

Food Waste and Sustainability Impact

Subjects: [Agriculture](#), [Dairy & Animal Science](#)

Contributor: Charles Stephen Brennan

Food losses in the agri-food sector have been estimated as representing between 30 and 80% of overall yield. The agro-food sector has a responsibility to work towards achieving FAO sustainable goals and global initiatives on responding to many issues, including climate pressures from changes we are experiencing globally.

regeneration

food innovation

sustainability

1. Food Waste and Sustainability Impact

Food losses due to the processing and production operations of the agri-food sector have been estimated to represent between 30 and 80% of overall yield ^[1], and this can be up to 1.3 billion metric tons of food material wasted each year, as illustrated in **Figure 1**. The majority of the losses have been calculated as originating from waste issues in the fruit and vegetable industry (possibly due to the high perishability of such products). However, the aqua food industry and meat industries closely follow the overall amount of production and processing loss related to supply chain issues ^[2].

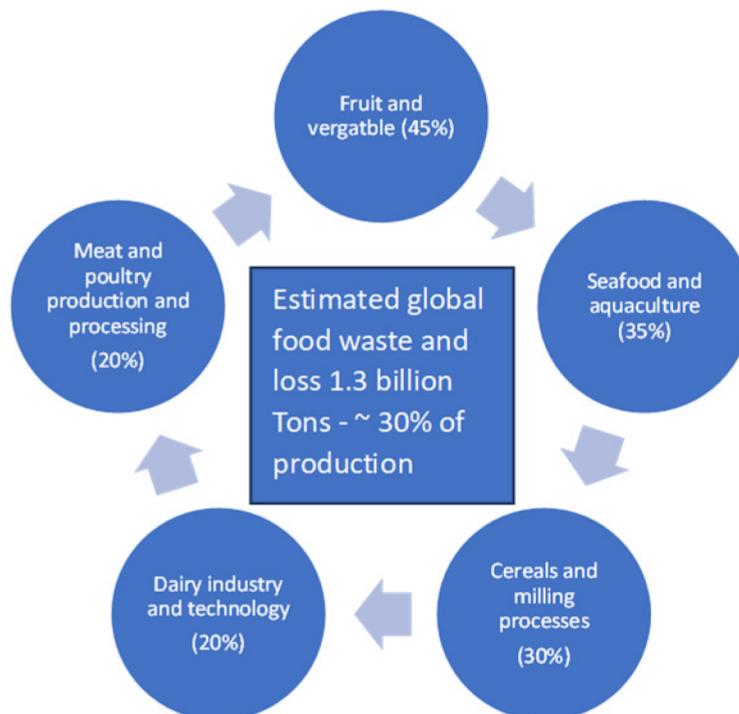


Figure 1. Pictorial representation of total amount of estimated food waste and loss per year based on the primary sectors.

2. Distribution of Origins of Food Waste and Loss across the Globe

Many researchers have illustrated that this issue of waste material originates from processing, supply chain and consumer use stages of the lifecycle of food rather than production losses specifically derived from farming practices [2]. This is also dependent on culture and governmental influence. For instance, in Australasia, the amount of food loss from grocery supply chains accounts for 5–6% of all food loss, whereas in Europe, the figure is close to 16%, whilst in Asia, this can be between 20 and 30% [3]. The research from Martindale et al. [2] illustrates the need for an integrated approach to achieve the goals of sustainability, which we have been addressing for a while, and that this needs to reflect strategies to reduce the impact of climate change on the supply and security of the food and beverage industry. **Table 1** illustrates a recent estimate of global food waste produced on behalf of each household in major countries throughout the world. What it illustrates is that there is a significant variation in the estimated food waste per capita each year depending on regionality and supply chain procedures [3]. What is of interest is the per capita differentiation between countries, possibly due to cultural influence.

Table 1. Estimated scale of food waste per household on an annual basis in selected countries data obtained from [3].

