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Assessment of Post-harvest Handling Practices: Knowledge and Losses of Fruits in Bagamoyo District of Tanzania

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Abstract

The harvesting practices, knowledge and post-harvest losses of fruits along the supply chain in Bagamoyo District were investigated. 142 farmers, 50 retailers and 10 wholesalers dealing with fruits were involved in the study. Data were collected using structured questionnaires. The results indicate that, 90.14% of the respondents harvested fruits when they are just ripe and the great market losses were reported to occur due to rotting (microbial) at 63%, physiological at 20% and 17% by insects and rodents. Along the supply chain, mechanical damage was observed to be the major type of loss during harvesting (79%) and transportation (56%) while microbial damage was observed by majority (67%) during marketing. Poor infrastructure from farm to the market was observed to account for large percentage of losses in the market. The findings also shows that all farmers (100%) interviewed have no knowledge on post-harvest losses and management. In the view of the findings, it can be concluded that, post-harvest handling practices and knowledge of stakeholders involved in fruit sub sector in the country are not good enough to prevent the losses. It is therefore imperative to improve educational knowledge, skills and fruits quality from the field to reduce post-harvest losses.

Keywords: Post-harvest practices, knowledge, losses, fruits

1. Introduction

Post-harvest loss is a "measurable quantitative and qualitative loss of a product at any moment during the post-harvest chain" and includes the "change in the availability, edibility, wholesomeness or quality of the food that prevents its consumption" (Adeoye, 2009; Buyukbay *et al*. (2010). Fruit losses during and after the harvest have been reported by various workers. Muntad (2009) reported both quantitative and qualitative losses of extremely variable magnitudes occurring at all stages in the post-harvest system from harvesting, through handling, storage, processing and marketing to final delivery to the consumer.

Tanzania climate allows cultivation of fruits and vegetables however, the post-harvest loss is so enormous. Post-harvest loss of fruits and vegetables is estimated to be 30-40% in developing countries, Tanzania inclusive (Karim and Hawlader, 2005; Aujla *et al.* 2011). The principal causes are mentioned to be poverty, inadequate post-harvest handlings, lack of appropriate processing technology and storage facilities, poor infrastructure as well as poor marketing systems (Buyukbay *et al*. 2010). Due to absence of proper storage and marketing facilities, farmers are forced to sell their produces at throw away prices (Omolo *et al.* 2011) leading to economic losses. FAO (2008) added that, most losses occur in the latter part of the food chain through excessive processing, packaging and marketing. It has been reported that, the magnitude of losses depend on the nature of the commodities, the condition of the produce at the time of collection, distance travelled and the nature of the road network. Improper harvest and post-harvest practices result in losses due to spoiling of the product before reaching the market, as well as quality losses such as deterioration in appearance, taste and nutritional value (Turan, 2008). Despite adequate literature on post-harvest handling practice but the information on harvesting practices and post-harvest losses of fruits is limited to fruit handlers in Tanzania. Therefore, the aim of the present study was to assess harvesting practices and post-harvest losses of fruits along the supply chain.

2. Methodology

2.1 Study area

The study was conducted in Bagamoyo district which consists of 16 wards and a total population of 230,164 according to the 2002 Tanzania National census. The district is located on Pwani region and experiences general tropical climate condition characterised by hot and humid weather throughout the year. About 131,707 people of this area are involved in the crop production especially cereal crops such as sorghum and maize while about 98,457 are involved in production of fruits including mangoes, oranges, pineapples and lime. Three wards within the district were selected including Chalinze, Lugoba and Kiwangwa with a population of 76,721 of which 4000 are involved in production of fruits with representative sample of farmers, wholesalers, and retailers.

2.2 Sampling procedures and sample size

A purposive sampling was adopted to select three wards Chalinze, Lugoba and Kiwangwa (with farmers growing fruits whereby the number of farmers (n) selected in each ward was such that n/N represented a figure greater or equal to 5% of ward population as stated by Boyd *et al*. (1981). The percent of sampled population (C) was computed using the formula: C= n / N x 100; where n is the number of selected farmers and N is the total number of farmers in the ward. For the purpose of this study, a sample size of 200 was selected from the population that include 142 farmers and 60 traders. A purposive sampling was adopted to get fruit traders who have the best knowledge and experience in the business. With the assistance from the market masters, the list of traders was provided and these were selected randomly whereby a sample size of 50 retailers and 10 wholesalers were interviewed.

