

PERSPECTIVES ON FOOD WASTE MANAGEMENT AND THE GREEN FOOD MOVEMENT

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Abstract. Global food waste management poses significant real-world challenges, with environmental, economic, and societal implications. This article discusses the sources, consequences, management aspects and impacts, and green food movement perspectives while highlighting the importance of sustainable food waste management in an intellectually stimulated learning space and practice in the food waste management landscape.

Keywords: food waste; food waste management; green food movement; consequence of food waste

Introductory Input

Food appropriate for human consumption being discarded is called food waste (FW) and can occur anywhere throughout the whole supply chain from farm to fork. FW is a global concern because of improper management and stakeholders' ignorance. Global issues affecting the FW problems include consumerism, population growth, contamination, and climate change. Global food waste (FW) statistics indicate a significant problem, causing the economy billions of dollars and contributing to global climate change, and if the current trend continues food loss and waste could double by 2050.¹ The world wasted 1.05 billion tons of food (19 % of the food available) at different levels (60 % household, 28 % food services, 12 % retail). It accounts for ~10 % of greenhouse gas (GHG) emissions and costs the global economy 1 trillion USD annually. The global FW management market is estimated at 56.8 billion USD in 2027. This FW ends up in landfill, composting, animal feed, sewer, incineration, donations, industrial uses, anerobic digestion, land application, and dumping in various percentages in different countries worldwide (Lauria 2024). An urgent transformation is required to reduce FW around the globe. Harnessing expertise driven by shared values and a collaborative global network toward a goal-directed approach, uniting consumers, businesses, governments, and non-government organizations (NGOs) to minimize FW through strategic and comprehensive management protocols that directly depict social and environmental responsibility.

Sources and Consequences

Food waste sources involve residential (kitchen/municipal FW), institutional (catering waste), commercial (grocery retail/supermarket FW), industrial (hospitality sector/food industry, processing residues and wastewater), and agricultural (fruit and vegetable residues) wastes. Processing issues, overproduction, unstable markets, consumer waste, and poor planning contribute to overall FW. FW at several stages of the food supply chain include overproduction, improper drying or inadequate storage facilities, inefficient harvesting techniques, high temperatures/humidity levels, transportation issues, and processing waste while converting raw materials into packed products. Impulse buying of food products, misunderstanding of labels, and community norms at the consumer/household level can generate FW. Discarding food that does not meet nutritional standards or aesthetic criteria also contributes to waste.

Multiple FW consequences include economic loss, resource depletion, poverty and hunger, air/water/soil/odor/scenic pollution, loss of soil fertility/land degradation, GHG/toxic gas emissions, global warming, and climate change (Usubiaga et al. 2018). Other consequences of FW include natural resource degradation, loss of biodiversity, freshwater loss, reduced food availability, environmental pollution, and food security issues. The negative implications of FW involve the production of GHGs like CH₄ and CO₂ when disposed of in landfills, the impact on the global economy, climate change, and the increasing cost of food. It represents a significant financial loss for producers, retailers, and consumers. The resources used to grow food (soil, water, fertilizers) and biodiversity loss for agricultural expansion are also of global concern as impacts of FW. Many people worldwide lack access to adequate nutrition and improper disposal can lead to sanitation problems, and disease transmission. It is impossible to predict how climate change will affect rainfall patterns worldwide and how agricultural productivity differs because of weather, soil, and sunlight. Tropical temperature increases also affect the overall food production scenario.

Fight Food Waste

About one-fifth of all edible food produced for human consumption is wasted annually, contributing to around 1.05 billion tons worldwide. Reducing the waste of edible food must be the top priority in commercial/household kitchens. FW recycling activities include composting, reusing the food packaging material, converting it into biogas, donating waste for animal feed, and creatively using leftovers. The FW index from the United Nations tracks the total fresh FW at the retail/consumer levels and the food loss index tracks the crop/livestock that exits the food supply chain after harvest/slaughter (Zseni et al. 2024). FW distribution of households (60 %), food services (28 %), and retail (12 %) amounts to about 132 Kg per person and the loss is estimated to be one trillion US dollars. It contributes

to about 10 % of annual global greenhouse gas emissions. FW is an ethical issue as 800 million people don't have access to edible food. FW is a big opportunity for sustainable development goals (SDGs).

