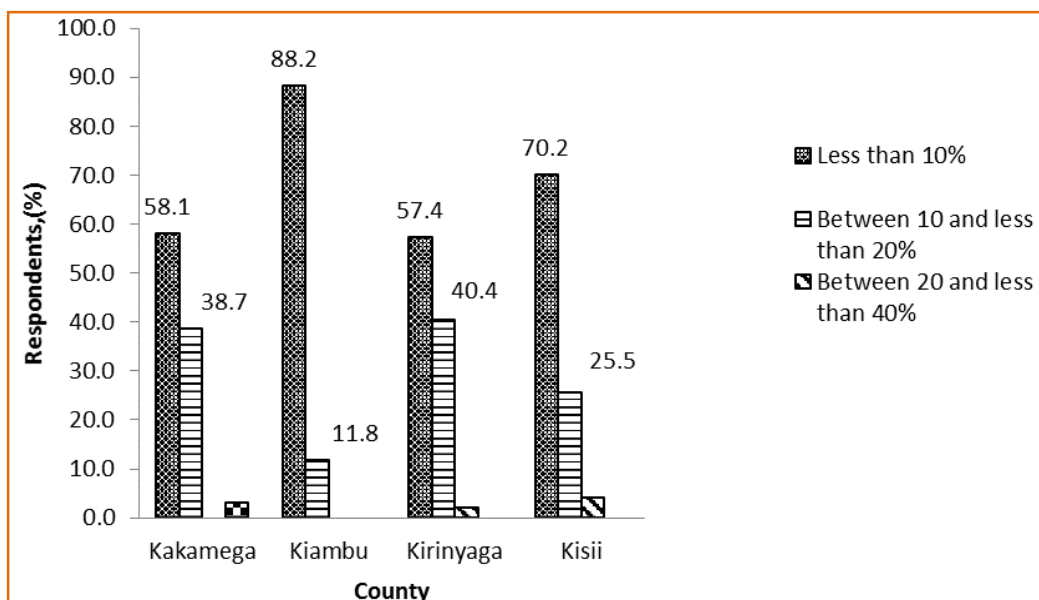


Figure 2: Proportion of damaged vegetables thrown away after value addition

Table 2: Quantities (%) of vegetables lost

Vegetable type	Kiambu	Kirinyaga	Kakamega	Kisii
Cabbage	38.6	-	-	-
Kales	13.6	-	-	-
Tomatoes	-	24.2	-	-
Indigenous vegetables	-	-	12.5	3.4

## Demographics

The levels of losses are lowest in the densely populated county of Kiambu and Kisii compared to Kakamega and Kirinyaga (Table 3). This could be attributed to the high population in the two counties leading to high demand and hence lower losses. The two counties also have more urban setting where there is more trading, with urban dwellers buy more since they do not engage in agricultural production.

Table 3: Level of Losses in the counties

Level of losses	Kakamega	Kiambu	Kirinyaga	Kisii
Less than 10%	58.10%	88.20%	57.40%	70.20%
Between 10 and less than 20%	38.70%	11.80%	40.40%	25.50%
Between 20 and less than 40%	0.00%	0.00%	2.10%	4.30%
More than 40%	3.20%	0.00%	0.00%	0.00%

**Gender**

There was also an observable effect of gender on postharvest losses, with women traders losing less than male; with 46.4% of male losing less than 10% compared to 74.3% of women traders. In Kenya women are more involved in trading than men, also women have better handling skill than men. In earlier studies on the role of gender in losses Aidoo (2014) had found a positive relationship of female gender, but in production losses, a fact attributed to them having less time and being less strong than men, thus subjecting crop to more time during harvesting, thus leading to higher losses. Folayan (2013) also identified that gender was one of the determinants of postharvest losses in maize in Nigeria. This effect is significant given that the majority of the vegetable traders were mainly female in all counties. Generally in Kenya vegetable trading is considered as female economic activity, a reason why the majority of traders are female. The relatively high number of males trading in vegetables in Kiambu and Kirinyaga is perhaps due to the high returns from the exotic vegetables. Males in these counties are normally engaged during the wholesale stage while females are mostly involved at the retail level.