2.3 Data collection

Primary data were collected which included the field survey on fruit post-harvest handling practices along the food chain and associated quantitative losses. Farmers and traders were interviewed using structured questionnaire with open and closed questions. The questions sought to obtain information on harvest practices and post-harvest losses at each handling stage (harvesting, transportation and marketing). Data obtained from the structured questionnaires were supplemented by focus group discussions with some traders.

2.4 Data analysis

Data were analysed using statistical Package for Social Sciences (SPSS) version 17 (SPSS Inc, USA). Frequency distributions were computed and presented in Tables and bar chart graphs.

3. Results and discussion

3.1 Harvesting practices of fruits

3.1.1 Stage for harvesting fruits

The results in Figure 1 show that 90.14% of the respondents harvest fruits when they are just ripe while 7.75% harvest unripe fruits and the rest (2.11%) when fully ripened. These findings suggest that, unripe fruits are hard to harvest compared to fully ripened ones and are not easily damaged during harvesting and transportation but when fruits are fully ripened the spoilage is easier because of high amount of sugar and water (Shahnawz *et al.* 2012). These observations are in agreement with the report by Kadzere *et al.* (2006) that unripe fruits are hard to harvest compared to ripen one. It is not recommended to pick fruits when fully ripen because of danger of post-picking loses mounting up. Change in colour sometimes is the external indication which may guide the orchardist in individual cases. Therefore, fruits must be harvested firm enough to stand handling and to keep for a number of days and also to allow long distance if so required (Kadzere *et al.* 2006). The quality of fruits picked green is not equal to that picked ripe and it is necessary to strike a balance as to when the picking is to be done.

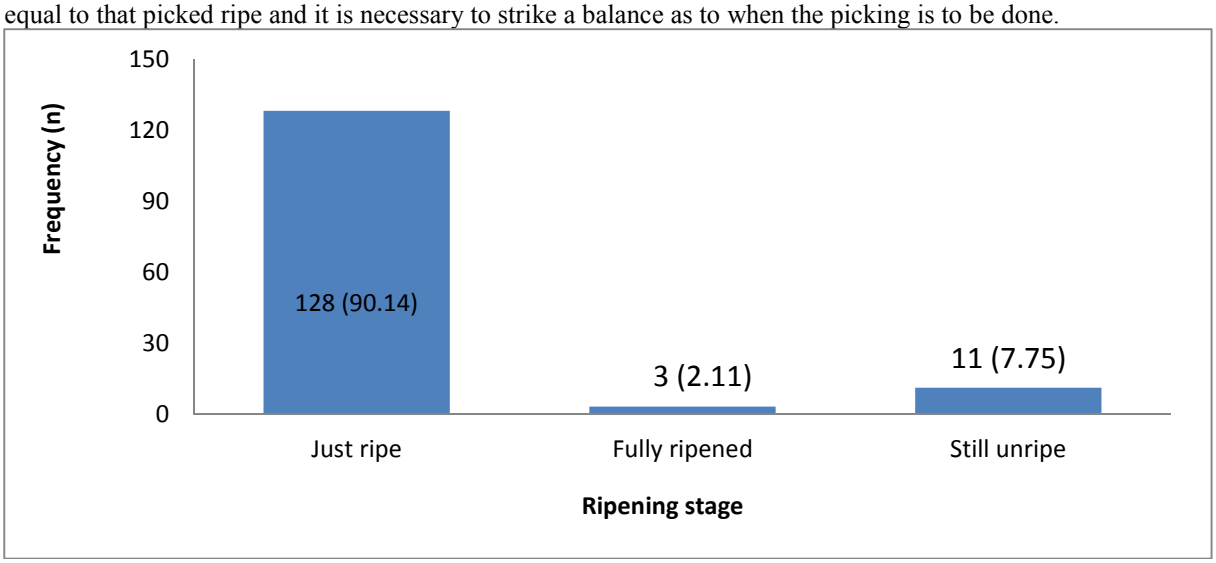

Figure 1: Distribution of farmers according to the stage in which they harvest fruits (n=142)

3.1.2 Harvesting time

The results for harvesting time of the fruits in Table 2 shows that majority of the respondents (95%) harvest fruits early in the morning and the rest (5%) in the afternoon. In the morning there is high humidity and therefore the fruits are healthy, heavy, and turgid. In the afternoon, high temperature and evaporation are the key issues that cause fruit shrinkage and become unacceptable to consumers. Similar results have been reported by Genova *et al*. (2006) that harvesting activities should be completed during the coolest time of the day, which is usually in the early morning and produce should be kept shaded in the field and handled gently.