Food Waste Management

Integrated remediation, circular economy, bioconversion, and sustainable valorization are the sustainable options available in the future. FW can be valorized for generating thermal and electrical energy, solid/liquid fuels, chemical substances, or biomaterials for several applications depending on the characteristics of waste food. Microorganisms (bacteria, fungi, yeast) convert dairy waste (whey waste) into value-added products such as bioplastics, biosurfactants, and biofuels (biological conversion) (Lin et al. 2013). Integrated strategies for dairy waste valorization can foster sustainable production using this biodegradable feedstock and reduce environmental impact by diverting FW from landfills. It is essential to contribute to a more sustainable food system by minimizing FW, maximizing resource utilization, and promoting a circular economy by keeping longer resource use periods (Prokic et al. 2022).

We need to dramatically reduce the volume of FW to contribute to solving the global hunger problem. FW management involves tracking and prevention, reuse, recovery, recycling, and disposal stages (Giroto et al. 2015). It may include food banks, using food as animal feed, anaerobic digestion, composting, and landfills. It is essential to have a robust FW tracking process and technology-enabled automated FW management with AI for large-scale hospitality businesses. Based on the insight available, the chefs can make operational decisions in the kitchen to reduce the main types of FW. The investment in FW management can yield great returns. FW management offers vast potential to mitigate GHG emissions and save money for companies and households. It is important to review FW data regularly to identify action plans and savings potential. Regular audits and measurement help in materials management and waste reduction. Composting and growing local vegetables is a small step towards sustainable food management. Sustainable waste management conserves resources, and energy, reduces air/water pollution, and saves landfill space. In nature, the product components are recyclable or biodegradable, and waste is reused for plant/crop growth.

The FW management and sustainable food supply chain management approach must include quantification and categorization of FW, assessment of each management method's environmental impact, and selection of the best alternative from the social/economic/environmental perspective. The world produces abundant food to feed everyone, but one-third is wasted. Ideologically crystallized but physically amorphous FW management strategies include the 3R formula to reduce (regular food usage), reuse (change throw approach), and recycle (generate secondary market). It is essential to produce enough food to meet the

nutritional needs of the current and growing global population while balancing the distribution of different food groups. A radical change in people's mindset to reduce FW is required to meet global nutritional needs. Reducing food production/storage/transportation losses, educating consumers about the negative consequences of FW and the pressing need to maintain food security, and implementing proper food labeling format to combat consumer confusion to maintain the sustainability of global food systems. FW could be used as a resource for animal feed or energy production. Establishing social networking systems to collect surplus edible food from households, caterers, and restaurants to distribute it to needy people is another aspect of global FW management. It is important to carry out a life cycle assessment to analyze the environmental impact of food production, processing, distribution, consumption, and disposal stages to identify gap areas for improvement. Implementing supply chain optimization practices such as improved logistics, better forecasting, and standardized packaging to minimize FW is essential. Policy interventions include implementing strict regulations and providing incentives for FW reduction, enhancing labeling standards, and supporting innovative food technologies are equally important in reducing food loss and waste.

FW management involves collecting, processing, and disposing of/using FW at the production/retail/household level. Optimizing raw material usage, efficient food processing techniques, smart packaging solutions, energy and water efficiency, efficient supply chain management, and creating consumer awareness are important in reducing FW in food production factories. FW tracking and monitoring systems, sustainable packaging, smart shopping, food recovery programs, anaerobic digestion, and composting can help reduce FW, reduce the amount of food in landfills, improve soil quality for crop production, reduce environmental impact and generate value-added products (biogas/manure). In the hospitality industry, steps like hygienic food distribution, food service management, real-time monitoring, automated alerts, predictive analytics using computer software and hardware, and IoT /AI systems would help reduce FW. Some best practices for global FW management schemes include integrated FW management planning, enhancing food supply chain efficiency, inventory management, menu planning for less waste, FW disposition for composting, anaerobic digestion, incineration, animal feed, food banks, industrial uses or landfilling, and building food loss and waste infrastructures.

