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Post-Harvest Loss Assessment in Key Crops

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Post-harvest losses have considerable effects on the amount and quality of farm produce between harvest and consumption. Post-harvest losses take place at different stages of harvesting, drying, storage, and transportation. Farmers' revenue and food supply decrease through quantitative and qualitative losses. The causes, measurement, and managing of losses in major crops, government actions, and capacity building to promote food security and sustainable agriculture are emphasized in this bulletin.

1. Introduction

Post-harvest losses (PHLs) are a serious concern in world agriculture. They are the deterioration in quantity and quality of food products from harvest to consumption. In most developing nations, including India, 20–30% of the total agricultural produce is lost at the post-harvest stage because of improper handling, inadequate infrastructure, absence of awareness, and lack of storage and processing facilities. Reducing post-harvest losses is not only crucial to food security, but it also helps to enhance farmers' income and alleviate environmental pressures from surplus production. This bulletin provides a detailed analysis of post-harvest losses in major crops and the interventions to reduce them.

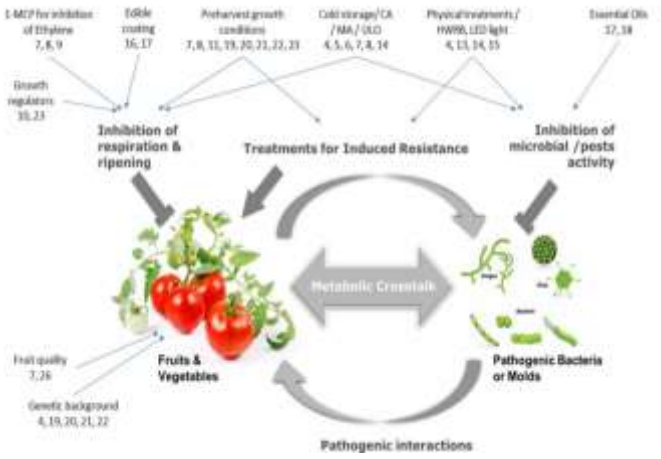
2. Definition of Post-Harvest Losses (PHLs)

Post-harvest losses are quantifiable reductions in the amount and quality of farm products during the different phases after harvesting, such as handling, storage, processing, packaging, transport, and marketing. Post-harvest losses have great implications on food security, farmers' revenues, and the efficient use of resources.

Quantitative losses are the actual loss of volume or weight of the produce. This can be a consequence of mechanical damage during threshing or harvesting, spillage while in transit, pest attack, or microbial rot while in store. Grains, for example, can be consumed by rodents or lost through poor packaging and handling.

Qualitative losses, however, imply the reduction of the nutritional, market, or consumer quality of the produce. These consist of the loss of taste, texture, appearance, color, or nutrient quality due to causes such as mold development, biochemical reaction, insect infestation, or exposure to inappropriate temperatures and humidity.

Collectively, these losses lower the marketability and utility of food crops and may account for as much as 30% of output in certain crops. Efficient post-harvest handling is critical to lower such losses and provide consumers with safe, healthy, and high-quality food while enhancing profitability for producers.



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3. Phases of Post-Harvest Loss

Post-harvest losses are cumulative and take place at every step in the chain from farm to consumer. The major stages are:

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1. Harvesting: Losses arise due to too early or too late harvesting, incorrect methods, or mechanical damage, resulting in shattering or bruising.

2. Threshing/Shelling: Ineffective processes can lead to grain breakage or loss while separating produce from plant material.

3.Drying: Insufficient drying results in excessive moisture content, promoting susceptibility to fungal invasion, spoilage, and insect infestation.

4.Cleaning and Grading: Inadequate grading lowers market value, while improper removal of contaminants jeopardizes food safety and quality.

5.Packaging: Poor packaging in improper or damaged containers results in spilling, contamination, and quality degradation.

6.Transportation: Crude handling, overloading, and poor road conditions result in physical damage and spoilage, particularly in perishables.

7.Storage: Insects, rodents, moisture, and microbial activity cause major losses in both quantity and quality.

