FOOD FORWARD NDCs

Reducing post-harvest food loss at storage, transport, and processing levels

Overview

Food loss is generally defined as the decrease in quality or quantity of food resulting from decisions and actions of food supply chain actors, not including food retailers or consumers. **Post-harvest food loss** refers to the loss of food across the supply chain from harvesting up until (but not including) the retail and consumption stages. Traceability and lack of data, as well as a lack of clarity about where food loss occurs, presents a significant challenge for addressing the problem.

Estimates around food loss vary widely; the FAO estimates that 13.8% of food produced globally is lost between the farm up to but excluding the retail stage. Food loss and waste **costs** an estimated USD 2.6 billion annually and represents an estimated USD 1 trillion in annual economic losses. Minimising global post-harvest food loss is important for **climate change mitigation and adaption**, as well as for addressing related global development issues such as food insecurity and poverty.

Concrete measures to implement

Measures to tackle post-harvest food loss range from specific technological solutions in storage, transport and processing to sectoral policy interventions. They can include:

- Storage measures, such as:
    - Investment in cold storage facilities. It is estimated that, globally, **526 million tons** of perishable foods were spoiled in 2017 because of lack of refrigeration.
    - Promotion of storage technologies such as **hermetic storage** (i.e., sealed, waterproof and airtight storage systems such as **metal silos**).
    - Investment in **warehouse receipt systems**, where food from farms is taken to modern and centralised storage areas.
    - Establishment of **aggregation centers** for storing and preserving food at multiple temperature levels.
    - Promotion of **field storage clamps**, a low-cost storage alternative for crops such as potatoes, turnips, sugar beets and others. Clamp is a compact heap, mound or pile of material and formed by excavating a shallow rectangular depression in the field to create the base of the clump, and straw or old hay can then be used to cover the top, protecting it from rain erosion.
- Distribution and transportation measures, including:
    - Promotion of improved packing practices and packaging technologies by:
        - Establishing national standards with proper enforcement for food packaging.
        - Building awareness of the most effective packing techniques/technologies while promoting the development of skills necessary to implement these behaviours and technologies.
        - Providing financial resources (e.g., subsidies) to actors along the supply chain who could benefit from implementing these practices and technologies.

- Promotion of **transportation materials**, such as natural and synthetic fibre sacks and moulded plastic boxes, that can safely transport crops to distant markets. This is especially relevant for high-perishability crops (e.g., crops with high moisture content).

- Processing and handling measures, such as:
  - Promotion of food processing methods/technologies that can extend shelf life of products, such as drying, smoking, salting, fermenting, pickling, canning and irradiation.
  - Promotion of **Dry Chain** technologies, which dry products before storage and maintain seed dryness through hermetic packaging.
  - Promotion of **proper handling practices** along the supply chain that can reduce contamination of products.

- Cross-cutting measures, such as:
  - Use of **phase change materials (PCMs)** to maintain products within a desired temperature range, thus maintaining the quality of the products as they move along the supply chain. PCMs range from more natural and/or organic materials (e.g., gelatin) to more synthetic materials (e.g., polystyrene). PCMs can reduce emissions associated with cold chains by increasing the energy efficiency of storage and distribution operations, as well as by reducing food loss. (See ***Reducing emissions from food storage, cold chains, transport and processing***).
  - Promotion of food monitoring and tracing technologies to reduce supply chain inefficiencies and improve knowledge of where food losses are occurring along food supply chains. **Measures** to build more efficient and intelligent value chains include: vertical integration; expanded contracting from retailers and wholesalers; **computer-based modelling and monitoring systems** that optimize transportation scheduling and routes; and funding methods to lessen information constraints and bottlenecks.
  - Creating incentives for companies to measure food loss and waste and implement **policies to address food loss and waste**; for example, through success cases demonstrating possible cost savings, company reporting and disclosure to investors, or third-party monitoring.

- Boost responsible investments in inclusive value chains, including processing and distribution, at local, regional, national and international levels, to promote sustainable, resilient food value chains and reduce inequalities. Specific emphasis should be place on areas with prevalent multidimensional poverty with the goal to respect, promote and monitor labor rights and mitigate against abuse, sexual exploitation and harassment.