Country	Total Annual Food Waste (Tonnes)	Food Waste per Capita (kg per Person)
China	91,646,213	64
India	68,760,163	50
United States	19,359,951	59
Japan	8,159,891	64
Germany	6,263,775	75
Australia	2,562,110	102

3. Potential of Digital Technology in Guiding Us through Process Optimisation

The development of the Internet of Things (IoT) will aid the digitalisation of the food processing and production sectors, and understanding the data that is within such studies would help improve our insight into the potential methodologies we can employ to reduce waste as well as optimise industry processing. For instance, Caldeira et al. ^[4] approached the issue from a mass balance exercise across multiple stages of the lifecycle analysis within the food industries in Europe and broke the potential of waste generation into specific areas across the lifecycle of food. Such a high level of waste has been subjected to evaluation in relation to the FAO sustainable goals and global initiatives in harnessing food ingredients from secondary side streams of the agri-food industry ^[5]. The focus of the analysis by Caldeira et al. ^[4] was on the opportunity to develop strategies that could address Sustainable Development Goal 12, which emphasises ensuring sustainable consumption and production patterns across society and which has led to governmental policy documents outlining a proposal to reduce levels of waste by up to a half by 2030.

4. Sustainability, Food Waste and Environmental Concerns on Food Valorisation

Figure 2 is a simplistic diagrammatic representation of the complexity of the factors involved in food waste utilisation in the food industry. Researchers have identified that food waste quantities vary across sectors and regions, with differences in practices, infrastructure and cultural norms impacting the amount of waste generated.



Figure 2. A simplified pictorial of the independent components that interact when considering food sustainability and security. In particular, there is a dependency on supply chain, processing and production systems in reducing waste generation in order to protect the environment for the future.

The environmental impact of food waste is considered a high priority from a governmental policy framework as it contributes to greenhouse gas emissions, as decomposing food releases methane in landfills. The FAO has reported that the carbon footprint of food waste could be as much as 3.3 billion tons of carbon a year, having a significant effect on the levers of climate change [5]. The impact of high levels of food waste on sustainability and resource use cannot be underestimated, especially in the food production and processing industries, which consume resources including water, land and energy. As such, this waste production exerts economic implications as loss of resources invested in production, transportation and distribution. It affects profitability for businesses and can lead to increased costs for consumers as well as food scarcity [3][4].

So, while the wasting of foods across the supply chain raises ethical concerns in a world where millions of the population face hunger, it remains a possibility that redirecting food waste to those in need can address some aspects of food insecurity issues. This emphasis on employing measures to reduce waste production in a short period of time has also created intense interest in the opportunity to recover and reuse waste from production and process operations [6][7][8][9]. Much of the focus has been on improving the recovery rates from plant- [10] and meat-

based material [\[11\]](#) to reduce the impact on the environment and create added-value products that can be used as ingredients in the circular economy within food ingredient utilisation. These initiatives have a beneficial effect in terms of recovering potentially powerful bioactive compounds, which may be effective in the improvement of human health, with research illustrating the potential to utilise waste streams from plant-based products as enhancers to the nutritional quality of processed foods [\[9\]](#)[\[11\]](#)[\[12\]](#)[\[13\]](#)[\[14\]](#).

It is undeniable that as the growth in the world's population steadily progresses toward the figure of 9 billion individuals, the stress and strain applied to the food production and processing systems upon a delicate global environmental fabric will need to be addressed rapidly [\[2\]](#)[\[4\]](#)[\[5\]](#). Reflecting on this from a purely academic viewpoint, we, as thought leaders, have a responsibility to act as stewards for the future and develop a sense of governance of our land and waters, together with food systems regionally, nationally and globally. A word that springs to mind when considering this situation is that of curation. We have the duty to be mature curators of our future whereby, being respectful of the past, we can establish a new vision for the future with the principles of stewardship and governance securely at the centre of our decision-making processes.