**Age**

Age is also a crucial factor with the young losing more than the elderly. 63.8% of those below 40 years lost less than 10%, compared to 78.3% and 81.8% of those aged 40-59 years and those above 60 years respectively. This could be attributed to the experience in terms of value adding (e.g. sorting) by elderly as compared to the young traders, the elderly are also well established and known and able to dispose their products. In terms of the age distribution, the majority of the vegetable traders were youth (16-39 years) followed by mid-age (40-59 years) as presented in Figure 3. However, in Kiambu and Kisii, there is a fair involvement of both the youth and the mid-age in vegetable trading.

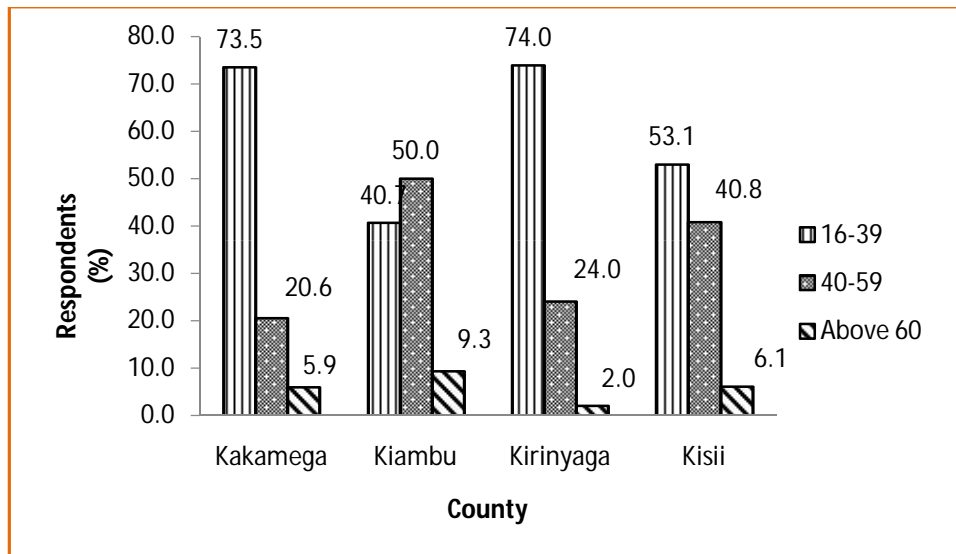


Figure 3: Age distribution of the vegetable traders in the market survey in Kakamega, Kiambu, Kirinyaga and Kisii Counties in Kenya.

**Education Level**

The level of education did not significantly influence the level of losses. There was a significant association (Chi-squared value =19.698, df=8, p-value=0.012 at 5%  $\alpha$ -level of significance) between the highest levels of education and age group, with the aged being less educated than younger. Since the aged incur fewer losses, then the aged and the less educated were incurring less loss than the young and educated. However, there was no significant association (p-

value=0.164) between the highest levels of education and gender. From the survey, it is evident that most of the vegetable traders are female and they cut across all the education levels (non-tertiary), therefore the low losses incurred by women cannot be attributed to the level of education.

### Type of vegetable sold

Most of the vegetable traders in Kiambu County deal in cabbages and kales while those in the Kirinyaga County deal in tomatoes. The traders in Kisii and Kakamega counties predominantly engage in selling of indigenous vegetable. There was a significant association ( $p$ -value < 0.05) between age group and the proportion of traders dealing in cabbages and kales most of the time and none for tomatoes and indigenous vegetables. The results further support the results that the youth and mid-age groups are the ones who are seriously involved in trading in vegetables. There was no significant difference in the level of losses in cabbages and kales. However, there were more losses in tomatoes and indigenous vegetables than in kales and cabbages, this could be attributed to the physical characteristic like shape and texture. Further, the association between gender and the proportion of traders dealing in various vegetables, most of the time was found to be significant for tomatoes and indigenous vegetables ( $p < 0.05$ ) and not for cabbages and kales (Table 4.).

**Table 4: Associathe proportionen gender and proportion of traders dealing in vegetables**

Gender	Percentage			
	Cabbage	Kales	Tomatoes	Indigenous
Male	14.0	13.9	26.7	5.7
Female	86.0	86.1	73.3	94.3
Total	100.0	100.0	100.0	100.0
p-value	0.330	0.228	0.041	0.001
Chi-squared	0.948	1.450	4.171	12.039
df	1	1	1	1

The studies relate to earlier studies where Aidoo et al. (2014) reported that type of tomato cultivated was positively associated with losses in tomato production in Ghana.

