



THE FRUIT AND VEGETABLE INDUSTRY SERIES



FRUIT AND VEGETABLES SCHEME



OECD-COLEAD Fruit and Vegetables Industry Series

Session 5 - Innovations and technologies to reduce food waste and losses

Wednesday 11 October 2023 – 08:00-09:30 UTC / 10:00-11:30 CET

[Online \(Zoom\)](#)

English-French interpretation available

1. Context

Food losses and waste (FLW) refers to the decrease in the quantity or quality of food throughout the supply chain, from production and post-harvest handling to processing, distribution, and consumption.

Food loss, on the one hand, refers to the decrease in quantity or quality of food resulting from decisions or actions by food suppliers (excluding retail providers and consumers). Food waste, on the other hand, is the decrease in quality and quantity of food due to decisions or actions by delivery services and other aggregators, food service providers, and consumers. Food loss usually occurs post-harvest and up to but not including retail level while food waste usually occurs at retail and forward stages.¹

FLW remains a critical and widespread issue with significant social, economic, and environmental consequences. FLW affects the whole food chain, from farmers to retailers to consumers, jeopardising the efficiency and sustainability of the food system. While FLW occurs, millions of people worldwide suffer from hunger and malnutrition. Redirecting even a fraction of the lost or wasted food could help alleviate global food insecurity.

The substantial amount of food that is lost and wasted every year has severe implications in terms of food and nutrition security, economic losses but also negative impacts on the environment, use of land and water resources, biodiversity, climate change² and pollution.

According to FAO's latest report on The State of Food Security and Nutrition in the World (SOFI),³ the number of people affected by hunger rose to as much as 828 million in 2021, an increase of about 46 million since 2020 and 150 million since 2019. In all, an estimated 3.1 billion people do

¹ Swati Malhotra IFPRI. International Day of Zero Waste: [Reducing loss and waste in fruit and vegetable supply chains](#). 30th March 2023.

² FAO. [Sustainable and circular bioeconomy in the climate agenda: Opportunities to transform agri-food systems](#). 2022.

³ FAO, IFAD, UNICEF, WFP and WHO. 2023. [The State of Food Security and Nutrition in the World 2023. Urbanization, agri-food systems transformation and healthy diets across the rural-urban continuum](#). Rome, FAO.



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not have access to a healthy diet.⁴ Meanwhile, according to FAO's [State of Food and Agriculture \(2019\)](#) report, around 14 percent of the world's food (valued at \$400 billion per year) continues to be lost after it is harvested and before it reaches the shops, while UNEP's [Food Waste Index Report](#) shows that a further 17 percent of our food ends up being wasted in retail and by consumers, particularly in households. According to FAO estimates, the food that is lost and wasted could feed 1.26 billion hungry people every year.

At European Union (EU) level, the total food waste measured in 2020 nearly reached 59 million tonnes of fresh mass. Household food waste represented more than 31 million tonnes of fresh mass, with a 53 percent share of the total. The second sector in terms of share (20 percent) was processing and manufacturing, where the amount of measured food waste was nearly 12 million tonnes of fresh mass. The remaining share, a quarter of the total food waste, was from primary production sector (6 million tonnes, 11 percent share towards the total amount of food waste), restaurants and food services (more than 5 million tonnes, 9 percent share towards the total) and retail and other distribution of food sectors (more than 4 million tonnes, 7 percent share).⁵

– FLW in fruit and vegetables

Highly perishable fruit and vegetables have the highest rates of loss and waste, usually within the range of 40–50 percent.⁶

Fruit and vegetables are the most widely consumed and also complex foods to manage in the agri-food supply chain due to their short shelf life. The leading causes of loss generation in the processing stage are human errors, poor management or technical failures.⁷ A critical challenge is the tremendous perishability of fruit and vegetables, particularly in tropical climates, where refrigeration, food processing and sustainable packaging may be critical contributions in creating environmental and public health value.⁸

The barriers and drivers behind the adoption of the strategies to be pursued to minimise the losses in the processing stage have not been comprehensively researched.⁹

Packaging of perishable fruit and vegetables can limit losses,¹⁰ but also contributes to environmental pollution and greenhouse gas emissions.¹¹ More understanding is needed of the production, processing and distribution options and trade-offs, and of food loss and waste, specifically for fruit and vegetables in different contexts.

