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Article

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GOOD PRACTICES ON REDUCING FOOD WASTE THROUGHOUT THE FOOD SUPPLY CHAIN

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Abstract

Research to identify initiatives to reduce food waste (FW) in Romania is quite limited, and existing studies at the European and international level have highlighted the need to promote models of good practice that can be multiplied on a large scale. In this context, the aim of the paper is to highlight good practices for preventing and reducing food waste in the EU and in Romania, so that different organizations and decision makers can develop better interventions in this regard. The best practices for preventing and reducing FW identified and presented in the paper refer to: the use of digital technology, projects and platforms, organizations involved in volunteering, food banks, mobile applications, social innovation, corporate social entrepreneurship, education, and public awareness.

The paper also identified the determinants of food waste, encountered at the end of the food supply chain FSC (Food Supply Chain), as well as good practices to prevent and reduce it, to make it available to organizations, authorities, and households a wide range of models that can be implemented internationally and in Romania as well.

Keywords: best practices, food waste, food supply chain, EU, Romania

JEL classification: F53, Q13, Q18, Q58

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Introduction

In a world where more than 820 million people are starving and 2.3 billion people do not have access to adequate quality and sufficient food, the safety and security of food is becoming more and more a societal problem.

The problem of food waste affects all regions of the world and therefore requires integrated global solutions (Zmieńka and Staniszewski, 2020). The reduction of food waste (FW) leads to more efficient land use, better management of water, energy, and labor resources with positive effects for the entire agri-food sector worldwide, (Farcas et al., 2021), contributing to the fight against malnutrition.

FW occurs at the level of retail, food, and household services, representing a decrease in the quantity or quality of food, resulting from the decisions and actions of retailers, food services, and consumers. Food Losses (FL) occur along the food supply chain FSC (Food Supply Chain) from harvesting, processing, and logistics, not including the retail level (Nicastro and Carillo, 2021).

There is modest research in Romania on ways to reduce FW, but internationally many studies have shown good practices of great value that can be implemented on a large scale. (Schinkel, 2019; Campoy-Muñoz et al., 2021). In this context, the paper helps to clarify existing practices for reducing FW, with implications for raising awareness of home consumers and entrepreneurs, in developing business strategies, as well as for decision makers, who can create updated regulations on food safety, food quality, food supply chains and reduction of food waste.

The work continues with a review of the specialized literature, followed by a record of aspects of food waste worldwide, in the EU and in Romania. Subsequently, the rest of the paper focuses on good practices on reducing food waste, and concludes with the highlighting of the main conclusions.

1. Review of specialized literature

Of the 17 United Nations' Sustainable Development Goals, 10 are closely linked to food sustainability. Food production accounts for 26% of the overall ecological footprint, and integrating sustainability must be an intrinsic part of food security. Covering the growing need for healthy, good quality, and affordable food requires a multidisciplinary approach (United Nations, 2015). At the same time, the 12th sustainable development target 2030 (Responsible production and consumption) set by sub-objective 12.3 the target of halving food waste at the level of retail and consumption, by 2030 (Djekic et al., 2021; Faggini, Cosimato and Parziale, 2021), this being a collective responsibility to act, people being part of the solutions. Reducing food waste is a way to contribute to the sustainability of the food system (Gkoutani and Tsoulfas, 2021), and the circular economy (Adelodun et al., 2021) requires the improvement of local production that promotes sustainable production and consumption. As a result, to compensate for risks in the food system and reduce food losses and waste, FAO has made a number of recommendations, such as: properly managing the existing production surplus under the FSC; creating strategic food reserves; increasing local production and managing its quality a (FAO, IFAD, UNICEF, 2021).

The Food and Agriculture Organization of the United Nations (FAO) definition of food waste is: *food and associated inedible parts removed from the human food supply chain in the following sectors: manufacturing of food products (under certain circumstances); food/grocery retail; food service; and households* (United Nations Environment Programme, 2021b).

Very important from an operational point of view is the clarification made by some authors such as Ouyang et al. (2021), which considers that the dynamics of work on the prevention and reduction of food waste can be grouped into the following stages: a primary stage (before 2007), a consolidation stage (2007-2014), and a rapid development stage (after 2015).

