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Chapter 6

Food Losses and Waste: Case Studies in Food Retail

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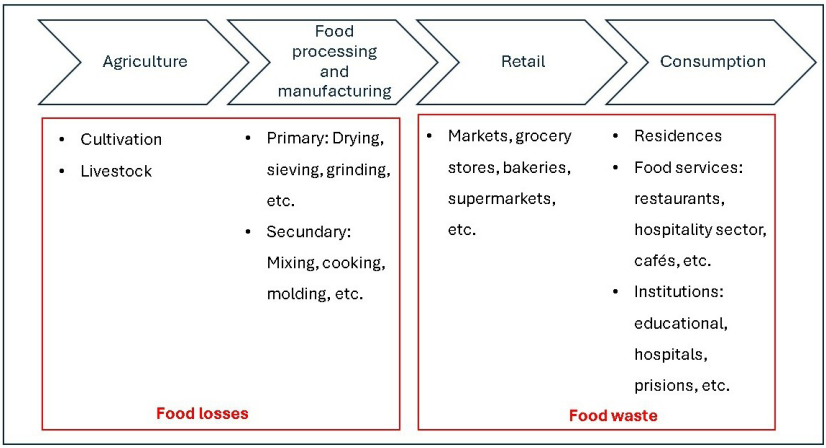
Food Losses and Waste: Context and Impacts

Food losses and waste can occur throughout the supply chain. From the producer to the final consumer, food is lost and wasted (FAO, 2019; Horós; Ruppenthal, 2021). In 2011, a study by the Food and Agriculture Organization of the United Nations (FAO) pointed out that about one-third of the food produced on the planet is lost or wasted every year. However, the organization started studying new indices to improve PDA estimates. The new index, the Food Loss Index (FLI), suggests that 14% of the food produced is lost even before reaching retail (SOFA, 2019). Even with the significant reduction, the topic is still relevant, as it represents not only economic loss but also environmental, nutritional, and moral loss, given the increasing number of hunger and food insecurity around the planet (FAO, 2023).

Although the terms "food losses" and "food waste" are used interchangeably, they are different concepts. Both represent a reduction in the availability of food for human consumption occurring along the supply chain; however, losses mainly occur in the production, post-harvest, and processing phases (Parfitt *et al.*, 2010). Waste, on the other hand, occurs at the end of the food chain (retail and consumption) due to the behaviors of retailers (in their commercial establishments) and consumers (in their homes) (FAO, 2011; Gustavsson *et al.*, 2011; Parfitt *et al.*, 2010). These distinctions are useful since strategies to reduce waste and their causes differ between the initial stages of the production chain and the final stages. Figure 1 shows the stages of the supply chain where PDA occurs.

Figure 1 – Activities that generate losses and waste along the supply chain



Source: Papargyropoulou *et al.*, 2014, p. 107.

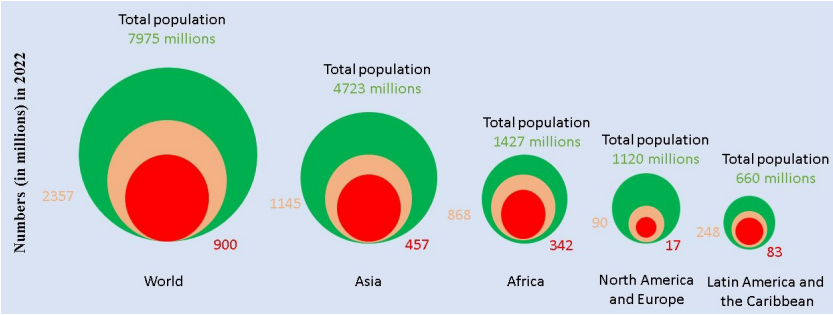
Worldwide, 1.6 billion tons of food are wasted annually. Without global actions, this figure could reach an equivalent expenditure of $1.5 trillion by 2030, according to the Boston Consulting Group – BCG (2018). According to the FAO (2017), 54% of losses occur during the harvest and handling phases, and 46% during storage, transportation, and consumption phases. At the same time as being one of the largest food producers on the planet, Brazil discards 37 million tons annually, according to data from the Brazilian Agricultural Research Corporation - Embrapa (2018).

This waste represents an estimated economic loss of R$61.3 billion per year, considering the environmental and social impacts caused by the problem, and places Brazil as the 10th country that wastes the most food on the planet (FAO, 2017).