Table 2. Harvesting time (n=142)

Time	Frequency	Percent
Morning	135	95
Afternoons	7	5

3.2 Packaging of fruits

The results of the present study show that 57 (40%) of the respondents pack the fruits in plastic sacks, 28 (20%) in baskets, 36 (25%) in woven bamboo baskets "*tenga*" while 21 (15%) in wooden crates (Figure 2). These packaging materials are reported to be cheap and mostly available. However, they have several disadvantages because the sides are sharp, they are too deep and they both bruise the produce and cause it to be jarred and or compressed. The use of sacks does not protect the fruits from mechanical damage as they cause fruit losses by crushing. Moreover, large congestion of fruits creates high heat in the sacks due to physiological change by metabolic reaction which in turn accelerates mechanical damage and microbial attack (El Assi, 2004; Kader and Rolle, 2004). The wooden packaging material has a slight effect on mechanical damage of fruits compared to others.

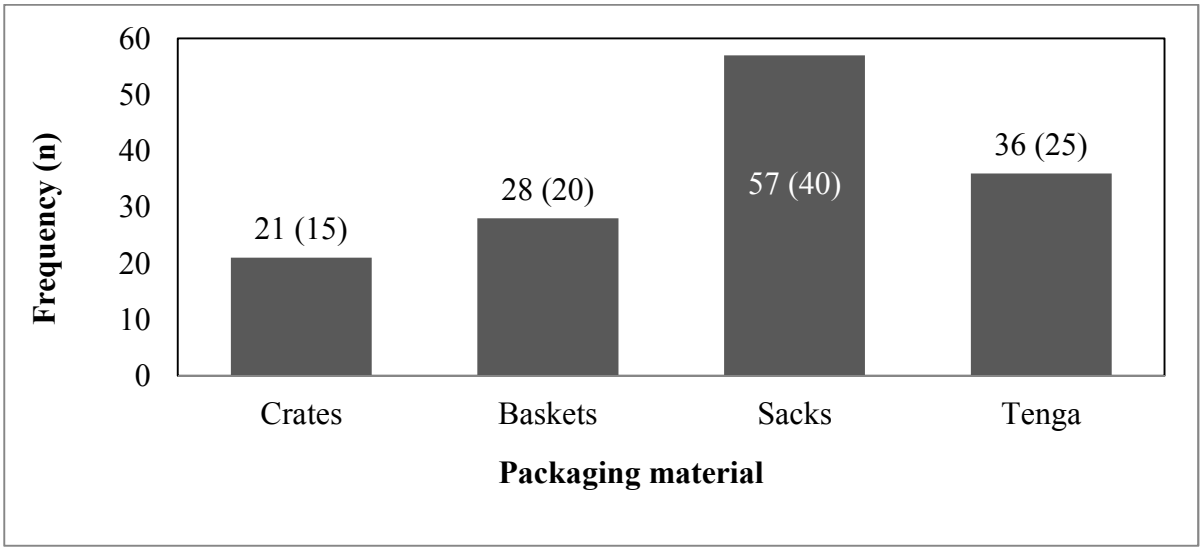

Figure 2: Distribution of respondents according to the types of packaging materials (n=142)

According to FAO (2008) and Nasrin *et al*. (2008) fruits have soft cover which is easily destructed and easily attacked by microbes which bring deterioration. Packages should be designed to have sufficient openings for allowing air ventilation to the fruits. However, the cost of packaging materials has escalated sharply in recent years, hence poor quality; lightweight containers that are easily cause damage by handling or accelerate moisture are no longer tolerated by farmers (Vitroy, 2008).

