



# Journal of Stored Products and Postharvest Research

Volume 7 Number 5 May 2016

ISSN 2141-6567



*Academic  
Journals*

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**ARTICLE**

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Abadi Gebre Mezgebe, Zemenu Kerie Terefe, Tafese Bosha, Tilku Desalegn Muchie and Yosef Teklegiorgis

*Full Length Research Paper*

# Post-harvest losses and handling practices of durable and perishable crops produced in relation with food security of households in Ethiopia: Secondary data analysis

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Received 8 February, 2016; Accepted 4 May, 2016

**This secondary data analysis was conducted to assess post-harvest losses and handling practices. The postharvest section of the Living Standard Measurement Survey (LSMS) data set of the Ethiopian Rural Socio-economic Survey (ERSS) was used as a data source. The analysis result showed losses of 153.29 kg of cereal crops (7.7% households), 120.16 kg of pulses (5.5% households), 320 kg of oilseeds (4.1% households), 102.19 kg of fruit crops (11% households), 181.86 kg of vegetable (8.2% households), 105.56 kg of root crops (5% households), and 556.13 kg of cash crops (8.2% households). Higher number of households (30%) lost 30% of fruits, 10% of vegetables (21.62% household), 50 and 60% of root and cash crops (26.5% households), respectively. The major cause for cereals and oilseeds loss was rodents/pests, others for pulses and diseases for the perishable crops. Additionally, 84% of the households stored cereal, 63.9% pulses, 80.9% oilseeds, 7.6% fruits, 16.6% vegetables, 25.7% roots and 29% cash crops. The main storage method of durable crops was bags in house and sacks for perishable crops. Furthermore, 91% of the households protected cereal crops, 59.97% pulses, 74.8% oilseeds, 78.4% fruits, 81.7% vegetables, 71% roots and 78.5% cash crops. The major technique used for protection of cereal, pulse, vegetable and cash crops was elevation, while other techniques were used for fruits and root crops. About 50.4% of households did not protect oilseeds. Postharvest losses varied among crop types and handling practices. Reduction of losses could contribute to food and nutritional security; hence attention should be given towards improving postharvest handling practices.**

**Key words:** Durable crops, perishable crops, postharvest losses, handling practices, food security.

## INTRODUCTION

Achieving food security continues to be a challenge as it is affected by a complexity of factors (Nicholas et al., 2006; FAO, 2009; Dercon and Krishnan, 2015). Increasing the food availability is therefore not only

increasing the productivity in agriculture, there is also a need to lower the losses (Kader, 2005; Parfitt et al., 2010; Victor, 2014). Food losses after harvest until the food reach the consumer are significant (FAO and World Bank,

**Table 1.** Percentage of food losses in low-income sub-Saharan African countries.

Food type	Agricultural production (%)	Post-harvest handling practices (%)	Processing and packaging (%)	Distribution (%)	Consumption (%)	Total loss (%)
Cereals	6	8	3.5	2	1	20.5
Roots and tubers	14	18	15	5	2	54
Oilseeds and pulses	12	8	8	2	1	31
Fruit and vegetable	10	9	25	17	5	66
Meat	15	0.7	5	7	2	29.7
Fish and seafood	5.7	6	9	15	2	37.7
Milk	6	11	0.1	10	0.1	27.2

Source: International congress of Save Food (2011), with modification on the total loss (total was calculated through summing up of all the losses along the chain).

2010; FAO, 2014). A large amount of food and products are not reaching the consumer particularly due to post-harvest losses (Kader, 2005; FAO, 2009; FAO and World Bank, 2010) during harvesting, handling, transporting, storage, processing, packaging and distribution. Handling and processing of the food are of high importance in order to ensure food-safety (Kader, 2003). Post-harvest loss leads to an inadequate food intake and it could be manifested by seed loss, monetary loss, food loss and loss of reputation which in turn affect marketing (Gross et al., 2000; FAO and World Bank, 2010). Post-harvest losses can be caused by mechanical damage and injury, physiological processes, poor handling, lack of processing, inadequate packaging, poor logistics and sub-optimal storage conditions (Chakraverty et al., 2003). According to FAO (2014) post-harvest losses in developing countries can range from 15 to 50%.