5. Can Valorisation Be the Answer to Sustainability and Regeneration

This could include the role of waste recovery and reutilisation to address issues of sustainability and food insecurity, with researchers indicating that up to 2% of global food consumers are facing real-life food insecurity issues, which means that up to 2 billion people are witnessing the effects of malnutrition [\[15\]](#). The signposts are clear and evident for all of us reading academic literature as well as social media content, namely that things have to change. The term regenerative food innovation attempts to create a vision whereby researchers, policy makers, industry stakeholders and the global consumer body can move not only to return to what was considered appropriate in sustainability and security systems of the last decade or two but to reinvent these systems to create newness and a more sustainable and secure future for food production, consumption and innovation. Tittonell et al. [\[16\]](#) recently reviewed the importance of regenerative agriculture in providing agroecological solutions to sustainability across diverse cultures and governments. The authors highlight that the proponents of regenerative agriculture aim for outcomes beyond what sustainability can provide by establishing a balance between agricultural use and practices of the land, which is deeply connected to the concept of governance of land and areas. This could be a mixture of cultural–historical practices, socioeconomic pressures and sovereignty of lands and waters in a complex interconnection of themes (**Figure 3**).

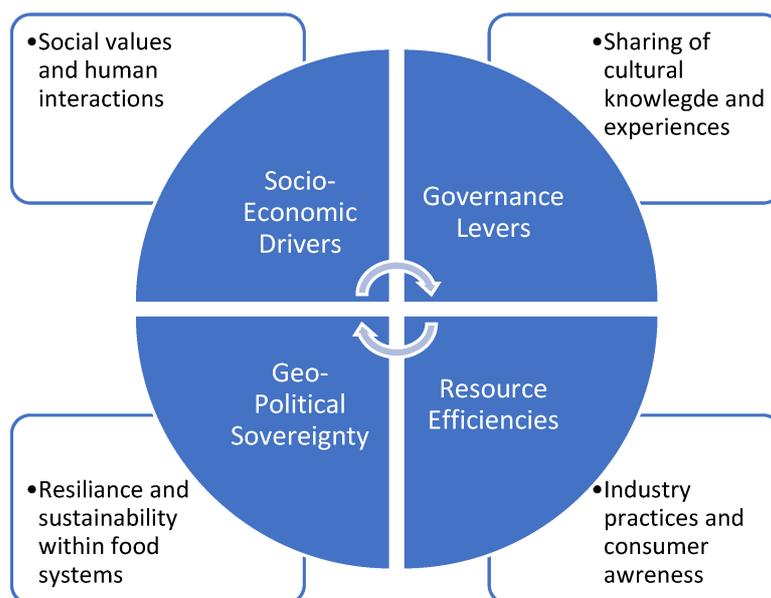


Figure 3. Simplistic representation of factors interplaying with the socioeconomic and geopolitical cross-cultural drivers for regenerative food systems.

There is undoubtable a link here between understanding production practices and process operations in order to achieve some of the future benefits we are seeking. For instance, Das et al. ^[17] have evaluated the impact of food production and storage processes in order to enhance both food security and sustainability in emerging nations. A good example of this is the recent study that examined the effects of climate change and maritime security in the Indo-pacific regions, as this has direct effects on smaller nations where land-based agricultural systems are only part of the story for sustainability and security issues, as they rely heavily on maritime resources for trade, economic development and basic provision of foods ^[18]. At the same time, Bhatkar et al. ^{[8][9]} illustrated that concerns related to production, processing and post farm gate systems are essential in creating efficiencies in the overall supply chain of food production. Careful consideration of each step in the food production and processing cycle will illustrate potential savings to be obtained at the pre-farm gate stages, harvesting and preparation, ingredient generation and food production operations, as well as cold chain systems and consumer utilisation. Small gains from each of these stages, when combined, could create large wholesale benefits in terms of sustainability savings. Indeed, supply chain dynamics and improving the resilience of blockchains are major subjects in addressing the sustainable development goals placed on food systems ^{[19][20]}.

References

1. Read, Q.D.; Muth, M.K. Cost-effectiveness of four food waste interventions: Is food waste reduction a “win–win”? *Resour. Conserv. Recycl.* 2021, 168, 105448.
2. Martindale, W.; Hollands, T.Æ.; Jagtap, S.; Hebishy, E.; Duong, L. Turn-key research in food processing and manufacturing for reducing the impact of climate change. *Int. J. Food Sci.*