Regarding global data, the latest edition of the report 'The State of Food Security and Nutrition in the World' (Pincer, 2023), a joint effort by five specialized agencies of the United Nations – the Food and Agriculture Organization, the International Fund for Agricultural Development (IFAD), the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the World Food Programme (WFP)

– reports that an average of 735 million people went hungry in 2022, representing almost 10% of the global population. This number increased rapidly due to the Covid-19 pandemic, which added about 122 million people to this condition since 2019. Figure 2 shows the concentration and distribution of food security by severity around the world and the differences between world regions.

Figure 2 – The concentration and distribution of food security by severity differ greatly among the regions of the world



Source: FAO adapted, 2023, p. 22.

Malnutrition is also concerning as it affects millions of children under the age of five, causing stunted growth (148.1 million), acute malnutrition (45 million), and obesity (37 million). Additionally, the "Global Burden of Disease" Study (2019) identified dietary risk as the second highest risk factor for deaths among women and the third among men (FAO, 2023).

The same situation is observed in developing countries like Brazil. In this country, about 21.1 million people go hungry daily, and 70.3 million live in a state of food insecurity. Additionally, 10 million Brazilians are malnourished (FAO, 2023).

Ten percent of losses/waste of Brazilian products occur still in the field, 30% in activities related to storage and distribution, 50% in transportation, and 10% in households (FAO, 2023). Half of these lost/wasted foods are fruits and vegetables (Brasil, 2022).

To reduce the problem, it is noted that among the Sustainable Development Goals of the 2030 Agenda are SDG 2 (regarding the eradication of hunger) and SDG 12 (which concerns sustainable consumption and production patterns, with a reduction of half of the losses and food waste occurring along the production and supply chain). Achieving these goals is of utmost importance, given the projection of a population of more than nine billion people by 2050 (FAO, 2015), which will require an increase of around 60% in food production to meet human needs. However, the FAO warns that if trends remain, it is estimated that by 2030, approximately 600 million people will go hungry, highlighting that despite the reduction of people with hunger in the world, the 2030 Agenda goals will not be achieved (FAO, 2023).

The FAO points out that there are greater losses and waste for specific groups of certain foods, occurring at various levels of the supply chain, to a greater or lesser extent (SOFA, 2019).

Considering the highly perishable characteristics of FLV (Gustavsson *et al.*, 2011; Lana, 2018; Silva *et al.*, 2021), their PDA percentages are high, especially in the production and distribution phases (Schneider, 2013), even being the most wasted food group in retail, according to research in various countries, such as Italy, Denmark, Sweden, the United States, among others (Bilska; Piecek; Kołożyn-Krajewska, 2018; Eriksson *et al.*, 2012).

Food is essential for maintaining human life and health. The WHO and the Ministry of Health recommend the daily consumption of 400 g of fruits and vegetables, divided into five servings per person. In Brazil, less than 10% of the population has access to this amount. This situation contrasts with the condition of the country that is among the largest food producers in the world (FAO, 2020) and, at the same time, wastes about 37 million tons of food per year (EMBRAPA, 2018).

As for the losses/waste of vegetables and fruits in Brazil, it is estimated that between 35% and 55% occur in the post-harvest phase. However, it is admitted that there is a lack of greater precision of these values, which were obtained from a restricted database and through subjective methodologies,

making it difficult to compare results, quantify volume, and identify causes more accurately, as warned by Lana (2016).

Despite numerous efforts to reuse food, such as reuse, recycling, and recovery, to avoid disposal, it is essential that their destination be, first, human consumption. Thus, the prevention of losses and waste is the most recommended action and contributes most to the better use of increasingly scarce natural and environmental resources on the planet (Hermsdorf *et al.*, 2017; Natural Resources Defense Council – NRDC, 2017; WRAP, 2018).

To combat the problem, the prevention and reduction of PDA must be prioritized by all links in the supply chain to know and understand the various causative and interrelated factors. However, it is important to emphasize the power of retail over the links in the production and distribution chain, both downstream and upstream (Mena *et al.*, 2014; Moraes *et al.*, 2020; Silva *et al.*, 2021), influencing from the food produced in the field, causing primary losses (Lana; Banci, 2020), to the consumption habits of the population. Moreover, the aesthetic standardization of commercialized foods, stimulated by FLV retailers in recent decades, has impacted consumer criteria in choosing "perfect" fruits, vegetables, and greens, contributing to the waste of these products (Baker *et al.*, 2019). Being the link that connects food production to consumption, food retail is an important link that can dictate and signal the necessary changes in the production chain, whether in production or consumer behavior.