### Source of produce

More losses were incurred by those buying from the markets than those buying from another source. The losses from farmers groups were higher than from farmgate and the losses from those buying from middlemen were lower those buying from farmers groups, but higher than from the farmgate. This could be attributed to duration from harvest to selling and storage duration. In the markets the vegetables have to be transported and stored which is time consuming. There is also more value addition, especially of sorting by middlemen. The relationship was however not significant. This collaborates with the fact that most traders from Kiambu (85.2%), Kirinyaga (90.0%) and Kakamega (79.4%) Counties, buy their vegetables directly from farmers as opposed to those from Kisii County (65.3%) who purchase most of their stock from middle men. This raises concerns about marketing groups for vegetables with possibilities of them delivering low quality produce for sale.

### Quantity purchased

The results indicate that, except for indigenous vegetables, traders purchasing large volumes incur more losses than those purchasing less quantities (Table 5). Those with high quantities have challenges of handling and storage and therefore the need for better market infrastructure. There was also an observable trend in level losses in respect of prices, with less losses occurring in low price season. The differences were however not statistically significant.

Table 5: Level of losses for different quantities of vegetables purchased per batch

Vegetable type	Quantity purchased per batch (Kgs)	Level of losses
Cabbages	157.94	Less than 10%
	269.54	Between 10 and less than 20%
Kales	69.65	Less than 10%
	166.67	Between 10 and less than 20%
Tomatoes	187.93	Less than 10%
	456.26	Between 10 and less than 20%
Indigenous vegetables	117.60	Less than 10%
	117.27	Between 10 and less than 20%

### Time taken to sell and transport the produce

Those who take longer to sell their produce incur more losses than those who take a shorter time. It generally takes less than one (1) hour to transport the vegetables from the source to the market in all the counties implying that the primary marketing centers are near the sources of production (Figure 4). However, in Kakamega, Kiambu and Kisii, a number of the traders require between one (1) and three (3) hours to transport the vegetables, perhaps because of the poor road networks in these counties, especially during the rainy season.

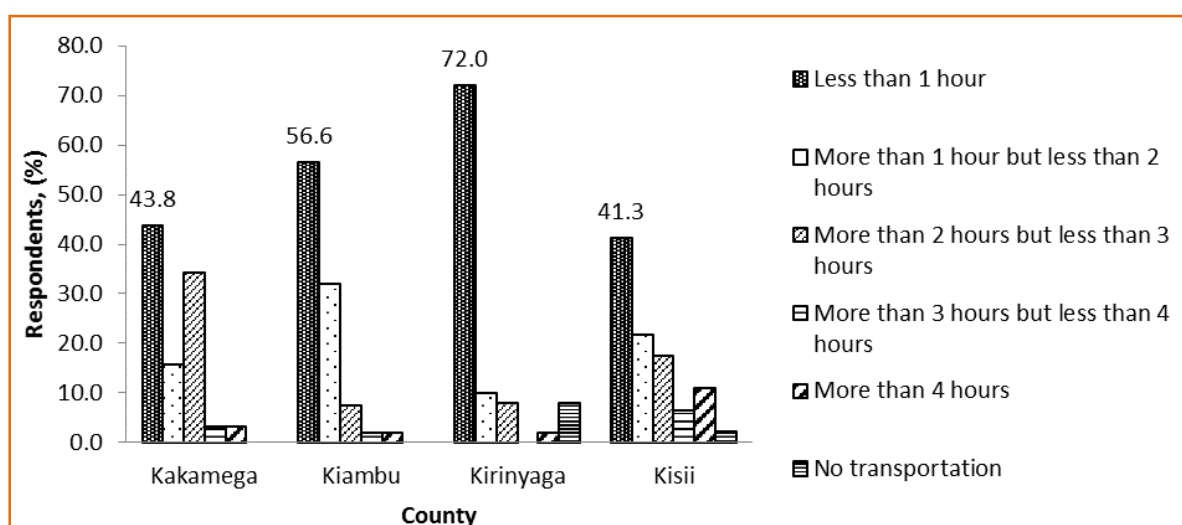


Figure 4: Duration for transporting the vegetable from source to market in Kakamega, Kiambu, Kirinyaga and Kisii Counties in Kenya.

The longer it takes to transport the produce to the market the higher the traders' losses (Table 6). The produce will normally deteriorate with the length of time the produce is in an uncontrolled environment.

