

Sustainable Strategies to Reduce Food Loss and Waste across the Supply Chain: A Forward-Looking Perspective

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Food waste is considered a significant problem that affects every part of the production process of food and concerns the stakeholders in the food supply chain, including wholesalers, producers, farmers, and consumers. Acquiring worldwide food sustainability and security, and well-recognized food waste management, are indispensable factors to ensure that people, families, and nations have ongoing access to food. This editorial discusses the different definitions of food loss and waste (FLW), consequences and impact of FLW with some statistical insights and causes, and provides efficient actions that should be considered by consumers, community, government, private sectors, data collectors, and researchers for decreasing FLW and thus improving the security of food and nutrition worldwide.

Keywords: Food supply chain; food security; Sustainable food systems; food loss and waste; waste reduction.

INTRODUCTION

- **Food Loss vs. Food Waste: Multiple Definitions, One Global Challenge**

A standardized definition of FLW did not exist until recently [1, 2]. Previously, both academic literature and policy texts, employed a wide array of disparate definitions [2]. This gap lies in the method of analyzing FLW, including the accurate measurement at national, regional, and international levels. To address this conceptual ambiguity, the Food and Agriculture Organization (FAO) defines FLW as "decrease in quantity or quality of food along the food supply chain" [3]. Under this framework, food losses occur throughout the supply chain from post-harvest up to the retail stage, in contrast, food waste primarily manifests during retail and consumption [1,4]. Other reports have broadened the concept to include food losses, both quantitative and qualitative, before harvesting [2]. On the other hand, United Nations Environment Programme (UNEP) provided a more precise definition of food waste in the Food Waste Index Report 2021 to involve both edible food and non-edible portions that exit the human food supply chain within the retail, food service, and household sectors [2,5]. Ultimately, FLW is driven by a multitude of interrelated factors that can arise at any stage of the supply chain, as summarized in Chart 1 [6].

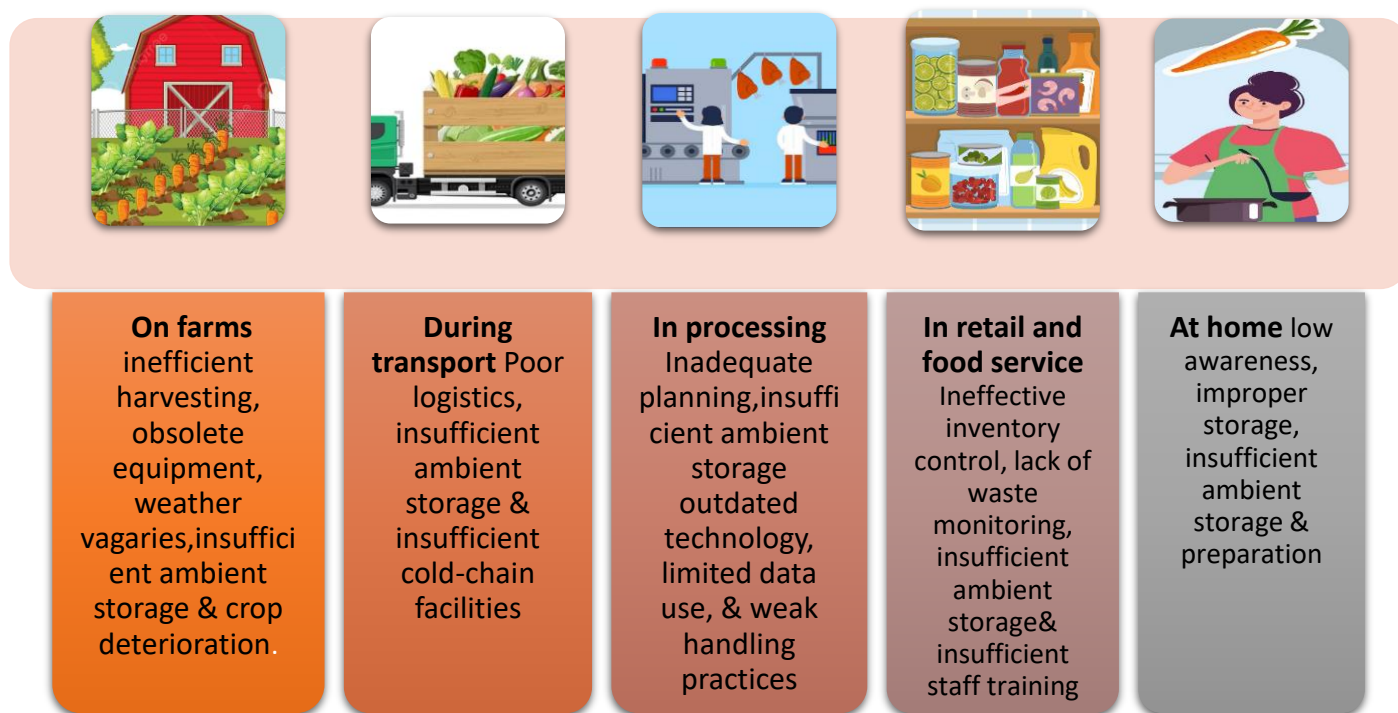


Chart 1: Main factors contributing to food loss and waste across the food supply chain [6].

• Statistical Insights and Consequences of Food Loss and Waste (FLW)

Globally, approximately a third of the food produced worldwide is wasted [4,7]. More specifically, according to the latest 2024 UNEP statistics, about 13.2 % of the food produced worldwide is lost within the supply chain between harvest and the point before retail. While an additional 19 % is wasted at the retail, food service, and household levels [8].

