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VIEWPOINT

Determining sustainability key performance indicators for food loss reduction

1. Introduction

Globally, food systems produce about 24% of the greenhouse-gas emissions that are responsible for 60% of terrestrial biodiversity loss, as well as being the main cause of 33% of soil degradation (Rohmer *et al.*, 2019). In the European Union (EU) context, the food sector and agriculture production, in particular, is the most energy and water demanding sectors (Maguire *et al.*, 2017). A growing population, with an unsustainable production and consumption pattern of food, puts further pressure on the environment in the form of resource depletion (Unep, 2016; Rohmer *et al.*, 2019) and poses a threat to the food security of future generations (Rohmer *et al.*, 2019; Irani and Sharif, 2016). Sustainable development that addresses environmental, economic and social issues is therefore receiving growing attention in the context of food supply chain (FSC) management (Luo *et al.*, 2018; Muth *et al.*, 2019).

The FSC is a highly dynamic and complex network involving many actors, a variety of products and a long series of processes, ranging from agriculture production to manufacturing processes and through to logistic and retail activities (Trienekens *et al.*, 2012). Recently, increasing attention has been given to food loss and food waste issues and their implications in terms of food security and sustainability development (Khalid *et al.*, 2019; Gokarn and Kuthambalayan, 2019; Irani *et al.*, 2018). In fact, food is an essential factor in many sustainable development goals (SDGs) such as no poverty, zero hunger, good health and well-being, responsible consumption and production, clean water and sanitation and life on land.

Food loss and food waste, therefore, are a significant global problem for several reasons. First, there are around one billion people in the world and most of those from developing countries are undernourished (United Nations, 2018). Second, in food supply chains, food loss and food waste are resulting in economic loss with the present phase of discarding, leading to financial losses of up to US$1 trillion per year globally (Hanson *et al.*, 2016; Lipinski *et al.*, 2017), which affects all the supply chain actors, including the final consumer (Bourlakis *et al.*, 2014). Finally, it also indicates wastage of natural resources, such as soil and water at the farm-gate level and shows that unnecessary pollution has been added to the environment (Muth *et al.*, 2019). Therefore, reducing food loss and food waste has continued to be one of the targets of the SDGs to be achieved by the 2030 Agenda – namely, the SDG 12.3: "*By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses*" (United Nations, 2018). As a result, sustainability standards and performance system requirements can contribute to reducing different risks for FSC entities, including risks such as poor quality, delivery problems, demand and supply misalignment and climate risks (Nakandala *et al.*, 2017). Performance measurement is, therefore, a critical issue in FSC management and a key factor in monitoring and controlling supply chain operations in order to increase FSC efficiency (Acar *et al.*, 2019).

Noting the above, this paper presents a brief description of the impact of food loss and waste reduction on food security. It then provides the main themes regarding food loss, which are related to inefficiencies along FSC, rather than to food waste due to behaviours at the

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consumption stage. In doing so, it provides coherent knowledge about the global problem of food loss.

2. Food loss reduction as the bedrock of enhancing food security

Food insecurity is one of the significant development challenges of the world (FAO, 2018). As mentioned before, close to a billion people are still malnourished (United Nations, 2018). Recently, there is renewed attention regarding the food insecurity issue at global and national levels (Khalid *et al.*, 2019). Some efforts are currently being considered by governments and decision-makers to mitigate the food insecurity threat, such as: increasing the productivity of the agriculture sector, especially in developing and less productive countries (Pradhan *et al.*, 2015); enhancing trade in food (Singh, 2017; Clapp, 2017) and shifting towards plentiful types of food (Ranganathan *et al.*, 2016). Nevertheless, this situation is not expected to improve soon, as the world's population will continue to increase and food production will also be affected by climatic changes, especially in countries suffering from the problem of food insecurity (Aragie *et al.*, 2018). However, reducing the considerable level of food loss and food waste is one of the most effective ways of closing the gap in food requirement (Dou *et al.*, 2016), roughly estimated at one-third of food produced for humans globally (FAO, 2019). The statistics point out that, if a quarter of the total food currently lost or wasted globally could be saved, it would be enough to feed all the hungry people in the world (Ocicka and Raźniewsk, 2018).

