FOOD WASTE PREVENTION SOLUTIONS IN THE ANNUAL REPORTS OF EUROPEAN COMPANIES

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Abstract
Food waste is a social, environmental, and economic challenge today. The European Union's Green Deal demands tackling this problem. Our research question is: "What are the solutions regarding food waste prevention across the companies' supply chain?" The mixed research method consisted of content and thematic analysis. We collected information from the reports published by European food companies that have joined the Green Deal and the Farm to Fork Strategy. The data were structured using a theoretical model in which we integrated ten essential stages of the food chain. The findings show that most of the information is reported for the manufacturing/production stage. Although transfer to landfill is unavoidable in supply chains, organizations make substantial efforts to reduce the proportion of food waste. The methods applied by food companies are inspired by European regulations regarding environmental protection. Our research identifies solutions brought about by the Green Deal on food waste prevention.

Keywords: food waste, regulations, reporting, Green Deal, European Union, food chain.

JEL Classification: M14, Q56.

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Introduction

It is estimated that 14% of the food produced globally is wasted between harvest and supermarket (FAO, 2019). At the same time, in 2020, between 720 and 811 million people did not have enough food (FAO et al., 2021). Food production, which should meet the needs of a growing world population, continues to cause pollution, affecting biodiversity, and accelerating climate change. Thus, enormous amounts of natural resources are consumed, while a significant part of the food is wasted. Current production models need to become sustainable worldwide. The European Green Deal (EGD) is the reference in this regard. This initiative is a component of the European Commission's strategy for implementing the 2030 Agenda of the United Nations and the Sustainable Development Goals (European Commission, 2019a; United Nations, 2015).

In response to climate and environmental challenges, the EGD sets out the strategy for transforming the EU into a fair and prosperous society with a resource-efficient economy aiming for net-zero greenhouse gas emissions (GHG) by 2050. The EGD seeks to protect, conserve, and strengthen the EU's natural capital by encouraging the development of policies to restore natural ecosystems, promote the sustainable use of resources, and ensure citizens' health and well-being. One of the purposes of the EGD is to design a fair, healthy, and environmentally friendly food system by implementing the Farm to Fork (F2F) Strategy. The objectives of this strategy are grouped into four clusters: sustainable food production, food processing and distribution, sustainable food consumption, and prevention of food loss and food waste. We will focus on the last cluster in this paper.

Our research question is: "Which are the solutions regarding food waste prevention across the companies' supply chain?" To answer this question, we considered the regulations issued in the EU concerning food waste. These rules may accelerate the implementation of solutions in this field (Dumitru et al., 2017). Starting from the literature, we built a theoretical model in which we included the stages of the supply chain in which food waste can occur. We have selected a sample of 41 companies operating in the food sector and which endorsed the EGD. Starting from the idea that reporting allows us to assess the effects of various regulations (Trombetta et al., 2012), we performed a content and thematic analysis of the most recent annual or sustainability reports, selecting specific fragments on the topics of "food loss" and "food waste." The fragments were interpreted by applying the theoretical model.

The paper is structured as follows. In the first part, we presented the normative framework of the EU and the literature in the field. After the research method, we included the results, which are structured according to the model derived from the literature. The paper ends with the authors' conclusions.

1. The European Union's normative framework regarding food waste

Since 1973, the Environment Action Programmes (EAPs) have been the cornerstone of the EU's environmental policy (European Commission, 2019b). Waste prevention was considered a specific point of interest starting with the first EAP. From the 5th EAP onward, waste prevention was integrated into the broader concept of waste management. The 5th EAP (1993-2000) sought to close the gaps in existing waste prevention and recycling measures by proposing a mix of instruments: legislative measures, market-based instruments, environmental statistics, scientific research, and financial support mechanisms. The 6th EAP

(2002-2012) proposed a priority area through ensuring the sustainable management of natural resources and waste. One solution was to engage the market and consumers to improve the environmental performance of products throughout their life cycle. The 7th EAP (2014-2020) focused on prevention rather than remediation across a wide range of areas, including waste and resource efficiency. In October 2020, the 8th EAP (European Commission, 2020) was on track to be adopted. The state of implementation will be assessed through indicators in various areas, including a report on waste management and prevention.

In 1975, the first Directive on Waste (Directive 75/442/EEC) was issued. It suggested principles underlying the waste hierarchy in European policy while setting the following priorities: reducing waste, protecting the environment, and ensuring human health. Directive 75/442/EEC has been repealed and replaced by the Directive on Waste 2006/12/EC, which established the "legislative framework for waste management". It contained definitions of key concepts, essential requirements for waste management, and important principles such as the obligation to treat waste in a way that does not adversely affect the natural environment and human health. The Directive encouraged the implementation of the "polluter pays" principle.

Directive 2006/12/EC was subsequently repealed and replaced by Directive 2008/98/EC on waste. The factors which determined this change were: the clarification of the key-concepts ("waste", "recovery", "disposal"), the inclusion of an approach based on the entire life cycle of products, and the strengthening of the measures to prevent waste generation. The purpose of this Directive was to create a legislative framework for waste treatment in the EU, in line with the environmental laws that govern the most significant waste management operations. Waste recovery and recycling techniques increase production efficiency and preserve natural resources. The waste hierarchy sets out priorities such as preventing waste generation; waste management; preparation for reuse, recycling, and other operations; energy recovery; and waste disposal (Gregson et al., 2013). By analyzing the whole life cycle and the effects of the generation and management of certain waste, the hierarchy confirms the "polluter pays" principle. The initial waste producer or current and previous owners should bear the waste management costs. The Directive introduces the "concept of extended producer responsibility," which is the financial or organizational responsibility for the management of the waste phase of a product's life cycle.