When food is lost or wasted, all the resources that were used to produce this food - including water, land, energy, labour and capital - go to waste. In addition, the disposal of food loss and waste in landfills leads to greenhouse gas emissions, contributing to climate change.¹²

⁴ FAO, IFAD, UNICEF, WFP and WHO. 2022. The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Rome, FAO. <https://doi.org/10.4060/cc0639en>

⁵ EUROSTAT. [Food waste and food waste prevention estimates](#). Data extracted in March 2023.

In 2020, the first year of the COVID-19 pandemic, around 131 kilogrammes (kg) of food waste per inhabitant were generated in the EU. Households generated 53 % of food waste, accounting for 70 kg per inhabitant. The remaining 47 % was waste generated upwards in the food supply chain.

⁶ FAO (2019) Moving forward on food loss and waste reduction. The State of Food and Agriculture.

⁷ *Ibid.*

⁸ Mason-D'Croz D, Bogard JR, Sulser TB et al (2019) Gaps between fruit and vegetable production, demand, and recommended consumption at global and national levels: an integrated modelling study. *Lancet Planet Health* 3(7):e318–e329

⁹ Francesco Facchini, Bartolomeo Silvestri, Salvatore Digiesi, Andrea Lucchese, [Agri-food loss and waste management: Win-win strategies for edible discarded fruits and vegetables sustainable reuse](#). *Innovative Food Science & Emerging Technologies*, Volume 83, 2023, 103235, ISSN 1466-8564.

¹⁰ Wohner B, Pauer E, Heinrich V, Tacker M (2019) Packaging-related food losses and waste: an overview of drivers and issues. *Sustainability* 11(1):264

¹¹ Crippa M, Solazzo E, Guizzardi D, Monforti-Ferrario F, Tubiello F, Leip A (2021) Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food*:1–12

Yates J, Deeney M, Rolker HB, White H, Kalamatianou S, Kadiyala S (2021) A systematic scoping review of environmental, food security and health impacts of food system plastics. *Nature Food* 2(2):80–87

¹² UN. [Reducing food loss and waste: Taking Action to Transform Food Systems](#). 2023.

Factors contribution to the FLW

Several factors contribute to the continued prevalence of FLW resulting in resulting in losses during production, processing, storage and distribution and consumption.¹³

At production level:

- Specific weather conditions which cause sun damage to fruit, and wind or hail damage
- Poor management and decision making on water management, planting practices and timing, of harvesting and crop monitoring
- Incorrect pesticide use and application of pesticides, herbicides or fertilisers
- Pests and diseases

Handling and storage:

- Harvested food eaten by pests or food degraded by fungus or disease
- Fruit discarded due to bruising during picking
- Crops sorted out postharvest for not meeting cosmetic standards
- Crops left behind in fields due to poor mechanical harvesting or drops in prices
- Lack of market access due to insufficient knowledge of the demand and prices, overproduction and oversupply

Processing and packaging:

- Food sorted out as not suitable for processing, discarded in processing plants because damaged or dented due to the transport or processing activities
- The dependency of small- and medium-scale farmers on third-party packhouses is costly and can contribute to food wastage
- Inadequate storage and cooling infrastructure

Distribution and market:

- Poor transportation facilities, delays at ports, and high cost of transport are major contributors to food waste, resulting in losses during storage and distribution. The challenges of exporting fresh produce according to strict cold-chain regulations and tight time schedules have resulted in entire shipping containers of food being wasted because of bottlenecks at ports.¹⁴
- Food sorted out due to quality
- Safe food disposed because of going past sell-by date before being purchased
- Food spilled or damaged in market

Consumption:

- Large quantities of wholesome edible food are often unused or left over and discarded from household kitchens and eating establishments
- Behavioural causes due to retailers and consumer preferences who reject food based on cosmetic considerations, leading to food waste
- Insufficient information on the multiple consequences of FLW and insufficient policies and regulations to reduce FWL and consumer habits. Foods that are close to, at or beyond the "best-before" date are often discarded by retailers and consumers.

¹³ World resources Institute. REDUCING FOOD LOSS AND WASTE Setting a Global Action Agenda KATIE FLANAGAN, KAI ROBERTSON, AND CRAIG HANSON.

[reducing-food-loss-waste-global-action-agenda_0.pdf \(wriorg.s3.amazonaws.com\)](https://www.wri.org/s3.amazonaws.com/reducing-food-loss-waste-global-action-agenda_0.pdf)

¹⁴ Fourie J, Engelbrecht K, Govender P, Pillay P and W Engel. 2023. [Food loss and waste in farming: Insights from South African farmers](#). WWF South Africa, Cape Town, South Africa.

