

Innovators and Transformers Is wasted food just *waste*? Reconceptualising food loss and waste in operations and supply chain management research and practice

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Abstract

Purpose – Food waste is generated along the entire agricultural supply chain. From farm overproduction to lack of cold chain infrastructure, waste occurs for multiple reasons and negatively impacts the environment and society while generating economic losses. Although various supply chain actors and institutions have made attempts to reduce it, the activity is often confined to a single farm or to a retailer and charity dyad, without a systematic resolution of the problem. The environment is not only negatively impacted by the reduction of soil, water and biodiversity but also human beings suffer from malnutrition and food insecurity and finally, the entire supply chain faces considerable economic losses. Various supply chain actors have attempted to reduce this waste, but the results are often limited. The purpose of this paper is to consider systematic resolution by proposing a reconceptualisation from an alternative Operations and Supply Chain Management (O&SCM) perspective.

Design/methodology/approach – The proposed paper is problem-based research, which merges the research and industry perspectives derived from the authors' field experience interviewing different supply chain stakeholders in Italy, the UK, the USA and France with an analysis of O&SCM literature related to food loss and waste.

Findings – In order to address the food waste problem, we propose a new perspective in dealing with food loss and waste through the lens of O&SCM. By reconceptualising O&SCM theories and methods with the unique aspects of food loss and waste and taking into account the multitude of stakeholders involved, we propose five research avenues.

Originality/value – The perspective of O&SCM management is missing when dealing systematically with food loss and waste, as researchers neglect its unique characteristics.

Keywords Sustainability, Circular economy, Food loss and waste, Operations and supply chain management, Problem-based research

Paper type Conceptual paper

1. Introduction

Food loss and waste (FLW) presents complex supply chain management challenges fraught with trade-offs. Viewed simplistically, FLW is food left over from various aspects of

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production from farm to fork. However, it encompasses multifaceted social, environmental and economic dimensions (Gibbert *et al.*, 2023), intricately intertwined with unique supply chain hurdles such as significant power imbalances among stakeholders, heightened perishability and human safety concerns.

Instances of FLW often slip under the radar, whether occurring within households or along supply chain processes. Yet, it has become a force to catalyse public opinion and institutional response, particularly when deliberate, as seen when farmers intentionally discard entire harvests because of the lack of economic viability. Despite playing a crucial role in the shift towards agroecology, as seen in their recent protests around Europe, small growers and processors feel pressured to produce at minimal costs by actors with a higher bargaining power in the downstream supply chain (Pullman *et al.*, 2009). And, while advocating against the EU Green Deal's environmental regulations, farmers are also disproportionately affected by climate change impacts like floods and drought compared to other supply chain actors.

Recent publications in Operations and Supply Chain Management (O&SCM) journals (e.g. Akkerman *et al.*, 2023; Winkler *et al.*, 2023) and special issues (Gibbert *et al.*, 2023) provide evidence of a growing interest concerning FLW in O&SCM research. However, despite the increasing controversy, much of the literature still deals with this topic from a limited view, with recurrent themes such as preventing and reducing FLW, stakeholder collaboration, logistics and operations optimisation and FLW measurement along the supply chain. In this paper, we argue that O&SCM should provide different tools, models and theories to understand and tackle FLW issues along the agri-food supply chain, but such tools require adaptation and reconceptualisation to account for the idiosyncrasies and trade-offs associated with FLW. By applying existing O&SCM approaches to this topic, there may be the risk of underestimating or neglecting important aspects. Therefore, we first present the multi-faced issues of FLW and contributions of O&SCM literature so far. We then provide an agenda for stimulating further avenues in research and practice.

2. Theoretical background and research foundations

The methodology employed for constructing the theoretical background of this conceptual paper involved a thorough analysis of the literature on FLW and O&SCM and the authors' extensive experience spanning several years in the field of FLW and agri-food supply chains, collaborating with practitioners and other researchers. The analysis of the literature builds on Chauhan *et al.*'s (2021) paper, additionally encompassing the consumption stage and redistribution activities and updated with recent papers until February 2024. Therefore, the insights presented in this paper derive from a dual perspective, encompassing both researchers' and the practitioners' viewpoints, which are summarised in Table 1 and Table 2.