The EGD includes eight action directions, one of which is agriculture. Combating food loss and waste is essential for sustainable development. Reducing food waste generates savings for both consumers and operators. The recovery and redistribution of food surplus that would otherwise be wasted have an important social dimension. This measure is linked to policies on the recovery of nutrients and secondary raw materials, food security, biodiversity, bioeconomy, waste management, and energy from renewable sources.

The Commission will present suggestions for revising EU standards on product date marking ("consume by" and "best before") that may cause confusion among consumers. The Commission will also analyze food losses during the production phase and consider measures for preventing them. Coordinated actions at the EU level will strengthen measures taken at the national level. The Commission facilitates the exchange of experience in food waste prevention through the EU Food Loss and Food Waste Platform. The EU also supports research and innovation on food loss and waste prevention through the Horizon program, from primary production to consumers. Finally, the EU is working with partner governments

and the private sector to reduce food losses in developing countries by improving crop protection and warehouses.

2. Literature review

Food production generates "air, water, and soil pollution, contributes to biodiversity loss and climate change, and consumes excessive amounts of natural resources, while a significant part of food is wasted" (European Commission, 2019a, p.11). Food destined for human consumption that has not reached this stage is considered food waste. The debate on food waste occurs in the broader context of the discussions on "green consumption," which has significantly increased in the past ten years. The research topics refer to the avoidance of food waste through innovative packaging (Bhargava et al., 2020), edible food waste (Papargyropoulou et al., 2014; Halloran, 2014), combating and reducing food waste by identifying methods of extracting fiber and probiotics from fruit and vegetable waste (Pop et al., 2021), and the management of food surplus (Papargyropoulou et al., 2014).

New concepts have emerged, such as the waste hierarchy (Gharfalkar et al., 2015), the 3Rs – reduce, reuse, recycle (Sakai et al., 2011), extended producer responsibility, the "polluter pays" principle (Engel et al., 2008), sustainable consumption and production (Pires et al., 2011), and sustainable waste management (Ghinea and Gavrilescu, 2019; Tirtoaca and Przydatek, 2021). In this context, Papargyropoulou et al. (2014) tried to find an answer to the question: "How can surplus food and food waste be managed sustainably?" The discussion starts from the premise that proper waste management is a condition of sustainable development (UNEP, 2011; UNHSP, 2010).

The distinction between food losses and food waste allows for analyzing the causes and effects of these processes in different stages of the supply chain. Thus, *food losses* refer to the decrease in the edible food mass in the entire supply chain – harvesting, production, processing (Gustavsson et al., 2011; Grolleau and Caswell, 2006). In contrast, *food waste* is specific to the marketing and consumption stages, associated with consumer behavior (Parfitt et al., 2010). The category refers to food disposed of for economic or aesthetic reasons or because of the proximity to the date mentioned on the label as "use by" or "best before" (European Parliament, 2011). Food waste can also be a consequence of consumption habits, such as removing some edible parts of vegetables or fruits. To better define food losses and waste generated throughout the supply chains, the *Save Food* initiative of the FAO has established that food loss and waste "shall be measured only for products that are directed to human consumption, excluding feed and inedible parts of products" (FAO, 2011).

The economic impact of food waste has been highlighted by several authors (Evans, 2011a; Morrissey and Browne, 2004) and various organizations (FAO, 2013; EPA, 2003). The US Environmental Protection Agency (EPA) encourages those who produce food, wholesalers, and those involved in services related to food production and consumption to reduce food waste to achieve significant cost reductions (EPA, 2003).

The environmental impact of food loss and waste is primarily linked to the release of methane and carbon dioxide (both of which are greenhouse gasses) as part of the natural decomposition process (Nichita et al., 2021). GHG emissions occur during all activities associated with the production, processing, transport, storage, and distribution of food. It is estimated that more than 1.3 billion tons of food waste are generated along the entire food

supply chain, from the agricultural phase to the final consumption phase. The impact on the environment is estimated at around 3.3 billion tons of CO_2 equivalent per year, 6% of total anthropogenic GHG emissions (Amicarelli et al., 2021a; European Commission, 2006). Other environmental influences are associated with food losses and waste, such as the depletion of natural resources and nutrients in the soil and water, energy waste, and the disruption of biogenic cycles due to intensive agricultural activities.

Food waste also has social implications (Salhofer et al., 2008). Therefore, the ethical and moral aspects of food waste are considered in terms of food poverty specific to some areas (Evans, 2011b) and the lack of access to agricultural land (Lipton and Saghai, 2017). About 10.7% of the world's population (almost 815 million people) are malnourished and, by 2050, a global population of 9.6 billion people will have to be adequately fed (FAO et al., 2018). Reducing food losses and waste in supply chains is considered a first step toward achieving food security (Haberl et al., 2011).

The causes of food waste were identified and explained by many authors (Papargyropoulou et al., 2014; Gustavsson et al., 2011), establishing the links and differences between food surplus and food waste, as well as between waste prevention and waste management. Most studies that analyzed the level of food losses and food waste were carried out in developed versus developing countries (Parfitt et al., 2010; Smil, 2004; Halloran et al., 2014). Gustavsson et al. (2011) provided evidence that industrialized countries generate food waste on a par with developing countries. However, there are significant differences between the two groups of countries in terms of the waste generation stage. More than 40% of food losses occur in the post-harvest and processing stages in developing countries. In contrast, about 40% of waste occurs in retail stores and consumers in industrialized countries.