Table 6: Length of transport and associated losses

Level of losses	Less than 1 hour	More than 1 hour but less than 2 hours	More than 2 hours but less than 3 hours	More than 3 hours but less than 4 hours	More than 4 hours	No transportation
Less than 10%	83.90%	68.60%	44.40%	20.00%	42.90%	25.00%
Between 10 and less than 20%	15.10%	28.60%	48.10%	80.00%	57.10%	75.00%

The mode of transport was also found to have an influence on the level of losses with the highest losses occurring with hired vehicle transportation, followed by cycling, manual, draught and motor bicycles. Also noted to influence losses was the type of packaging.

### Market infrastructure

Market infrastructure had an effect on the level of losses with under-shade storage incurring less loss than those using open trading areas. This relates to other earlier studies; with Kader (2013) pointing out that the major environmental factors influencing food losses were temperature and relative humidity, and these factors are affected by type of infrastructure. Chun-Ta (2010) further indicated that technologies meant to protect products through minimizing respiration rates and developmental events such as growth or ripening through low temperature storage are key to overcoming food losses.

### Value addition (sorting, grading)

Value addition also affects levels of losses, with those doing value addition, like grading and sorting, incurring less losses than those who do not; with 73.5% of those who do value addition incurring losses of less than 10% compared to 59.1% of those who do not do value addition. The type of system of value addition affects the level of losses, for example, with those using mechanical systems for value addition incurring more losses than those who use manual system.

Storage and type of storage also affect levels of losses with those practicing storage in the appropriate system incurring less losses than those who did not; of those who store under shade, 77% incurred losses of less than 10% compared to 41% of those who did not use shades. The study relates to other studies; with Folayan (2013) indicating that the type of storage facilities was one the determinants of postharvest losses. Chun-Ta (2010) further indicated that the methods that are geared towards manipulating products physiological activities, or eliminating or suppressing microbial activities are key to overcoming food losses.

The effect of time on storage was visible in tomatoes, where those who stored for a shorter time incurred, less loss than those who stored for a longer period.

### Market information

The availability of market information affects the level of losses. With those able to get market information through various sources such as radio, short message service, extension officers and friends incurring less losses than those who do not (Table 7). The study is related to that of Folayan (2013) who identified that the source of information was a determinant of postharvest losses in maize in Nigeria.

**Table 7: Market information sources and respondents incurring various sources**

Source of Market Information	% of respondents accessing information from this source incurring losses less than 10%	% of respondents accessing information from this source incurring losses less than 10%
Radio	75.8	68.5
From Friends	72.3	50.0
Extension officers	87.5	69.0
Short message services	75.0	69.6

### CONCLUSION

A number of factors have been identified as having influence on post harvest losses at traders' level, these includes; age, urbanization, population, appropriate market infrastructure like shade, and female gender; with all having a negative



relationship to losses. The type of vegetable had an influence on the level of losses; with cabbages experiencing higher losses than tomatoes, and indigenous vegetables experiencing the lowest losses. The source of produce for sale also influenced food losses with vegetable sourced from market undergoing highest losses. This was followed by that from farmers groups, middlemen and the least being of the product sourced at farmgate. There was a positive relationship between losses and batch sizes purchased for sale and also the length of time to sell and transport the produce. Other factors that had influence on food losses at a trader's level included a mode of transport, market infrastructure, levels of value addition as well as market information. Highest losses in transportation occurred with the use of vehicles, followed by cycling, manual, draught and least with motorcycle. This value adding produce through grading and sorting and those who had access and used market information incurred less losses.

Reduction of postharvest losses is one of the possible interventions of realizing food security. The investment required in the technologies for loss reduction may be modest but the benefits are worth (Kiaya, 2014). There exist opportunity to develop systems and interventions to reduce the losses due to the various factors highlighted above. Research is also needed to be tailored to address the various gaps, identify in this study. The study also recommends detailed study of the effect of individual analyses factors and their interrelation in contributed to food losses.

## ACKNOWLEDGEMENT

The authors acknowledge the support of Renewable Energy for Food (RE4Food) Jomo Kenyatta University of Agriculture and Technology project through the Department of International Development (DFID), Engineering and Physical Sciences Research Council (EPSRC), Department of Energy and Climate Change (DECC), and Newcastle University for the financial support for the undertaking of the study.

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