

Tomato Postharvest Management in Rwanda

PEF White Paper 19-04

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1. Introduction

While the food insecure population remains unacceptably high (FAO, 2010; IFAD, WFP and FAO, 2012), each year and worldwide, massive quantities of food is lost due to spoilage and damage on the journey to consumers (FAO, 2011; Stuart, 2009; FAO, 2002). In some African, Caribbean and Pacific countries, where tropical weather and poorly developed infrastructure contribute to the problem, wastage can regularly be as high as 40-50%. CSAM studies in Rwanda have measured losses for tomatoes to be 50 to 60% (Chahine 2017, Kitinoja et al 2019). Obviously, one of the major ways of strengthening food security is by reducing these postharvest losses. Along with the renewed focus on investment in agriculture that began in 2008, there is an increasing interest in effective intervention for postharvest loss reduction. The investment required to reduce postharvest losses is relatively modest and the return on that investment rises rapidly as the market value of the commodity increases.

During a research prioritization exercise undertaken on Food Security and Livelihoods sector (FSL) in 2011, postharvest handling was recognized as one of the important areas requiring attention. It is of high importance in the effort to combat hunger, raise income and improve food security and livelihoods when postharvest loss reduction technologies are applied. This white paper highlights the major causes of the postharvest losses for tomatoes in Rwanda and offers a strategy to reduce them. The term “postharvest loss” refers to measurable quantitative and qualitative food loss in the postharvest system. This system comprises interconnected activities from the time of harvest through crop handling, processing, marketing and food preparation, to the final decision by the consumer to eat or discard the food.

Currently, interventions in postharvest loss reduction are seen as an important component of the efforts of many agencies to reduce food insecurity. Postharvest loss is increasingly being recognized as part of an integrated approach to realizing agriculture’s full potential to meet the world’s increasing food and energy needs. Therefore, reducing postharvest losses along with making more effective uses of today’s crops, improving productivity on existing farmland, and sustainably bringing additional acreage into production is critical for facing the challenge of feeding and increased world population.

Postharvest and value addition are integral components of strategies to improve agricultural productivity and linkages between farmers and markets which will help to contribute to food security and economic development of its target population.

This white paper highlights some concepts and problems of postharvest food losses in perishable crops, and critical factors governing postharvest losses and food waste for tomatoes in Rwanda. It covers losses occurring along the entire food chain and highlights some options and alternative ways of preventing and reducing these losses.

2. Critical factors contributing to postharvest loss

2.1. Internal factors

The following sections describe postharvest losses occurring at all stages in the food supply chain from the moment of harvesting, to handling, storage, processing and marketing.

2.1.1. Harvesting

The time of harvesting is determined by the degree of crop maturity and weather conditions. Primary causes of losses at the harvest stage include:

- Absence of an established maturity indices (when to harvest for best quality)
- Low adoption of established indices, as price and distance to market influence adoption.
- Poor weather at harvesting time which affects the operations and functionality of harvesting machines or human labor and usually increases exposure to plant pathogens
- Use of improper harvesting methods such as rough handling and untimely harvesting
- Lack of appropriate and/or poorly-designed harvesting tools, equipment, and harvesting containers.

2.1.2. Pre-cooling

Pre-cooling is the procedure to remove/reduce the field heat before packing or transferring the produce to the storage. The loss at this stage is primarily due to the high cost and lack of availability of pre-cooling facilities, inadequate training on pre-cooling technology at the commercial scale, and lack of information on the costs and benefits of pre-cooling technology.

2.1.3. Transportation

Primary challenges in the transportation stage of the supply chain include poor infrastructure (roads, bridges, etc.), lack of appropriate transport systems, and a lack of refrigerated transport. In Rwanda, roads in rural areas are often rough and unpaved. Also, transport vehicles and other modes of transport, especially those suitable for horticultural crops, are not widely available. This is true both for local marketing and export to other countries. Most producers have small holdings and cannot afford to purchase their transport vehicles. In a few cases, marketing organizations and cooperatives have been able to acquire transport vehicles but cannot alleviate poor road conditions.

2.1.4. Storage

Facilities, hygiene, and monitoring must all be adequate for effective and long-term storage. In closed structures control of cleanliness, temperature, and humidity is particularly important. For tomatoes, cool storage at high relative humidity is required to prevent high levels of water loss. It is also very important to manage pests and diseases, since damage caused by pests (insects, rodents) and molds can lead to deterioration of facilities (e.g. termites in wooden posts) and result in losses in quality and food value as well as quantity.