In developing countries, food waste generation is mainly determined by financing, managerial and technical limitations in harvesting and storage processes, the lack of cooling facilities, and poor infrastructure regarding packaging and retail. Food supply chains could be strengthened in developing countries by encouraging small farmers to organize, diversify, and improve production and sales through investments in infrastructure, transport, and packaging technologies. In contrast, in industrialized countries, food waste occurs mainly due to consumer behavior and a lack of coordination between the different actors in the supply chain (Gustavsson et al., 2011; FAO, 2011).

Food loss occurs for reasons such as: crops left in the fields, losses during transport, thrown away food due to the purchase of excessive quantities, or mismanagement of inventories (Parfitt et al., 2010). The planning and purchase routines are identified as causes of the food waste by Ștefan et al. (2013). Several actors in the food supply chain indirectly contribute to food waste by influencing consumer behavior through larger packaging sizes, promotions on the sale of large quantities, or price reductions.

A widespread view is that food loss is unavoidable. However, much of it can be prevented if interventions are made along supply chains (Papargyropoulou et al., 2014; Teigiserova et al., 2020; Girotto et al., 2015). Two related issues are discussed in the literature: waste prevention, and waste separation once it is generated. The discussion is also influenced by the stage of the supply chain at which they appear, namely: production and distribution, on the one hand, or consumption, on the other. One solution to reduce food loss was found in Denmark, where, in the last decade of the 20th century, the structure of the food supply chain

was reorganized through consolidations and a reduction in the number of firms at each stage of the supply chain (Baker, 2003).

The European Federation of Food Banks (FEBA) plays an important role in encouraging food donations. The main objective is to reduce food insecurity in Europe by preventing food waste (including the recovery of surplus food for human consumption). According to the annual report published on the FEBA website, at the European level, 860,000 tons of food were collected and distributed through 335 food banks in 2020. The distribution of food was carried out to 12.8 million disadvantaged people, through more than 48,000 charitable organizations and with the support of more than 37,000 volunteers (FEBA, 2020).

Thyberg and Tonjes (2016) examined the effects of urbanization, industrialization, economic growth, and globalization on food waste generation. One of the main effects of the modernization of the food system is the increased distance between individual consumers and the place where food is produced and prepared. Additionally, by analyzing the socio-demographic, cultural, political, and economic causes of food waste, it appears that effective food waste prevention policies should start from consumer behavior and motivations. Thus, the authors propose several mechanisms and policies to prevent food waste, namely educating the public and employees regarding the proper preparation of food; reducing portion sizes; ensuring the flexibility of food orders; redistribution policies through food banks; transport that reduces food damage; improvements in packaging solutions; better inventory management; improving the labeling system; educating the public on the issue of food waste and why it is an environmental, economic, and social concern.

3. Research Method

Our research question is: "Which are the solutions regarding food waste prevention across the companies' supply chain?" The sample consisted of 41 companies (26 food manufacturers, 14 food retailers, 1 from the food service sector) that signed the EU Code of Conduct on Responsible Food Business and Marketing Practices, which is part of the F2F strategy of the European Union.[*] This code of conduct was developed through a dialogue with all stakeholders and is an essential part of the EU's efforts to increase the availability and accessibility of healthy and sustainable food options. Food industry associations and companies that sign the code of conduct are committed to accelerating their contribution to a sustainable transition and reducing their overall environmental footprint.

We downloaded from the companies' websites 60 reports prepared for the last financial year (2020) on September 2nd, 2021. The reports were classified as: integrated reports (10), annual reports (28), sustainability reports (22). For three companies, the reports were only available online. Some companies have published several types of reports (for example, annual and sustainability reports). The research method is mixed (Dragomir & Dumitru, 2022), having a quantitative dimension (content analysis) and a qualitative dimension (thematic analysis).

On the quantitative side of the research, 24 key concepts from the F2F strategy were identified. The frequency of these concepts in the reports was measured using the NVivo qualitative analysis software. We identified information on "food waste" in 42 of the 60 selected reports. The lowest number of occurrences of the term "food waste" was one, and

[*] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3385

the highest was 90. The average occurrence of this concept was 13.10 per report. The phrase "food loss" appeared in 16 reports. The lowest number of occurrences in a report was one, the highest was 24, and the average was 7.06 per report. A higher frequency was recorded only for the concept of "climate change," which is a phrase that can be used in different contexts. Therefore, "food waste" is a key concern for the sample companies.

Information on food loss and/or waste was identified for 31 companies in the sample. On the qualitative dimension of the research, we focused on food waste and the actions taken by companies to increase resource efficiency along the food chain. The main research method is semi-objective and consists of content analysis. This research methodology is relevant for corporate reporting (Al-Tuwaijri ș.a., 2004; Cormier ș.a., 2005; Gray ș.a., 1995) and was used in many studies of corporate social responsibility (Cho, 2009; Tilling and Tilt, 2010; Dragomir and Anghel Ilcu, 2011). We extracted all the sections that referred to food waste in the selected reports and critically investigated them. The percentages reported in the Results section were calculated by reference to a total of 31 companies.

The list of items was established a priori, using the theoretical model in Figure no. 1.