The Role of Food Retail

The discussion around food losses and waste should be supported by the sustainability triad: economic, environmental, and social. Winterich (2019) defines sustainability as a set of ideas, attitudes, intentions, and behaviors that involve the strategic consideration of economic, environmental, and social resources for the success of current and future generations. Bravo *et al.* (2021) add two other equally important factors, health and culture, as sustainable food production models, besides

having a direct impact on the population's diet and, consequently, health, must contemplate the cultural elements of specific populations, such as indigenous groups, quilombolas, Africans, among others.

The concern of chain agents, especially retail, is profitability, however, such profitability - as one of the dimensions of sustainability (economic) - is tied to the other dimensions, social and environmental. Sustainability in the supply chain requires retailers to implement system integration throughout the supply chain to minimize damage to the environment and individuals. Beyond the insertion of recycling bins in retail stores, sustainability includes a complete consideration of the environmental and social impact of businesses, from product acquisition, disposal, reuse, or recycling; from employee safety and well-being to the safety and well-being of society in general. A notable characteristic is to evaluate the emphasis on the economic (profit), social (people), and environmental (planet) triad of supply chain activities with a view to their future long-term impact (Vadakkepatt *et al*., 2020).

Economic benefits aside, retailers are beginning to consider operational costs, limiting the use of natural resources, and minimizing ecosystem damage by reducing emissions. For example, food retailers are responsible for approximately ten percent of food waste in the United States (Weigel, 2020). Responding to this challenge, large food retailers are implementing technology to reduce food waste throughout the supply chain, saving money and environmental resources (Kleinman; Schneider; Strumwasser, 2018; Kor; Prabhu; Esposito, 2017).

In terms of social impacts, supermarkets and hypermarkets impact and are impacted by their employees, suppliers, consumers, and the communities in which the stores operate. Thus, some large retail chains in the United States, for example, invest in training their employees, training their direct and indirect suppliers to reduce losses, and in campaigns to consumers in purchasing local food (Weigel, 2020). Efficient management of supply chains leads to the prevention of losses and waste, which results in lower product prices, directly impacting the economic performance of the business and the accessibility of safe and healthy food to the consumer.

According to data from the Brazilian Association of Supermarkets (ABRAS, 2021), food waste in the supermarket sector reached 1.79% in 2020, which corresponds to R$7.6 billion. Among the categories of food products, FLV leads in terms of waste. It should be noted that these data are only estimates, indicating that there is still a need for better mapping of the situation and research related to the topic.

The retail sector is particularly affected by the lack of studies that use primary data. This can be explained by the fact that food waste data is often confidential information for retailers and suppliers and is subject to confidentiality agreements. There are several examples in the literature reporting the impediment of comprehensive investigation due to such issues (Egarrone *et al.*, 2016; Lebersorger; Schneider, 2014; Mena *et al.*, 2011; Mourad, 2016; Stenmarck *et al.*, 2011). The Food Waste Index (United Nations Environment Programme, 2021) reports that worldwide, there is insufficient data in most countries at the retail level and calls for more quantification, particularly in low- and middle-income countries.

The poorest population has less access to FLV products, as a reduction in consumption was observed between 2008 and 2018 (ABRAS, 2021).

It is urgent that to mitigate the issue of food and nutritional insecurity in the country, in addition to developing public policies aimed at promoting food security, strategies should be devised to reduce the disparity between food losses and waste on one side and hunger and food insecurity on the other (Zaro *et al.*, 2018).

However, the definition of strategies to reduce PDA, as well as the necessary public policies, first requires a better understanding of the factors that cause losses throughout the production chain (Lana; Banci, 2020). This understanding is reinforced in the report "Intersectoral Strategy for the Reduction of Food Losses and Waste in Brazil," by the Interministerial Chamber of Food and Nutritional Security (CAISAN, 2018).

In this sense, knowledge of the practices carried out by supermarket retail companies regarding food waste, from the perspective of sustainability, as pointed out by Vadakkepatt *et al.* (2020) and Bravo *et al.* (2021), is necessary.