3.3 Transportation mode of fruits and its contribution to quality loss

The results in Figure 3 show that the major means of transport to ferry fruits to the market is by lorries 83 (58.5%) followed by head 33 (23.2%), and bicycles 26 (18.3%). The majority of respondents depend on the use of lorries due to the fact, that the road network is relatively good despite some of the roads are not easily passable during the rainy season. The mode of transport also contributes to mechanical and physiological damage of fruits. The practice of poor arrangement of sacks on top of each other and making a huge heap of packed fruits during transportation cause fruits damage due to shaking of the vehicle especially on corrugated roads. Meanwhile the accumulation of unarranged packed fresh fruit in lorries during transportation may also lead to increased heat due to metabolic reaction of the cells and it may accelerate their mechanical damage. The breakdowns of vehicles can be a significant cause of losses in some areas as perishable produce can be left in the sun for a day or more while

repairs are carried out. The existence of poor infrastructure, poor farm practices and storage and transportation facilities causes up to 40% losses (Mehmood *et al.;* Aujla *et al.* 2011).

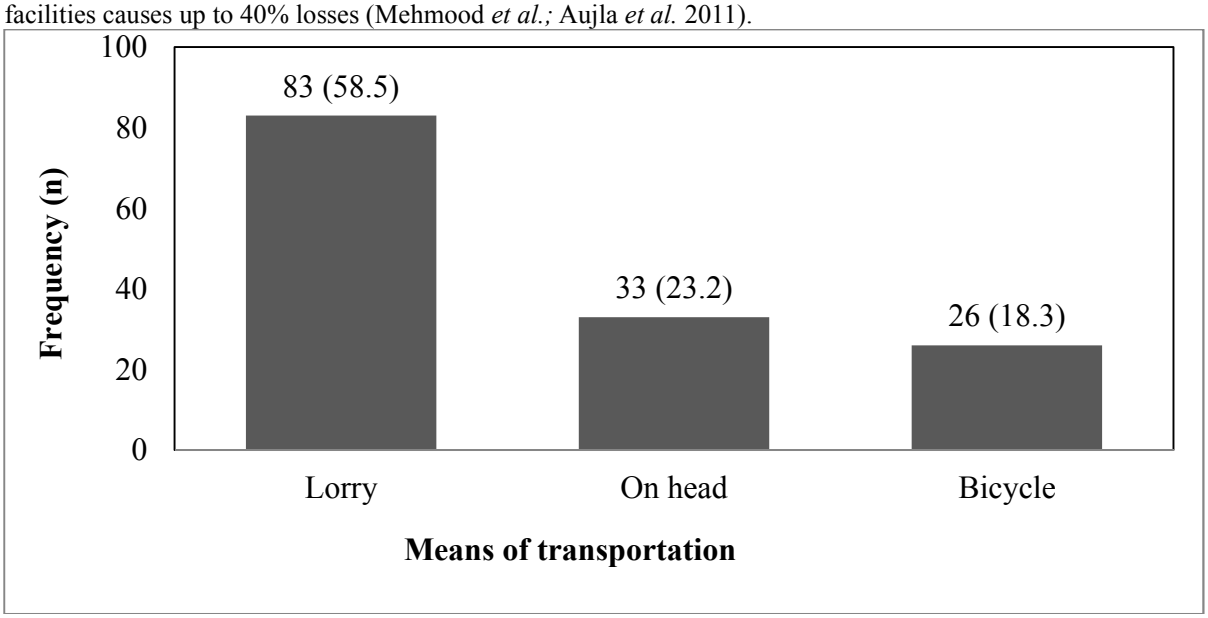

Figure 3: Distribution of respondents according to the means of transportation (n=142)

3.4 Market losses and fruits quality

Table 1 show the market loss and effect of sunlight to fruit quality. It was reported that great market losses occur due to rotting which accounts for 63% physiological for 20% and 17% by insects and rodents infestation. The results also show that spoilage was the major loss due to sunlight (53%) followed by softening (35%) while change in organoleptic properties of the fruits was the minor loss. Through group discussion it was observed that 93% of the respondents reported that temporary poor roofing materials used to protect fruits from sunlight and/or rainfall at the market contribute to spoilage of fruits. The presence of roof at the market especially in the perishable selling areas prevents fruits from sunlight and from rains. Exposing a fruit to the sunlight leads to water loss through transpiration which causes the fruits quality change and rain increases moisture to the fruits which may cause fruits spoilage (Lallu *et al.* 2003).