Causes of food waste are: internal characteristics of food; social and economic factors; individual consumer behaviors; priorities targeted by private and public stakeholders; various factors, such as: poor management, inefficient legislation, lack of awareness or information; suboptimal use of available technologies. The causes of FW also depend on the food group. Fresh fruits and vegetables, baked goods, and dairy products are wasted because they are not used in time. Uneaten leftovers from the meal are due to too large portions. The deterioration of perishable products is mainly due to storage at a temperature above 4°C (Jeswani, Figueroa-Torres and Azapagic, 2021). This diversity of causes that generate FW requires specific monitoring systems, targeted policy measures, and actions from all stakeholders at each stage of the FSC (Canali et al., 2017). As a result, coordinated interdisciplinary activities are needed throughout the FSC, with a view to developing a sustainable and responsible food chain, from 'precision' agriculture to 'precision' food waste, with water, soil, and biodiversity management (Knorr, Augustin and Tiwari, 2020) and improved cooperation among all these factors (Ocicka and Raźniewska, 2018; Kleineidam, 2020; Sánchez-Teba, Gemar and Soler, 2021).

Another important aspect is the fact that the specialized literature in this field unites the groups interested in the reduction of FW within the FSC in the following categories: political factors, which catalyze the change; citizens and educational institutions, who understand the food system; farmers, processors, retailers, social enterprises, who use policy tools; financial institutions, which have a wider impact; educational institutions, NGOs, social enterprises, researchers, who educate and transmit the knowledge (Cristobal et al., 2016).

Abideen et al. (2021) consider that the latest trends in FSC-related research emphasize *the role of digital transformation and the inclusion of technological advances* as part of the so-called Industry 4.0: the Internet, blockchain technology, artificial intelligence, big data, social media, wireless sensor networks, computing technologies, remote sensing, machine learning, fuzzy applications, QR code, and geographic information systems. Digital technologies are increasingly applied in all stages of FSC (Chauhan et al., 2021), are in the attention of researchers in many fields (Amentae and Gebresenbet, 2021) and allow the introduction of circularity in the system, with applications in agriculture, processing, distribution, food security, FW reduction, and circular economy (Rejeb et al., 2022). Information and communication technologies (ICT) allow for frequent and rapid exchanges of information between FSC actors to coordinate their activities (Ada et al., 2021; Vernier et al., 2021), as well as for the introduction of FSC in the circular economy.

2. Aspects on the situation of food waste worldwide, in the EU and in Romania

There are major differences in the FW quantity reported, mainly due to differences between definitions and quantification methods (Campoy-Muñoz et al., 2021). Amicarelli and Bux (2020) show that the most common methodologies for estimating the quantities of lost and/or wasted food identified are: consumer journals, questionnaires, combined methods (direct measurements, supplemented by data from the literature; questionnaire and analysis of waste composition); liquid waste analysis; photographing leftovers from the plate; expenditure surveys. These should be chosen according to the geographical area of interest, the stage within the FSC, and the availability of data.

2.1. Global food waste

In the year 2021, the United Nations Environment Programme (UNEP) published a methodology for countries to measure FW at the household, food, and retail levels to track national progress towards the Sustainable Development Goals (SDGs) and to report on the reduction of food waste (United Nations Environment Program, 2021b), and the United States Environmental Protection Agency (US-EPA) proposes a pyramid to reduce FW, with a focus on prevention and recovery actions of the FW (United States Environmental Protection Agency, 2021) and the impact on the economy, the environment, and society. The latest estimates show that the level of food waste worldwide reached 931 million tons in 2019 (representing about 17% of total food production), of which 61% in households, 26% in public food services, 13% in retail (EUFIC, 2021). Worldwide reported food waste per capita reached 121 kg / person / year, of which: 74 kg in households, 32 kg in food services and 15 kg in retail (United Nations Environment Programme, 2021b).

The contrast between food waste levels in different parts of the world is strong. The highest amounts of food waste per person are recorded in the countries of West Asia (110 kg/person/year) and Sub-Saharan Africa (108 kg/person/year), while the lowest amounts are observed in the countries of Eastern Europe (61 kg/person/year) and East Asia (64 kg/person/year) (Statista, 2021).

