Abstract: It is widely recognized that postharvest losses in agriculture have a significant impact on the sustainability and security of the world's food supply. This essay aims to investigate the reasons behind these losses, their effects, and possible solutions. Several factors, such as insufficient infrastructure, inadequate storage facilities, improper handling procedures, and limited market access, are analyzed as potential causes of postharvest losses. The discussion primarily focuses on the negative consequences of these losses on farmers' livelihoods, food supply, and resource utilization, as well as the economic, environmental, and social implications.

The paper suggests several strategies to minimize postharvest losses, including strengthening value chains, promoting appropriate technology for processing and storage, enhancing farmer education and training, and upgrading transportation and storage infrastructure. Additionally, the significance of market processes and policy interventions in reducing losses is highlighted. By reducing postharvest agricultural losses, it is expected that food security, resource efficiency, and sustainable development will be improved.

Keywords: Losses, postharvest, vegetables, fruits.
Post-harvest losses can cause significant financial losses for farmers and the economy as a whole. Farmers lose the labor, materials, and other investments they made to produce the lost crop. These losses also affect farmers' revenues, restrict their capacity to reinvest in their farming operations, and lower output levels. Furthermore, these losses also reduce the amount of products available in the marketplaces.

One of the significant challenges facing agriculture is post-harvest losses. According to the Food and Agriculture Organization of the United Nations (FAO), each year, about one-third or 1.4 billion tons of food produced globally for human consumption is lost or wasted. Fruits, vegetables, roots, tubers, and oilseeds experience the most significant losses.

Here are the step-by-step instructions to reduce post-harvest losses in agriculture:

a) Harvest at the right time: Harvesting crops at the right time can go an extended method in dropping postharvest losses. Make sure to properly time your harvest, as leaving produce in the field for too long can lead to spoilage and damage.

b) Handle produce with care: When handling produce, be careful not to bruise or damage anything in the process. Use appropriate tools to ensure that fruits and vegetables are handled delicately, minimizing any potential damage.

c) Proper storage: Appropriate storage conditions are crucial for reducing post-harvest losses. Keep produce in a cool, dry, and well-ventilated area to minimize the growth of mould and bacteria. Avoid storing produce in direct sunlight or areas prone to high temperatures.

d) Maintain equipment: Make sure to regularly inspect and maintain equipment, such as refrigeration and cooling systems. These are crucial for keeping produce fresh and reducing spoil.

The word "system" signifies a moving, collection total of reasonably interconnected roles or processes inside a specific scope of action. The word "chain" or "pipeline" indicates the useful sequence of several processes but then tend to disregard their complex interaction.

Fig. 1. The Food Supply Chain.

2 Amount of Postharvest Losses for Fresh Fruit and Vegetables
of a final product and greens due to physiological and metabolic damage are closely linked and can be investigated as the primary and secondary reasons for losses.

2.1 Losses in Quality
Measuring the loss of quality in food, such as loss of taste, nutritional value, caloric content, and consumer satisfaction, is more challenging than measuring the quantity of food. This varies significantly between different cultures and countries, affecting the choices available to consumers and the efficiency required while shopping. For example, it is easier to remove unwanted materials from food products before advertising them in underdeveloped countries than in wealthy countries, where there may be an excessive emphasis on aesthetics. Vitamin C, an essential antioxidant that protects cells from cancer-causing substances, is one of the factors that contribute to the quality of food. It can be found in reasonable amounts in fruits and vegetables.