Table 1. Market losses and effect of sunlight to fruit quality (n=60)

Market losses	Frequency	Percept
Rotting (microbial)	38	63
physiological	12	20
Insects/rodents	10	17
Effects of sunlight		
Softening	21	35
Spoilage	32	53
Organoleptic properties of fruits	7	12

During the peak season high spoilage losses could be attributed by the marketing practices. This emanates that most of the respondents place their fruits on top of each other and make a huge heap on the table which leads to spoilage of fruits at the bottom due to high heat generated and condensation which encourage mould to grow on the surface of fruits. Because of limited source of income, business men sell their fruits which are damaged by poor harvesting practices. Resultant damage can include splitting of fruits, internal bruising, superficial wounds and crushing of soft produce. Poor handling can thus result in development of entry points for mould and bacteria, increased water loss and an increased respiration rate (Dixie, 2005). The level of contamination could be greater due to the use of contaminated field package, dirt water for washing produce before packing, decaying, rejected produce lying around packing area and unhealthy produce contaminating healthy ones in the same package (Kader, 2005). At the retailer marketing stage losses can be significant particularly in villages. Poor quality markets often provide little protection for the produce against temperature, leading to rapid produce deterioration. Sorting of produce to separate the saleable from the non-saleable can result in high percent being discarded. Arrival of fresh

supplies in the market may lead to some existing older stock being discarded or sold at very low prices (Lopez and Andres, 2004).

3.5 Type of losses occurring during fruit handling

The types of losses that occur during fruit handling are presented in Figure 4. The results show that out of 60 respondents, 21 (67%) mentioned rotting as the major type of loss during handling while 8 (13%) and 12 (20%) mentioned mechanical damage and physiological as the major problems during handling of fruits respectively. The high percent score in rotting could be explained by the fact that during handling, fruits are infected with various pathogens which are not visible prior to handling but will cause decay and rot during handling. It is therefore, advised to leave fruits free from any contamination of microbes, pests, rodents, insects and dust as a means of preventing fruits quality loss. Dirty handling environment might be the source of fruits contamination and quality loss from microbes, pest or insect all of which contribute to the spread of diseases to fruits.

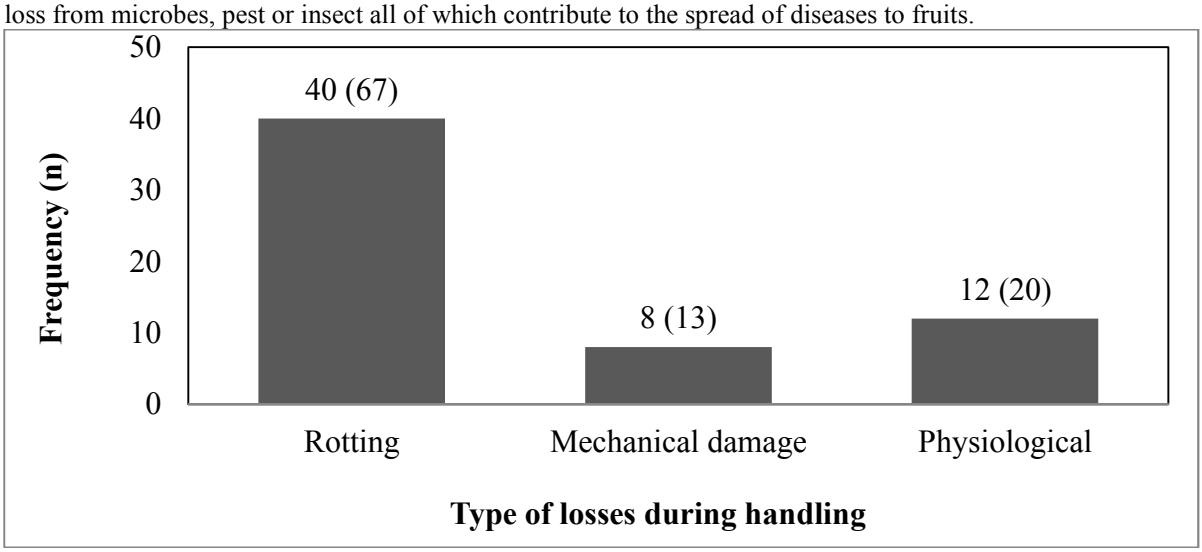

Figure 4: Distribution of respondents according to the type of fruit losses during handling (n=60)

3.6 Hygienic practices

The results of the present study indicate that 42 (70%) of the respondents reported that daily cleanliness of fruits in the markets was not practised. Hygienic conditions of fruits in the market need to be effectively improved to prevent them from any source of contamination. Washing with potable water and cleaning of fruits reduce surface contamination (Ofor *et al.* 2009). Fruits are rich in nutrients and thus naturally contaminated with microbes; therefore, keep the number of microorganisms as low as possible by keeping clean environment together with fruits (SCF, 2002; Ofor *et al.* 2009).