There are studies that reinforce the hypothesis that waste - when evaluated in retail - should be considered in the supplier-seller relationship since, often, unsold products in retail are returned to the supplier, who bears all the expenses (Brancoli, 2019). According to Brancoli (2019), in studies in the bakery sector in Sweden, the model adopted by the largest bread distribution bakeries in Sweden involves a total return agreement (Take-Back Agreement – TBA) between retailer and supplier, in which the bakeries are responsible for forecasting, ordering, placing, and removing products from supermarket shelves. In addition, bakeries are financially responsible for unsold products (including their collection and waste management), operating in a reverse or circular supply chain, unlike most products sold in retail. When it comes to FLV, it is known that many of the products sold in Brazilian supermarkets and hypermarkets are consigned, meaning that if they are not sold, they should be deducted from the purchase price, and in many cases, the supplier must still remove the products from the shelves, considering the destination of the collected products (Cunha, Saes, Mainville, 2013; Souza; Scur, 2011).

In this sense, the importance of retailers concerning PDA is emphasized, as they are in a unique position to influence the generation or prevention of waste in other supply chain agents, such as primary production, distribution, and final consumption.

The following topic addresses two case studies conducted in food retail, specifically concerning waste in the FLV sector, in two municipalities in the state of São Paulo (SP), Tupã, and Ribeirão Preto.

Food Retail Case Studies

Studies were conducted in the cities of Tupã and Ribeirão Preto to identify and analyze practices for the prevention and reduction of PDA in retail establishments.

To carry out both studies, the strategies used were interviews with those responsible for the FLV sector in retail establishments, direct observations, and analysis of secondary documents.

For Study 1, interviews were conducted in four retail establishments, identified as follows: Small supermarket (M1), Medium supermarket (M2), Large supermarket (M3), and Small supermarket (M4). For Study 2, a single store of a supermarket chain was evaluated (M5); the choice was made by the network manager, who agreed to participate in the research and pointed it out as having the highest FLV waste index. In Box 1, it is possible to analyze the questions addressed and the responses obtained by the interviewees.

Box 1 – Interview responses with those responsible for the FLV sector of different retail establishments in the cities of Tupã and Ribeirão Preto

Is there any purchasing planning for FLV?	
Stores	**STUDY 1 (M1, M2, M3, and M4 - Tupã-SP) and STUDY 2 (M5 - Ribeirão Preto-SP)**
M1	Sales history from the previous year
M2	Sales history from the previous year
M3	Sales history from the previous year and analysis by the employee responsible for the sector
M4	Analysis by the employee responsible for the sector
M5	Sales history from the previous year, analysis by the employee responsible for the sector, and product purchase price
What are the criteria for defining the storage methods for FLV?	
M1	The central unit advises that more perishable products should be placed in cold rooms until they are available for sale and then depends on space.
M2	The sector employee evaluates and identifies the need for a cold room or not; in the sales area, it depends on available space.
M3	The sector employee evaluates and identifies the need for a cold room or not; in the sales area, it depends on available space.
M4	The sector employee evaluates and identifies the need for a cold room or not; in the sales area, it depends on available space.
M5	Most products go to the sales area; however, part of the food is stored in common stock without refrigeration. The sector employee directs only very sensitive products to the small cold room.

When there are leftovers of these products, who bears the loss?	
M1	Depends on the product: leafy greens are the producer's responsibility; others are the establishment's responsibility.
M2	Depends on the product: leafy greens are the producer's responsibility; others are the establishment's responsibility.
M3	Depends on the product: leafy greens are the producer's responsibility; others are the establishment's responsibility.
M4	Depends on the product: leafy greens are the producer's responsibility; others are the establishment's responsibility.
M5	Depends on the product: leafy greens and chopped vegetables on consignment are the producer's responsibility, others are the establishment's responsibility.
When there are leftovers, what is done with these foods?	
M1	Donated to farmers who use them to feed animals.
M2	Donated to charity institutions in the city.
M3	Donated to charity institutions in the city and what is unsuitable for human consumption is donated to farmers who use them to feed animals.
M4	Donated to farmers who use them to feed animals.
M5	Donated to an animal breeder.
Is there any practice that the market performs with the aim of preventing and reducing PDA?	
M1	No.
M2	No.
M3	No
M4	No
M5	In prevention, no. To reduce, some foods are processed and vacuum-packed; others are turned into fruit salads. There is also the sorting of tomatoes, potatoes, and other vegetables packed in plastic nets, which return to the sales area. On the stands, riper products are placed on top during restocking.

Source: Prepared by the authors, based on the responses of the surveyed establishments.