2.2 Losses in Quantity
Around one-third of the food produced annually, which is 1.3 billion tons, goes to waste in both affluent and developing countries. In middle-class and wealthy nations, many foods still acceptable for human consumption are routinely rejected. Developing nations experience over 41% of food losses at the retail and buyer levels, while postharvest and processing phases are the cause of food losses early on in the supply chain (Table 1). 35–45% of grains and vegetables are lost or rejected after leaving the farm. In wealthier nations, postharvest losses in vegetables and fresh fruit range from 5 to 40%, whereas in poorer nations, the losses exceed 30%. New products and fruits are lost during transportation from the earliest agricultural manufacturing to the final consumption (Table 1). The first table highlights how losses in the rural manufacturing sections of three industrialized nations exceed all levels, often due to merchants having high demands. Food delivery businesses in these countries generate significant waste since customers return 16–35% of their orders. However, in developing nations, losses in the fresh produce chain are more important than those in processing and packing. This can be attributed to seasonality, which results in unsalable gluts, and the need for reducing perishable foods in hot and humid climates. Agriculture-related manufacturing processes also result in significant losses, likely due to a lack of technology, funds, and knowledge.

2.3 Effect on The Climate and Environment
The process of agricultural manufacturing can have serious environmental consequences, including deforestation, soil depletion, and contamination of subsurface water due to pesticide residue. Additionally, the transportation, cooling, and disposal of harvested crops require more energy. There is a need for more sustainable practices in the food manufacturing process to reduce the impact on the environment. Postharvest losses can also have a negative impact on farmers' incomes and exacerbate food insecurity as described in Table 1. Interestingly, weather variations and postharvest losses can be addressed through the use of weather-smart farming techniques and reducing food waste. This can lead to a decrease in greenhouse gas emissions and an increase in sustainable output. Food waste and losses can harm the ecosystem by wasting resources such as soil, water, electricity, biodiversity, and carbon emissions. There is no financial penalty for producing meals that will not be consumed, leading to unnecessary carbon dioxide emissions. From a biological perspective, food loss and waste lead to wasteful water-land usage and unnecessary greenhouse gas emissions. Approximately 25% of all water used for agriculture, or 174 m² of water intake annually, is linked to food loss and waste.
Table 1. Illustrations of food waste and loss.

<table>
<thead>
<tr>
<th>Processes</th>
<th>Loss in %</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td></td>
<td>- Harvest losses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Losses throughout transport, handling, and storage</td>
</tr>
<tr>
<td>Processing and packaging</td>
<td></td>
<td>- Losses during processes and packaging</td>
</tr>
<tr>
<td>Distribution and market</td>
<td></td>
<td>- Losses and wastes during distribution and in wholesale and retail sectors</td>
</tr>
<tr>
<td>Consumption</td>
<td></td>
<td>- Consumer waste: domestic, food service sector, etc.</td>
</tr>
</tbody>
</table>

3 Key Essentials of The Post-Harvest Structure for Non-Perishable Goods

3.1 Harvest

- Appropriate pre- and post-harvest management practices can help vegetables, fruits, and grains stay fresh for a longer time. Pre-harvest handling refers to the measures taken before fruit harvesting to enhance its quality and prolong its shelf life during post-harvest storage.

After harvest, it is essential to preserve fruit quality to prevent it from deteriorating before it reaches the consumers. There are various pre- and post-harvest techniques available, each having a unique impact. Depending on the area or processing goal, the same technique can have different results. Therefore, it is necessary to scrutinize the critical outcomes from prior relevant research to determine the appropriate handling conditions shown in Table 3.

This examination can help establish pre- and post-harvest handling protocols that ensure fruit safety and quality.

3.2 Transportation

- When transporting crops, it is important to do so carefully to avoid any loss of produce. However, quantifying the extent of fruit loss during transportation can be challenging. Some African countries have reported losses of more than 20% in tomatoes and other fruits during transportation alone. If there are no adequate transportation options available, there may be significant post-harvest losses. During transportation, fresh produce is susceptible to mechanical damage or bruising, which can harm the plant tissue.

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Table 1.