Duration (time) of selling fruits at the market

Figure 5 shows duration of selling fruits in the market. The results show that, most of the respondents take more than 3 days to sell out their fruit consignments. The fruits deteriorate as they take long time in the market, time of exposure to sunlight, rain, and dust as well as dirt environment. The longer time fruits take in the market the higher change in texture, aroma, flavour, spoilage and softening (Yahia, 2006).

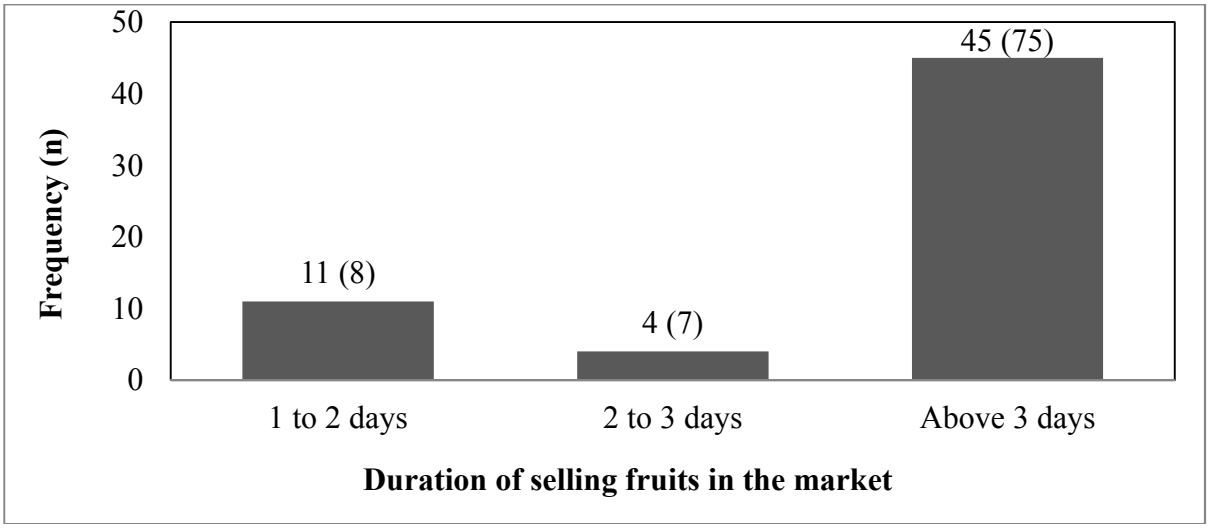

Figure 5: Distribution of respondents according to the duration of selling fruits (n=60)

Types of losses along the supply chain

Figure 6 shows the types and magnitudes of fruits losses at various handling stages. Mechanical damage was reported by majority 112 (79%) and 80 (56%) as a main types of post-harvesting losses during harvesting and transportation respectively while microbial damage was mentioned by 40 (67%) as the main post-harvest loss during marketing. The loss is influenced by poor harvesting methods used by farmers, corrugated roads and poor handling during marketing stage. The high mechanical damage losses could be explained by the fact that most fruits are harvested by shaking trees or by picking them when they fall down, the methods of which are unfortunately not friendly. Moreover, mechanical damage causes internal bruising which results in physiological damage or splitting and skin breakage, thus rapidly increasing water loss and the rate of normal physiological breakdown. The flesh of fruits is very susceptible to mechanical damage which once damaged it become discoloured, unsightly, and prone to invasion by decay organisms (De La Cruz Medina; García, 2002). This suggests that internal and external inspection of the fruits is important to determine the extent of mechanical damage.

