The policy problem: The causes and consequences of food loss and waste

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Abstract
This chapter investigates the causes and consequences of FLW, providing an extensive literature review that offers several insights into where FLW is produced and why. The chapter analyses micro-, meso- and macro-level causes across the food supply chain. The impact of FLW is mainly analysed in terms of sustainability and food security. As for environmental consequences, it provides a thorough investigation of FLW's impacts on greenhouse gas emissions, depletion of blue water and landfill disposal. Finally, the chapter provides an analysis of the complex interactions between FLW and food security, showing that positive outcomes following FLW reduction are not guaranteed.

Introduction
This chapter focuses on the causes (Section "Causes of Food Loss and Waste") and on the consequences (Section "The consequences of Food Loss and Waste") of food loss and waste (FLW).

Many causes of FLW have been identified. The circumstances under which food losses and waste occur are strongly dependent on the specific food and waste-related conditions in each country, each country having its own production, processing, distribution and consumption practices. Disparities in the causes of FLW also depend on the income level of the country. Gustavsson et al. (2011) identified that the causes of food losses and waste in low-income countries are mainly related to financial, managerial and technical limitations in harvesting techniques; storage and cooling facilities in difficult climatic conditions; and infrastructure, packaging and marketing systems. The causes of food losses and waste in medium-/high-income countries mainly relate to consumer behaviour and a lack of coordination between actors in the supply chain (Chalak et al. 2016). Farmer−buyer sales agreements in these countries are seen as contributing to quantities of farm crops being wasted, for example by the imposition of quality standards, which reject food items with imperfect shape or appearance. At the consumer level, medium-/high-income countries, insufficient purchase planning and expiring 'best-before dates' were also identified as causing large amounts of waste, combined with the careless attitude of consumers who can afford to waste food. For these countries, Parfitt et al. (2010) identifies the main drivers of food waste as quality standards, excessive management regulation, poor environmental conditions during display and consumer behaviour.

The causes of FLW are also strictly interrelated with various stages on the Food Supply Chain (FSC; Parfitt et al. 2010, Gustavsson et al. 2011, Hodges et al. 2011, Canali et al. 2014). Canali et al. (2014) identify 105 drivers for the current causes of food waste and 133 future threats of increase of FLW. Of the current drivers, 28 drivers related to technology, 38 to business management and economy, 23 to legislation and 16 to consumer behaviour and lifestyles (Canali et al. 2014, Blakeney 2019).

As far as the consequences of FLW are concerned, the focus of Section "The consequences of FLW" is on two main broad consequences, namely, the consequences for the environment (greenhouse gas emissions, the water footprint and landfills) and the consequences for food security and nutrition.

Causes of Food Loss and Waste

The 2014 report of the High Panel of Experts classifies the causes of FLW at each stage of the food chain, which it described as the micro-level causes of FLW, as they result from the actions (or non-actions) of individual actors at each stage in response to external factors (HLPE 2014, 39).

Below, we discuss the micro-level causes of FLW at each stage of the FSC: pre-harvest, post-harvest, storage, transportation, wholesale and retail, hospitality sector and household consumption. Subsequently, we present the meso-level and the macro-level causes of FLW.

Micro-level causes of FLW

Pre-harvest factors

For pre-harvest factors, we refer to damage that can occur in the field prior to harvest, such as that caused by weeds, insect pests and diseases, that is factors that indirectly lead to losses at later stages in the chain. The pre-harvest factors driving post-harvest FLW can be divided into the following (Blakeney 2019):

i) The choice of crop varieties, which can have an important impact on the quality of produce (Kader, 2005). For example, the choice of incorrect varieties of cereals, such as maize, wheat and sorghum, may render them vulnerable to fungal infections in moist climates and to the loss of harvestable seed in windy areas. Similar adverse impacts have been observed regarding fruit (de Jager and de Putter 1999, Galvis-Sanchez et al. 2004).

ii) Agronomic practices, including the management of fertilizers, soil additives, water management and pest and disease management: Regarding fruit and vegetables, differences in agronomic practices have been identified as contributing to poor visual and nutritional results and the consequent rejection (Ferguson et al. 1999, Stanley et al. 2014, Magzawa et al. 2017). Harvesting at the wrong stage of maturity can compromise quality (Klahre et al. 1987) and vitamin content (Nagy 1980, Yang et al. 2011) and affect the suitability for transport and storage (Luton and Holland 1986, Florkowski et al. 2014). Poor water and nutrient management can contribute to poor produce quality, resulting in a high level of rejection (Ambuko et al. 2013, Caleb et al. 2015). Poor fertilisation practices can affect the nutritional content of crops and fruit (Reitz and Koo 1960, Mann and Sandhu 1988, Toivonen et al. 1994, Lee and Kader 2000).