2.1.5. Grading

Proper packing and packaging technologies are critical in order to minimize mechanical injury of tomatoes during the transit of produce from rural to urban areas. Causes of postharvest losses in the grading stages are lack of national standards and poor enforcement of standards, lack of skills, awareness, and financial resources.

2.1.6. Packing and labeling

After harvest, fresh tomatoes are generally transported from the farm to either a packing house or distribution centre. Farmers sell their produce in fresh markets or in wholesale markets. At the retail level, fresh tomatoes are sold in an unpackaged form, large baskets or are tied into bundles. This type of market handling of fresh tomatoes greatly reduces shelf life if not sold quickly.

2.1.7. Secondary processing

Causes of postharvest loss in this stage include limited availability of suitable varieties for processing, lack of appropriate processing technologies, inadequate commercialization of new technologies and lack of basic infrastructure, inadequate facilities and infrastructure, and insufficient promotion of processed products (Chahine et al 2017).

2.1.8. Biological/Physiological

Biological causes of deterioration include respiration rate, ethylene production and action, rates of compositional changes (associated with color, texture, flavor, and nutritive value), mechanical injuries, water stress, sprouting and rooting, physiological disorders, and pathological breakdown. The rate of biological deterioration depends on several environmental factors, including temperature, relative humidity, air velocity, and atmospheric composition (concentration of oxygen, carbon dioxide, and ethylene), and sanitation procedures. All these factors have been discussed by numerous authors (Kitinoja and Gorny, 1999; Kader, 2002; Gross et al, 2002).

2.1.9. Microbiological

Micro-organisms cause damage to stored foods (e.g., fungi and bacteria). Usually, microorganisms affect only a small amount of the food directly, but they damage the food to the point that it becomes unacceptable.

2.1.10. Chemical

Many of the chemical constituents naturally present in stored foods spontaneously react causing loss of color, flavor, texture and nutritional value. There can also be harmful chemicals such as pesticides or obnoxious chemical such as lubricating oil (Atanda et al., 2011).

2.2. External factors

Factors outside of the food supply chain can cause significant postharvest loss. These factors can be grouped into two primary categories: environmental factors and socio-economic patterns and trends.

2.2.1. Environmental factors

Climatic conditions, including wind, humidity, rainfall, and temperature influence both the quantity and quality of a harvest (FAO, 2002).

2.2.1.1 Temperature

In general, the higher the temperature the shorter the storage life of horticultural products and the greater the amount of loss within a given time period, as most factors that destroy the produce or lower its quality occur at a faster rate as the temperature increases (Atanda et al. 2011).

2.2.1.2. Humidity

There is movement of water vapor between stored food and its surrounding atmosphere until the equilibrium of water activity in the food and the atmosphere. Moist food will give up moisture to the air while dry food will absorb moisture from the air. Fresh tomatoes have high moisture content and need to be stored under conditions of high relative moisture loss and wilting. Dried or dehydrated products need to be stored under conditions of low relative humidity in order to avoid adsorbing moisture to the point where mold growth occurs.

2.2.1.3. Altitude

Within given latitude, the prevailing temperature is dependent upon the elevation when other factors are constant. There is on the average a drop in the temperature of 6.5°C (Atanda et al. 2011) for each kilometer increase in elevation above sea level. Storing food at high altitudes will, therefore, tend to increase the storage life and decrease the losses in food provided it is kept out of direct rays of the sun (FAO, 1983).

2.2.1.4. Time

The longer the time the food is stored the greater is the deterioration in quality and the greater is the chance of damage and loss. Hence, storage time is a critical factor in the loss of foods especially for tomatoes that have a short natural shelf life.

2.2.2. Socio-economic factors

A social trend such as urbanization has driven more and more people from rural areas to large cities, resulting in high demand for food products in urban centers, increasing the need for more efficient and extended food supply chains (Parfitt et al. 2010).

2.3. Critical factors governing postharvest losses and waste in Rwanda

In Rwanda like in other Less Developed Countries (LDCs), the main cause of tomato loss is biological spoilage. Fruit and vegetables lose value very quickly when handled roughly and without cooling and refrigeration.

The causes of food losses and waste in Rwanda like in other low-income countries are mainly connected to financial, managerial and technical limitations in harvesting and postharvest handling techniques, storage and cooling facilities in difficult climatic conditions, and the lack of supporting infrastructure, improved packaging and marketing systems. Given that many smallholder farmers in developing countries live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their livelihoods.

3. Technologies and practices to reduce postharvest losses

3.1. Use of shade

Providing shade for fresh tomatoes or other produce after harvest helps to reduce the pulp temperature and extend shelf life.