Education and Engagement

Food waste management courses including practical knowledge and skills to adapt to diverse situations as a part of higher education programs are relevant in changing times. Student-centric value-based management education prepares good leaders of tomorrow with a global mindset and social sensitivity. Live projects in FW management during the internship period and workshops on the challenges

of FW provide much-needed experiential learning exposure. Educational tours and industry visits to various conventional and the new generation food and beverage companies must become an integral part of training and development. Food resource management, global industry expert talks on trending topics, principles of responsible management education, mentoring ecosystem for budding entrepreneurs, multidisciplinary approach to education, food production labs, global perspectives, international student exchange programs, community engagement services, global collaborations, and holistic approach to management education all foster professional development for the future. Global perspectives and exposure equip learners with a broader view and a competitive advantage to become visionaries and change-makers in an interconnected world. Universities have to educate the public through awareness campaigns and outreach activities about the consequences of FW and how to deal with it at their level. Strategic partnerships of higher education institutes with some of the leading food corporations ensure that the curriculum remains future-focused. 'Buy less, use all, and waste nothing' must be the slogan regarding creating awareness of FW consequences as it is a major global problem.

Green Food Movement Perspectives

The goal of the green food movement is to improve food quality, promote consumer health, and protect the environment (Mulvaney 2011). Green foods are nutritious with high vitamin and mineral contents and they are grown using organic farming practices with low environmental pollution (water pollution/soil damage) (Ashaolu & Ashaolu 2020). The use of high-yielding variety seeds, controlled water supply, use of agrochemical fertilizers, better financial assistance and minimum support price, and farming mechanization is a part of the green food movement. Sustainable food security and traceability of food supply chains will have a significant impact on the green food movement. Green foods are high quality, safe for human consumption, and eco-friendly. In this movement citizens demand safe food, the farmer grows safe food, suppliers and distributors supply safe food, create a knowledge bank of safe food and all the stakeholders minimize food waste in the entire supply chain from farm to fork to have the desired impact.

The green food movement includes sustainable agriculture practices, green food processing, and green food analysis. Sustainable agriculture involves resource optimization using vertical farming, hydroponics, and precision farming, economic viability focusing on public health and animal welfare, and environmental management promoting conservation and biodiversity. Green food processing could use data-driven insights to cultivate crops more efficiently, and innovative growing techniques to minimize environmental impact. Green food analysis includes the use of green solvents like supercritical fluids (e.g. sc-CO_2) for eco-friendly extraction techniques and using predictive models to identify nutritional compounds in foods.

The positive consequences include increased crop yields, reduced production costs, and access to crop genetic improvements. The negative consequences include soil degradation, water/air pollution, health issues, and biodiversity loss. The green food movement is an integral part of the green movement regarding concerns for environmental conservation and health improvement. A shift from ‘fast food’ to a ‘slow food’ culture could contribute to sustainable food movement. It promotes organic food with less pesticides/fertilizer, fair compensation to farmers/food producers, supports public health, and inculcates in-season tastier and healthier eating habits. Transforming ‘today’s aspirant into tomorrow’s food waste manager facing remarkable FW realities symbolizes the visionary approach of higher education institutions toward holistic education.

Concluding Comments

FW occurs in all segments of the food chain and for all food items and its analysis provides valuable insights into the practical aspects of FW management. More sustainable and eco-friendly agricultural cultivation needs to be practiced to feed a growing world population sustainably without compromising the needs of future generations. Food that is prepared in an environmentally friendly way and that supports public health with fair pay for the labor of food producers promotes the local sustainable food movement. The unique blend of global perspectives and local ethos, and the use of technology help reduce the carbon footprint and minimize FW. To promote sustainable food practices we have to bridge the gap between weak environmental practices and global green food practices. The food choices people make have an impact on the entire planet and going green can have positive effects on personal health, economic benefits, and the environment. The above overall perspectives highlight the need for unwavering commitment to reducing FW worldwide through strategic thinking, ethical decision-making, and remarkable collaborations in an era where sustainability is a necessity. A standard operating procedure (SOP) for FW management includes the following steps; i) evaluate the amount of FW generated, ii) reduce the amount of FW produced, iii) reuse or repurpose FW, iv) compost organic FW, v) recycle FW, and vi) disposing it in an eco-friendly way. From a safety viewpoint, it is necessary to wear gloves and proper footwear when handling waste, wash hands thoroughly after waste handling, and regularly clean and maintain the composter. Exploring FW management from a sustainability perspective provides insight into the transformative potential of education, research, and practice.

NOTES

1. Food Waste Index Report 2024 – <https://www.unep.org/resources/publication/food-waste-index-report-2024>

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