iii) Climate and environment: Climatic and environmental factors have an obvious effect on yield, with climate change inflicting a series of agricultural stresses through increases in heat, salinity and pest infestation (OECD 2010, Almas and Campbell 2012, Meldelsohn and Dinar 2012, Maharjan and Joshi 2013, Zolin and Rodrigues 2015, Das 2016).

iv) Market factors: These include the leaving of fruit and vegetables unharvested because of the failure to meet certain quality standards regarding to the appearance of produce dictated by processors, wholesalers, retailers or consumers (Stuart 2009, Buzbt et al. 2011, Aschemann-Witzel et al. 2015, de Hooge et al. 2017). A more recent pre-harvest market factor is the competition for crops from global food markets and subsequent increases in food prices (OECD 2005). Renzaho et al. (2017) estimate that 40% of the US maize crop was diverted from global food markets to produce biofuels, accounting for 20−25% increases in the price of maize and 7−8% of soybean price increases between 2001 and 2017 (Zilberman et al. 2013).

Post-harvest factors

Losses of quantity and quality can occur at any stage of the postharvest chain (Grolleaud 2002). Post-harvest losses (PHL) are difficult to estimate, especially in developing countries which lack reliable and up-to-date data. The causes of PHL are considerably different between perishable (fresh fruit and vegetables) and non-perishable (cereal grains) crops. A delay in harvesting can cause the loss of crops through bird, rodent or insect attack. Alternatively, it might be caused by rotting and the development of moulds if the delay coincides with the rainy season (Lewis et al. 2005, Alakonya et al. 2008). The loss of perishable crops is common in both developed and developing countries, although developing countries, lacking appropriate harvest and post-harvest technologies for both grains, fruits and vegetables, are highly vulnerable to unfavourable weather conditions (Hailu and Derbew 2015). Grain losses in developed countries are much smaller than those in developing countries, although there is a lack of reliable data (Parfitt et al. 2010, Shafiee-Jood and Cai 2016).

Storage

Careless handling of produce during transport and storage will lead to damage reducing the value of the produce or causing it to be rejected.

Storage stability and shelf life depend on the quality of food resulting from cultivation practices and environmental influences. In developed countries, high-quality storage facilities and advanced post-harvest technologies, such as refrigeration and a controlled atmosphere, significantly extend the marketing period and shelf life of perishable foods. In developing countries, the lack of proper storage facilities is a major cause of post-harvest losses due to the combined action of moulds, insects, rodents and pests.

In the case of grains, pests and fungi are the major causes of deterioration at the storage phase. In West Africa, maize is an important part of the diets of both rural and urban populations in Nigeria, Ghana, Benin and Burkina Faso. Losses due to post-harvest pests of maize in those countries are estimated to average between 20% and 30% after three months of storage (Boxall 2002).

Transportation

Transportation infrastructures are essential to reduce FLW. In developing countries, poor roads and a lack of suitable vehicles are responsible for the deterioration of perishable commodities during transport (Rolle 2006).

The transport of livestock, even in developed countries, causes FLW. Frimpong et al. (2012) estimate losses of livestock of 16% in Ghana due to death, injuries or sickness.

Logistical factors can also have an impact on FLW. Shukla and Jharkharia (2013) and Negi and Anand (2015) show that where there is a long and fragmented supply chain of perishable produce, waste increases and the per-unit consumption price also increase.

<u>Wholesale and Retail</u>

The environmental conditions within retail outlets can influence the quality, shelf life and attractiveness of products to consumers (Blakeney 2019). FLW occurs in the retail stage in perishable commodities, even in developed countries. Buzby et al. (2014) estimate in-store food losses of 10% of the total food supply in the US. In open-air markets in developing countries, traders' practice of sprinkling unclean water on vegetables and fruits results in unsafe foods, causing them to be rejected by buyers (HLPE 2014, 47).

Another significant cause of FLW at the retail stage is the miscalculation of consumer demand. In developed countries, food retailers apply the so-called 'rule of the one-third', requiring that processed foods must reach suppliers in up to one-third of their shelf life. Products that fail to arrive by the first third of their shelf life will be rejected by retailers, leading to the discarding of safe food (HLPE 2014, 47).