Food security is defined by the Food and Agriculture Organization (FAO) as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." (FAO, 2018, p. 159). Based on the FAO definition, food availability, physical and economic access to food, food utilization and stability over time are the four main requirements for food security. Internationally, the FAO has focused on the impact of food loss and waste across the supply chains in its efforts to improve food security, raise income, stimulate economic development and save the environment (Gustavsson *et al.*, 2011).

Moreover, food security and food loss and waste are closely associated, as reducing food loss and waste could lead to reducing the pressure on natural resources and increasing the availability of food for more people (Garcia-Herrero *et al.*, 2018; Aktas *et al.*, 2018), thereby increasing food self-sufficiency and enhancing food security (Clapp, 2017). Achieving food security is a significant challenge that requires a set of efforts and actions to be established by many actors, including governments, non-governmental organisations, food businesses, agriculturalists and supply chain members. Undoubtedly, tackling food loss and food waste issues is one of the key milestones in achieving global food security (Irani and Sharif, 2016).

3. Key causes of food loss

Food loss and food waste occur along food supply chain stages due to significant and continuous changes in the mass and quality of different products from agriculture production to consumption (Lemaire and Limbourg, 2019). There is no agreement among researchers on the definition of food loss and food waste. Indeed, researchers have used food loss and food waste interchangeably. As a consequence, there is difficulty in considering and comparing the findings from different countries in the context of food loss and waste (Derqui *et al.*, 2016). This lack of clarity may have a negative impact on loss and waste reduction policies (Koester, 2017). However, few studies differentiate between food loss and food waste. For example, Parfitt *et al.* (2010) linked food waste at later stages with behavioural issues. Food loss, conversely, relates to a lack of infrastructural capacity. Similarly, (Lipinski *et al.*, 2013; Hlpe, 2014; Gustavsson *et al.*, 2011) have used the same classification in their studies. This paper considers the food loss issue from a supply chain management perspective, similar to the

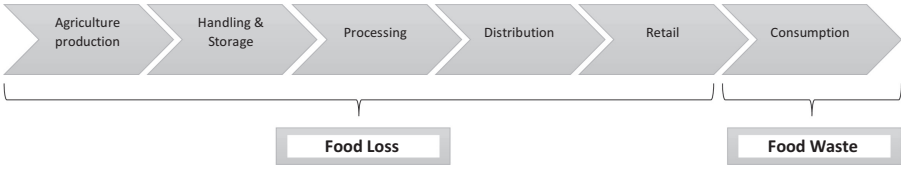
FAO in defining food loss as "a decrease in mass (dry matter) or nutritional value (quality) of food that was originally intended for human consumption" FAO (2013, p. 8). These losses are mainly due to inefficiencies in the FSCs, such as poor infrastructure, poor logistics, lack of technology, insufficient skills, lack of market access and inefficient management solutions, in addition to limited control factors such as natural disasters and weather fluctuations (see Figure 1).

Identifying the key causes of food loss is imperative for improving the current situation and helping to reduce the losses along the supply chain by developing and designing suitable practices and programmes. There are numerous studies from the normative literature that have identified various causes of food loss from different perspectives. Table 1 presents the main causes of food loss.

Each organisation along the supply chain is responsible for improving the performance of FSC in the context of food loss reduction. Therefore, the actors should focus on the internal processes and regulations, of which they have full control, to manage food loss in their supply chains. At the same time, they should contribute to tackling other causes of food loss resulting from other stakeholders. From this point of view, food loss causes can be categorized into three groups based on the organisational theory. First, internal causes are related to the internal activities and environment of organizations along the supply chain. These factors that generate food loss include operational activities, product-related causes, organizational factors, etc. Second, there are micro-environmental causes comprised of practices by different stakeholders such as suppliers, consumers and competitors. Finally, there are macro-environmental causes, over which the supply chain entities have no control or limited control. These include natural, political and economic factors. As such, Figure 2 seeks to offer the causes of food loss based on the organisational environment along the FSC and the next sections present a brief discussion regarding each group of causes.