Quantitative and qualitative losses could occur in crops (Kidane et al., 2006; FAO and World Bank, 2010). Qualitative losses, such as loss in edibility, nutritional quality, caloric value, and consumer acceptability of the products, are much more difficult to assess than quantitative losses (Kader, 2005; Adeoye, 2009; Buyukbay et al., 2011). Post-harvest losses reduce the availability of food crops and income that could be generated by selling these products, thus in terms of quantity are linked to food security (FAO and World Bank, 2010; Jayne et al., 2010; Hodges et al., 2011). The qualitative losses are related directly to nutritional and they are more complicated to measure. However the quantitative losses are of greater importance to measure in developing countries (Humble and Reneby, 2014).

Food grains (cereals, pulses and oil crops) constitute the major sources of food intake in Ethiopia (Abebe, 2000; CSA, 2006, 2012). Some preliminary estimates

show that post-harvest losses could range between 5 and 26% of production, which is enormous given the state of food insecurity of the country (Abebe, 2000). It is important to recognize that post-harvest management practices and capacities (not only just production and marketing) are consequential for many reasons including attaining high level of food and nutritional security. As described by FAO (2014), Felleke (2004), Kader (2005), Nega and Semeon (2006) and Abebe and Bekele (2011) post-harvest losses studies are generally rare in Ethiopia; and even these few available are related to aspects of engineering structures and not with aspects of food and nutrition security.

Post-harvest losses may vary greatly among commodities, production, areas, seasons, handling and management practices. Nearly 20% of losses of fresh fruits and vegetables are due to product deterioration. This may include the excess of perishable products that are discarded and the food that is wasted, not consumed by the purchaser) (Kader, 2005; Victor, 2014). Some estimates would suggest the magnitude of post-harvest losses in Ethiopia to be tremendous; for example depending on the type of post-harvest handling method, the losses could range between 5 and 19% for maize, 6 and 26% for millet, 6 and 23% for wheat, and 5 and 20% for teff (Dereje, 2000). The international congress of Save Food (FAO, 2011) reported that the percent weight of food losses in the post-harvest chain for different economic status countries and it has shown estimates of food losses in low-income sub-Saharan African countries including Ethiopia (Table 1).

Mrema and Rolle (2002), Jayne et al. (2010) and Hodges et al. (2011) indicated an evolution of priorities within the post-harvest sector of developing countries from a primarily technical focus geared towards the

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reduction of losses, to a greater holistic approach designed to link farm activities to processing, marketing, and distribution. However, the major constraints continue to be high post-harvest losses, poor marketing systems, weak research and development capacity, and inadequacies in policies, infrastructure, and information exchange. Overcoming the socio-economic constraints is essential to achieving the goal of reducing the post-harvest losses of food (Kader, 2005; Abebe and Bekele, 2006).

Reduction in food losses are sometimes considered as the 'third dimension' to the world food supply equation, that is, in addition to increase in food production and population. In Ethiopia, grain storage at farm level is carried out by means of grain pits, underground holes, and sacks. Grain losses due to poor storage by farmers are reported to range between 11 and 19% (Abebe, 2000; Abebe and Bekele, 2006). Grain traders also store grains in warehouses with small but varying capacities; moreover, these are characterized by poor ventilation and dirt floors (Kader, 2005). Hence, poor storage naturally leads to high grain damages from pests and moisture. Inadequacy of storage, combined with the vulnerability of crops to damage, makes traders unwilling to store stocks beyond the minimum turnover period. Similarly, pre-damage treatment (aeration, application of pesticides, etc) is seldom practiced by most farmers, and post-damage treatment is limited to aeration.

In Ethiopia, consumers buy unprocessed crops actually unchanged since processing is not undertaken either by producers or middlemen. Processing is essentially undertaken as and when grains are prepared for consumption rather than as an important economic activity (Abebe and Bekele, 2006). The aim of this study was to assess post-harvest and handling practices of crops produced in Ethiopia in relation with food security of households.