<u>Hospitality Sector</u>

The hospitality sector includes for-profit establishments such as restaurants and not-for-profit establishments, such as canteens and cafeterias at school and hospitals. There is scarce evidence of FLW in this sector. Parfitt et al. (2010) studied the UK hospitality sector, and they estimate that up to 50% of the food was wasted and that 75% of this waste was avoidable.

Murphy et al. (2018) explore the hospitality FLW in relation to tourism. Block et al. (2016) and Juvan et al. (2018) document that people on holiday tend toward excess and consume foods not available at home, particularly in buffets. Stenmark et al. (2016) estimate that hotels, restaurants and the catering sector in the EU were responsible for about 14% of FLW.

<u>Household Consumption</u>

In developed countries, consumers make a significant contribution to FLW. The European Commission (2010) estimate that food waste exceeds 40% for households, compared with 5% for retailers. Food waste in the US was estimated to be 9% of annual expenditure on food per consumer (Buzby et al. 2014) and 15% of expenditure on food and drink by UK consumers (Quested and Johnson, 2009).

The causes of this waste in developed countries are largely behavioural and involve:

- Demanding the high-level appearance of food (de Hooge et al. 2017, Aschermann-Witzel et al. 2017)
- Poor planning (Aschermann-Witzel et al. 2017, Stancu et al. 2016)

- Unawareness of the amount of food being wasted (Quested et al. 2013)
- Lack of the priority of minimizing food waste (Graham-Rowe et al. 2014)

Buying less often and in greater quantities may increase waste. Purchasing in bulk to maximise value for money can result in waste from spoilage (Canali et al. 2014). The elimination of these behaviours will avoid or reduce the waste, but it will require a public education campaign.

Another important driver of FLW at the consumer stage of the food supply chain is the confusion about date labelling (Theotokis at al. 2012, van Boxstael et al. 2014). Among the options are: 'Best by', 'Fresh by', Sell by', 'Use by' and 'Best if used by'. Several studies indicate that consumers tend to rely more on expiration dates than a sensory evaluation of the safety of their food purchases (Tsiros and Heilmen 2005, Newsome et al 2014). Wilson et al. (2017) estimate that the 'Use by' date tends to generate the greatest amount of food waste.

Several studies have noted that consumers who purchase more frequently significantly limit their wastage of perishables (Setti et al. 2016) and that food waste is highest when consumers purchase mainly from supermarket chains, compared with purchases from smaller stores and farmers' markets (Yildirim et al. 2016).

Finally, household waste results from private decisions not subject to public scrutiny. Consequently, social censure does not play much of a role in discouraging wasteful behaviour (Blakeney 2019).

Meso-level causes of FLW

The High Level Panel of Experts points out that in evaluating the drivers of FLW, we should consider the meso-level causes of FLW, which include structural aspects of the food chain, such as the lack of support for investment and innovation, a lack of coordination among actors and the general lack of adequate infrastructure (Blakenay 2019).

In developing countries, the small scale of food production and farming is a disincentive to investments, especially because of limited access to finance and credit. In rural areas, credit constraints are among the primary obstacles to investment in technologies to reduce FLW across the food supply chain (HLPE 2013). In addition, the lack of appropriate infrastructures for transportation and the storage of food such as cool and cold chambers, as well as an absence of effective processing and preservation techniques, causes a significant amount of FLW (Negi and Anand 2017). Negi and Anand (2015) estimate that a third of the losses of fruits and vegetables grown in India are attributed to gaps in the cold chain. Fonseca and Njie (2009) estimate similar losses for the same reason in Latin America and the Caribbean.

Macro-level causes of FLW

The 2014 report of the High Level Panel of Experts highlights the relevance of broader macro-level causes of FLW, arising from the policy and regulatory environments and systemic causes (HLPE 2014, 53).

As far as the policy and the regulatory environments are concerned, FLW can be affected by food labelling and packaging regulations. More generally, policies concerned with agricultural investment, agricultural development, transport and storage infrastructure can also affect FLW (Blakenay 2019).

As far as the systemic causes of FLW are concerned, we need to distinguish between developing and developed countries. Developing countries are generally hampered by financial constraints in establishing a transport, storage and marketing infrastructure and by a lack of managerial capacities. McCullough et al. (2008) suggest that the expansion of supermarkets in developing countries is another risk factor, given the difficulties of small producers in complying with the food standards imposed by supermarkets.