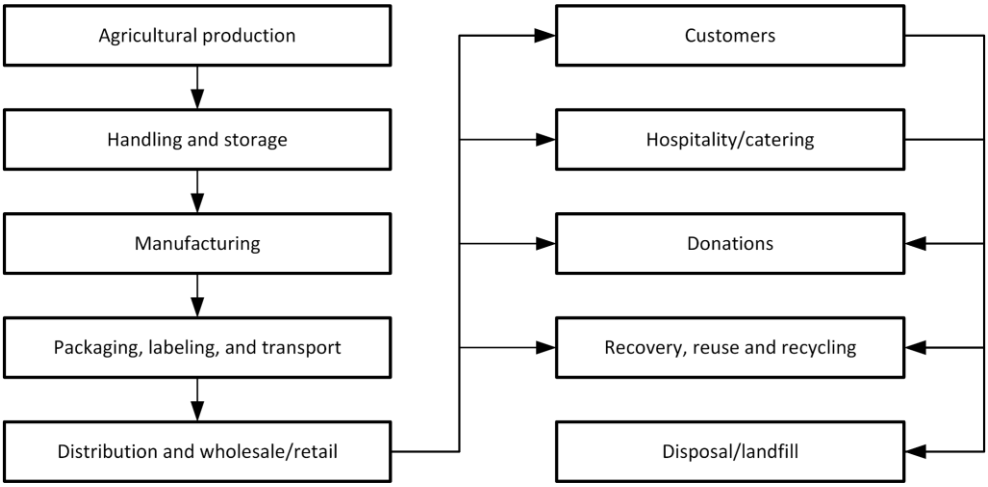

Figure no. 1. The supply chain in the food industry
Source: Authors' compilation, 2021

The stages of the food chain in relation to food waste were extracted from the literature, as follows:

- agricultural production (Parfitt et al., 2010; Chauhan et al., 2021; Beretta et al., 2013; Priefer et al., 2016; Do et al., 2021; Wunderlich and Martinez, 2018).

- handling and storage (Parfitt et al., 2010; Beretta et al., 2013; Wunderlich and Martinez, 2018).

- manufacturing (Parfitt et al., 2010; Beretta et al., 2013; Priefer et al., 2016; Do et al., 2021; Wunderlich and Martinez, 2018).

- packaging, labeling, and transport (Parfitt et al., 2010; Chauhan et al., 2021; Wunderlich and Martinez, 2018).

- distribution and wholesale/retail (Parfitt et al., 2010; Chauhan et al., 2021; Beretta et al., 2013; Priefer et al., 2016; Do et al., 2021; Wunderlich and Martinez, 2018).

- customers (Parfitt et al., 2010; Chauhan et al., 2021; Beretta et al., 2013; Do, 2021; Wunderlich and Martinez, 2018).

- hospitality/catering (HORECA – hotels, restaurants, canteens) (Do et al., 2021).

- donations (Beretta et al., 2013).

- recovery, reuse, and recycling (Parfitt et al., 2010; Beretta et al., 2013; Chauhan et al., 2021; Demartini et al., 2022).

- disposal/landfill (Parfitt et al., 2010; Beretta et al., 2013; Chauhan et al., 2021).

4. Results and Discussion

This section is presented following the structure in Figure no. 1. For each category, we presented the percentage of companies that report information on that aspect, the importance of the category, the actions taken, and the relevance of the measures assumed by the companies.

Agricultural production

Food loss prevention starts from the first stage of the chain, namely agricultural production, for which 29.03% of the sample companies disclose relevant information. In this regard, companies work with suppliers to address waste management (Ahold Delhaize, Colruyt, Jerónimo Martins, Nestlé, Sonae), implement responsible crop protection using pesticides (Co-op), redistribute "ugly" food (Jerónimo Martins), and publish information on collaborators (Tesco).

Handling and storage

In the analyzed sample, 25.81% of the companies disclosed information on food losses from handling and storage processes. Co-op uses inventory forecasting and management systems, while Ahold Delhaize promotes "responsible handling" to reduce waste in the distribution and processing chain and provides recommendations to customers. Coca-Cola and Sonae implement actions to minimize the number of products likely to expire (for example, Sonae prints the "sell-by" date on product labels).

The indicator used by Coca-Cola regarding the performance in this area was the percentage of expired products (in 2020, the company reported a reduction from 0.5% to 0.3% in expired products in the last five years). ICA Gruppen established the target of halving food losses in warehouses and stores by 2025 compared to 2016 (in 2020, the company achieved a reduction of 4% compared to 2016).

Manufacturing

The results indicate that 58.06% of sample companies reported information on manufacturing activities. The importance of this dimension is given by the fact that, for some companies,

most of the food losses come from the manufacturing stage (Greenyard). For example, Mondelez aims to reduce food loss in the manufacturing phase by 15%. Some of the companies in the sample are members of Champions 12.3 (Nestlé, Royal DSM, Sodexo), and some are members of the 10x20x30 initiative (Ahold Delhaize, Nestlé, Nomad, Sodexo, Metro).

Companies are working with producers to find new ways to tackle food loss (Ahold Delhaize, Colruyt, Sonae through the Waste Farmers' Market program). Attempts are made to obtain new products from the waste produced during the manufacturing process. The Danish Crown contributes to the SDG by using as much raw material as possible in the processing stage. For example, the company uses 84% of the mass of slaughtered pigs and 95% of slaughtered cattle. One solution is to use parts that are difficult to cook for canning.