By merging the two viewpoints, we find that FLW can be considered a "wicked problem" (Touboulic *et al.*, 2020). Indeed, FLW garners attention from various stakeholders, often having different perspectives and (sometimes conflicting) interests, thus requiring a balance of existing trade-offs and controversial aspects. For instance, despite efforts to improve operations and supply chain management practices, constraints such as limited resources, reliance on volunteer labour, lack of coordination and limited information sharing persist, hindering systemwide solutions. Such issues emerged in literature, especially after the COVID-19 outbreak, when the food surplus redistribution activities performed by charities became essential to helping people in need, thus preventing and reducing FLW while covering institutional voids. While literature is beginning to discuss behavioural aspects related to FLW, i.e. digitalisation and governance mechanisms to enhance FLW management, most research continue to focus on FLW measurement and pinpointing its causes. However, by giving more weight to the insights of practitioners, we could enhance the perspective of O&SCM and discover innovative FLW solutions.

FLW-related themes	Deductive perspective <i>Research viewpoint</i> Most recurrent themes	Representative references
Operations and supply chain management	<ul style="list-style-type: none"> Improving and optimising operations and supply chain management practices to prevent and reduce FLW, with the aim of minimising waste Improving and optimising operations and supply chain management practices of food surplus redistribution activities performed by food banks and food charities High focus on supply chain challenges such as managing perishable products, on the retail stage and food service High focus on reducing FLW by improving logistics and implementing reverse logistics to prevent FLW Adoption of O&SCM tools such as lean thinking to minimise and mitigate FLW 	Akkerman <i>et al.</i> (2023), Luo <i>et al.</i> (2022), Sengul Orgut and Lodree (2023), Winkler <i>et al.</i> (2023)
Behavioural	<ul style="list-style-type: none"> High focus on investigating, preventing and reducing FW in households Impact of Covid-19 on households FW Investigating consumers behaviour in online food shopping and redistribution FW management in canteens and food services Consumers behaviour and perception towards food sharing High focus on consumers behaviour (while organisational behaviour is missing) 	Ananda <i>et al.</i> (2023)
Digitalisation	<ul style="list-style-type: none"> Adopting circular economy practices for FLW prevention and reduction Assessing the impact of FLW on social, environmental and economic sustainability Investigating sustainable business model for FLW prevention, reduction and management 	Principato <i>et al.</i> (2023)
Social environmental and economic sustainability	<ul style="list-style-type: none"> Industry 4.0 technologies for FLW prevention and reduction Digital platforms for food surplus redistribution, sharing and FLW prevention Impact of delivery apps on FW Digital technologies for information sharing Digital technologies supporting sustainable business model models 	Jain and Gualandris (2023)

(continued)

Table 1. Research perspective summarising the key issues of FLW topic along the agri-food supply chain and agri-food industry. The deductive perspective is based on a systematic review of the literature. For the sake of simplicity, we report only the most recent references for each topic (table by authors)

FLW-related themes	Deductive perspective <i>Research viewpoint</i>	
	Most recurrent themes	Representative references
Causes of FLW and FLW measurement	<ul style="list-style-type: none"> • Measuring FLW along the agri-food supply chain • High focus on measuring FLW at farm-level and in households • FLW causes and drivers along the agri-food supply chain 	Jayasekara <i>et al.</i> (2024), Magalhães <i>et al.</i> (2022)
Supply chain governance	<ul style="list-style-type: none"> • Multi-stakeholder collaboration for FLW prevention, reduction and food surplus redistribution • Pricing strategies and incentives for FLW reduction • Industrial symbiosis for FLW prevention • Managing risks in supply chains and impact on FLW reduction • Power imbalances among supply chain actors and impact of FLW generation is not discussed in depth • Rise of strategic importance of FLW management as well as strategic alignment between business and operational strategy 	Somlai (2023), Sundgren (2022)
Food safety, security and healthy nutrition	<ul style="list-style-type: none"> • Investigating food surplus redistribution, donations and sharing activities • Role of food banks and charities in times of crisis • Impact of FLW reduction on food security improvement • FLW prevention and reduction in developing countries 	Capodistrias <i>et al.</i> (2022), Lowrey and Boyer (2024)

Table 1.