- Broader policy measures, such as:

  - Adoption of legally-binding food loss and waste **reduction targets.**
  - Adoption of a **national strategy for reducing food loss**, including programmes, policies, practices, incentives and/or related measures to influence the actions of farmers, companies, consumers and political bodies.

Enabling governance measures

Effective implementation of measures to address post-harvest food loss should be guided and incentivised through national governance and policy reforms.

The following governance measures can facilitate the deployment of food loss reduction measures:

- Address prices for agricultural produce that are too low, since low prices contribute to high food loss dynamics at or near the farm level. Food loss could be partially reduced through implementing Fair and Remunerative Price (FRP) schemes.
- Assess whether quality standards increase food losses due to grading out. Quality standards should be appropriate to local production, and "imperfect foods" markets should be supported wherever possible.
- **Reform agricultural policies** (e.g., introduce market-based measures or subsidies) to enable the design and implementation of improved technologies for food storage, processing and transportation.
    - For example, policies that support R&D and innovative business models can unlock investments into more energy-efficient **cold chains** methods.
- Raise awareness and train supply chain actors on the best available technologies for reducing food loss, and also on how available subsidy programmes can be deployed to reduce barriers to new technologies uptake.
- Improve **transportation** infrastructure (e.g., roads, bridges) to enable efficient transportation and distribution of products. In addition, improve responsible investment in logistics, technologies, services and supply chains by adopting territorial approaches and strengthening local, regional, national and international market connectivity and trade.
- Provide incentives for the production, import and use of transport solutions that explicitly offer food waste reduction solutions, such as refrigeration.
- Bring global practitioners together to create knowledge sharing and exchange best practices on strategies for post-harvest food loss reduction. This could be facilitated through **global conferences** co-organised by relevant global institutions (e.g., FAO, UNEP, IFAD, WFP) and supported by national governments. These could provide a key platform for building capacity to achieve global food loss reduction goals (e.g., through development of a facilitating mechanism for SDG 12.3 and other SDGs related to food loss).

Tools and MRV systems to monitor progress

FAO Food Loss App (FLAPP)

An open-source app that uses scientific research and crowd-sourced data from farmers to quickly measure food loss. It provides accessible information on food loss (e.g., video advisories) for farmers, producer associations, companies and cooperatives that can inform decision-making.

Link: https://flapp.fao.org/users/sign_in

Global Farm Loss Tool

Assists farmers around the world to measure surplus food and post-harvest food loss, in order to coordinate with buyers to utilise more of what food is grown.

Link: https://www.globalfarmlosstool.org/

Country-level food loss databases and reports

Country-level food loss databases and reports, such as those prepared by the UK's Waste & Resources Action Programme (WRAP).

Link: https://wrap.org.uk/taking-action/food-drink/sectors/farmers-growers

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WRAP's Data Capture Sheet

For example, WRAP's Data Capture Sheet provides sector-specific guidance on food loss quantification methods. It is intended for common use by food businesses in the United Kingdom, but it can be applied worldwide.

Link: https://wrap.org.uk/resources/tool/food-loss-and-waste-data-capture-sheet

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FAO Food Loss Index (FLI)

FAO Food Loss Index (FLI) methodology measures and monitors progress on SDG Target 12.3, providing important information on food loss trends and directing interventions towards where they will have the most impact.

Link: https://www.fao.org/3/CA2640EN/ca2640en.pdf

International Food Policy Research Institute (IFPRI)

International Food Policy Research Institute (IFPRI) food loss methodology can be used to measure quantities of food lost, as well as reductions in food quality, along the value chain.

Link: https://mpra.ub.uni-muenchen.de/80378/

FAO Technical Platform

FAO Technical Platform on the Measurement and Reduction of Food Loss and Waste includes a variety of publications (such as case studies, reports and discussion papers) addressing food loss.

Link: https://www.fao.org/platform-food-loss-waste/resources/publications/en

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FAO methodology

FAO methodology for conducting food loss analysis case studies. The methodology focuses on revealing and analysing the multidimensional causes of losses in selected food supply chains, identification of critical loss points and recommendation of feasible food loss reduction solutions and strategies. An introduction to the methodology is available via an e-learning course.