The extent of food loss depends on the type of product. For example, the loss is greater for fresh fruits and vegetables at Greenyard. Bread ranks third in the list of products that often turn into food waste (Orkla). Therefore, companies focus on how different intermediate products can be processed to avoid food waste (Orkla, Puratos Group). Special dough, enzymes, or improvers (Puratos Group, Royal DSM) can be used for bakery and confectionery products.

Packaging, labeling, and transport

Of the companies analyzed, only eight (25.81%) presented information on packaging, labeling, and transport. The aim was to reduce food loss in operations, including in shops and warehouses, during transport. The use of electronic labels on shelves would reduce the quantity approaching the expiration date (Ahold Delhaize).

The companies are involved in research projects to discover new storage and packaging technologies that extend the shelf life of fruits and vegetables, saving a large amount of raw materials (Colruyt). The company Greenyard aims to minimize waste in all its activities, from fruit and vegetable processing to packaging materials. Processes are constantly reviewed, and packaging is used for food waste prevention.

Clarification of label data is a major concern for companies, as the guidelines on how to store food and when to use it are not always clear. Correct and intelligible labeling reduces food waste during the consumption phase (Nestlé). Jerónimo Martins provides support to consumers in understanding the expiration date of food products. By 2020, the company managed to clarify the information on the label regarding the average consumption period after opening, especially for the most perishable products such as mayonnaise, milk, and fruit jams.

Many consumers choose products with a lower environmental impact and a "clean label," without artificial preservatives. At the same time, manufacturers must meet these requirements by maintaining or increasing shelf life (Kerry). Orkla Foods Norge would push until 2023 its *Green Opportunities* project, funded by the Norwegian Research Council, to achieve the circular economy of packaging without increasing food waste.

Distribution and wholesale/retail

Information on this stage is reported by 48.39% of the companies in the sample. Supermarkets are a link in the supply chain, with the strategic role of coordinating the work of other partners to ensure efficient use of resources and combat food waste (Eroski).

The first direction of action is a better management of inventories (Carrefour, Colruyt, Sonae). For example, store areas are dedicated to products with a short shelf life (Carrefour). Sonae signals with "Pink Stickers" the products whose expiration date is approaching, thus improving the sales flow. Colruyt uses monitoring systems to ensure optimum inventories. Sonae also optimizes supply flows by entering the expiration date into algorithms, in addition to forecasted outflows. The effect is tighter control of the shelf life within the supply chain, maintaining the quality and freshness of products for customers. ICA Gruppen focuses on the supply process, systematically collecting, monitoring, and analyzing data to determine the types of food waste in stores and the reason for their occurrence.

Price optimization is another dimension for food waste prevention in wholesale and retail distribution processes. All companies resort to discounts before the expiration date or for products with minor defects. Another way to reduce waste is to create special packages for products close to expiration. For example, Sonae sells baskets with five kilograms of fruits and vegetables close to the optimal date of consumption ("ZER0% Waste Box"). Decathlon sells such mixed packages for a quarter of the normal price, in partnership with Too Good To Go. Several companies in our sample use the services of this company and its mobile app (Carrefour, Danone, Metro, Nestlé, Sonae).

Another set of solutions refers to the products sold. Eroski sells food that is ready and safe for consumption, regardless of appearance. Greenyard sells frozen or prepared foods. Reducing food waste also depends on maintaining the freshness of the products (e.g., by using special packaging materials through Colruyt's Apeel technology and using improvers at Puratos Group).

Companies cooperate with various entities in this field, such as organizations specializing in the production and serving of food (canteens, restaurants), and food charities to avoid food waste in their stores (Metro).

The indicators used to report food losses and waste in wholesale and retail distribution are: halving the amount of waste in warehouses and stores by 2025 (for ICA Gruppen, which achieved in 2020 a 4% reduction compared to 2016), or the amount of waste avoided by actions implemented in stores (Jerónimo Martins).

Customers

Regarding the companies included in the sample, 51.61% disclosed information on food waste from consumer use. More than 60% of food waste occurs in developed countries after the sale (Kerry Group). Food waste is also caused by the consumers' preference for fresh (Ahold Delhaize) and organic (Kerry Group, Royal DSM) products.

Food companies can contribute to responsible consumption (Danish Crown, Eroski) by reducing the financial and environmental impact of food waste (Central England Cooperative, Puratos Group) and increasing the reuse of food waste, including in customers' homes (Ahold Delhaize). Firms are involved in public awareness campaigns such as "Love Food, Hate Waste" (Central England Cooperative) or "Stay-In (spired)" (Unilever) and organize public events to educate the consumers about domestic waste, such as "ready steady cook" (Central England Cooperative), "Consumer Eroski" (Eroski), promoting the book "Zero Desperdício à Mesa com o Pingo Doce" (Jerónimo Martins), or the project "Single Banana" (Sonae).

Collaborating with customers to place orders is another way to avoid excess products that lead to food losses (Kerry Group). Other initiatives include joining the Coalition of Action on Food Waste, Too Good to Go (Decathlon, Nestlé), United Against Waste (Sonae), or creating waste monitoring systems, such as Premium Pro (Orkla).

Hospitality/catering

Information on food waste produced by the HORECA sector is presented by 12.90% of companies. HORECA can help reduce food waste through original recipes (Ahold Delhaize), and cooperation with organizations (for example, Too Good To Go). For example, Sodexo avoided 17,000 tons of carbon emissions through the "WasteWatch" monitoring program.

