

MITIGATING FOOD LOSS AND WASTE IN INDIAN SUPPLY CHAINS: A PATHWAY TOWARDS SUSTAINABLE DEVELOPMENT

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Abstract:

Food loss and waste (FLW) represent critical barriers to achieving global food security, sustainable livelihoods, and environmental sustainability. This review examines the extent, causes, and implications of FLW across agri-food supply chains, with particular emphasis on its impact on vulnerable populations and developing economies. The study analyses key stages of the supply chain, from production and post-harvest handling to distribution and consumption, where significant losses occur due to infrastructural gaps, market inefficiencies, and consumer behaviour. It further explores the socio-economic consequences of FLW, highlighting how its reduction can enhance farmer incomes, improve resource utilization, and strengthen food system resilience. Current strategies for FLW mitigation, including technological innovations, improved storage and logistics, policy frameworks, and multi-stakeholder engagement, are critically reviewed. The paper underscores the vital role of FLW reduction in advancing the Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 12 (Responsible Consumption and Production). The review concludes that an integrated, system-based approach to FLW reduction is essential for ensuring sustainable livelihoods and long-term food security?

Keywords: Food loss, food waste, supply chain, food security, sustainable livelihood, SDGs, post-harvest loss

1. INTRODUCTION

Food loss and waste (FLW) have emerged as critical challenges in the 21st century, undermining food security, environmental sustainability, and economic resilience. Globally, nearly one-third of food produced is lost or wasted annually, equivalent to about 1.3 billion tonnes of food, valued at nearly USD 1 trillion [1]. In India, post-harvest losses of cereals, pulses, fruits, and vegetables remain significantly high due to infrastructural deficits and inefficiencies in supply chains [2,3]. This is particularly alarming for a country with one of the largest populations, rising food demand, and a substantial segment of vulnerable communities facing malnutrition and poverty. The issue of FLW is not only a food security concern but also a sustainability challenge. Wasted food implies wasted land, water, energy, and labour, while contributing to greenhouse gas (GHG) emissions through landfill disposal [4,5]. According to UNEP (2021), FLW accounts for 8–10% of total global GHG emissions [6]. Hence, reducing FLW aligns directly with the United Nations Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) [7]. This paper critically reviews FLW across Indian agriculture-food supply chains, identifies underlying causes, and evaluates mitigation strategies, with a focus on creating sustainable livelihoods and resilient food systems.

2.METHODOLOGY

This review is based on a systematic literature analysis of peer-reviewed articles, policy documents, government reports, and international publications (FAO, UNEP, FSSAI).

Steps followed:

Database Search – Sources included Scopus, Web of Science, Google Scholar, FAO, and Indian government repositories.

Inclusion Criteria – Studies from 2000–2025 focusing on Indian supply chains or relevant global benchmarks.

Exclusion Criteria – Duplicates, non-English papers, and studies lacking empirical or policy relevance.

Screening – Initial 300+ articles screened → ~80 selected for detailed analysis and 30 taken for references.

Data Extraction & Categorization – Causes, stages of loss, socio-economic impacts, mitigation strategies.

Synthesis – Comparative evaluation across stages of the supply chain, highlighting Indian context and policy implications.

3. CAUSES AND STAGES OF FLW IN INDIAN SUPPLY CHAINS

3.1 Production Stage

- Losses due to poor harvesting practices, climatic variability, and pest infestation [8].
- Lack of farmer training in Good Agricultural Practices (GAP) and inadequate mechanization [9].
- Limited access to credit and crop insurance increases vulnerability [10].

3.2 Post-Harvest Handling and Storage

- Inadequate cold chain facilities for perishable commodities such as fruits, vegetables, and dairy [11].
- Lack of scientific storage structures at the farm and rural level [12].
- High spillage and damage during manual handling, packaging, and transport [13].

3.3 Processing and Distribution

- Processing losses due to outdated equipment, low mechanization, and energy inefficiency [14].
- Poor road and transport infrastructure → delays and spoilage [15].
- Inadequate market connectivity leading to distress sales and gluts [16].

3.4 Retail and Consumption

- Retail waste due to improper packaging, poor display, and cold storage gaps [17].
- Consumer behavior: over-purchasing, plate waste, and lack of awareness [18].
- Cultural practices around food excess during events and festivals [19].

4. SOCIO-ECONOMIC AND ENVIRONMENTAL IMPLICATIONS

- **Food Security** – FLW exacerbates hunger and undernutrition in a country already struggling with high child stunting and anemia rates [20].
- **Livelihoods** – Losses directly reduce farmer income and market opportunities [21].
- **Natural Resources** – Wasted food = wasted water, fertilizers, energy, and labour [22].
- **Environment** – Disposal contributes to methane emissions, worsening climate change [23].
- **Economy** – NITI Aayog estimates India loses ₹92,000 crores annually from post-harvest food losses [24].

5. STRATEGIES FOR MITIGATION

5.1 Technological Innovations

- Improved cold chain logistics and refrigerated transport [25].
- Sensor-based monitoring for storage conditions.
- Digital platforms linking farmers directly with consumers (farm-to-fork models).

5.2 Policy and Governance

- Government schemes: PM Kisan SAMPADA, Mega Food Parks, and FSSAI's "Save Food, Share Food" initiative [26].
- Strengthening procurement and warehousing policies.
- Subsidies and incentives for private investment in infrastructure.

5.3 Community and Consumer Engagement

- Awareness campaigns on food waste reduction [27].
- Food banks and redistribution networks for surplus food.
- Encouraging sustainable dietary practices and portion control.

5.4 Multi-Stakeholder Collaboration

- Public-private partnerships for infrastructure development.
- Involvement of NGOs and academia in training and awareness [28].
- Collaboration with international organizations (FAO, UNEP, WFP) for best practices [29].

6. DISCUSSION

The Indian food system is at a crossroads. While efforts to expand food production continue, the persistence of FLW undermines progress towards food security and sustainability. An integrated system-based approach is necessary, combining technology, policy, and behavioural change [30]. Comparative studies show that countries like Japan and Germany have achieved remarkable reductions in FLW through strict policies, efficient logistics, and consumer awareness campaigns. India can adapt such practices within its unique socio-economic context, prioritizing rural infrastructure and inclusive policies.

7. CONCLUSION

Food loss and waste reduction is both a necessity and an opportunity. By addressing inefficiencies in Indian supply chains, it is possible to improve farmer livelihoods, enhance resource use efficiency, and strengthen national food security. The pathway aligns with global commitments to SDGs and climate resilience. A coordinated multi-stakeholder effort is essential to transform FLW from a challenge into a driver of sustainability.

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