Although the theoretical background is based on a thorough analysis of the literature, the aim of this conceptual paper is not to categorise and analyse previous studies. Rather, we seek to reconceptualise the emerging themes by building upon real-world problems and opportunities from the management of FLW along the agri-food supply chains.

3. Reconceptualising food loss and waste: suggested research avenues

The complexity of managing agri-food supply chains (AFSCs) and the social, economic and environmental implications of FLW influence how stakeholders perceive the salience of its reduction. The idiosyncrasies of AFSCs add complexity to FLW management as they face different uncertainty and risk factors compared with other supply chains (Lezoche *et al.*, 2020). High perishability of fresh food products, such as fruits and vegetables, strict health and safety regulations, food security and quality policies, supply and demand uncertainty and price volatility (Soto-Silva *et al.*, 2016) are just a few factors impacting the complex management of AFSCs and contributing to FLW. Moreover, FLW management measures are extremely country-specific; for instance, measures designed for developed countries may not be suitable for developing countries with their poor logistics infrastructure and lack of cold

FLW related themes	Inductive perspective <i>Authors' experience and industrial viewpoint</i>		
	Project description	Data collection	Key concerns raised by practitioners
Operations and supply chain management	<ul style="list-style-type: none"> Investigating a company's efforts to reduce food waste in its food services worldwide through data-driven optimisation strategies, preventing over 4.2 million kilograms of food waste in two years 	<ul style="list-style-type: none"> Multiple in-depth interviews with company's food waste policy leader and their vendor for food waste analytics 	<ul style="list-style-type: none"> Charities have limited available resources and rely on volunteer labour, lack coordination and have conflicting goals with other stakeholders, which prevent adequate data collection and the development of structured operations and supply chain management solutions
Behavioural	<ul style="list-style-type: none"> Involvement in a university project for reducing FLW in university food service 	<ul style="list-style-type: none"> Multiple in-depth interviews with US university food service directors and their third-party contract caterers 	<ul style="list-style-type: none"> Consumers focus on food waste issues related to recycling and ignore their own more damaging behaviours such as meat consumption and leftover plate food University contracts with corporate food service providers are cost focused rather than other metrics such as waste reduction or local purchasing
Digitalisation	<ul style="list-style-type: none"> Investigating how digitalisation contributes to the sustainable business model innovation of a platform for FLW redistribution Investigating the impact of digital technologies for FLW prevention and reduction 	<ul style="list-style-type: none"> Interviews to the platform owner, technology provider and to the platform's customer and supplier sides Systematic literature review 	<ul style="list-style-type: none"> Actors, particularly public entities like municipalities, are generally hesitant to share their data due to privacy concerns B2B platforms for sharing and redistributing surplus food are still not widely adopted
Social environmental and economic sustainability	<ul style="list-style-type: none"> Investigating the business model of a digital multi-sided platform for the redistribution of food surplus from business actors to charities 	<ul style="list-style-type: none"> Interviews to the platform owner, technology provider and to the platform's customer and supplier sides, including charities and municipalities 	<ul style="list-style-type: none"> The survival of digital platforms in the market depends on the ability of the platform's leader to ensure the innovation of platform's business model and technology based on the customers and market's social, environmental and economic sustainability requirements

(continued)

Table 2. Industry perspective summarising the key issues of FLW topic along the agri-food supply chain and agri-food industry. The inductive perspective is based on the authors own experience. For the sake of simplicity, we report only the most recent references for each topic (table by authors)