There was no pattern observed among the studied cases regarding the purchasing planning for the FLV section. However, among leafy greens, it is unanimous that there is no acquisition planning since all establishments reported that their products are consigned. Therefore, when there is no sale, the responsibility for the exchange or collection of the products lies with the producers themselves. Regarding fruits

and vegetables, establishments are basically based on the purchasing history from previous years or rely on the "experience" of the employee responsible for the sector for new orders, which greatly contributes to PDA, as basing on previous years does not guarantee that the same type or quantity of fruits and vegetables will be sold.

In study 2, besides the sales history guiding FLV purchases, the employee also mentioned that the prices found for each product contribute as well. If the product is offered at higher prices, the buyer may reduce the quantities purchased; and in the case of attractive prices, larger quantities are ordered, and later, the supermarket chain promotes sales in its eleven stores distributed throughout the region.

When questioned about the criteria for defining the storage locations for fruits and vegetables, in study 1, it was reported that only the degree of ripeness of each type is considered. Therefore, the food that the employee identifies as riper upon receipt will go to refrigeration until the time of sale, and may or may not be maintained later, depending on the availability of cold rooms and space in the sales areas.

Regarding the storage of leafy greens in case study 1, in establishments M1 and M4, it occurs in the establishment's own cold rooms during exposure for sale. Each producer has space to accommodate their merchandise, and they themselves handle the collection and replenishment. In establishments M2 and M3, the scenario is different. In M2, the producer provides a cold room in the sales area to ensure the quality of only their product for a longer time. However, of all the suppliers they have, only one provided a cold room, while leafy greens from other producers were kept at room temperature.

In M3, a cold room (owned by the establishment) is also available for use by leafy green suppliers, but products were also found at room temperature. When questioned about this, the employee reported that it was a new contract, and there was no available space in the cold room, so they were kept at room temperature. Additionally, those products from this producer that arrived fresh in the morning and were not sold by the end of the day were promoted (by the producer) to prevent loss.

In case study 2, most of the products, upon receipt, go directly to the sales area. The remainder is stored in the common stock, without refrigeration, alongside other grocery products in the supermarket. When large quantities of food are purchased due to low prices found by the network's buyer, product overlap occurs on the shelves (up to five layers, like tomatoes, for example). As the foods on the shelves are sold, they are replenished with stocked products. Only very heat-sensitive products are directed to the store's small cold room, which shares space with other non-FLV products.

The disposal (of FLV considered unfit for sale) in both case studies follows the same system as the criteria for defining product storage locations, i.e., it is based on visual selection. However, there is no specific training for this procedure. The orientation that employees report receiving is: "what you and your family would buy should be kept, what you would not, should be discarded," according to employee reports.

Regarding the destination of food in case study 1, two establishments reported donating those considered unfit for sale but suitable for consumption. Donations are made to charities responsible for selection and removal. The other two establishments send the food (regardless of its condition) to the common trash or to farmers who request it to feed their animals. In case study 2, there are no donations for human consumption. The products are donated to an animal breeder.

When questioned about adopting practices that could contribute to PDA prevention in the establishments, all interviewees reported that there are none, but all cited the need for more cold rooms for storage during receipt and in the sales area to prolong food shelf life, control the accelerated ripening process, and reduce PDA.

In this context, retail establishments daily remove various types of food from their shelves, and most are still suitable for human consumption. However, consumer demands contribute to increased waste, along with inefficiency—not only of the store—but from the producer, through the Supply Centers (CEASA), and the network's distribution center. It is therefore relevant to raise awareness among retail employees and consumers about the impact of PDA, and this issue should be seen as urgent so that they take responsibility and develop actions to reduce it.

Final considerations

When addressing food losses and waste, it is not possible to only address the economic loss regarding the costs associated with the production and distribution of food products. The impacts related to PDA directly reflect the final consumer price, but their extent, in terms of consequences, directly impacts social aspects when the possibility of supplying a significant number of a population suffering from food and nutritional insecurity is removed. When natural resources such as water and energy are used and greenhouse gases are emitted for the production, distribution, and availability of products that will not be consumed, it harms the planet's health.

Retail is the channel member that connects the producer and the consumer, and it becomes relevant for directing changes in habits and consumption behavior. In this sense, it can be the agent to signal necessary changes. As observed in the presentation of the case studies, despite some efforts to avoid food waste, it is still necessary to incorporate some elements, such as more efficient purchasing planning, acquisition of local products, and control and maintenance of acquired products to increase their shelf life. Additionally, it is essential that retail lead campaigns to reduce waste so that consumers adopt a more proactive stance in this process by purchasing imperfect but consumable products, handling products correctly when selecting purchased products, and prioritizing seasonal products.

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