8.Marketing and Processing: Delays, poor infrastructure, and inadequate processing techniques further degrade produce quality.

4. Causes of Post-Harvest Losses

Cause	Examples
Mechanical Damage	Bruising, cuts during harvesting, threshing
Biological	Pest infestation (insects, rodents), microbial spoilage
Chemical	Oxidation, discoloration, nutrient degradation
Environmental	Humidity, temperature fluctuations
Infrastructural	Poor roads, lack of cold chains, inadequate storage
Human Factors	Lack of skill, poor packaging, unscientific drying

5. Assessment of Post-Harvest Losses in Key Crops

Post-harvest losses are very variable across crop types because of variation in physical structure, perishability, storage needs, and handling. The following evaluation tabulates the estimated losses, principal causes, and feasible interventions for reducing post-harvest losses in broad crop groups.

A. Cereals

1. Rice (Oryza sativa)

- Total Losses: 8–12%
- Broad Causes: Shattering during harvest, incorrect threshing practices, excessive grain moisture at storage, and insect or rodent attack at storage.
- Assessment: Losses are greatest during threshing (about 3%) and storage (about 4%). Better harvesting timing and drying methods are crucial.

2. Wheat (Triticum aestivum)

- Total Losses: 6–10%
- Causes: Delayed harvesting, poor drying, and rodent infestation in unscientific godowns.
- Assessment: Efficient drying and application of aerated godowns can reduce these losses

B. Pulses

1. Chickpea (Cicer arietinum)

- Total Losses: 6–9%
- Causes: Insect infestation, particularly by Callosobruchus (bruchid beetles), and excess moisture during storage.

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- Assessment: Encouraging seed treatment and adoption of hermetic storage (e.g., metal bins or PICS bags) is advisable.

2. Pigeonpea (Cajanus cajan)

- Total Losses: 7–10%
- Causes: Shattering of pods at maturity and fungal infection during slow drying.
- Assessment: Adoption of mechanical threshers that minimize breakage and proper timing of drying can minimize losses.

C. Oilseeds

1. Mustard (Brassica juncea)

- Total Losses: 10–15%
- Causes: Shattering of mature pods, inadequate post-harvest handling, and poor packaging practices.
- Assessment: Early harvest and use of pod shatter-resistant varieties can minimize losses.

2. Groundnut (*Arachis hypogaea*)

- Total Losses: 12–18%
- Causes: Drying and storage mold growth, and aflatoxin contamination.
- Assessment: Dry in clean surfaces and post-harvest curing are essential practices.

D. Fruits and Vegetables

1. Tomato (*Solanum lycopersicum*)

- Total Losses: 25–30%
- Causes: Handling bruising, premature ripening in storage, and fungal rot.
- Assessment: Utilizing ventilated plastic crates and determining cold chains can minimize deterioration.

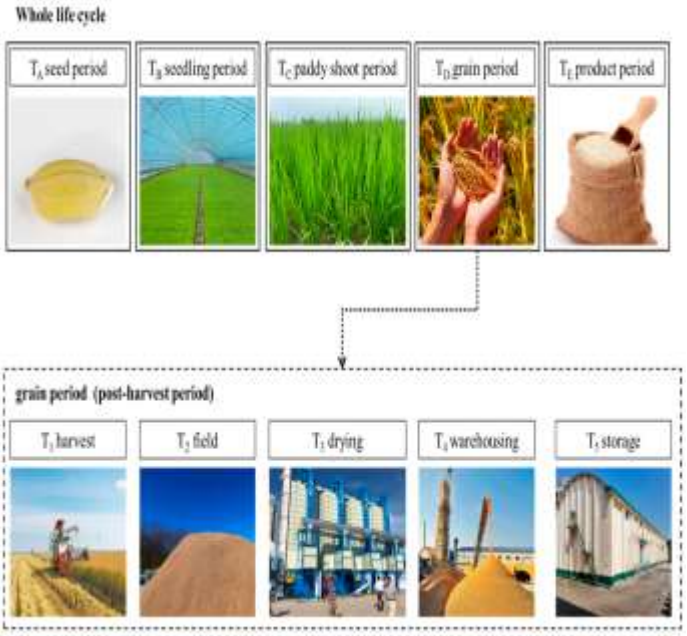
2. Mango (*Mangifera indica*)

- Total Losses: 30–35%
- Reasons: Sap burn, early ripening, mechanical injuries, and improper packing.
- Assessment: Pre-cooling, ripening chambers, and cushioning in packaging should be practiced.