## METHODOLOGY

The Living Standard Measurement Survey (LSMS) data set of the Ethiopian Rural Socio-economic Survey (ERSS) of the year 2012/2013 from the agriculture postharvest section was used as the data source for this secondary analysis. The data were organized to answer the specific research objectives. All the households that produce crops (Durable crops: cereals, pulses, oilseeds and perishable crops: fruits, vegetables, root and cash crops) were considered in the analysis. Crops were categorized as cereals (barley, maize, millet, oats, rice, sorghum, teff and wheat), pulses (chickpeas, haricot beans, horse beans lentils, field peas and soya beans), oilseeds (linseed, ground nuts, nung, rape seed, sesame and sunflower), fruits (banana, lemon, mango, orange, papaya, pineapple and avocado), vegetables (red pepper, cabbage, carrot, cauliflower, garlic, kale, lettuce, onion, green pepper, pumpkins and tomatoes), root crops (potato, sweet potato, *Godere* and *Enset*) and cash crops (coffee, cotton, *Gesho* and sugar cane).

The specific questions from the LSMS - ERSS - Agriculture postharvest data considered for this research were: For durable crops: (1) Were there losses of crop? (2) Was any portion of the crop lost postharvest due to rotting, insects, and rodents? (3) Did

you have any of this harvest stored now? (4) Did you protect the stored crop? (5) What is the reason of the losses of the stored crops? (6) What is the method of storage? (6) What are the techniques used for protection of stored crops? (8) The unit of losses of the crop? For perishable crops: (1) Were there losses of fruit/crop? (2) Was any portion of the fruit/crop lost postharvest due to rotting, insects, and rodents? (3) Did you have any of this harvest stored now? (4) Did you do something to protect the stored crop? (5) What is the reason of the losses of the stored crops? (6) What is the method of storage? (7) What are the techniques used for protection of stored crops? (8) Out of 10 fruits how many was lost?

The data in the original source was collected from different regions of Ethiopia which had produced the crops listed. Analysis was conducted in SPSS version 16.0. Descriptive statistical methods (relative frequency, mean, range, percentage) were used to report the results of the analysis. Postharvest losses, causes of losses, availability of stored crop, storage method, and protection of stored crops and techniques of protection were reported.

## RESULTS AND DISCUSSION

### Postharvest losses and causes

As shown in Table 2, concerning the cereal producers (5639 households), 7.7% reported to have crops losses with mean of 153.29 kg. About 5.2% of the pulse producers (from the total of 1612 households) responded to have losses with average of 120.16 kg. From the oil seed producers (860 households), 4.1% responded to have losses with mean of 207.16 kg. The percentages of losses of the crops were not calculated as the data for production was not collected in the original data source. However, these findings are within the range reported by Dereje (2000), Abebe (2000), Abebe and Bekele, (2006) and Kader (2005). It is known that food grains (cereals, pulses and oil crops) constitute the major source of food in Ethiopia, accounting for 82 and 70% of total calorie intake and food expenditure, respectively (Abebe, 2000; CSA, 2006, 2012). Cereals alone provide about 70% of the average Ethiopian's calorie intake (Howard et al., 1995). Hence efforts should be done to reduce the losses.

In relation to the fruits producers (1007 households, 11% responded to have losses of the crops with average of 102.19 kg, and about the vegetable producers, 8.2% of a total of 1913 households, reported to have 181.86 kg of losses. About 5% of the root crops producers (out of the total of 1398 households) lost around 105.56 kg. Regarding the cash crop producers, 8.2% reported losses of 556.46 kg) (Table 2).