Donations

Of the companies included in the sample, 54.84% present information on the donations made. Companies (Ahold Delhaize, Danone, Nomad, Orkla, Colruyt) entered into direct agreements with food banks or used their networks to establish links between food producers and food banks. Danone and ICA Gruppen entered into agreements committing to redistribute surplus food to food banks, food aid organizations, and other specialized charities. FareShare, for instance, distributed food to local charities (Co-op in 79% of its stores, Tesco – more than 6,500 local community groups) and shelters for the elderly, lunch clubs, and community centers (Greenyard). The companies also chose to donate food through their stores (Co-op), non-governmental organizations, and the Olio application (Tesco). Donations went to vulnerable people and employees (Suntory, Jerónimo Martins, Orkla), by placing surplus food in canteens of stores and company warehouses (Sonae).

To further combat food waste, companies launched their own campaigns (for instance, "Co-op Food Share"). Danone invested in two start-ups created in 2014 (Phénix in France and Hungry Harvest in the USA). With the help of its network (professionals, non-profit organizations, dedicated citizens), Phénix provided 100 million meals. Hungry Harvest avoided sending 9 million tons of food to dumpsters while distributing more than half a ton of fruits and vegetables to people in need. Jerónimo Martins contributed to the circular economy, fighting hunger and malnutrition by donating food surplus that met food security standards in all countries where the group operates.

Eroski created the "Robin Food" Program, which involves recovering food waste through the participation of people at risk of social exclusion. "ZeroWaste" is the program through which Eroski fights food waste by creating an action protocol to ensure food safety. Donated products are in optimal condition for consumption, and a transportation warranty is provided to the recipient. The campaign "Let's Fight Food Waste Together" was launched to raise awareness of food waste and provide prevention tips. More than 600 non-governmental organizations had the opportunity to work with Jerónimo Martins to build partnerships to combat food waste through food donations. In Poland, the food donation program to social institutions has been expanded to 1,941 stores, up 18% from 2019 (Jerónimo Martins). "LIFEFood Cycle" was an innovative and pioneering project at the European level developed by Sonae. It involved a digital platform that enabled the company to manage inventory losses, optimizing donations to charities.

The indicators used in the reports on donations were as follows: the total number of meals donated per year (Carrefour, Central England Cooperative, Nomad), the percentage of unsold food (Colruyt, Tesco), the amount of food and basic products donated (Eroski, Jerónimo

Martins), and the value of donations (Sonae). For instance, edible food waste per ton of finished products has been reduced by 31% compared to 2015 (Nomad), and companies have managed to save over 4.5 million tons of food (Carrefour), 100% of the "best before" products they would usually send to landfill (Central England Cooperative). Sonae has donated food daily since 2020. The restrictions imposed by the COVID-19 pandemic have led to an increase in the amount of unsold food (AB InBev) and limited the ability to reuse certain waste streams (ADM). However, companies' efforts to support vulnerable people continued during the pandemic (Nestlé, Nomad, Ahold Delhaize).

Recovery, reuse, and recycling

A total of 21 companies in the sample (67.74%) reported information on food recovery, reuse, and recycling. Food waste recovery can be seen in the following initiatives: using citrus waste to obtain eco-packaging through the "Life Citruspack" Project (Eroski); creating unique concepts, such as a dough used to make bread from unsold, fermented, and combined bakery products with the starter Sonextra Sustain (Orkla); sale of coffee waste as a raw material for the production of instant coffee (Paulig); projects to produce nutraceuticals from food waste (Eroski); the "Meio Ambiente nas Escolas" program for the recovery of used cooking oil, a program that focused on ecological education in schools and in collaboration with municipal education networks to raise awareness among students, families, and communities (ADM).

Companies have found innovative solutions to reuse food waste: obtaining gin by distilling beer that could have been otherwise wasted (AB InBev); transformation of rejected fruits into by-products such as apple juice, cakes, or sorbet (Colruyt); products from vegetables that would otherwise be wasted, such as the Krumm Glücklich (Nestlé) range of soups; collaborating with other players to use the surplus cheese, yogurt, beer, and apple juice as ingredients in cakes and bread (Orkla).

Recycling usually refers to the transformation of food waste into energy. Some examples are the use of new equipment for the separation of packaging for recycling, with fruit and vegetable waste being transformed into energy (Greenyard); collecting used coffee grounds to produce electricity at biogas stations (Paulig); biomethane production (Carrefour, Ahold Delhaize, Danish Crown, Paulig, Midcounties Cooperative); transformation of waste into fuel and raw materials for soaps and detergents (ADM); compost/fertilizer production (Ahold Delhaize, ADM, Danish Crown, Jerónimo Martins).

The companies presented different indicators and their degree of fulfillment: the recycling of food waste has decreased to 75%, although the target was 90% (Greenyard); about 60% of the waste streams are reused (for example, for animal feed), and 38% are recycled (Greenyard); more than 10.8 thousand tons of by-products of the food industry were introduced in animal feed, 20% more than in 2019 (Jerónimo Martins); the use of waste for fertilizers or renewable energy increased by 8.4% (Jerónimo Martins); 10% reduction in food waste (Kerry Group); 87% of the total waste was recycled, and the amount of waste from the landfill has been reduced from year to year (Paulig); the share of non-recyclable waste from roasting Tver coffee has decreased from 10 to 4% (Paulig).

Some of the disclosed objectives are the focus on recycling (Ahold Delhaize), at least 90% of waste to be reused, recycled, or "otherwise diverted from landfill" by 2035 (ADM), the development of circular processes that ensure recycling (Danish Crown), preventing waste generation, and improving the recycling rate (Paulig).