Link: https://www.fao.org/3/az568e/az568e.pdf

The Food Loss and Waste Protocol

The Food Loss and Waste Protocol (FLW Protocol) provides tools for measuring food loss/waste, including the FLW Value Calculator and the FLW Standard. The FLW Standard enables a wide range of actors (such as companies, countries and other organisations) to measure how much food loss/waste is created and identify where it is occurring, thus informing targeted food loss/waste reduction efforts.

Link: https://www.wri.org/initiatives/food-loss-waste-protocol

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The African Post-Harvest Losses Information System (APHLIS)

The African Post-Harvest Losses Information System (APHLIS) is an international effort to collect, analyse and disseminate data on post-harvest losses of cereal grains in sub-Saharan Africa. The APHLIS calculator algorithm combines post-harvest loss data from academic research with contextual, observational data from local experts.

Link: https://www.aphlis.net/en?form=collecting_new_data

GIZ's Rapid Loss Appraisal Tool (RLAT)

GIZ's Rapid Loss Appraisal Tool (RLAT) provides a methodology for assessing food loss hotspots. It has been used to assess food loss in multiple food value chains, including white rice in Nigeria.

Link: https://wocatpedia.net/images/5/55/GIZ_RLAT_toolbox.pdf

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Life cycle assessments (LCA)

Life cycle assessments (LCA) can serve to evaluate the environmental impacts of agri-food chains, including food loss.

Link: https://link.springer.com/chapter/10.1007/978-94-024-1016-7_19

Ex-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)

Ex-Ante Carbon-balance Tool for Value Chains (EX-ACT VC) is a method to measure quantities of food loss across the entire value chain, standardising losses at each level of the value chain and aggregating all levels to calculate an overall estimate of food that does not reach the retail level.

Link: https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en/

Climate change mitigation benefits

Use of improved food storage technologies that reduce food loss/waste avoids greenhouse gas emissions from food that would otherwise go to landfill, as well as from the reduced need to produce food:

- Globally, 8 to 10 percent of greenhouse gas emissions are associated with food loss and waste.
- A reduction of food losses could lead to a significant decrease in land-use change, which would reduce emissions associated with primary production (i.e., emissions generated via land-use change).
- For more information on measures to reduce supply chain emissions, see *Reducing emissions from food storage, cold chains, transport and processing*.

Other environmental benefits

- Reduced land use change: Pressure to convert natural ecosystems for agriculture can be reduced, as post-harvest losses could translate to more food available for sale and consumption, while also improving income and economic well-being for households and businesses.
- Reduced air pollution: Food waste is diverted from landfills where it may be burned.

Adaptation benefits

- Improved food safety and quality.
- Decreased pressure on natural resources such as **land and water**. Lost and wasted food consumes one **quarter of all water used by agriculture annually, and the area of cropland used to produce the total amount of food that is ultimately lost or wasted is equivalent in size to China.**
- Improved storage technology can reduce post-harvest food loss while increasing **grain supply and food security** without wasting other resources such as land, labour, water and other inputs.
- Improved smallholder farmer incomes and livelihoods: Access to affordable and effective storage technologies can motivate farmers to store their grains for longer and obtain higher prices rather than selling immediately after harvest when grain supply is higher. This can also help reduce farmers' exposure to price risks.

Other sustainable development benefits

- SDG 1 (No poverty): improving income from food production.
- SDG 2 (Zero hunger): improving food availability.
- SDG 12 (Responsible consumption and production), in particular SDG 12.3 to "by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses."
- SDG 13 (Climate action): avoided emissions from food loss.
- SDG 8 (Decent work and economic growth): generating **employment and income opportunities** through processing and marketing, as well as reducing labor costs in developing countries.
- **Less direct SDG benefits** could fall under:
    - SDG 6 (Clean water and sanitation)
    - SDG 10 (Reduced inequalities)
    - SDG 11 (Sustainable cities and communities)
    - SDG 14 (Life below water)