The percentage of losses of perishable crops show that higher number of household (30%) lost their fruit as much as 30%, and 21.62% of the household lost 10% vegetables. With regard to root crops and cash crops higher number of households (26.5%) reported about 50 and 60% of losses, respectively (Table 3). The percent of reported losses (about 20%) of fruits, vegetables, root crops and cash crops was reported by corresponding respondents of 17.9, 16.2, 25 and 25%, respectively. The results are in line with reports of Admassu (2005), Save

**Table 2.** Respondents (%) and crop loss (kg) reported by sampled households in Ethiopia.

Crop type	No. of HH	% respondents reported loss	Average crop loss (kg)
Cereals	5639	7.7	153.29
Pulses	1612	5.2	120.16
Oilseeds	860	4.1	207.16
Fruits	1007	11.0	102.19
Vegetables	1913	8.2	181.86
Root Crops	1398	5.0	105.56
Cash crops	1249	8.2	556.13

HH= Households producing the crops.

**Table 3.** Percentage of losses reported by sampled household (perishable crops).

Loss reported (%)	Percentage of respondents with respective crop type (%)			
	Fruits (n=106)	Vegetables (n=148)	Root crop (n=68)	Cash crops (n=68)
10	16.00	21.62	14.70	14.70
20	17.90	16.20	25.00	25.00
30	30.00	8.78	11.00	2.90
40	9.40	4.73	7.40	11.00
50	24.50	2.70	26.50	7.40
60	2.80	5.40	2.90	26.50
70	1.90	2.03	1.50	2.90
80	5.70	2.70	1.50	1.50
90	0.90	12.20	1.50	1.50
100	0.94	2.03	0.00	1.50

n = number of households sampled.

**Table 4.** Percentage of main causes for crop loss reported (durable crops).

Crop type	Total no. HH	Rotting	Insects	Rodents/pests	Flood	Theft	Other specify
Cereals	834	14.9	14.7	41.5	4.6	1.4	22.9
Pulses	179	21.2	13.4	21.8	2.8	3.9	36.9
Oilseeds	68	8.8	13.2	41.2	5.9	2.9	27.9

HH= Households producing the crops.

Food (2011), Abebe and Bekele (2006), and Humble and Reneby (2014). According to FAO (2014) post-harvest losses in developing countries can range from 15 up to 50%. Horticultural crops are perishable products and they are more prone to greater losses than for non-perishable crops (Parfitt et al., 2010).

As shown in Table 4, the main cause of the losses for cereal crops was reported to be rodents/pests (41.5%). Rotting and insects were also reported to be the cause of the losses of cereals with 14.9 and 14.7%, respectively. With regard to pulse crops the main reason for the losses was reported to be rodents/pests (22.8%) and rotting (21.2%). insects were also the cause for the losses of

pulses (13.4%). The oil seed losses were mainly due to rodents/insects (41.2%). Insects were also reported to be the cause of the losses of the oil seeds with 13.2%. Comparing with all the crops, the losses due to flood and theft were minor. It has been addressed that pests, rodents, rotting/insects, flood and theft could cause the losses of grains. More detailed causes of postharvest losses were reported by Boxall (2001), Kader (2005), Magan and Aldred (2007), Parfitt et al. (2010), Tefera et al. (2011, 2012), Hodges et al. (2011), and Humble and Hundie (2014).

The main causes of the losses of fruits (Table 5) were reported to be primarily diseases (30.1%), birds (21.9%),

**Table 5.** Percentage of 1<sup>st</sup> and 2<sup>nd</sup> causes of the crop losses of the perishable crops.

Crop type	Causes priority	No. of HH	Birds	Animals	Insects	Diseases	Thefts	Other specify
Fruits	1 <sup>st</sup>	183	21.9	6.0	16.4	30.1	11.5	14.2
	2 <sup>nd</sup>	110	33.6	18.2	4.5	0.0	11.8	31.8
Vegetables	1 <sup>st</sup>	355	2.8	11.0	19.4	44.8	2.0	20.0
	2 <sup>nd</sup>	155	25.2	36.1	8.4	1.3	4.5	24.5
Root crops	1 <sup>st</sup>	137	0.7	10.9	16.1	36.5	5.8	29.9
	2 <sup>nd</sup>	69	17.4	33.3	4.3	1.4	7.2	36.2
Cash crops	1 <sup>st</sup>	282	3.5	3.5	16.0	51.8	9.9	15.2
	2 <sup>nd</sup>	103	5.8	25.2	1.9	0.0	19.4	47.6

HH= Households producing the crops.