FLW related themes	Inductive perspective <i>Authors' experience and industrial viewpoint</i>		
	Project description	Data collection	Key concerns raised by practitioners
Causes of FLW and FLW measurement	<ul style="list-style-type: none"> Measuring FLW along the entire agri-food supply chain (cultivation, milling, production, distribution and consumption) with the objective to identify opportunities to implement circular economy initiatives 	<ul style="list-style-type: none"> In-depth interviews with the company's managers and secondary data collection 	<ul style="list-style-type: none"> Companies tend to adopt short-term solutions or restrict their efforts to internal waste reduction without involving all supply chain stakeholders
Supply chain governance	<ul style="list-style-type: none"> Investigating the creation of collaborative initiatives for food surplus redistribution Investigating power imbalances among agri-food supply chain actors, such as lack of buying and bargaining power of small companies 	<ul style="list-style-type: none"> Interviews with Retailers/Charities/institutional stakeholders involved in food surplus redistribution projects In-depth interviews with a company in the UK craft brewing sector and secondary data collection 	<ul style="list-style-type: none"> Collaboration among supply chain actors for food surplus redistribution is frequently hindered by conflicting goals of involved actors as well as by their reluctance to share data Companies need adequate incentives to donate food surplus, such as the possibility to measure their social, economic and environmental impact for reporting purposes
Food safety, security and healthy nutrition	<ul style="list-style-type: none"> Investigating the effect of Covid-19 pandemic on the operations and logistics of a charitable organisation redistributing food surplus for the families in need in Italy. Investigating the key role of food banks in Italy, UK and USA Investigating the impacts of policies for food surplus redistribution in Italy (e.g. Legge Gadda, which aims at reducing food loss throughout the supply chain by encouraging shopkeepers to donate by lowering their waste tax) Analysing the relationship among charities and retailers in the context of food surplus redistribution in UK 	<ul style="list-style-type: none"> Interviews with Charity/Food bank/Municipalities 	<ul style="list-style-type: none"> The quality of surplus food donated to charities and food banks for redistribution to those in need is frequently low, with imbalanced nutrients being a common issue. Charities often find themselves burdened with surplus food from supermarkets that is no longer edible, necessitating their involvement in disposal efforts. Additionally, imposing a tax on food waste may inadvertently incentivise supermarkets to donate food in poor condition, further exacerbating the problem

Table 2.

chains, therefore requiring different solutions for FLW reduction (Tröger *et al.*, 2020). In addition, behavioural and cultural aspects related to FLW and each actor's role in AFSCs play a crucial role both at the customer's level and among other supply chain stakeholders. Generally, food supply chain actors tend to focus on local optimisation, with suboptimal results for the entire supply chain, and particularly in small companies, managers tend to consider the generation of food losses as a natural part of the production process (Kurthy *et al.*, 2021).

Therefore, considering FLW as a simple by-product of production, operations and logistics management processes is reductive given its complex nature. While O&SCM research has addressed waste minimisation, i.e. through lean philosophy, the unique features of FLW offer different implications and trade-offs. In light of these considerations, it is necessary to differentiate food waste from "traditional operational waste" and develop tools, solutions and theories to directly address the global issue of FLW. We thus urge the O&SCM field to reconceptualise the role of food loss and waste from a system thinking perspective and develop effective tools and novel managerial approaches to address FLW issues along the entire AFSC.