In developed countries, the increasingly low cost of food compared with other goods and services leads to poor food management practices, such as over-purchasing and the consequent waste. Moreover, as highlighted by Lundqvist et al. (2008), higher incomes induce a shift from starchy staples to perishable fruits and vegetables, which are associated with a higher level of waste.

The Consequences of FLW

From a global perspective, the reduction of FLW improves both food security and environment, if less food gets lost, less needs to be produced to improve global food security thus also reducing environmental impacts. Recently, FAO (2019) and Santeramo and Lamonaca (2021) summarize the current state of knowledge on FLW with a focus on food security and environmental concerns. This section focuses on the consequences of FLW in terms of impacts on the environment (Section "Environmental Impacts of FLW") and impacts on food security and nutrition (Section "Impacts of FLW on food security and nutrition").

Environmental Impacts of FLW

The loss and waste of food has significant environmental impacts because FLW occur in all phases of the food supply chain. Globally, the production of FLW has been estimated to account for 24% of total freshwater resources used in food production, 23% of global cropland and 23% of global fertiliser use (Thyberg and Tonjes 2016). Thus, the reduction of FLW reduces the negative environmental consequences of FLW, which are presented in detail in the next sub-sections.

Greenhouse Gas Emission

FAO (2013) estimated that agriculture is associated with approximately 22% of all greenhouse gas (GHG) emissions. Besides the direct impact of agriculture on GHG emissions, there are also indirect impacts such as deforestation induced by agriculture, which is estimated to add between 6 and 17% of all GHG emissions. Wasted food represents a GHG cost that could otherwise have been avoided. UK National Statistics (2016) estimated that, in the UK, 3% of the total GHG emissions resulted from household food waste. In the US, Venkat (2011) estimated that GHG emissions due to avoidable food waste amounted to 2%.

The consumption of energy used to produce lost and wasted food also has GHG implications. Cuéllar and Webber (2010) estimated that the energy embedded in wasted food represents approximately 2% of annual energy consumption in the US. WRAP (2011) estimated that avoidable food waste led to the equivalent of 17 million tons of carbon dioxide in 2010. Buzby et al. (2011) estimated that the decomposition of food waste in US landfills contributed to 34% of all human-related methane emissions in the world.

The wastage of fruits and vegetables across all regions contributes a significant amount of GHG emissions because of the greater proportion of products that spoil (Blakeney 2019).

Water Loss

Hoekstra et al. (2011) suggested the water footprint comprises three colour-coded components: 1) green water (water evaporated from soil moisture supplemented by rainfall); 2) blue water (water withdrawn from ground or surface water sources); and 3) grey water (the polluted volume of blue water returned after production). The discarding of food that does not meet the standards of wholesalers, retailers and consumers represents an inefficient use of green and blue water resources. FLW accounts for 24% of total freshwater resources used in crop production (Kummu et al. 2012). In the UK, the water footprint of avoidable food waste amounts to 6% of the total water footprint per person.

Landfill

In both developed and developing countries, discarded food waste accounts for a significant percentage of municipal solid waste that is disposed of in a landfill. Ahamed et al. (2016) estimated that in the US in 2012, food waste accounted for 21.1% of the municipal waste stream, and in China in 2010, it accounted for 51% of the municipal waste stream. In developing countries, one of the main environmental impacts of food waste relates to its final disposal in landfills. Adhikari et al. (2006) estimated that around 90% of FLW is disposed of by landfills. Landfills are the largest contributor to the generation of methane in developed countries. For instance, Abassi et al. (2012) estimated that in the US landfills account for 34% of all methane emissions.

Impacts of FLW on food security and nutrition

According to FAO (2019a), FLW has potential effects on food security and nutrition through changes in the four dimensions of food security: food availability, access, utilization and stability. However, the links between food loss and waste reduction and food security are complex, and positive outcomes are not always certain. Reaching acceptable levels of food security and nutrition inevitably implies certain levels of food loss and waste. Maintaining buffers to ensure food stability requires a certain amount of food to be lost or wasted (Kaaya et al 2006). At the same time, ensuring food safety involves discarding unsafe food, which then gets counted as lost or wasted, while higher-quality diets tend to include more highly perishable foods. Location and point in the food supply chain matter for the food security and nutrition impact of reducing food loss and waste. How the impacts on the different dimensions of food security play out and affect the food security of different population groups depends on where in the food supply chain the reduction in losses or waste takes place as well as on where nutritionally vulnerable and food-insecure people are located geographically.