3.1 Internal causes

These are composed of inefficient operations management, product-related causes and organisational factors. A wide range of food loss causes is associated with operational practices along the supply chain. For example, food loss may occur during harvesting, production, handling and storage, processing or distribution-management operations (Dora *et al.*, 2019). Poor planning is the first point of food loss because of misalignment of demand and supply (Muriana, 2017; Beausang *et al.*, 2017) or inaccurate forecasting (Gunders and Bloom, 2017), which lead to overproduction. In addition, limited use of new technology is influential in food loss generation (Vázquez-Rowe *et al.*, 2019). Inappropriate logistics facilities are also related to food loss, such as improper handling practices (Raut *et al.*, 2019a; Balaji and Arshinder, 2016), sub-optimal storage (Sharif and Irani, 2016; Wohner *et al.*, 2019), poor transportation (Verma *et al.*, 2019; Lipińska *et al.*, 2019), inadequate packaging (La Scalia *et al.*, 2019); Dora *et al.*, 2019) and lack of proper cold-chain facilities and temperature control (Wu *et al.*, 2019; Raut *et al.*, 2019b).



Source(s): Adapted from FAO (2013)

Figure 1.
Food loss and waste along the food supply chain stages

Table 1.
The main causes of food loss along different stages of FSC

FSC stage	Themes and research related to food loss causes	References
Agriculture production loss Description: loss occurs during and right after harvest operations	Natural disasters and weather fluctuations	FAO (2013), Buzby and Hyman (2012), Irani and Sharif (2016), Sharif and Irani (2016), Gunders and Bloom (2017), Verma *et al.* (2019)
	Poor harvesting methods	Balaji and Arshinder (2016), Papargyropoulou *et al.* (2014), FAO (2013), Gustavsson *et al.* (2011)
	Quality-standards rejections (colour, appearance, size, etc)	Mena *et al.* (2014), Arias Bustos and Moors (2018), Irani and Sharif (2016), Sharif and Irani (2016), Gunders and Bloom (2017)
	Poor operations management	Mena *et al.* (2014), Irani and Sharif (2016), Sharif and Irani (2016)
	Lack of infrastructure	Verma *et al.* (2019), Raut *et al.* (2019a), Buchner *et al.* (2012), FAO (2013)
	Labour shortages which affect the harvest level	Gunders and Bloom (2017), Verma *et al.* (2019)
	Poor logistics (packaging, storage and transportation)	Kazancoglu *et al.* (2018), Liljestrand (2017), Beausang *et al.* (2017), Principato *et al.* (2019), FAO (2013)
	Lack of research and training for food loss prevention	Arivazhagan *et al.* (2016), Gunders and Bloom (2017), Verma *et al.* (2019)
	Misalignment of demand and supply, which leads to overproduction	Liljestrand (2017), Beausang *et al.* (2017), Muriana (2017), Raut *et al.* (2019a), Gunders and Bloom (2017)
	Lower market price which forces the producers to leave the product in the field without harvesting it	Priefer *et al.* (2016), Muriana (2017), Gunders and Bloom (2017)
	Absence of cooperation between FSC actors	Verma *et al.* (2019); Balaji and Arshinder (2016)
Handling and storage loss Description: loss occurs during upstream handling, transportation and storage	Inadequate packaging and sub-optimal storage	La Scalia *et al.* (2019), Kazancoglu *et al.* (2018), Arias Bustos and Moors (2018), Muriana (2017), Irani and Sharif (2016), Sharif and Irani (2016), Dora *et al.* (2019), Wohner *et al.* (2019), Vázquez-Rowe *et al.* (2019)
	Poor inventory management practices	Dora *et al.* (2019), Willersinn *et al.* (2015)
	Improper handling practices	Raut *et al.* (2019a), Balaji and Arshinder (2016)
	Poor transportation	Dora *et al.* (2019), Lipińska *et al.* (2019), Vázquez-Rowe *et al.* (2019), Verma *et al.* (2019), Willersinn *et al.* (2015)
	Lack of proper cold-chain facilities and temperature control	Arias Bustos and Moors (2018), Wu *et al.* (2019), Raut *et al.* (2019a), Balaji and Arshinder (2016)
	Ignoring food-safety requirements	Gunders and Bloom (2017), Willersinn *et al.* (2015), FAO (2013)
	Lack of communication between SC members	Arias Bustos and Moors (2018), Vázquez-Rowe *et al.* (2019), Balaji and Arshinder (2016)
	Lack of awareness regarding food loss impact	Arias Bustos and Moors (2018), Vázquez-Rowe *et al.* (2019)
	Limited use of new technologies	Arias Bustos and Moors (2018), Vázquez-Rowe *et al.* (2019)
	Lack of infrastructure	Irani and Sharif (2016), Sharif and Irani (2016), Vázquez-Rowe *et al.* (2019), Raut *et al.* (2019a)