3.2. Harvesting tools and equipment

There are more simple tools that can be used to harvest horticultural produce with less damage/bruises, like harvesting clippers, hand-held pruners, a picking basket on a long pole, harvesting bags that can be worn during picking, and color charts for visual determination of proper maturity for tomatoes and various other fruits and vegetable crops.

3.3. Improved packages, containers and packaging materials

Use of improved containers and packages for handling harvested produce, like wooden crates and plastic crates can be used to reduce postharvest loss. Adding a liner (such as paper or plant materials) to a rough container can help to reduce abrasion damage.

3.4. Evaporative cooling

Evaporative cooling can be provided with a few simple tools, including a solar-powered fan, a fiber pad (aspen wood fiber, straw or poly-cellulose fiber) and a digital temperature probe or wall thermometer. Air is cooled by pulling or pushing it through a wet pad, and then the cooled air is used to reduce the temperature of the packed produce.

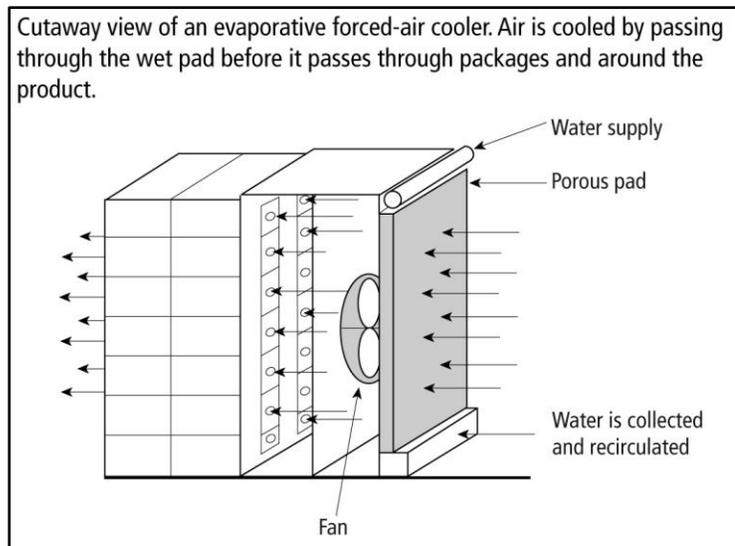


Illustration via UC Davis Postharvest Technology Center.

3.5. Zero Energy Cool Chambers (ZECC)

This technology is made of materials that are easy to find, like low-cost bricks and sand to make an evaporative cooling chamber and includes 6 medium-sized plastic crates to hold stored fresh produce and a thatched shade cover on wooden poles to protect the ZECC from direct sun and reduce heat gain from solar radiation.



ZECC in Mulindi, Rwanda at the PTSC (photo by Bertha Mjawa)

3.6. Small insulated cold room equipped with a CoolBot™ controller

Small cold rooms can be constructed for temporary cool storage of tomatoes, in size of 3m × 4m. The room can be built using the traditional local mud bricks for walls and plastered with cement inside and outside. The inside walls are insulated with two layers of double-bubble reflective sheeting (R6 for each layer) that have been applied to the walls using silicone construction grade adhesive. The height of the room is 2.5m, and the ceiling of the inside of the room is also insulated and has a covered fluorescent light fixture (for food safety). The door is typically a plain wooden door with a heavy layer of insulation on the inside and a plastic strip curtain on the outside. The top of the cold room ceiling is covered with another layer of reflective insulation sheeting, and the room sits under a large metal-roofed shade cover

4. Strategies for reducing postharvest food losses of tomatoes in Rwanda

A systematic analysis of each commodity production and handling system is the logical first step in identifying an appropriate strategy for reducing postharvest losses (Bell et al., 1999; Kitinoja and Gorny, 1999).

It is important to highlight that some varieties of the same crop store better than others. Therefore, to reduce food loss and to achieve maximum shelf-life, only varieties are known to store well should be stored. Processing of tomatoes has the potential to be a loss reduction strategy for Rwanda, based upon assessed local demand for various types of processed products.

Table 1: Reducing losses for tomatoes in Rwanda

Stage in the food system	Description and strategy
Harvesting	<p>Harvesting should be carried out as carefully as possible to minimize mechanical injury such as scratches, punctures and bruises to the crop. The time of the day when harvesting is done also affects produce quality and shelf-life. In general, harvesting during the coolest time of the day (early morning) is desirable; the produce is not exposed to the heat of the sun and the work efficiency of the harvesters is higher. If harvesting during the hotter part of the day cannot be avoided, the produce should be kept shaded in the field to minimize product weight loss and wilting.</p>
Handling	<p>Mechanical injury provides sites for pest attack and increases physiological losses. Therefore, avoid mechanical injury to the crop while handling. Because of their soft texture, all horticultural products (fruits and vegetables) should be handled gently to minimize bruising and breaking of the skin. The skin of horticultural products is an effective barrier to most of the opportunistic bacteria and fungi that cause rotting of the tissues. Breaking of the skin also stimulates physiological deterioration and dehydration. Reducing the number of times, the commodity is handled reduces the extent of mechanical damage.</p>
Sorting and cleaning	<p>Systematic sorting or grading coupled with appropriate packaging and storage, will extend shelf life, maintain wholesomeness, freshness, and quality, and substantially reduce losses and marketing costs. Sorting is done to separate poor produce from good produce, and further classify the good produce based on other quality parameters like size (Bautista & Acedo, 1987).</p>