3.1 Research avenue 1: the "lean paradox" of unavoidable FLW requires adaption and reconceptualisation of O&SCM tools

In lean manufacturing, preventing and reducing waste usually brings tangible benefits to the organisation in terms of improved efficiency and overall performance optimisation. The main aim of lean management consists of eliminating waste to deliver quality products and services, minimising time and costs. However, reducing FLW drives unique behaviours as achieving "zero waste" goals in agri-food systems is challenging and requires significant coordination and costs. From a service-level perspective, food companies might keep extra capacity in their processes to satisfy service levels and increase supply resilience, resulting in food surpluses (Bajželj *et al.*, 2020). Some of the resulting "waste" is gathered by non-profit actors (charities, food banks, etc.) and redistributed to feed people in need, thus creating positive social impact. While a lean "zero-waste" AFSC would be more economically and environmentally sustainable, it would eliminate this source of food surplus. However, while food surplus redistribution has been recognised as a win-win strategy for avoiding food waste and feeding the needy, other studies question whether it has a genuine social benefit or it is a mechanism for accommodating overproduction in the food system, reinternalizing the system's excesses (Midgley, 2014). Indeed, charities often complain about the low quality of food surplus donations, thus questioning whether alternative supply sources would be more appropriate for feeding the needy. We define this challenge as a "lean paradox": the extreme optimisation may have negative impact on important social and environmental issues. Assuming that a certain level of FLW is unavoidable, O&SCM scholars should investigate solutions addressing FLW and feeding the people in need that account not only the economic costs but also social and environmental implications. Researchers and practitioners could develop and adapt O&SCM tools to address these trade-offs as well as consider the public policy approaches. Therefore, we derive the first research question:

- R1.* How can supply chain innovation simultaneously minimise FLW while mitigating the negative impacts on social and environmental dimensions?

3.2 Research avenue 2: enhancing ecosystem health by prioritising FLW prevention with O&SCM tools

The "Waste equals food" key principle of the Cradle-to-Cradle framework (Braungart and McDonough, 2002) states that the "waste" of one system becomes food for another. This

concept aligns with the need for recognising food surplus, food loss and waste as sources of value along the AFSC. First, in line with circular economy principles, food waste prevention activities, such as food surplus redistribution for human consumption for social impact [1], should be prioritised relative to other FLW management activities, such as recycling food waste into animal feed or energy generation (Papargyropoulou *et al.*, 2014). As the circular economy perspective incorporates a social dimension, surplus food distribution leads to increased food security by ensuring access to food for those in need (Kusumowardani *et al.*, 2022). Recent studies indicate that adopting a harm minimisation approach is inadequate, emphasizing the need for supply chains to actively contribute to the regeneration of social-ecological systems, going beyond mere economic sustainability (Gualandris *et al.*, 2024). Food loss and waste, in particular, exacerbate ecosystem and biodiversity damage and undermine the long-term resilience of the global food system (Bajželj *et al.*, 2020), as it accounts for significant portions (around 24%) of global water, cropland and fertilizer use as well as contributing to CO₂ and nitrogen emissions (Guo *et al.*, 2023).

Therefore, circular economy principles could be considered through the adoption of the Ecologically Dominant logic (Montabon *et al.*, 2016), as opposed to Triple Bottom Line logic, as Ecologically Dominant logic recognises that the environmental sustainability aspect should be prioritised over the social one, which in turn has a higher priority over the economic aspect. In this sense, food system sustainability becomes a prerequisite for long-term resilience (Bajželj *et al.*, 2020). By integrating the principles of a regenerative supply chain and the lens of both the Ecologically Dominant logic and the circular economy, the approach would be to build food systems that allow natural capital to thrive, as food is grown through practices tailored to local contexts and provides habitat for a wide range of organisms, thus enhancing biodiversity. From this perspective, a healthy and functioning natural ecosystem is necessary for mankind's survival since social sustainability is dependent and supported by the environment (Montabon *et al.*, 2016). As a result, we ask:

R2. How can FLW management strategies use innovation to enhance the environment, to improve society impact and finally, to enhance economic outcomes?