(*continued*)

Table 1.

FSC stage	Themes and research related to food loss causes	References
Processing loss Description: loss occurs during the manufacturing process, treatment and packaging	Poor process control	Mena *et al.* (2014), Vázquez-Rowe *et al.* (2019), Dora *et al.* (2019)
	Inefficient operations management	Irani and Sharif (2016), Sharif and Irani (2016), Dora *et al.* (2019)
	Lack of training regarding the proper practices to avoid food loss	Arivazhagan *et al.* (2016), Verma *et al.* (2019), Dora *et al.* (2019)
	Product defects and damage	Buzby and Hyman (2012), Mena *et al.* (2011), Richter and Bokelmann (2016), Dora *et al.* (2019)
	Quality standards	Mena *et al.* (2014), Gunders and Bloom (2017), Willersinn *et al.* (2015)
	Ignoring food-safety requirements	Willersinn *et al.* (2015)
	Technical faults during the manufacturing process	Richter and Bokelmann (2016), Gunders and Bloom (2017), Verma *et al.* (2019)
	Trading standards and retail regulation	Richter and Bokelmann (2016)
	Packaging problems	Buzby and Hyman (2012), Mena *et al.* (2011), Irani and Sharif (2016), Arivazhagan *et al.* (2016), Sharif and Irani (2016), Gunders and Bloom (2017), Wohner *et al.* (2019)
	Sub-optimal inventory management	Dora *et al.* (2019), Vázquez-Rowe *et al.* (2019), Willersinn *et al.* (2015)
	Poor demand forecasting	Buzby and Hyman (2012), Mena *et al.* (2011), Mena *et al.* (2014), Irani and Sharif (2016), Sharif and Irani (2016)
	Overproduction due to misalignment between supply and demand	Buzby and Hyman (2012), Mena *et al.* (2011), Gunders and Bloom (2017), Willersinn *et al.* (2015)
	Inefficient management solutions	Buzby and Hyman (2012), Mena *et al.* (2011), Willersinn *et al.* (2015)
Distribution loss Description: loss occurs during the downstream distribution of final products to wholesalers and retails	Poor inventory practices	Mena *et al.* (2014); Balaji and Arshinder (2016)
	Poor logistics (packaging, handling, and transportation)	Li *et al.* (2014), Gunders and Bloom (2017), Wohner *et al.* (2019)
	Lack of cold-chain facilities	Priefer *et al.* (2016), Gunders and Bloom (2017), Balaji and Arshinder (2016)
	Lack of training	Arivazhagan *et al.* (2016)
	Long delivery distance	Priefer *et al.* (2016), Arivazhagan *et al.* (2016), Gunders and Bloom (2017)
	Increasing the number of intermediaries and product deliveries	Priefer *et al.* (2016), Balaji and Arshinder (2016); Göbel *et al.* (2015)
Retailing Description: loss occurs during retailing activities	Demand uncertainty due to specific periods (e.g. holidays, special events)	Göbel *et al.* (2015), Mena *et al.* (2014), Muriana (2017), Gunders and Bloom (2017), Mena *et al.* (2011)
	Sales rates and dimensions	Lebersorger and Schneider (2014), Mena *et al.* (2014)
	Forecasting accuracy (e.g. overstocked product displays)	Mena *et al.* (2014), Mena *et al.* (2011), Gunders and Bloom (2017)
	Logistics problems (inadequate handling, damaged packaging and improper stock techniques)	Mena *et al.* (2014), Liljestrand (2017), Wohner *et al.* (2019), Principato *et al.* (2019)
	Cold-chain interruptions	Mena *et al.* (2011), Wu *et al.* (2019)
	Marketing strategies and pricing policies	Muriana (2017), Irani and Sharif (2016), Sharif and Irani (2016), Mena *et al.* (2011)
	Labelling issues	Mena *et al.* (2014), Gunders and Bloom (2017), Buchner *et al.* (2012)
	Shelf life management	Mena *et al.* (2014), La Scalia *et al.* (2019)

