

Food losses, food security, and climate change:

Navigating the triple threat

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Food losses and food waste are challenges to global food security, environmental sustainability, and economic development. An intricate relationship exists between the food system and the environment, highlighting how unsustainable practices in food production contribute to resource depletion and environmental degradation. Despite India's status as a major agricultural producer, substantial post-harvest losses undermine food security and economic stability. Food loss and waste exacerbate these issues, leading to inefficient resource use and increased greenhouse gas emissions. This article provides a comprehensive analysis of food loss statistics, examines its implications for food and nutritional security and its environmental impact and deals with some of the actionable strategies to mitigate food losses and waste through infrastructure improvements, institutional support, policy reforms, community engagement, and market linkages, aimed at enhancing food system efficiency and sustainability.

Keywords: Food loss, Food waste, GHG emission, Post-harvest losses

The food system and environment are intricately related to each other. A healthy environment strengthens the food supply, thereby enhancing food security and vice versa. The unsustainable practices in the food production system cause rapid depletion of the stock of natural resources like groundwater and contamination of the environment with harmful chemicals. The food distribution system ensures access to healthy foods to the hungry stomach but also adds to harmful emissions to the environment. However, the food consumption system not only ensures that the available food is being utilised by the body to attain the desirable health outcomes but through food loss and waste reduce the efficiency of the food production system and contribute to environmental contamination.

Food losses and food waste are challenges in the global food system, with far-reaching

implications for food security, environmental sustainability, and economic development. According to the Food and Agriculture Organization (FAO), approximately one-third of all food produced for human consumption is lost or wasted annually, undermining efforts to achieve food security and exacerbating environmental degradation through inefficient resource use and heightened GHG emissions

Food loss and food waste

Food loss refers to any edible food that goes uneaten at any stage, including crops left in the field, spoilage during transit, not making it to a store, and uneaten food in households and eateries that are served in gatherings and businesses. This typically results from poor infrastructure, lack of technology, and inefficient supply chains, particularly in developing countries. Food waste, on the other hand,

refers to food that is discarded or uneaten after it has been purchased or served. Food waste includes unconsumed meals in restaurants, leftovers from kitchens and tables and spoiled food (FoodPrint 2018), often due to over-estimated buying and improper storage, and non-compliance to aesthetic standards in affluent societies.

Status of food losses in India

Despite being one of the world's largest agricultural producers, India grapples with significant post-harvest losses across various crops, from staple grains like wheat and rice to perishable fruits and vegetables. These losses stem from a combination of factors, including inadequate storage infrastructure, inefficient handling practices, inadequate processing technologies, etc. Preventing food waste is crucial not only for ensuring that the nation's food resources are utilized effectively but also for enhancing the

livelihoods of farmers and reducing contamination of the environment associated with agricultural activities. Understanding the status and scale of food losses is essential for developing targeted strategies to mitigate these issues.

Food losses, waste and nutritional security

Approximately one-third of all food produced globally is lost or wasted, which can otherwise feed millions of hungry people. This leads to higher food prices and reduced

access to food, especially in low-income communities. The financial burden of food loss and waste is immense, affecting both producers, who lose potential income, and consumers, who face higher costs.

Food loss and waste exacerbate nutritional insecurity. The discarding of perishable and nutrient-rich foods, such as fruits and vegetables, reduces the availability of essential vitamins and minerals, worsening nutrient deficiencies, particularly in vulnerable populations and affecting

health and development, especially in children and expected mothers. Food loss and waste disrupt food systems. During natural disasters or pandemics, the ability to supply food is hindered, exacerbating food insecurity. Additionally, the disparity between regions with high food waste and those with food scarcity highlights global inequalities in food access, perpetuating hunger and malnutrition in poorer areas.

Food loss and waste: Economic implications

Food loss and waste (FLW) have significant economic implications, severely impacting the nation's economy. An estimated 40% of the food produced in India is wasted, amounting to an annual loss of about ₹92,000 crore, nearly 1% of the country's GDP. This loss is not merely of only wasted food but includes the cost of the resources used in its production, such as water, land, labour, etc.

In 2014, post-harvest losses alone were valued at ₹926.51 billion (USD 15.19 billion) due to inadequate infrastructure, poor storage facilities, and inefficient supply chains. Additionally, household food waste contributes to food loss, with Indian homes wasting about 68.7 million tonnes of food annually.