3.3 Research avenue 3: beyond FLW measurement, tracking and monitoring, towards a digital AFSC

Industry 4.0 digital technologies are widely adopted across AFSC since they provide several benefits in terms of product traceability through blockchain technology, measuring and monitoring through sensing devices, enhancing sustainability performance and enabling “smart” agriculture (Trevisan and Formentini, 2023). Digital technologies offer potential for achieving circular agri-food systems as new transactions and collaborations are possible (Ciccullo *et al.*, 2021). Nevertheless, the adoption of digital technologies for reducing and preventing FLW is still limited; the majority of studies deal with digital platforms, especially in the downstream part of the AFSC (Trevisan and Formentini, 2023) and frequently have the objective of redistributing or sharing food surplus (Cane and Parra, 2020). Recently, Principato *et al.* (2023) studied the business model of the digital business-to-business (B2B) platform “Regusto”, which aims at measuring social, environmental and economic impacts of enhancing food surplus redistribution activities at the B2B level. The study suggests that leveraging the opportunities offered by digital technologies fosters social, economic and environmental value creation and supports business model innovation, confirming that digital technologies can enable novel sustainable business models. O&SCM could adapt ideas from Industry 4.0 and digital transition to the context of FLW going beyond food traceability at single supply chain tiers. For example, Sainsbury (UK) established a “partnership in produce” agreement with a fresh produce cooperative, not only ensuring high-quality products for the retailer and access to a nation-wide market for the cooperative but also

reducing FLW through joint planning (Bhattacharya and Fayezi, 2021). The agreement required a governance structure, which enabled a minimal level of alignment of different objectives and incentives among involved actors (Moreno-Miranda and Dries, 2022). This leads to the third research question:

- R3. How can digital technologies be adopted along the entire AFSC to enable collaboration and information sharing among supply chain actors to meet environmental, social and economic goals?

3.4 Research avenue 4: governance mechanisms, policy, coordination, integration and supply chain vision

AFSC are often characterised by lack of supply chain coordination and integration, such as poor communication exacerbated by difficulties of accurate demand forecasting, lack of information and demand-data sharing among actors and poor planning practices (Kaipia *et al.*, 2013). Information asymmetry and power imbalances are common among large firms and small suppliers, as the AFSC has experienced mass consolidation in many of the key supply chain roles, such as retailers, but additionally with key commodity brokers and producers, which hinders the achievement of a common supply chain vision beyond cost reduction and efficiency (Pullman and Wu, 2021; Touboulic *et al.*, 2014). However, Liljestrand (2017) provides an example of how logistics solutions can be adapted to address FLW after identifying its causes. Indeed, the right logistic solution is strongly dependent on the focal food product category, supply chain actor or geopolitical context. For instance, reducing prices for soon-to-expire retail food to prevent waste may have unintended consequences, as waste streams could simply shift from retail to household level. This example underlines that a supply chain strategy, supported by appropriate policy and governance mechanisms, is essential to reduce FLW. Additional research is required to understand the role played by national policies on food surplus redistribution, the consequences of which emerged in recent studies investigating Italian and French retailers and charities (Owasi and Formentini, 2021). Collaboration between private and public sectors, whereby farmers, retailers/wholesalers, NGOs and governments work together to reduce FLW, is suggested as a solution (Bhattacharya and Fayezi, 2021), but in practice little evidence exists regarding formal governance mechanisms to promote such practices at the AFSC level (Sá *et al.*, 2020). On the contrary, evidence from the AFSC literature shows the preference for firm-level strategies rather than supply chain solutions and a lack of inter-firm collaboration (Sá *et al.*, 2020). O&SCM should consider the establishment of governance structures to capture value from specific investments aimed at creating cooperation among AFSC members, society and the environment, with an overarching goal of establishing a circular agri-food system. We thus propose the following two research questions:

- R4a. How can governance mechanisms support innovation via digitalisation efforts for FLW reduction throughout the supply chains?
- R4b. How can governance mechanisms for supply chain collaboration mitigate the FLW resulting from supply chain power imbalances?

3.5 Research avenue 5: food safety and food security, two facets of supply chain resilience

The connection between FLW and supply chain resilience demands greater attention from both O&SCM researchers and practitioners. However, any discussion surrounding AFSC resilience cannot be adequately addressed without considering food safety and security. The term food safety refers to all those hazards, whether chronic or acute, that may make food dangerous to consumers' health [2]. Consumers expect to be safeguarded against these

hazards throughout the entire food chain. In food sectors with the most strict regulations (i.e. dairy, meat), food safety concerns are one of the primary causes of food losses, while in the fresh produce sectors, losses occur due to perceived rather than actual food safety issues (Toma *et al.*, 2020) or simply for cosmetic concerns.