**Table 6.** Relative frequencies of households (HH) who had crops in storage.

Crop type	No. of HH	% Positively responded
Cereals	5562	84.0
Pulses	1587	63.9
Oilseeds	881	80.9
Fruits	1008	7.6
Vegetables	1913	16.6
Root Crops	1403	25.7
Cash Crops	1252	29.0

HH= Households producing the crops.

insects (16.4%) and thefts (11.5%). The losses due to animals seem to be low as compared to the others. Vegetables losses were mainly reported primarily due to diseases (44.8%). Next to the diseases, the main causes for the losses of vegetables were insects (19.4%) and Animals (11%). The losses of vegetables due to thefts and birds were less. As secondary causes of the losses of due to birds (33.6%), animals (18.2%) and thefts (11.8%) were reported for fruits and animals (36.1%), birds (25.2%) and insects (8.4%) for vegetables. Moreover some detail of the main causes of losses of fruits and vegetables after harvest have been studied by Kader (2002), Kader (2005), Wu (2010), Victor (2014) and Devkota et al. (2014).

The main cause of root crops loss was reported to be diseases (36.5%) primarily (Table 5). Insects and animals were also main causes. Theft and birds were reported less likely to cause the losses. The main reason for losses of cash crop was reported to be primarily due to diseases (51.8%). Insects and thefts were also reported to be the main causes. Birds and animals were less likely reported to cause losses of cash crops. With regard to the secondary main causes of the losses of root crops, animals (33.3%) and birds (17.4%) were reported. As for the cash crops, animals (25.2%) and thefts (19.4%) were reported. With differences in the relative frequency, root crops and cash crops seemed to have similar causes of with fruits and vegetables. Moreover, the possible main

causes were addressed in the reports of Adda et al. (2002), Chakraverty et al. (2003), Kader (2002) and Rembold et al. (2011).

### Storage and methods used for storage

As shown in Table 6, about 84% of the producers stored cereals, 63.9% pulses, 80.9% oilseeds, 7.6% fruits, 16.6% vegetables, 25.7% root crops and 29% cash crops. This result is probably due to the nature of the commodities, since the perishable one can not stay long in the storage.

With regard to the storage methods used, the bags in house was the mainly used for cereals, pulses and oil seeds storage (Table 7), while the producers were using mainly sacks for fruits, vegetables, root crops and cash crops (Table 8). There were no producers that used unprotected pile for storing the perishable crops. The storage methods used by the producers is in agreement with the study done by Abebe and Bekele (2006); and the possible options that could be considered for choosing these methods is the cost as indicated by McFarlane (1998).

It is well known that perishable crops should be kept in cold places with proper temperature, and humidity.

Selection of storage depends on the volume of production and the operation and establishment costs (David and David, 1998). The common storage structure used by most of Ethiopian farmers are the traditional ones with poor

**Table 7.** Percentage of storage methods used by the households for durable crops.

Crop type	No. HH	Unprotected pile	Heaped in house	Bags in house	Metallic silo	Other specify
Cereal	4574	8.6	7.7	48.9	0.4	34.4
Pulses	997	5.0	8.9	61.6	0.2	24.3
Oilseeds	685	1.6	4.2	68.8	0.1	25.3

HH= Households producing the crops.

**Table 8.** Percentage of storage methods used by households for perishable crops.

Crop type	No. HH	Locally made traditional structure	Improved locally made structure	Modern store	Sacks	Other
Fruits	76	1.3	2.6	0.0	94.7	1.3
Vegetables	318	7.9	0.6	0.3	90.3	0.9
Root Crops	359	12.3	0.0	0.0	86.4	1.4
Cash Crops	359	3.9	0.3	0.3	95.0	0.6

HH= Households producing the crops.