Food losses and waste: Implications for societal outcome

Food loss and waste (FLW) have profound implications on society and the broader food system, exacerbating issues such as hunger, malnutrition, and inequality. With FLW, the resources invested in its production, such as water, energy, and labour are squandered, reducing the overall efficiency of the food system. This inefficiency directly impacts food security by reducing the amount of food available for consumption, driving up prices, and making nutritious food less accessible, particularly for vulnerable populations.

Furthermore, FLW exacerbates social inequalities by highlighting the disparity between food abundance in some areas and severe shortages in others. While

Table 1. Food loss (in %) in crops and commodities

Category	Crop/Commodity	ICAR-CIPHET (2015)	NABCONS (2022)
Cereals	Paddy	5.53	4.77
	Wheat	4.93	4.17
	Maize	4.65	3.89
	Bajra	5.23	4.37
	Sorghum	5.99	5.92
Pulses	Pigeonpea	6.36	5.65
	Chick Pea	8.41	6.74
	Black Gram	7.07	5.83
	Green Gram	6.60	6.19
	Mustard	5.54	4.46
Oilseeds	Cotton Seeds	3.08	2.87
	Soyabean	9.96	7.51
	Safflower	3.24	3.06
	Sunflower	5.26	4.38
	Groundnut	6.03	5.73
Fruits	Apple	10.39	9.51
	Banana	7.76	7.53
	Citrus	9.69	7.71
	Grapes	8.63	7.15
	Guava	15.88	15.05
Vegetables	Mango	9.16	8.53
	Papaya	6.70	6.59
	Sapota	9.73	9.53
	Onion	8.20	7.26
	Potato	7.32	5.96
Plantation Crops	Tomato	12.44	11.61
	Tapioca	4.58	4.87
	Cashew nut	4.17	3.72
	Areca nut	4.91	4.41
	Coconut	4.77	3.86
Spices	Sugarcane	7.89	7.33
	Black pepper	1.18	1.29
	Chilly	6.51	6.11
	Coriander	5.87	5.32
	Turmeric	4.44	5.36
Dairy	Milk	0.92	0.87
Fishery	Inland fishery	5.23	4.86
	Marine fishery	10.56	8.76
Livestock	Meat	2.71	2.34
Poultry	Poultry	6.74	5.63
	Egg	7.19	6.03

Source: ICAR-Central Institute of Post-Harvest Engineering and Technology (2015), NABCONS (2022)

millions of people in low-income communities struggle with hunger and malnutrition, vast quantities of food are wasted in affluent regions. This imbalance perpetuates poverty and food insecurity, undermining efforts to create a more equitable society.

FLW also leads to economic losses for producers as they are unable to sell spoiled or wasted products, and for consumers, who pay higher prices due to the inefficiency in the supply chain. Addressing FLW is essential for building a more sustainable and resilient food system that can meet the needs of a growing global population.

Food losses and waste: Environmental implications

FLW has severe implications for the environment and biodiversity, as highlighted by multiple global studies. FLW contributes to greenhouse gas (GHG) emissions, resource depletion, and habitat destruction, which collectively exacerbate climate change and biodiversity loss.

According to the Food and Agriculture Organization (FAO), FLW is responsible for approximately 8–10% of global GHG emissions (UNFCCC 2024). The energy, water, and land used in its production are wasted when food is wasted. FAO report states that the carbon footprint of wasted food is around 3.3 gigatons of CO₂ equivalent/year, making FLW a major contributor to GHG emissions.

Additionally, FLW drives the expansion of agricultural land, leading to deforestation and habitat loss. The World Wildlife Fund (WWF) reports that agricultural expansion for food production, a significant fraction of which is ultimately wasted, is a leading cause of deforestation, accounting for 70–80% of global tropical deforestation. This loss of habitat is devastating for biodiversity, as it leads to the extinction of species and the degradation of ecosystems. A study estimates that by 2050, agricultural land expansion driven by the

demand for food could lead to the loss of forest areas (Bahar *et al.* 2020), which may fuel biodiversity loss.

Furthermore, the FAO highlights that losing biodiversity due to FLW affects ecosystem services, such as pollination, which are critical for food production. The decline in pollinator populations, exacerbated by habitat loss, threatens the stability of food systems and the environment.