A reduction in the amount of food wasted by consumers in high-income countries, for example, does not necessarily mean there is more food available to poor households in distant, low-income countries. Subsistence farmers consume all or a considerable share of their own production. Thus, a reduction in losses of food sold commercially improves the availability of food beyond farming households (Kaaya et al 2006). For food-secure countries highly dependent on food imports, food loss and waste reduction is seen as a strategy for safeguarding their food supply (FAO 2018).

Reducing on-farm losses – particularly for small-scale farmers in low-income countries – can allow farmers to improve their diets due to increased food availability and gain higher incomes if selling part of their produce. It can also lead to increased supply and lower prices further along the food supply chain and eventually for consumers. On the other hand, if a processor reduces losses, while this will also lead to increased supply and lower prices further down the food supply chain and eventually for consumers, it may result in farmers seeing reduced demand for their produce and thus lower income and worsening food security. Reducing consumers' food waste may improve their food availability and access, in addition to that of possible direct beneficiaries of food redistribution schemes, but farmers and other supply chain actors may be worse off as they are selling less and/or at lower prices (FAO 2019a).

Improving the availability of food is only a first step towards improving food security and nutrition. Any additional food resulting from loss or waste reduction must also be physically and economically accessible.

The reduction of FLW can have mixed results on the accessibility of food. Whether the net effect of loss or waste reductions on food accessibility is positive or negative depends on the price effects of the reductions, which are in turn determined by the location of the reductions. How these price effects influence the incomes of households depends, in turn, on their income sources (FAO 2019a).

A fall in prices from loss reductions improves consumer's access to food but it may diminish the food security status of commercial farming households, who receive a lower price for their output. The food security status of subsistence farmers, on the other hand, is improved by a reduction in on-farm losses, which boosts the amount of food available to farming households.

Avoiding qualitative food losses and waste throughout the food supply chain ensured that more nutritious and healthy foods become available for consumers. However, safe and healthy diets necessitate a certain level of food loss and waste. Indeed, to ensure food safety, unsafe foods need to be discarded. Moreover, a nutritious and diversified diet includes highly perishable food products such as fruits, vegetables and animal products, which are prone to spoilage.

A study based on an economy-wide modelling framework assesses the impact of reductions in food loss and waste in the European Union (EU) on producers and consumers in sub-Saharan Africa. The study finds that a reduction in agricultural losses in the EU means that producers demand fewer inputs to produce more output. As a result, the supply of food in the EU increases, while food prices fall. The fall in food prices is partially transmitted to overseas markets, including sub-Saharan Africa, where consumers benefit from more affordable food imports. Meanwhile, the impact of reduced food losses in the EU on producers in sub-Saharan Africa is mixed. They benefit from the fall in the price of imported food to be used as an intermediate input, but are negatively affected by the competition from cheaper imports of final food products, forcing them to cut sales prices. Moreover, sub-Saharan Africa's exports to the EU have to compete there with lower-priced domestically produced food. As a result of the increased competition in both domestic and foreign markets, farmers in sub-Saharan Africa produce less than before.(Kumar and Kalita, 2017). A similar study using the same modelling framework found that the long-distance impact on food security in sub-Saharan Africa of a reduction in the amount of food wasted by retailers and households in the EU is positive, but relatively small (COMCEC 2017).

The reduction in food losses through better on-farm storage can improve the food security status of farming households. Smallholders are often compelled to sell all their grain soon after the harvest, because traditional storage facilities cannot guarantee protection against pests and pathogens. This may force them to buy grain for their own consumption later, at possibly higher prices. Case studies in Africa, Asia and Latin America have demonstrated that the use of metal silos prevents grain storage losses and enhances household food security (Fonseca and Vergara, 2015) One study found that in Kenya, farmers who used metal silos to store maize had 1.8 months more in adequate food provisioning than nonadopters, which ensured the stability of their food consumption throughout the year. Metal silos allowed farmers to limit their immediate sales to those necessary to meet urgent cash needs and to hold on to the bulk of their harvest for up to five months after production. (Parfitt et al. 2010).

As far as the nexus between FLW and nutrition is concerned, Nutrient loss due to quantitative and qualitative food loss and waste may represent a missed opportunity to reduce malnutrition and micronutrient deficiencies (FAO 2019b).