Source(s): Compiled by the authors

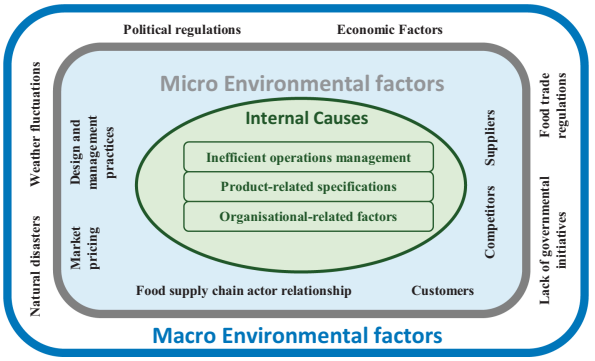


Figure 2.
The key food loss generation factors in each organisation along the supply chain

Source(s): The authors

Product-related specifications are assumed to have a considerable impact on food loss regardless of food type (Mena *et al.*, 2014). The products' quality standards are considered as the main cause of food loss (Irani and Sharif, 2016). The products should meet market-quality requirements (Richter and Bokelmann, 2016) in terms of safety (Willersinn *et al.*, 2015), appearance and size (Gunders and Bloom, 2017; Mena *et al.*, 2014). In addition, there are product defects and damage along the supply chain (Dora *et al.*, 2019; Richter and Bokelmann, 2016).

The organisational-related factors which lead to food loss generation vary from one organisation to another. Previous studies have highlighted that a shortage of labourers contributes to reducing the harvesting level in the field (Verma *et al.*, 2019). Insufficient training regarding adequate practices to avoid food loss (Verma *et al.*, 2019; Dora *et al.*, 2019) and inadequate handling and sorting (Arivazhagan *et al.*, 2016) are other causes of food loss. An additional cause is a lack of awareness regarding the negative impact of food loss (Vázquez-Rowe *et al.*, 2019, Arias bustos and Moors, 2018). Moreover, inefficient marketing strategies generate food loss in organisations. For example, failing to offer a price reduction for a low-quality product generates food losses on the retailers' side (Aschemann-Witzel, 2018). However, some studies have mentioned that promotions generate food waste on the customer side through altering purchasing behaviour (Gunders and Bloom, 2017).

3.2 Micro-environmental causes

These are comprised of the practices by different stakeholders along the supply chain, such as suppliers, consumers and competitors. Indeed, the design and management practices of the FSC are associated with food loss generation. For example, supply chain routes and long delivery distances (Gunders and Bloom, 2017; Priefer *et al.*, 2016), an increasing number of intermediaries (Balaji and Arshinder, 2016) and a large number of product deliveries (Arivazhagan *et al.*, 2016) are all effective in generating food loss. In addition, inefficient management solutions by supply chain actors introduce food losses along the supply chain (Willersinn *et al.*, 2015).