2. Policy frameworks supporting the reduction of FLW

Global attention to FLW reduction is reflected in the 2030 Agenda for Sustainable Development, particularly in the Sustainable Development Goal (SDG) 12: Responsible Consumption and Production which seeks to “ensure sustainable consumption and production patterns.” Target 12.3 of that goal aims to “by 2030, halve the per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses.”¹⁵ Food waste reduction has significant implications for several of the UN SDGs such as SDG2 (Zero hunger), SDG3 (Improving food security and nutrition), SDG12 (Responsible consumption and production), SDG13 (Climate action and reducing greenhouse gas emissions), SDG14 (Life below water) and SDG 15(Life on land).

In January 2018, the European Commission released a new set of initiatives as part of the 2018 Circular Economy Package.¹⁶ In 2023, the European Commission revised the circular economy monitoring framework and added new indicators on material footprint and resource productivity - to monitor material efficiency and consumption footprint – to monitor if EU consumption fits within planetary boundaries.

The EU Platform on Food Losses and Food Waste was established in 2016, bringing together EU institutions, experts from the EU countries, international organisations and relevant stakeholders selected through an open call for applications. The Platform aims to support all actors in defining measures needed to prevent food waste; sharing best practice; and evaluating progress made over time.¹⁷

Several European countries are measuring food waste or loss within their borders and putting in place incentives to reduce food waste and recycle it. In February 2016, France adopted a law on fighting food waste that meant supermarkets were forbidden to destroy unsold food products and were compelled to donate it instead. This law constituted the starting point of the fight against food waste through banning its destruction and facilitating donation. Since the adoption, its scope has been extended further, as defined through new decrees and laws.¹⁸

In 2016 Italy passed a law against food waste, aimed at cutting one million tonnes of the estimated five million wasted every year. The law is meant to make it easier for food retailers to donate food to charities and food banks. Businesses won't face sanctions if they give away food past its sell-by date and will get tax cuts proportionate to the amount of food they give away.¹⁹

In February 2019 the German government released its national strategy on food waste. To mobilise the public, the government has launched the Zu Gut für die Tonne (Too Good for the Bin) programme, with a website offering background information and useful tips for everyday life, and an app with more than 700 cooking ideas including recipes from top chefs.

In the Netherlands, the Dutch Taskforce, a coalition of companies across the food supply chain, as well as national and local authorities, was launched in January 2017, in collaboration with the initiative Samen tegen Voedselverspilling (together against food waste). Different organisations and institutions jointly work to arrive at innovative solutions to prevent and reduce food waste throughout the food chain. The

¹⁵ SDG target 12.3 has two components, Losses and Waste that should be measured by two separate indicators.

Sub-Indicator 12.3.1.a - Food Loss Index: The Food Loss Index (FLI) focuses on food losses that occur from production up to (and not including) the retail level. It measures the changes in percentage losses for a basket of 10 main commodities by country in comparison with a base period. The FLI will contribute to measure progress towards SDG Target 12.3.

Sub-Indicator 12.3.1.b - Food Waste Index: A proposal for measuring Food Waste, which comprises the retail and consumption levels is under development. UN Environment is taking the lead on this sub-indicator.

UN Sustainable Development Goals. Goal 12: Ensure sustainable consumption and production patterns. <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>

¹⁶ European Commission. [Circular economy action plan](#).

¹⁷ [EU Platform on Food Losses and Food Waste](#).

¹⁸ Zero Waste Europe. [France's law for fighting food waste Food Waste Prevention Legislation](#). November 2020.

¹⁹ Zero Waste Europe. [Italy's law for donation and distribution of food and pharmaceuticals to limit food waste](#).

Ministry of Agriculture launched in 2020 a consumer campaign on date marking (difference between 'use by' and 'best before' dates).²⁰

In 2023, Spain's government adopted a law that requires all businesses in the food supply chain to prepare a waste prevention plan based on a food waste audit. Food businesses and food banks will have to form partnerships in order to define all the aspects of the donation, such as collection, transportation and storage. The main purpose of this new Decree is to make all packaging on the market recyclable by 2030 and, where possible, reusable.²¹

In order for cities and local governments to efficiently and effectively recycle food waste, actions taken at the household level to separate it out are essential - recycling schemes only work when waste is properly sorted at the source. Judiciously used, regulations can spur businesses and households to reduce food waste and better manage it when it is time to recycle.