A recent study based on FAO's 2011 food loss and waste estimates found that while the supply of all digestible protein, fat, calories, amino acids and essential vitamins and minerals exceeded average requirements, the large amounts of food lost throughout the food supply chain compound dietary inequalities within and between countries.

The results of the study further indicate that over 60 percent of total micronutrients, with the exception of vitamin B12, are lost as a result of the loss and waste of highly perishable foods, including fruits, vegetables and animal-based products. The study concludes that strategies focusing on improved storage and distribution management are likely to improve the availability of micronutrients more than that of macronutrients (EC 2019).

FAO recently piloted a method to estimate the percentage of children under five in Cameroon, India and Kenya whose micronutrient requirements of vitamin A, iron, zinc and vitamin C could theoretically be satisfied through reductions in food losses. The study shows that large amounts of nutrients are lost due to preventable post-harvest losses. It demonstrates that reducing post-harvest losses of selected crops could increase the availability of micronutrients, which could in turn improve nutrition (Lee et al. 2019). The study is the first to estimate the connection between nutrient loss in the food supply chain and micronutrient deficiencies in children. However, its results should be interpreted with caution. The study assumes that food loss decreases the intake of food and its nutrients by nutrient-deficient people and that micronutrient-deficient children would have access to the recovered nutrients. In reality, the lead cause of micronutrient deficiencies in children is not a lack of access to food, but rather infections, which reduce appetite and hamper the utilization of nutrients. (Fabi et al. 2018, FAO 2018).

The role of food loss and waste reduction in lowering food insecurity also depends on the degree of food insecurity prevalent in different countries. A global measurement of the severity of food insecurity is available through the Food Insecurity Experience Scale (FIES), which measures limits in access to food, at the level of households or individuals, due to lack of resources. Respondents are asked eight direct yes/no questions about their experiences in accessing food over the previous 12 months (Bellamare et al. 2017)

Based on the responses, levels of food insecurity are assessed according to the following scale:

- severely food insecure: no food for a day or more;
- moderately food insecure: compromising on food quality and variety or reducing food quantity and skipping meals;
- mildly food insecure or food secure: potential uncertainty about the ability to obtain food.

The FIES provides useful insights into the degree of urgency of ensuring food access, including food quality considerations. Where severe food insecurity is high – as in low-income and lower-middle-income countries - the scope for food loss and waste reduction to contribute to reducing hunger through increased availability and access to food is potentially large. Interventions preventing avoidable food loss can ameliorate food shortages, particularly at local level in smallholder production as these areas are not well connected to markets and therefore trade is minimal (FAO 2019c). This could increase farmers' incomes and improve food access. If reductions in losses are large enough to affect prices, the urban food insecure may also stand to benefit. Overall, a strategy aiming to reduce food loss and waste is likely to be more effective in improving food security for the populations in these countries than in high-income countries, particularly by focusing on reducing losses at the farm level and early steps in the supply chain.

Conclusions

This chapter investigated the causes and consequences of FLW. As far as the causes of FLW are concerned, the chapter has analysed the micro-, meso-, and macro-level causes across the food supply chain, and for the micro-level causes it analyses the drivers at each stage of the food-value supply chain, from the pre-harvest factors to consumer-related factors.

As far as the consequences of FLW are concerned, the chapter provided an investigation of the impacts of FLW on the environment (greenhouse gas emissions, depletion of blue water and landfill disposal) and on food security and nutrition. On the first impacts, the chapter highlights that the loss and waste of food has significant environmental impacts because FLW occur in all phases of the food supply chain. Globally, the production of FLW has been estimated to account for 24% of total freshwater resources used in food production, 23% of global cropland and 23% of global fertiliser use. Moreover, wasted food represents a GHG cost that could otherwise have been avoided.

On the impacts of FLW on food security and nutrition, the chapter highlights that the nexus between food loss and waste reduction and food security and nutrition are complex, and positive outcomes are not always certain. Reaching acceptable levels of food security and nutrition inevitably implies certain levels of food loss and waste. Maintaining buffers to ensure food stability requires a certain amount of food to be lost or wasted. At the same time, ensuring food safety involves discarding unsafe food, which then gets counted as lost or wasted, while higher-quality diets tend to include more highly perishable foods. In addition, the chapter highlighted how the location and point in the food supply chain matter for the food security and nutrition impact of reducing food loss and waste. How the impacts on the different dimensions of food security play out and affect the food security of different population groups depends on where in the food supply chain the reduction in losses or waste takes place as well as on where nutritionally vulnerable and food-insecure people are located geographically.

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