The relations between the FSC actors may lead to food loss (Balaji and Arshinder, 2016). For example, a lack of communication (Vázquez-Rowe *et al.*, 2019, Arias bustos and Moors, 2018) or an absence of cooperation between supply chain members (Verma *et al.*, 2019) has a negative effect on reducing food loss. In addition, the rejection of some products, based on contractual agreements with restricted quality requirements, may lead to food loss (Richter and Bokelmann, 2016; Tostivint *et al.*, 2017).

Furthermore, market pricing can contribute to food loss generation (Irani and Sharif, 2016; Muriana, 2017) when some producers leave the products at the field if the market prices are lower than the harvesting costs (Muriana, 2017). Furthermore, competitors' activities and strategies can also lead to food loss; for example, when the competitor offers the same product with a competitive price (Mena *et al.*, 2014, De Hooge *et al.*, 2018).

3.3 Macro-environmental causes

In this context, the supply chain entities have limited control, or no control, over natural, economic and political factors. Regarding natural causes, weather fluctuations generate food loss in different areas, including production, handling, transportation and demand (Verma *et al.*, 2019). For example, variations in weather affect fresh foods in terms of quality and shelf lifetime, as well as causing irregular demand due to changes in customer purchasing behaviours (Mena *et al.*, 2011). Political regulations also play a role in food loss generation. For example, food-safety standards in some countries limit the use of food for other purposes in order to avoid losses (Göbel *et al.*, 2015). Trade relations between countries in the field of food exchange are affected by political changes, which cause some losses due to the stopping of exports or imports. In addition, a lack of governmental initiatives and policymaking efforts (Lee, 2018) aimed at reducing the level of food loss also contributes to food loss generation. Furthermore, economic factors influence food loss generation and prevention as well, especially in developing countries due to a lack of new technologies and poor infrastructure.

The authors believe that it is crucial to know the role of the organisation in food loss generation to prevent losses and to identify sustainable solutions. Furthermore, the classification of food loss causes is also expected to help food companies to address the internal causes and then to understand the mutual and external factors. In doing so, it is important for organisations to focus on the interaction between these factors in order to improve their operations and activities in the context of food loss reduction.

4. Inclusion of food loss in sustainability performance indicators (SPIs): a call for action

Increasing awareness of social and environmental sustainability helps to encourage food companies to consider these valuable measures in their performance systems (Duman *et al.*, 2018). Therefore, food companies should consider sustainability issues by using the decision-making process to balance the three pillars (economic, social and environmental) of sustainability performance (Acar *et al.*, 2019). Consequently, performance measures are beneficial in formulating standards to evaluate performance measurement criteria. In doing so, help to provide stakeholders with the opportunity to pay more attention to a specific area. SPIs have been defined as "indicators that help to measure the performance of an organization at least in one of the three dimensions of sustainability" (Saeed and Kersten, 2017). In the context of the food industry, a majority of sustainable-assessment research papers have primarily considered only one or two dimensions (León-Bravo *et al.*, 2017). However, most recent studies have focused on the three pillars of sustainability performance (e.g. Tsolakis *et al.*, 2018; Dania *et al.*, 2018; Saeed and Kersten, 2017).

The food loss issue remains a significant challenge in FSC management due to its negative impact on social (e.g. failure to secure food for a wider population), environmental (energy, soil, water, greenhouse-gas emissions) and economic factors (e.g. direct loss for all actors along the supply chain) (Alamar *et al.*, 2018). Similarly, Gokarn and Kuthambalayan (2017) have summarized the impact of food loss and waste on the three pillars of sustainability: environmental (e.g. increase in greenhouse-gas emissions, non-productive use of natural resources such as agricultural land

and water and waste from non-renewable energy); social (e.g. increasing food prices, which affects access, negative effect on nutrition levels) and economic (e.g. profit reduction, disposal and treatment costs and negative impact on financial resources for other investments).