3. Actions to minimise FLW

Actions include addressing on-farm pests and diseases, pre-maturity harvesting due to climate shocks or seasonal gluts, and appropriate post-harvest handling, transport and storage. The use of hail and shade netting to prevent storm and sun damage can protect production for example. In middle-/high-income countries, quality grading standards set by retailers should be addressed.²²

Post-harvest solutions range from improved practices in crop and animal production and investment in storage, to the adoption of technical innovations in transport, processing and packaging. Postharvest handling and technologies offer opportunities to reduce food losses and waste, particularly in the context of Africa, where cold chains and refrigeration are largely non-existent and seasonality leads to gluts and shortages of perishable goods. Many of these losses can be prevented through proper training and better handling of goods, the adoption of appropriate tools or technologies, sound policies and marketing-related improvements. More investment is also needed in developing and making available solar driers and agroprocessing equipment such as shellers and de-pulpers.²³

Improved labelling and better understanding of 'use-by' and 'best-before' dates. There is need for better understanding from consumers on expiry dates and what they mean to prevent food waste. 'Best before' refers to food quality, and the food can often be consumed safely after that date, while 'use by' refers to food safety, and foods should NOT be eaten after that date.

Awareness raising and information campaigns. Public awareness campaigns and educational initiatives can inform consumers, businesses, and policymakers about the environmental, economic and social consequences of FLW and the steps they can take to reduce it. The UN Food and Agriculture Organization (FAO)²⁴ advises consumers to buy "ugly fruit and vegetables," so perfectly good and nutritious food does not get wasted. Wilting produce can be used in soups, and fruit past their peak can become smoothies and encourages consumers to eat or freeze leftovers before they go bad. Business - both those operating within the food chain and others with a large "food footprint" (large cafeterias, for instance) - can conduct food waste audits to determine how and why they waste food and identify opportunities to improve their performance.

²⁰ European Parliament. EPRS | European Parliamentary Research Service [Reducing food waste in the European Union](#). 2020.

²¹ COSLaw.eu. [Spanish requirements for packaging and packaging waste](#). January 2023.

²² Global Panel (2018). [Preventing nutrient loss and waste across the food system: policy actions for high-quality diets](#). Policy brief no. 12.

²³ Stathers T, Holcroft D, Kitinoja L, Mvumi BM, English A, Omotilewa O, Kocher M, Ault J, Torero M (2020) A scoping review of interventions for crop postharvest loss reduction in sub-Saharan Africa and South Asia. *Nat Sustain* 3:821–835.

²⁴ FAO. What governments, farmers, food businesses – and you – can do about food waste. [Toolkit: Reducing the Food Wastage Footprint](#). 2013.

Implementing **advanced technologies** such as blockchain, internet of things (IoT) and artificial intelligence (AI) can enhance supply chain efficiency, improve storage and transportation conditions (cold chain and refrigeration), and reduce losses. Technologies beyond the farm (food preservation technologies, food packaging and smart labelling, consumer-oriented smart devices or consumer and food-sharing apps) can further reduce FLW, enhance food safety, and enable value addition.²⁵

Many technologies contribute to reducing food waste such as innovations in refrigeration, thermal preservation, biological and bio-chemical preservation, solar-powered cold storage, active packaging, waste-to energy, composting, recycling and upcycling. Mobile applications also provide solutions for smart labelling, dynamic pricing, product traceability, intelligent redistribution, and storage.²⁶ Cold chains are key to reduce food loss, especially the ones close to the centres of production or markets which benefit farmers.

Innovative packaging solutions (longer shelf life). Another sizable challenge technologists are working to solve is how to prolong the shelf life of perishable fruit and vegetables in their existing environments.

More research and development is needed towards packaging solutions to extend the shelf-life of food, thereby reducing enzymatic activity and the growth of microorganisms and preventing moisture loss and decay. Thermal processing has been widely employed in the food industry for food safety assurance and extending product shelf-life by inhibiting or deactivating microorganisms.²⁷

Regulations and standards on aesthetic requirements for fruit and vegetables could stand to be revised. Some supermarkets have already begun relaxing their standards on fruit appearance, selling "misshaped" items for a reduced price and helping raise consumers' awareness that odd-shaped does not mean bad.

Food processing has the potential to contribute to the reduction of postharvest losses, enhancement of food safety and quality, creation of diversity, and stabilization of the food supply, reducing the prevalence of seasonal hunger and improving market access. When crops have cosmetic damage, such as marks, bruising or discolouration, and are not suitable for the buyers' market, they can be repurposed by juicing or pulping, freezing, drying or preserving. Food processing can generate jobs and increase the retention of organic waste in farming areas. Even simple processing methods can transform perishable crops into a range of convenient, storable, value-added products, which meet the needs of expanding markets.²⁸

Recycling. Rather than disposing waste in landfills, innovations in the use residual food as animal feed and use as compost and/or energy can be found.