Food losses, waste and climate change

Food waste and losses are significant contributors to climate change, primarily through the production of green house gases (GHGs) across various stages of the food supply chain.

One of the direct ways food waste contributes to climate change is through methane emissions. Methane is a potent GHG with a global warming potential approximately 28–34 times greater than that of carbon dioxide over 100 years. Methane is produced when organic waste, including food, decomposes anaerobically in landfills. According to the Intergovernmental Panel on Climate Change (IPCC), landfills are the third-largest source of methane emissions globally, largely due to the disposal of food waste.

FAO estimates that food waste accounts for approximately 8–10% of global GHG emissions. This includes emissions from deforestation for agricultural expansion, fossil fuels burned for food production and transport, and energy used for food processing and storage. If food waste is assumed as a country, it would be the third-largest emitter of GHGs after China and the United States (Scialabba 2015).

Reducing food waste is, therefore, a critical strategy for mitigating climate change. By addressing inefficiencies in the food supply chain and promoting sustainable consumption practices, significant reductions in GHG emissions can be achieved, contributing to global climate goals.

Strategies for mitigating food losses and waste

- **Infrastructure enhancement:** To address food losses and waste effectively, upgrading infrastructure across the food supply chain is crucial. Developing and modernising storage facilities can significantly reduce spoilage. For instance, temperature-controlled warehouses and advanced packaging technology help maintain food quality right from production to consumption. Efficient transportation networks with reliable refrigeration units are also key aspects to ensure that food reaches markets in optimal condition.
- **Strengthening institutions:** Institutional frameworks play a pivotal role in reducing food losses and waste. Governments should establish such frameworks to oversee and coordinate efforts in this area. These institutions can develop and enforce regulations on food quality standards, waste reduction practices, and reporting mechanisms. Creating partnerships between the public and private sectors fosters innovation and resource sharing. Institutions should also invest in research and development to identify best practices and emerging technologies for waste reduction. Collaborative platforms, such as industry associations and research consortia, can facilitate knowledge exchange and promote effective strategies.
- **Policy implementation:** Effective policies are essential for mitigating food waste and losses. Governments should introduce policies that incentivise waste reduction across the supply chain. For example, tax relief or subsidies for businesses that adopt waste-reducing technologies or practices can drive widespread adoption. Regulations mandating clear-date labelling on food products can prevent premature

disposal of edible food. Policies promoting food recovery initiatives, such as surplus food donation programs, can redirect excess food to those in need. Additionally, integrating food waste into the national accounting system would facilitate tracking the progress and identifying the areas for improvement.

- **Engaging people:** Engaging individuals and communities is fundamental to reducing food waste. Public awareness campaigns can educate consumers about the impact of food waste. Schools, colleges and universities should incorporate food waste education into their curricula to instil sustainable practices. Community-based initiatives, such as local food-sharing programs and farmers'

markets, can reduce excess production and consumption. Providing resources and training for households on proper food storage and meal planning can also help minimise waste. Involving consumers in waste reduction efforts fosters a culture of sustainability and shared responsibility.

- **Market linkages:** Linking strategies with market mechanisms enhances the effectiveness of waste reduction efforts. Establishing market incentives for food waste reduction, such as certifications for sustainable practices or eco-labels, can drive consumer demand for responsible products. Creating platforms for surplus food exchange between businesses can help redistribute excess food to those in need.

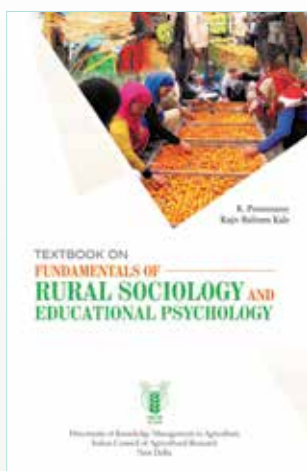
Furthermore, developing digital tools that connect food producers with consumers and food banks can streamline the redistribution process, ensuring that surplus food reaches its intended recipients efficiently.

SUMMARY

Addressing food losses and waste requires a comprehensive approach involving infrastructure improvements, institutional support, robust policies, community engagement, and market-driven strategies. By doing so, stakeholders can reduce food waste, enhance food security, and contribute to environmental sustainability.

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Textbook on Fundamentals of Rural Sociology and Educational Psychology



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TECHNICAL SPECIFICATIONS

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