    - SDG 15 (Life on land)
- Progress on other SDGs could ultimately lead to reduced food loss/waste, including:
    - SDG 5 (Gender equality)
    - SDG 7 (Affordable and clean energy)
    - SDG 9 (Infrastructure, industry, and innovation)
    - SDG 17 (Partnerships for the goals)

Main implementation challenges and potential negative externalities and trade-offs

- Technologies such as improved packaging may require additional costs for labour and capacity building to ensure proper use. Without the availability of tailored financial solutions, access to finance to deploy these interventions could serve as a barrier.
- Relatively high up-front costs of some of the post-harvest solutions for producers and other supply chain actors could translate into higher food prices for consumers. However, this price pressure may be counterbalanced by improved food quality and higher supply.
- Some post-harvest loss interventions may not currently be financially viable in developing countries due to high degree of seasonality of produce, which means that solutions like cold-storage facilities are not used year-round.
- Cold storage facilities use considerable amounts of energy, so expanding their use will likely lead to increases in emissions unless powered by clean energy sources.
- Increased use of packaging to reduce food losses could lead to increased GHG emissions associated with production of packaging materials, as well as increased plastic waste.
- Reduced food losses in post-farm stages of supply chains may result in farmers seeing reduced demand for their products and thus lower incomes. However, this may be counterbalanced by higher prices attained for higher quality, fresh produce.

Measures to minimize challenges and address potential negative externalities and trade-offs

- Additional costs from the purchase and use of improved technologies could be offset through subsidies or support from wealthier governments or institutions.

- Investing in cold storage facilities and storage systems powered by **renewable energy and/or with more efficient energy usage**. For more information, see ***Reducing emissions from food storage, cold chains, transport and processing***.
- Increased food prices as a result of food loss interventions could be offset through subsidies and/or implementation of social programmes targeted towards low-income consumers.
- In terms of reducing the impacts of increased use of packaging, **LCAs can be implemented to assess the entire packaging-product system** and evaluate the environmental impacts of packaging interventions. For example, in some cases it may be possible to replace single-use packaging/storage materials with reusable packaging/storage materials.

Implementation costs

- Up-front investment and annual operating costs are generally high for cold storage facilities, making them less accessible for developing countries due to **barriers to accessing finance**. Local private sector actors could contribute considerable funds for investment, and they could be actively encouraged to invest and support sustainable business models.
- **Metal silos** can have a high initial cost, presenting an obstacle for adoption by smallholders. Community-level silos could be an economic alternative, as the cost per unit of grains decreases with increases in the size of silos. The maintenance cost is very low for silos, which can compensate for the high initial cost to some extent.

Intervention in practice

- GIZ supported a wide range of food loss reduction technologies within their Green Innovation Centers. In Viet Nam, for example, the introduction of cold storage and hot water treatment (HWT) for mangos has led to an overall reduction in post-harvest losses of 84 percent, from 30 percent lost to less than 5 percent lost. Moreover, it has increased the mangos' shelf life from 7 to 21 days.
- Uganda developed a national strategy to reduce post-harvest losses in grain supply chains as part of the larger Ugandan National Food Waste Strategy. The development of the strategy was informed by FAO's food loss analysis methodology as well as multi-stakeholder consultations. Key strategic issues and feasible solutions for reducing post-harvest losses of grains in Uganda can be applicable to other national contexts in Africa.
- The FAO's Technical Cooperation Programme has introduced improved bulk packaging materials (e.g., reusable crates), as well as guidance for improved post-harvest management practices, to reduce food losses in fresh produce supply chains in various South Asian countries. The intervention significantly reduced food losses, led to economic benefits and improved overall welfare for farmers, retailers and consumers. It also led to environmental benefits through the replacement of single-use plastic bags for transport with reusable crates.
- The FAO pioneered a technique to smoke and dry fish, the FAO-Thiaroye Technique (FTT). This technique can be used regardless of climatic conditions and increases the range of species that can be processed, strengthening fish processors' resilience to climate variability. It can result in a near-complete elimination of food losses in the processing stage while enhancing the quality and safety of the products. For example, in Côte d'Ivoire, the technique is estimated to save USD 1.7 million annually through reduced losses of smoked fish products.

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