- Technol. 2023, 58, 5568–5577.
3. UNEP. Food Waste Index Report 2021; UN Environment Programme: Nairobi, Kenya, 2021; p. 100. ISBN 978-92-807-3868-1.
 4. Caldeira, C.; De Laurentiis, V.; Corrado, S.; van Holsteijn, F.; Sala, S. Quantification of food waste per product group along the food supply chain in the European Union: A mass flow analysis. *Resour. Conserv. Recycl.* 2019, 149, 479–488.
 5. FAO. Sustainable Development Goals. 2020. Available online: <https://www.fao.org/sustainable-development-goals-data-portal/data/> (accessed on 16 January 2024).
 6. Costello, C.; Birischi, E.; McGarvey, R.G. Food waste in campus dining operations: Inventory of pre- and post-consumer mass by food category, and estimation of embodied greenhouse gas emissions. *Renew. Agric. Food Syst.* 2015, 31, 191–201.
 7. Ben-Othman, S.; Jõudu, I.; Bhat, R. Bioactives from agri-food wastes: Present insights and future challenges. *Molecules* 2020, 25, 510.
 8. Bhatkar, N.S.; Shirkole, S.S.; Brennan, C.; Thorat, B.N. Pre-processed fruits as raw materials: Part I—Different forms, process conditions and applications. *Int. J. Food Sci. Technol.* 2022, 57, 4945–4962.
 9. Bhatkar, N.S.; Shirkole, S.S.; Brennan, C.; Thorat, B.N. Pre-processed fruits as raw materials: Part II—Process conditions, demand and safety aspects. *Int. J. Food Sci. Technol.* 2022, 57, 4918–4935.
 10. Pop, C.; Suharoschi, R.; Pop, O.L. Dietary Fiber and Prebiotic Compounds in Fruits and Vegetables Food Waste. *Sustainability* 2021, 13, 7219.
 11. Moslemy, N.; Sharifi, E.; Asadi-Eydivand, M.; Abolfathi, N. Review in edible materials for sustainable cultured meat: Scaffolds and microcarriers production. *Int. J. Food Sci. Technol.* 2023, 58, 6182–6191.
 12. Sadhukhan, J.; Dugmore, T.I.J.; Matharu, A.; Martinez-Hernandez, E.; Aburto, J.; Rahman, P.K.S.M.; Lynch, J. Perspectives on “Game Changer” Global Challenges for Sustainable 21st Century: Plant-Based Diet, Unavoidable Food Waste Biorefining, and Circular Economy. *Sustainability* 2020, 12, 1976.
 13. Ali, A.; Wei, S.; Liu, Z.; Fan, X.; Sun, Q.; Xia, Q.; Liu, S.; Hao, J.; Deng, C. Non-thermal processing technologies for the recovery of bioactive compounds from marine by-products. *LWT* 2021, 147, 111549.
 14. Conrad, Z.; Blackstone, N.T. Identifying the links between consumer food waste, nutrition, and environmental sustainability: A narrative review. *Nutr. Rev.* 2021, 79, 301–314.

15. Lai, M.; Rangan, A.; Grech, A. Enablers and barriers of harnessing food waste to address food insecurity: A scoping review. *Nutr. Rev.* 2020, 80, 1836–1855.
16. Tiftonell, P.; El Mujtar, V.; Georges, F.; Kebede, Y.; Laborda, L.; Luján, S.R.; de Vente, J. Regenerative agriculture—Agroecology without politics? *Front. Sustain. Food Syst.* 2022, 6, 844261.
17. Das, S.; Barve, A.; Sahu, N.C.; Muduli, K.; Kumar, A.; Luthra, S. Analysing the challenges to sustainable food grain storage management: A path to food security in emerging nations. *Int. J. Food Sci. Technol.* 2023, 58, 5501–5509.
18. Brennan, J.; Germond, B. A methodology for analysing the impacts of climate change on maritime security. *Clim. Chang.* 2024, 177, 15.
19. Galanakis, C. (Ed.) Food waste valorization opportunities for different food industries. In *The Interaction of Food Industry and Environment*; Academic Press: Cambridge, MA, USA, 2020; pp. 341–422. ISBN 9780128164495.
20. Zaraska, M. Fighting food waste. *New Sci.* 2021, 245, 42–45.

Retrieved from <https://encyclopedia.pub/entry/history/show/123594>