Based on the UNEP Food Waste Index Report, stark disparities exist in household food waste globally. The Maldives (207 kg/capita) and Syria (172 kg/capita) record the highest annual rates. Conversely, nations with high-confidence data like Russia (33 kg/capita) and Mongolia (41 kg/capita) exhibit significantly lower footprints. Meanwhile, Japan and the UK serve as successful models, reducing per capita food waste by 31% and 18%, respectively, through targeted policy interventions [9].

This staggering waste stands in stark contrast to global food insecurity; while an estimated 222 million tons of food are wasted annually in the developed world alone [7], approximately 2 billion people worldwide struggle to access nutritious meals, and over 820 million suffer from chronic hunger. Consequently, FLW carries grave moral and ethical ramifications [2].

Action-Driven Approaches to Mitigate FLW

Global efforts to curtail FLW have gained significant momentum, with novel

frameworks highlighting actionable, data-driven, and collaborative interventions [2]. In this context, both the public and private sectors play a pivotal role in implementing proactive measures and innovation to narrow the FLW issue [4]. These action-driven approaches to mitigating FLW are comprehensively summarized in Table 1.

Table 1: Action-Driven Approaches to Mitigate FLW [2].

Approaches	Implementation Details
Intensifying efforts toward practical application	In order to achieve SDG 12.3, which calls for halving per capita global food waste at the retail and consumer levels and reducing food losses by 2030, national, regional, and international leaders must demonstrate a greater commitment to action.
Using global knowledge to localize the issue	Data gaps hide FLW differences across regions. Low-income countries lose food mainly in production and processing, while high-income countries waste more at retail and consumption. Urbanization is increasing waste in developing regions, requiring tailored solutions.
Advancing food loss and waste data and intelligence	Data collection and analysis efforts should be intensified, extending to weather prediction systems to uncover the root drivers of FLW."
Promoting scientific inquiry and innovation	Research should focus on efficient machinery, integrating scientific, technological, and behavioral perspectives. Scaling digital monitoring and analytical tools is essential to accelerate tracking and effective solutions
Strengthening community involvement	Food recovery organizations, youth activists, and public awareness campaigns promote responsible consumption.
Strengthening the role of government	Public organizations should implement fiscally sustainable national initiatives and set attainable reduction targets.
Promoting private-sector partnerships	Commercial value is provided by FLW reduction through advanced packing and weather-proofed storage, accelerated by financial support."
Increasing cooperation across sectors	Effective FLW minimization requires long-term collaborations between governmental, corporate, and social groups.
Expanding the agenda at international forums	FLW minimization should be a primary priority for international conferences and summits.
Increasing public communication	Public personalities and targeted media outreach may mainstream sustainable food policies and change public opinions

It is anticipated that future climate variability and fluctuations will become more frequent and intense, which may potentially be exacerbating in post-harvest losses. Droughts and floods are examples of extreme weather phenomena that can devastate livestock and crops as well as harm the infrastructure of supply chains. Unpredictable rains can hinder drying procedures, result in losses in harvested produce, and foster the growth of infections that depend on moisture [10]. In addition, elevated temperatures

and increased humidity are expected to result in a rise in outbreaks of transboundary pests and diseases, potentially causing significant losses in agricultural, animal, aquaculture, and forestry goods [10]. Conversely, wasted food can also contribute to climate change; methane, a potent greenhouse gas 27–30 times more potent than carbon dioxide, is released when food is allowed to decompose in landfills. In the atmosphere, methane retains solar heat for about 12 years. It accounts for roughly 20% of greenhouse gas emissions worldwide. When taking into account the greenhouse gas emissions from the usage of natural resources, the impact to climate change is astounding. Enforcing an effective food waste treatment system has been shown to prevent around 11% of the world's greenhouse gas emissions [11].

In conclusion, FLW can arise at any stage of the food supply chain, with FLW denoting interconnected yet conceptually distinct issues influenced by diverse definitions in international literature. The consequences of FLW extend far beyond physical depletion, generating serious economic, environmental, and social challenges that directly threaten global food and nutrition security. Despite significant regional and value-chain variations, it also underscores the imperative need for coordinated, evidence-based, and scalable solutions. Advancing toward meaningful FLW minimizing relies on unified measurement standards, technological and behavioral innovation, and collaborative, stage-specific actions that prioritize sustainability and equitable food-system resilience.

List of Abbreviations

FLW	Food loss and waste
FAO	Food and Agriculture Organization
UNEP	United Nations Environment Programme

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A.N.O.: Conceptualization, Visualization, Writing – Review & Editing, Supervision. **S.H.:** Visualization, Writing – Original Draft, Writing – Review & Editing. **All authors** read and approved the final version of the manuscript.

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Conflicts of Interest

Both the authors serve as a member of the journal's Editorial Board. To ensure transparency and avoid any potential conflict of interest, the author was excluded from all editorial handling and decision-making related to this manuscript. The peer-review process and editorial assessment were managed independently by an assigned editor.

The authors declare no conflicts of interest regarding this manuscript.

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Declaration on Generative AI and AI-assisted Technologies

AI-assisted tools were used solely for grammar checking and language editing. No AI tools were used to generate, rephrase, or alter the scientific content of this manuscript. The authors retain full responsibility for the accuracy, originality, and integrity of the presented work.

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