<table>
<thead>
<tr>
<th>Country</th>
<th>Agricultural output (%)</th>
<th>Storage &amp; handling (%)</th>
<th>Processing &amp; packaging (%)</th>
<th>Supply (%)</th>
<th>Final consumption (%)</th>
<th>Overall (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia &amp; Europe</td>
<td>20.5</td>
<td>2.0</td>
<td>10.0</td>
<td>19.5</td>
<td>56.0</td>
<td></td>
</tr>
<tr>
<td>Oceania &amp; North America</td>
<td>20.4</td>
<td>2.0</td>
<td>12.0</td>
<td>28.0</td>
<td>66.0</td>
<td></td>
</tr>
<tr>
<td>Developed Asia</td>
<td>10.8</td>
<td>2.0</td>
<td>8.0</td>
<td>15.0</td>
<td>43.0</td>
<td></td>
</tr>
<tr>
<td>Sub Saharan Africa</td>
<td>10.9</td>
<td>2.6</td>
<td>18.0</td>
<td>6.0</td>
<td>66.0</td>
<td></td>
</tr>
<tr>
<td>North America, West &amp; Central Asia</td>
<td>18.1</td>
<td>1.1</td>
<td>11.6</td>
<td>1.0</td>
<td>72.0</td>
<td></td>
</tr>
<tr>
<td>Latin America</td>
<td>21.1</td>
<td>1.2</td>
<td>2.0</td>
<td>10.0</td>
<td>72.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.
3.3 Post-Harvest drying

The process of producing crops, particularly those related to grains, is a long and tedious one. Harvesting is the first critical step, followed by drying and proper storage. It is essential to dry agricultural products to decrease their natural moisture content and maintain their quality and shelf life. Therefore, careful drying is necessary to control the moisture level of the product [20-24].

3.4 Separating/Threshing

Sorting and separating are essential steps in crop production. Threshing is a crucial process used to separate the grain from the panicles. It can be done mechanically using threshers, animal power, or by hand (trampling, beating). In poor countries, manual threshing is the most popular method. However, excessive hitting, spilling of grain, and inadequate separation of grain from chaff are some primary causes of losses during the threshing process [9-11, 24-27].

3.5 Storage

The process of preserving agricultural products in their natural state for future use, such as for consumption, fuel, or raw materials, is known as storage. Storage involves various techniques to collect and protect different types of plants, depending on their intended use. The primary objectives of storage are to ensure a year-round supply of food, prevent food spoilage due to pests and diseases, ensure seed availability for the upcoming farming season, maintain a consistent supply of goods, obtain better prices during off-season periods, and ensure the safe delivery of raw materials to industries. With a good storage facility, farmers can increase their land use for cultivation [9-11, 28].

3.6 Processing

Food preservation is an essential process that enables food to be stored and consumed after harvest. The treatment of food ensures that it is safe for human consumption (Table 4). Food processing plays a crucial role in enhancing the complexity and variety of meals, providing consumers with more options. However, extreme threshing or hulling can lead to significant grain losses, especially during rice hulling, resulting in grain damage, lesions, and splits as described in Table 4 and Table 5 in details [9-11, 28].

3.7 Selling/Marketing

Marketing is the final and most critical stage in the post-harvest process. It starts with producing a farm product that can be sold and encompasses all aspects of the institutional and economic aspects of the market structure, relying solely on technical and financial considerations. It also includes pre- and post-harvest activities such as assembly, grading, storage, transportation, and distribution. These activities are all necessary for the successful marketing of agricultural products as described in Table 4 and Table 5 in details. (National Commission on Agriculture, 1976) [9-11, 28].
4 Conclusion

Post-harvest losses continue to be a significant challenge for the agriculture industry. Despite advancements in technology and improved methods, a considerable amount of crops are still left unused. These losses worsen poverty and food insecurity, resulting in financial harm to farmers and the entire value chain. To tackle post-harvest losses, a multidimensional strategy is needed that includes improved agricultural practices, increased access to market information, better infrastructure, improved storage and transportation solutions, and focused farmer education and training. Additionally, cooperation among stakeholders such as farmers, government agencies, researchers, and private sector entities is crucial to implementing effective solutions and reducing the burden of post-harvest losses. Addressing this issue will lead to greater food security, reduced waste, increased revenue, and a more sustainable agriculture system.

References