Stage in the food system	Description and strategy
Packaging	<p>Proper packing is essential to maintain the freshness of the leafy vegetable. Packaging should be designed to prevent premature deterioration in product quality, in addition to serving as a handling unit (Bautista & Acedo, 1987). Use clean, smooth and ventilated containers for packaging. This is a very an important factor in cutting down losses in these crops during harvesting, transportation, marketing and storage. Use containers that are appropriate for the crop.</p>
Transportation	<p>Minimizing losses during transport necessitate special attention to vehicles, equipment, infrastructure, and handling. Load and unload transport vehicles carefully. Use a clean, well-ventilated vehicle covered at the top for transportation. Transport crops during the cool part of the day by driving carefully over smooth roads to minimize damage to the crop. Fresh produce must not be watered prior to loading, as this will lead to decay, rotting, and extensive losses. Major causes of losses are improper handling (rough handling) during loading and unloading.</p>
Storage	<p>Only crops with high initial quality can be stored successfully; it is, therefore, essential to ensure that only crops of the highest quality (mature, undamaged) are stored. Shelf life can be extended by maintaining a commodity at its optimal temperature, relative humidity and environmental conditions. For tomatoes, this is 15 to 18°C and 95% RH.</p>
Processing	<p>Processing is an important value-added activity that stabilizes and diversifies food supplies and creates employment and income opportunities. It can minimize the high perishability problem of tomatoes. Processed products are also more stable, have improved digestibility, and permit a better diet diversity, giving consumers access to a wider choice of products and a wider range of vitamins and minerals. A few potentially useful processing technologies for tomatoes include Drying, salting, canning, bottling, fermenting, and pickling.</p>

5. Training and advocacy needs

5.1 Training programs

The needed training programs to overcome the issues of extreme postharvest losses are those focused on proper harvesting system at fields linked with knowing the proper maturity indices for tomatoes and improved handling at the packing shed; suitable transportation; proper handling and storage at wholesaler stage, and proper handling and storage at the retail stage.

5.2. Advocacy issues

The advocacy for increased investment on both technical and financial sides that will contribute on the reduction of postharvest losses of tomatoes will be explained to government leaders in charge of Agriculture, Non-government organizations working on agriculture and related fields, private institutions and companies engaged in agriculture especially in agribusiness.

6. Conclusions and recommendations

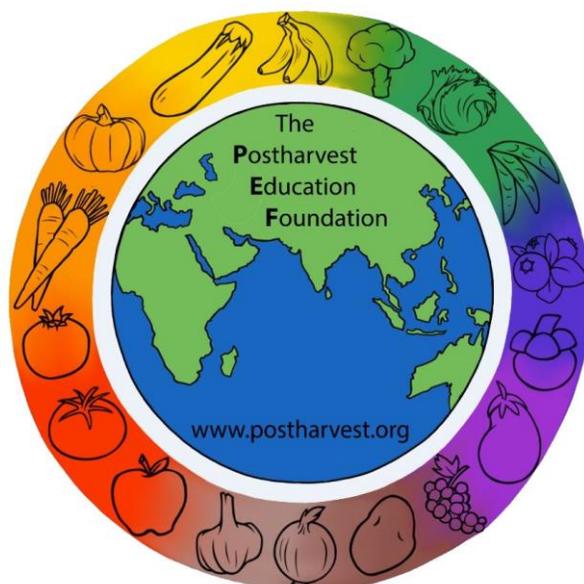
In summary, there is a wide range of technologies available that, if adopted, would enable smallholders and larger producers to improve the quality and quantity of tomatoes during postharvest handling and storage in Rwanda.

The postharvest losses strategy should be better integrated into agricultural programs to provide technical advice and affordable solutions to farmers. For smallholders with few options to invest in improved postharvest practices and technologies, the simplest options, with only minor financial implications, are the use of best practices for harvesting, basic postharvest handling, use of improved containers, storage hygiene, and gentle handling during transport for overall improved postharvest management.

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