**Table 9** Relative frequency of households who protect crops in storage.

Crop type	No. of HH	% Positively Responded
Cereals	100	91.00
Pulses	1589	59.97
Oilseeds	897	74.80
Fruits	74	78.4
Vegetables	317	81.7
Root Crops	359	71.0
Cash Crops	362	78.5

HH= Households producing the crops.

**Table 10.** Percentage of protection method of crops used by the Households.

Crop type	No. of HH	Spraying	Smoking	Hired guard	Did nothing	Elevation	Other specify
Cereal	4517	18.9	2.7	0.2	33.6	41.4	3.3
Pulses	967	15.0	3.7	0.4	34.7	42.1	4.0
Oilseeds	671	3.3	0.9	0.0	50.4	38.9	6.6
Fruits	58	0.0	1.7	0.0	10.3	8.6	79.3
Vegetables	259	0.8	15.8	0.4	13.1	59.5	10.4
Root Crops	254	0.0	1.2	1.2	13.4	13.8	70.5
Cash Crops	283	0.0	1.1	0.0	4.9	87.6	6.4

HH= Households producing the crops.

construction that expose the stored grains to different conditions and deterioration agents and in which the appropriate management of all the influencing factors has not been dealt in detail (Kemeru, 2007; Befikadu, 2014).

### Handling and methods used for protection

As indicated in Table 9, about 91% of the producers

protected cereals, 59.97% pulses, 74.8% oilseeds, 78.4% fruits, 81.7% vegetables, 71% root crops and 78.5% cash crops. According to the results in Table 10, elevation was the method used mainly for protection of cereals, pulses and oilseeds. There was higher percent of respondents that did nothing for protecting. Spraying was used by some of households. The protection method for fruits was not stated in the list and this indicates the respondents were using a different method. About 10% of the

households did nothing to protect the fruits. Vegetables were mainly protected by elevating followed by smoking. Still there were producers that did not protect the vegetables. Protection method for root crops was not stated in the list and this indicates that the respondents were using a different method. There were also about 13.1% of households that did nothing to protect the root crops. As shown in the Table 9, the cash crops were protected mainly by elevation.

Crops that have been put into the storage after harvest without proper management and handling can rapidly be deteriorated, becoming a worthless mass (David and David, 1998; Befikadu, 2014).

## Conclusion

Most of the households reported losses of both durable and perishable crops. These crops are source of income and calorie intake, hence reducing the losses could contribute to food security of the households. The main causes of durable crops losses were reported to be rodents, pests, rotting and insects. It has been observed that there were producers that didn't protect stored crops. Protection of the crops during storage helps to reduce the losses thereby contributing to food security. Moreover diseases, birds and animals were the major reasons for the loss of perishable crops. The loss/ spoilage by diseases, birds and animals could be prevented by appropriate postharvest handling. Regarding the storage most of the households used bags in house to store durable crops and sacks to store perishable crops. However, there were very few of the households using improved and modern local, for storing the crops. The majority of the households stated that the elevating was the main used method of protection. In addition to the increased income, reducing postharvest losses could increase the amount of food available for consumption by farmers, rural and urban consumers. The final consumer can also be benefited by the reducing prices as a result of the increased availability of foods. Improve postharvest handling and technology can create some job opportunities in long term. Therefore, reducing losses by postharvest handling practices will generally improve the livelihoods if it is done appropriately. Postharvest has been relatively little studied in relation to food security and nutrition. Considering the potential of postharvest for large impacts in food and nutrition security, this study recommends a primary research on the relationship of postharvest to food and nutrition security.

## Conflict of Interests

The authors have not declared any conflict of interests.

## ACKNOWLEDGEMENTS

The authors would like to appreciate and thank the

institutions which contributed to the secondary data analysis. This research work is made possible by the support of the American people through the United States Agency for International Development (USAID) under Agreement No.AID-663-A-11-00017. The contents of the document are sole responsibility of the researchers and do not necessarily reflect views of USAID or the United States Government.

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