However, the insights from the literature review show that the majority of sustainable-assessment research papers in the food industry have primarily considered only one or two sustainability dimensions, which has caused unbalanced measurement models in the context of sustainability development. In addition, most of the research fails to include food loss in the performance indicators, instead focussing predominantly on general indicators, which might be due to difficulties in quantifying food loss along the supply chain. Inclusion of food loss in key performance indicators (KPI) can help food industries to monitor and control the supply chain, which leads to reducing food loss to manageable proportions (Dora, 2019). Moreover, the KPIs help to improve awareness, as well as targeting and monitoring food loss along the supply chain (Vlajic *et al.*, 2012). Therefore, further research is needed to explore the indicators of food companies' performance in the context of food loss and waste (Lemaire and Limbourg, 2019). As a result, food companies should consider sustainability issues by using the decision-making process to balance the three pillars of sustainability performance (Acar *et al.*, 2019). Consequently, more comprehensive systems targeting the strategic decision-making level are needed in order to develop holistic models that can integrate environmental, social and economic issues with particular attention being paid to sustainability development aspects in FSC (Rohmer *et al.*, 2019).

The authors believe that understanding of all these inter-relationships between the main causes of food loss and consideration of its environmental and socio-economic impacts represents the most appropriate way to evaluate the current performance measurement in order to mitigate food loss risks and enhance food security. Therefore, there is a need for an integrated model for evaluating the key performance indicators of the food industry under sustainable development dimensions in the context of food loss reduction.

5. Conclusions

Food loss in large quantities is undoubtedly one of the significant global problems affecting our food security, as well as the world's sustainability development position. Yet countries around the world, especially in developing regions, do not consider this issue seriously due to the absence of a comprehensive view regarding its effect globally. Therefore, the integration of FSC actors' efforts to reduce food loss becomes a persistent need in order to tackle this problem through different tools along the supply chain.

However, there is a particular need for much research into the related factors that influence the involved actors' understanding of tackling the subject of food loss. This paper highlights the key themes below as findings pertaining to the food loss issue and its relationship with food security and sustainability development.

(1) Food loss reduction is a key solution for in tackling food insecurity and addressing the main causes of food loss at each stage along the supply chain helps to extend the different supply chain actors' understanding of key aspects of the issue in order to design effective food loss reduction strategies.

(2) Based on the organisational environment, the main causes of food loss are classified into three categories: internal causes (e.g. inefficient operations management, product-related causes and organisational-related causes); micro-environmental causes (e.g. practices by different stakeholders) and macro-environmental causes (e.g. natural, political and economic factors).

(3) Despite the negative impact of losses along the supply chain, food loss is not considered in the performance indicators of food industry organisations.

(4) Continued reductions in food loss, with a focus on the sustainability dimensions across different stages of FSC, will require coordination and collaboration between stakeholders along the supply chain.

(5) Food companies need to revise their measurement systems in order to reduce food loss levels along the supply chain. Therefore, the authors suggest that there is a need to adopt a holistic view of the performance measurement system in the food industry through incorporating sustainability pillars with traditional performance perspectives in the context of food loss, based on the root causes of loss.

Although this paper contributes to the normative literature and presents notable themes regarding the relationship between sustainability development and the food loss issue, the authors suggest that food loss and FSC sustainability topics require an increase in ongoing research to understand the combined nexus. Indeed, more data and in-depth analyses regarding the causes, quantity and dimensions of food loss along different supply chains are needed. Future research could also be designed to determine the other causes of food loss and the current KPIs in the food industry. Such measures will help to control and monitor food loss.

As for practical implications, this paper presents key aspects of this global issue which will allow the decision-makers in food companies to develop their understanding, so as to frame a new performance measurement system and diagnose their activities in the context of food loss reduction.

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