E. Root and Tuber Crops

1. Potato (*Solanum tuberosum*)

- Total Losses: 10–20%
- Reasons: Sprouting, greening due to light, microbial rot, and bruising during handling.
- Assessment: Controlled storage at refrigeration and anti-sprouting treatment can greatly minimize post-harvest damage.



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6. Methods of Loss Assessment

Post-harvest losses estimation is very important to prepare effective strategies to reduce them. Several scientific and participatory techniques are employed to estimate both quantitative and qualitative losses in various crops and at different stages of the post-harvest supply chain. The most important methods are described below:

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A. Empirical Field Surveys

Empirical field surveys are among the most popular techniques to measure post-harvest losses under actual farm conditions. These include:

- Sampling of crops at various post-harvest stages such as harvesting, threshing, drying, storage, and transport.
- Comparison between planned yield (on the basis of pre-harvest estimates) and actual amount harvested or sold.
- Visual checks and weight measurement are done to arrive at physical loss, contamination, or quality losses.

B. Storage Experimentation

In this approach, crops are stored in a simulated environment under controlled conditions to monitor the nature and magnitude of losses over time. Researchers evaluate:

- Infestation by pests and rodents
- Bacterial and fungal spoilage
- Impacts of storage time, temperature, and humidity

It assists in the determination of key factors causing storage loss and the testing of effectiveness of new storage technologies.

C. Remote Sensing and ICT Tools

Current technologies like drones, GIS mapping, IoT sensors, and mobile apps are now employed to measure post-harvest loss at scale. These technologies can:

- Detect grain quality, moisture, and storage conditions
- Remotely monitor crop condition and loss
- Enable real-time decision-making and interventions

D. Participatory Rural Appraisal (PRA)

This qualitative method involves active participation of farmers in identifying, mapping, and estimating post-harvest losses. Farmers share their experiences, and tools like focus group discussions, matrix ranking, and seasonal calendars are used.

7. Post-Harvest Management Techniques

1. Harvesting

Harvesting is the initial and most crucial operation in post-harvest management. It must be executed at the appropriate stage of physiological maturity to maximize quality and yield. Premature harvesting leads to immature produce, but delayed harvesting can cause losses from shattering, fungal infection, or pest infestation. Mechanical injuries are minimized by using sharp, clean equipment to avoid bruising and opening wounds, which otherwise lead to post-harvest spoilage.

2. Drying

Drying is necessary to minimize the moisture level of produce to a storage-safe level. Sun drying on clean, raised platforms is the conventional method used extensively by farmers. But solar dryers provide a better and controlled process of drying, particularly in unfavorable weather conditions. The moisture content should be monitored prior to storage—the recommended moisture levels are around 12% for cereals and 10% for pulses. Satisfactory drying avoids mold development, aflatoxin infection, and infestation from insects.

3. Cleaning and Grading

Cleaning and grading are necessary after drying to enhance both market value and storage quality. Cleaning eliminates dust, foreign particles, and diseased or damaged produce. Grading consists of sorting the produce according to size, color, and quality requirement. It not only beautifies the produce for the consumer but also fetches higher prices in the market.

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4. Packaging

Effective packaging keeps the produce safe from physical injury, pest attack, and climatic conditions. Jute bags, HDPE bags, or PICS bags are used for cereals and legumes. Ventilated crates and cushion boxes are used for fruits and vegetables. Proper labeling and handlings during packing also help minimize losses.

5. Storage

Scientific storage is important to maintain produce for extended periods. It comprises the utilization of proper storage units such as metallic bins, moisture-proof packets, or ventilated godowns. The internal climate should be checked on a regular basis for temperature and humidity. Fumigation or natural pest control should be applied to avoid damage due to insects, rodents, and fungi. Sanitation and aeration within storage units are also necessary.