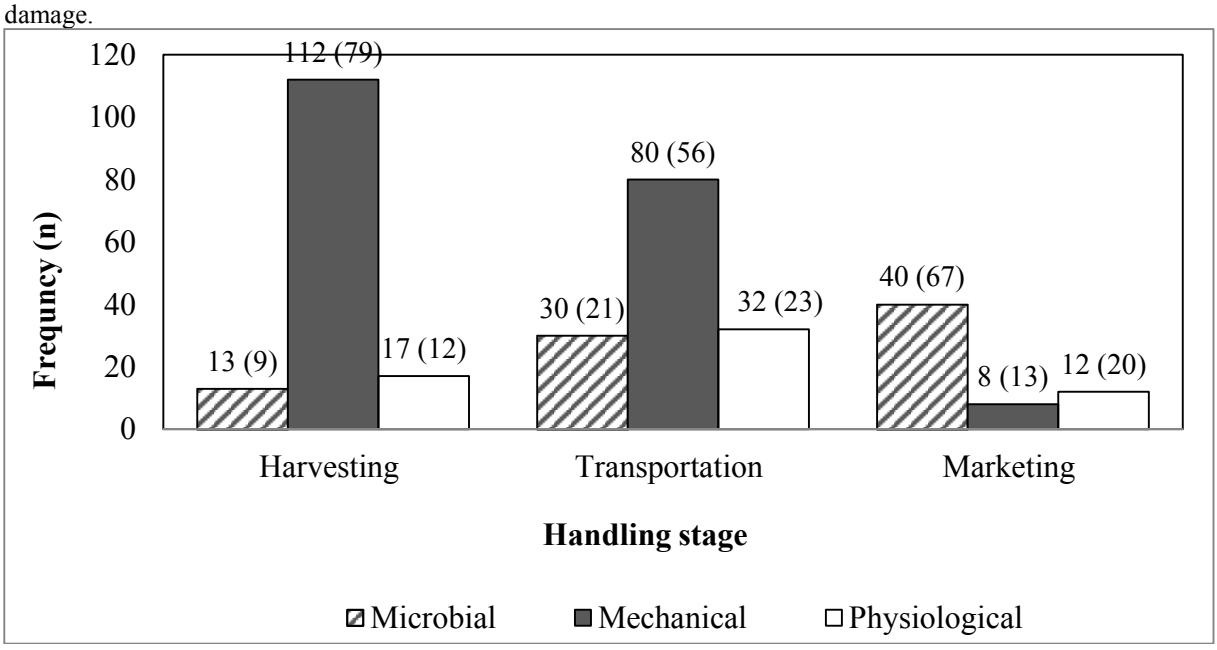

Figure 6: Types and magnitude of fruits losses at various handling stages

Knowledge on post-harvest handling practices of farmers and traders

The results on farmers and traders' knowledge on post-harvest handling practices in Table 2 show that all farmers (100%) interviewed reported that they have no formal knowledge on post-harvest losses and management. Regarding the education background of farmers, 48 (33.8%) of them had no formal education while 90 (63.4%)

had primary education and the rest 4 (2.8%) had secondary education. These observations indicate that there is both formal educational and post-harvest knowledge gaps which in turn affect the agricultural activities within the entire food chain.

Table 2. Educational knowledge of farmers and traders

Farmers (n=142)	Frequency	Percent
Formal knowledge of post-harvest losses	142	100
No formal education	48	33.8
Primary Education	90	63.4
Secondary Education	4	2.8
Traders (n=60)		
No formal education	34	57
Primary Education	14	23
Secondary Education	12	20

On the other hand 57% traders (retailers and wholesalers) who were interviewed reported to have primary education while 23% had not attended any formal education and 20% had secondary education (Table 2). However, 92% of traders who were interviewed reported not to have any basic knowledge on post-harvest practices. This indicates that there is a great need of education intervention on post-harvest handling practices.

5. Conclusion

Post-harvest losses of fruits are considered to be a major problem that affects many farmers in Tanzania. Most of fruit traders are taking fruits to the market for sale without considering the quality of the produce. It was observed that poor infrastructure from farm to the market account for great losses in the market including rough roads and means of transport. Other factors observed are packaging materials, sunlight, hygienic conditions and duration of selling the produce. In the light of discussion, it was considered that picking or harvesting time and stages, selling time, loading and unloading, distance from the market were found to be a problem due to educational level and inadequate information amongst farmers which could be overwhelmed by different forms of training and information availability.

To secure the additional production derived from the application of improved technology and high value inputs equal attention should be given to the post-harvest technology like that of production, handling and marketing which is vital sector of this industry. It is safe to say that post-harvest losses occur in every country but the magnitude of losses and the effective remedial methods differ greatly from country to country. To solve specific problems in a specific area effectively and economically, a comprehensive knowledge of the nature of post-harvest losses should be considered.

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