4. Way forward

FLW persists as a global challenge with far-reaching consequences, impacting economies, ecosystems, and food security. Tackling this issue requires a concerted effort from all sectors of society, including consumers, businesses, governments, and international organisations. By raising awareness, implementing innovative technologies, enacting effective policies, and fostering

²⁵ FAO. 2022. The State of Food and Agriculture 2022. [Leveraging automation in agriculture for transforming agrifood systems](#). Rome, FAO.

²⁶ UNEP DTU Partnership and United Nations Environment Programme (2021). [Reducing Consumer Food Waste Using Green and Digital Technologies](#). Copenhagen and Nairobi.

²⁷ Caminiti AM et al (2011) Impact of selected combinations of non-thermal processing technologies on the quality of an apple and cranberry juice blend. Food Chem 124:1387–1392

Stoica ML, Borda D, Alexe P (2013) Non-thermal novel food processing technologies. An overview. J Agroalimnt Process Technol 19(2):212–217

²⁸ Muyonga J (2014) Processing as a driver of agricultural development: the case of Makerere University Food Technology and Business Incubation Centre, Uganda.

collaboration, we can work toward a future where FLW is significantly reduced, ensuring that the world's resources are used more sustainably, and the global food system becomes more equitable and resilient.

Reducing FLW can be a significant lever for broader improvements of food systems – towards improved food security, food safety, food quality, sustainability, and for increased efficiency.

Governments should create and enforce regulations that promote sustainable practices, provide tax incentives for food donation, and establish clear guidelines for food labelling and expiration dates.

Supporting smallholder farmers with better post-harvest management practices and access to markets can reduce losses at the production level.

Collaboration among stakeholders in the food supply chain, including farmers, producers, distributors, retailers, and consumers, is crucial to tackle FLW comprehensively.

Losses can be prevented through proper training and better handling of goods, the adoption of appropriate tools or technologies, sound policies and marketing-related improvements.²⁹ More investment is also needed in developing and making available solar driers and agroprocessing equipment such as shellers and de-pulpers.

5. Promoting increased knowledge about the fruit and vegetable industry

In the context of the UN 2021 International Year of Fruits and Vegetables, the COLEAD³⁰ through its FFM SPS and FFM Plus programmes (funded by the EU and OACPS) and the OECD Fruit and Vegetables Scheme³¹ of the Trade and Agriculture Directorate launched an online series highlighting the significance of the fruit and vegetable sector and its various dimensions.

The main objectives of the series are:

- Sharing knowledge of markets and operators working in local and export fruit and vegetable markets
- Understanding the fruit and vegetable sector contribution to sustainable production and consumption
- Promoting fruit and vegetable contribution to healthy and nutritious diets
- Showcasing successes and innovations of private sector operators across the European Union and Southern countries and lessons learned.

²⁹ (Stathers et al. 2020)

³⁰ As a private sector (not-for-profit) organisation, COLEAD's purpose is to support activities that aim to increase the agricultural sector's contribution to achieving the Sustainable Development Goal. <https://www.colead.link/>

³¹ OECD Fruit and Vegetables Scheme promotes international trade through the harmonisation of implementation and interpretation of marketing standards. <https://www.oecd.org/agriculture/fruit-vegetables/>

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English-French interpretation available

PROGRAMME

Moderator: José Brambila-Macias, Programme Manager, Trade and Agriculture Directorate, Agricultural Codes and Schemes, OECD

10:00-10:10 Welcome and introduction

- Isolina Boto, Head of Networks and Alliances, COLEAD

10:10-10:30 Food losses and waste in the F&V sector

This panel will share information on trends, policies and innovations on food losses and waste in the F&V sector.

- Niels Gøtke, Head of Division, Danish Agency for Science, Technology and Innovation

Q&A session

10:30-11:20 Views from the operators

This panel will feature experiences from operators in the F&V industry who implement innovations to cope FLW.

- David Kat, VP Business Development, Wasteless, The Netherlands
- Diana Michael, Chief Finance Officer, East Africa Foods, Tanzania
- Talash Huijbers, Founder and CEO, Insecti Pro, Kenya

Q&A session

11:20-11:30 Conclusion and way forward

- Isolina Boto, Head of Networks and Alliances, COLEAD



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