6. Transportation

Transport is a weak link stage where much loss is experienced due to careless handling, bad roads, and overloading. To prevent losses, fruit should be transported in appropriate containers—plastic boxes for perishables, properly packed bags for grains. Cars should be clean, ventilated, and preferably temperature-controlled for delicate items. Eliminating long waits and undue loading/unloading minimizes physical damage and spoilage.

8. Government Interventions

1. FSSAI Rules for Food Safety Standards

FSSAI is responsible for guaranteeing food quality throughout the supply chain. FSSAI prescribes legal requirements for the handling, processing, packaging, labeling, and storage of food. Through enforcement of hygiene and safety practices, FSSAI reduces risks of contamination during post-harvest operations and ensures consumers' trust in farm products.

2. National Food Security Mission (NFSM)

The NFSM was initiated to raise the cultivation of rice, wheat, pulses, and other staples and incorporate post-harvest interventions. These involve assistance for mechanized threshers, seed processing, drying yards, and pest control measures. The mission tries to minimize post-harvest losses while maintaining food availability at the country level.

3. Gramin Bhandaran Yojana

This scheme encourages the establishment of scientific storage facilities in rural regions through capital investment incentives. Farmers and cooperatives can set up warehouses and godowns to store produce in a secure manner, avoiding post-harvest losses due to moisture, infestation, or rot. The scheme also allows farmers to store produce and sell it at a later point when prices are better in the market.

4. Operation Greens

Originally centered on Tomato, Onion, and Potato (TOP) crops, Operation Greens aimed to stabilize prices and foster value chain development. It facilitates cold storage, transport, and processing units so that post-harvest losses in such perishables are minimized. Financial assistance is offered for establishing integrated value chains from production up to consumption.

5. PM Formalization of Micro Food Processing Enterprises (PM-FME)

Under the Atmanirbhar Bharat Abhiyan, this scheme facilitates the modernization and formalization of micro food processing units. It aids small-scale entrepreneurs in terms of subsidies, capacity development, branding, and packaging. By enhancing food processing facilities as well as procedures, the PM-FME scheme indirectly impacts post-harvest losses as it increases shelf life and marketability.

9. Extension and Capacity Building 1. Training Programs for Farmers

Successful post-harvest management starts with the training of farmers. Regular training programs for best practices like scientific drying techniques, proper moisture management, and safe storage are conducted by extension agencies. These programs highlight how reducing post-harvest losses can help improve income and food security.

2. Utilization of New Technologies

Farmers are exposed to solar dryers, which facilitate hygienic and effective drying of pulses and grains. They are also trained in grain protectants and fumigation methods to avoid pest infestation and spoilage at storage.

3. KVK demonstrations

Krishi Vigyan Kendras (KVKs) are field-level interfaces for demonstrating post-harvest technology. Demonstration on a live basis enables farmers to comprehend handling practices, control of moisture, and equipment operation.

4. Provision of Tools and Kits

Extension services also assist farmers by providing moisture meters, hermetic storage bags, and packaging kits to enable them to adopt efficient and safe post-harvest practices.

10. Recommendations and Future Directions

- Embrace community storage facilities with scientific ventilation
- Support farmer cooperatives for mutual infrastructure
- Use digital tools such as mobile apps for post-harvest advisory
- Facilitate R&D in biodegradable packing and non-chemical storage
- Market linkages for timely procurement and processing

11. Conclusion

Post-harvest losses in major crops are a prime hurdle to attaining food security, import dependency reduction, and doubling farmers' income. With a systematic evaluation and emulation of advanced post-harvest technologies, we can reduce these losses considerably. A multi-stakeholder strategy that involves farmers, scientists, policy-makers, and extension workers is critical in redressing this challenge effectively. Not just a technological challenge, but also a social and economic imperative, post-harvest losses can be minimized. Increasing awareness, building capacity, and equipping farmers with the necessary tools and skills can make the agricultural industry more productive and resilient.

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