Disposal or transfer to landfills

Among the companies analyzed, a proportion of 70.96% reported efforts to avoid the transfer of food waste to landfills. Waste includes the edible part of food products (for example, its net weight without packaging). The waste that appears within the supply chain is classified as waste from stores, food returned to stores, waste from wholesale warehouses, waste from e-commerce warehouses (ICA Gruppen). Waste reduction increases food security and the conservation of natural resources (Ahold Delhaize). Several companies in our sample (Eroski, Greenyard, Nestlé) used the services of the International Zero Waste Alliance – ZWIA.

Reported initiatives for waste reduction include the detailed classification and measurement of food waste (Co-op), the analysis of the causes of its occurrence (ICA Gruppen, Danish Crown), the adoption of the food waste pyramid (Co-op), the focus on products that turn into higher-than-average waste (Co-op, Greenyard), models for redistribution of perishable products, efficient order placement (Central England Cooperative, Paulig). Companies can use various IT tools such as smart algorithms for sourcing and processing products, early identification of food at risk of becoming waste (ICA Gruppen), and smart pricing systems (Midcounties Cooperative). In this sense, it is essential to collaborate with suppliers (Tesco), join coalitions (Metro, Nomad, Sodexo, Royal DSM, Sodexo, Tesco), and participate in research studies (Paulig).

Some companies use the absolute "waste quantity" indicator (Carrefour, Central England Cooperative), which is directly proportional to the activity level. Other companies report the "waste intensity," using indicators such as the reduction in the number of tons of waste relative to the value of food sales (Ahold Delhaize), the percentage of products handled in landfills that become waste (Co-op), the amount of waste per amount sold (ICA Gruppen, Jerónimo Martins), the percentage of the total amount of food that is destined for incineration and fermentation (Colruyt), or the total amount of waste that is sent to the landfill (Paulig). One of the guidelines used for measuring, evaluating, and quantifying waste (Ahold Delhaize, ICA Gruppen) is the "Food Loss and Waste Protocol" (WRI, 2021).

Companies set targets for the entire business (Ahold Delhaize) or a segment (e.g., Colruyt for three selected products, Co-op for stores, ICA Gruppen for certain group entities, Mondelez for production activity, Nomad in certain markets, Orkla in certain countries). A certain year can be set as a basis for comparison (2016 for Ahold Delhaize and Carrefour).

An integrated perspective on food waste management in the value chain

Food waste occurs at all stages of the supply chain, requiring a holistic approach. Several companies in our sample have joined the United Nations Sustainable Development Goals (SDGs). SDG 12 aims to ensure sustainable consumption and production patterns. In particular, SDG 12.3 aims to halve the overall food waste per capita in retail and consumption, as well as reduce food losses along the production and supply chains, including post-harvest losses by 2030.

Based on the information collected, we calculated the frequency of disclosures on food waste prevention at each stage of the supply chain in the reports published by the sample companies (see Figure no. 2). Food companies aim to limit the waste of resources at every stage of the agri-food chain, optimizing production processes, establishing policies to prevent and reduce food loss and waste, promoting responsible consumption practices, improving recycling in operations and the supply chain, creating employee involvement and training programs,

analyzing the key factors of local food waste, tracking waste quantities, and communicating the results internally and to other stakeholders.

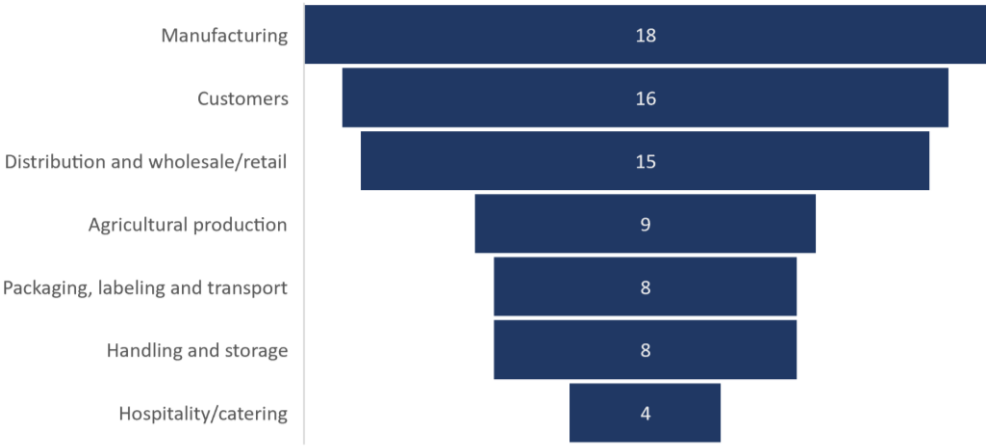

Figure no. 2. The frequency of codes for each stage of the value chain in the food industry
Source: Authors' compilation, 2021

Food waste can be reduced by donating, recovering, reusing, and recycling perishable food. As a last resort, food waste can be transferred to the landfill, which is not desirable. Figure no. 3 presents the frequencies of information regarding waste destinations in the reports of the sampled companies. The stage entitled "Transfer to landfill" includes information on the amounts discarded and initiatives to reduce the proportion of food wasted at various stages of the distribution cycle. Value chains in the food industry have characteristics that could be assimilated to the circular economy (Slorach et al., 2019), but there is a significant amount of food that is wasted and cannot be turned into any other resource. In these circumstances, an integrated approach must focus on maximizing the circular nature of the value chain in the food industry, by minimizing the proportion of food that is wasted.