Like the multifaceted nature of “sustainability”, the term “food security” encompasses various dimensions (Mooney and Hunt, 2009). Food security can be viewed in the context of addressing hunger and malnutrition, where marginalised populations are unable to access sufficient nutrients and calories. On the other hand, from a community perspective, food security goes beyond food access to incorporate measures to improve local food economies, protect the environment and preserve cultural heritage as well as addressing individuals’ well-being through food insecurity organisations (Thornton *et al.*, 2024). Minimising food loss at the initial stages of the supply chain (farm level) in countries facing significant food insecurity can enhance overall food security [3].

However, AFSCs involve organisations which are vulnerable to different yet interconnected food security risks. In particular, food production and delivery are subject to extreme weather volatility and climate change, energy price fluctuations and logistics restrictions (Stone and Rahimifard, 2018) as well as to geopolitical conflicts, their resulting instabilities and changes to food habits. For example, drought impacts sugar cane farmers and beverage processors differently, as the former suffer major losses of crops while the latter avoids the negative impacts on their operations, thanks to their diversification of sourcing (Sá *et al.*, 2020). Here, downstream nodes are able to ensure forward supply chain resilience even though upstream organisations lack resiliency due to farmers’ inability to adapt to the changed climate. In other contexts, disruptions upstream in the supply chain can cause major damages downstream, with negative consequences for food safety and food security. For instance, the recent conflict in Ukraine reduced cereal production by 40% year over year as well as a reduction in availability and access to critical agricultural inputs such as fertiliser (FAO, 2022). Therefore, O&SCM should investigate the AFSC ability to cope with risks and vulnerabilities and focus on factors like collaboration and information sharing to achieve supply chain resilience (Mishra *et al.*, 2022). Systems-wide solutions should be incentivised, as currently downstream nodes tend to search for individual solutions to assure their operations continuity but fail to address future uncertainties (Sá *et al.*, 2020), with a negative effect on the resilience of the entire AFSC. This leads to the following research question:

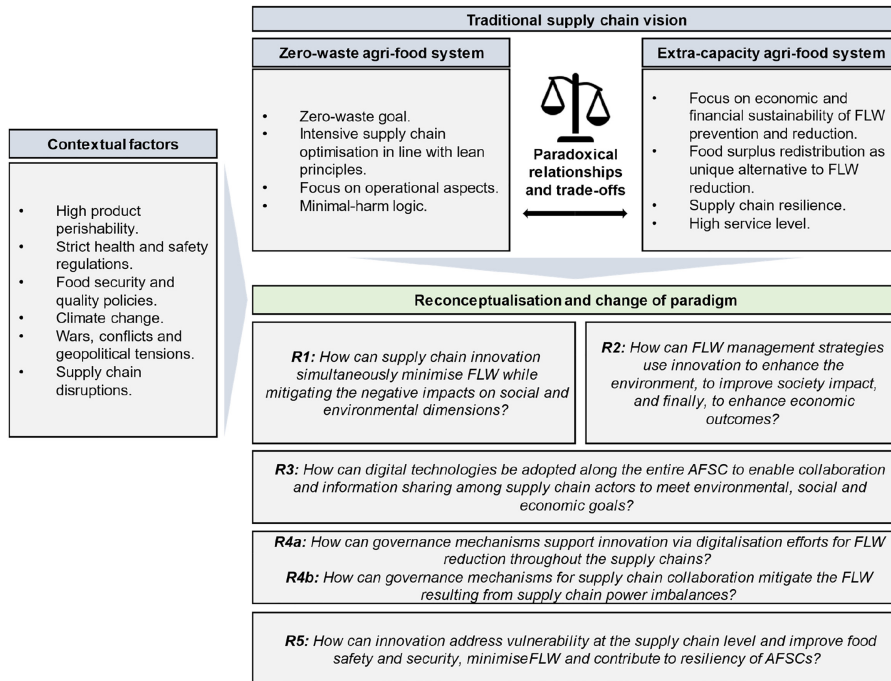
- R5. How can innovation address vulnerability at the supply chain level and improve food safety and security, minimise FLW and contribute to resiliency of AFSCs?