Figure no. 3. The frequency of codes regarding the destination of waste within the food supply chain
Source: Authors' compilation, 2021

The unwanted food surplus should be tackled first, and overproduction and excessive food supply should be avoided (Papargyropoulou et al., 2014; Smil, 2004). Where possible, food waste should be used as animal feed or to produce energy by anaerobic processes (e.g., the

production of biohydrogen or biomethane), as well as for specific chemicals or neutraceuticals (Espín et al., 2007). The many forms in which food waste can be reused have been presented by various authors (Kiran et al., 2014; Pham et al., 2015). Landfilling or incineration of waste should be the least used option.

Waste generation can be prevented by reducing losses and redirecting excess food that is still safe and edible to other end consumers. Non-governmental organizations and the media have been involved in campaigns to prevent food waste (Girotto et al., 2015). Other authors consider that actions to prevent food waste should focus on the processing, packaging, and distribution of fruits and vegetables (Nahman and de Lange, 2013). Food donation is a valid solution to minimize food waste (Schneider, 2013). Thus, excess food is recovered and reused according to the original purpose – human consumption.

Future preventive solutions should focus on shifting responsibilities from local stores to retail companies, through internal optimization (application of best practices to retail outlets), informing and training the employees, and updating the displays at the end of the day when inventories are depleted (Lebersorger and Schneider, 2014). Thus, if the waste must be disposed of at the retailer's expense, this situation will motivate the store to minimize losses, optimizing the ordering cue according to the demand (Gustavsson et al., 2011).

In a study on the perception of food waste and the behavior of Italian consumers, Amicarelli et al. (2021b) reached similar conclusions to those of our study. Smart delivery systems can lead to an improvement in purchasing decisions and, indirectly, to a reduction in food waste. An analysis by Strotmann et al. (2021) on the impact of digital technologies on food waste during the COVID-19 period showed that the whole value chain benefits from the window of opportunity represented by digital tools, which are useful in combating food waste in general, not just in pandemic periods. Most home consumers are aware of the potential for food waste and are looking for solutions to reduce this phenomenon. Principato et al. (2020) indicate that the COVID-19 pandemic has significantly altered eating habits and consumer behaviors, with an effect on reducing food waste. The results of our research confirm those obtained by Schneider (2013) on the role of food donations in waste prevention. Food banks across Europe have been able to redistribute significant amounts of food, even despite restrictions imposed by the COVID-19 pandemic (Capodistrias et al., 2021).

Schebesta and Candel (2020) believe that, despite very high expectations, the F2F strategy will only achieve its objectives if it overcomes the following challenges: the unresolved ambiguity of "food sustainability," political objectives and regulatory solutions, the complexity of institutional engagement, and the coordination between Member States. A list of relevant policies should complement practical solutions in the food supply chain (Thyberg and Tonjes, 2016): education to promote the importance of food waste prevention in terms of economic, social, and environmental effects; education to promote behavioral change in food consumption; policies to encourage the redistribution and donation of food from retail outlets; promoting the redistribution of products for animal feed; stimulating waste prevention; stepping up research and development; improving packaging technologies; improving product labeling; modifications in the design of waste collection systems; changing the way of treating the collected waste; and setting up waste prevention targets.

Conclusions

The results of this study and the integrated perspective highlighted above answer the research question: "What are the solutions regarding food waste prevention across the companies' supply chain?" Food waste is found in all stages of the supply chain, so it is a shared responsibility of all economic actors. At the same time, the reduction of food waste can only be achieved through the collaboration of the parties involved. For example, packaging and labeling to reduce waste could not have the expected effect if consumers did not purchase products close to the expiration date. There is also a cultural dimension to what is considered "acceptable" in terms of human consumption. In this regard, large food chain stores have a major impact on reformulating consumer preferences.

The EGD and the F2F strategy aim to prevent food loss and waste. According to reports analyzed, the companies in our sample are involved in achieving this goal through actions taken at all stages of the value chain. The strategy supports the achievement of a circular economy, which will aim to reduce the environmental impact of the food processing and retail sector by implementing measures aimed at transport, storage, food packaging, and food waste. Moreover, there are initiatives that can help companies in the reporting process. For example, the GRI 306 "Waste" Standard proposes a model for food industry producers, with details on waste categories and their specific destinations for production, upstream and downstream activities. Applying the GRI standard would help companies such as those in our sample to publish comparable information.

One of the limits of our research is the sample size. However, we consider that the companies chosen are relevant for the industry because they are involved in the implementation of the F2F strategy. Another limitation is that we only analyzed the reports published in one year, which did not allow us to compare the data over time. However, the differences in non-financial reporting topics from one year to another are not significant (Dragomir et al., 2022). The selection of fragments from the reports involves a degree of subjectivity, but we tried to mitigate it by using NVivo and studying each fragment in detail.

Future research on the EGD must take into account the humanitarian crisis and the deterioration of food chains as a result of the war in Ukraine. Crop destruction, embargoes, and export restrictions on agricultural products can lead to an increase in food shortages in countries that have trade relations with Ukraine and the Russian Federation. In this context, researchers can look at the extent to which the EGD can help reduce the pressure on food chains in Europe and elsewhere. Combating food loss and waste is all the more relevant in a European space that will focus on post-war reconstruction of Ukraine and the humanitarian support of millions of refugees.

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