The present paper makes a significant contribution by challenging the prevailing perspective dominating O&SCM research on FLW within agri-food supply chains. It also aims to inspire practitioners to broaden their awareness of the multifaceted nature of the FLW issue.

Previous research has predominately centred on operational aspects of FLW prevention and reduction, such as FLW measurement or redistribution, with a focus on optimal production, logistics and inventory management and frequently focusing on the downstream part of the supply chain (Chauhan *et al.*, 2021). As a consequence, the primary objective of both researchers and practitioners has been the economic benefits deriving from FLW reduction, with secondary consideration given to the positive environmental impacts. A similar approach has been adopted in research about food surplus redistribution as an emergency solution to help people suffering from hunger and poverty, especially during and after the COVID-19 pandemic. The trade-offs between economic, social and environmental benefits are evident in the management of FLW, exacerbated by recent global crises such as the pandemic, geo-political conflicts and emergent commercial tensions. While previous literature partially deals with FLW

complexities and rapidly evolving contextual factors, AFSCs practitioners at every supply chain tier are looking for answers to their challenges, thus re-shaping a research agenda to address the FLW issue.

In this paper, we propose five possible research avenues which could guide researchers in the reconceptualisation of the FLW challenge in AFSCs by taking into account the idiosyncrasies of FLW and AFSCs, potentially leading to a change of the existing paradigm and new perspectives. As summarised in Figure 1, we first explore the “lean paradox” (R1), which underscores the importance of considering broader social implications when implementing efficiency-driven strategies within food supply chains. Secondly, we advance the need for a paradigm shift in how FLW is perceived and managed (R2). We recommend moving away from a linear logic that prioritises economic benefits towards the prioritisation of environmental protection and social sustainability over the economic goal. Third, we suggest integrating Industry 4.0 digital technologies for FLW prevention and reduction (R3); applications which remain limited and could be an enabler for achieving the aforementioned goals. Moreover, the paper underscores the importance of governance mechanisms and policy interventions in promoting collaboration and alignment of incentives among stakeholders for FLW reduction (R4a and R4b). By establishing governance structures that support sustainability, digitalisation and reducing power imbalances, supply chains can better address FLW challenges and work towards shared goals. The last proposed avenue explores supply chain resilience-related food safety and security (R5). It investigates how vulnerability elements can be managed at the supply chain level to ensure food safety and security even in the face of disruptions.



Source(s): Figure by authors

Figure 1.
Discussion framework

4. Conclusions and contributions

Drawing on practical examples deriving from the authors' experience, case studies and ultimately, FLW academic literature, this paper makes a contribution by challenging existing O&SCM literature on FLW and identifies the current limitations O&SCM scholars and practitioners experience in managing FLW across the entire agri-food supply chain. FLW is a multifaceted phenomenon with various challenges such as product perishability, depletion of natural resources, biodiversity and environmental destruction, social inequalities and economic trade-offs. For this reason, we recognise the uniqueness of the issues and conclude that FLW cannot be treated by O&SCM scholars and practitioners as simple operational waste according to lean management principles. The paper presents five key research avenues for understanding and addressing FLW in agri-food supply chains, which serve as research questions for stimulating future academic contributions. Ultimately, the paper aims to bridge the gap between academics and practitioners by considering the voice of AFSC actors and fostering collaboration with key stakeholders, such as government bodies, non-profit organisations, and other entities which may benefit from food surplus redistribution practices and contribute to FLW prevention and reduction.

Notes

1. <https://sdgs.un.org/topics/food-security-and-nutrition-and-sustainable-agriculture>
2. <https://www.fao.org/3/y8705e/y8705e03.htm>
3. <https://www.unep.org/news-and-stories/press-release/food-loss-and-waste-must-be-reduced-greater-food-security-and>

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