Other estimates of FW show that approximately 1.3 billion tonnes of food are wasted annually, and that their amount per capita varies between 280 and 300 kg/head/year in European and North American countries, respectively, 95-115 kg/person/year at the level of household consumption (Schinkel, 2019).

2.2. Food waste at the EU level

Enormous amounts of food are wasted every day in the EU, which contributes to the loss of important resources, such as: water, soil, and energy. Food waste increases food insecurity and contributes significantly to global problems of climate change, pollution, and biodiversity loss, hence the importance of preventing and reducing it.

In 2016, the level of FW in the EU was 88 million tons, respectively, 174 kg/person, and additional costs of about 143 billion euros (Celli et al., 2022), at the level of the entire FSC. A report published in the FUSION project shows the share of FW in each sector as follows: household consumption (53%), processing (19%), food services (12%), primary production (11%), distribution, logistics, and sales in detail (5%).

Food losses and waste generated at the EU level in 2018 amounted to 812 million tonnes, respectively 1,818 kg / inhabitant, of which 8.5% were waste generated during the FSC (154.6 kg per capita) (Eurostat, 2021b). In the same year, Corrado and Sala (2018) reported a total of FW along the supply chain with variations between 194 kg / person / year and 389 kg / person / year globally and between 158 kg / person / year, respectively, 298 kg / person / year at European level.

The EU countries with the highest annual food waste per capita (kg / person / year) in the retail, food and household sectors are (Laurentiis and Caldeira, 2021): Denmark (213 kg), Spain (190 kg), Portugal (185kg), Italy (184 kg), Belgium (183), Croatia (164 kg), Poland (154 kg), Netherlands (146 kg), Ireland (129 kg) and Cyprus (129 kg).

Considering the above, the EU has taken a number of steps, of which the most important are the following:

- The European Waste Directive was founded from 2008 (2008/98/EC) and was revised in 2018 by Directive (EU) 2018/851. This includes monitoring the achievement of FW reduction targets (30% by 2025 and 50% by 2030), encouraging Member States to develop specific programs (European Union, 2018).
- In 2019, the European Commission adopted a methodology based on which FW can be quantified (European Parliament, 2020). The EU platform on Food Losses and Food Waste was created in 2016 and has been operational since 2020. It proposes a monitoring methodology compatible with SDG 12.3. The platform identifies effective interventions to reduce FW and facilitates their transferability at the EU level (Garske et al., 2020). Since 2017 and 2018, the European Commission has been recommending the use of unfit food for human consumption as animal feed, and the donation of excess food (Eurostat, 2021a), respectively. The FAO has proposed two indicators that quantify food loss and waste: Food Loss Index (FLI) and Food Waste Index (FWI) (FAO, 2019).
- In 2020, the European Commission launched the “Farm to Fork Strategy” within the “European Green Deal”, which proposes measures and targets for each stage of the food supply chain (FSC), in order to increase its sustainability. Policies aimed at food security, nutrient recovery, raw materials, biodiversity conservation, promotion of renewable energy also aim at preventing and reducing FW (European Commission, 2019).

2.3. Aspects regarding the food waste situation in Romania

The reduction of food waste has been regulated in Romania since 2017, with the publication of the methodological norms for application in 2019 (Government of Romania, 2019). In accordance with the law, economic operators must act to reduce food waste by offering discounted products at the end of their shelf life.

Romania is a country where concerns about reducing FW are more recent, with a relatively small number of papers published in this direction (United Nations Environment Programme, 2021b). In 2020, 505 kg of household waste/capita were produced at the EU level, and 280 kg/capita were reported for Romania (2019) (Eurostat, 2021b), that is, approx. 55% compared to the EU average, and statistics published by UNEP in 2021 show that in Romania, the level of household food waste was around 70 kg /year/person (Chinie, Biclesanu and Bellini, 2021), respectively, an estimated quantity of 1,353,077 tons/year at national level.

Recently published papers show that in Romania approximately 40.78% of the total FW is generated by household consumers (Dumitru, Iorga and Mustatea, 2021), and the level of FW in urban households depends on the sex of respondents, income level and number of people in the household. Studies conducted among more than 900 household consumers show that the level of FW in urban households in Romania decreased in 2020 (6.5%), compared to 2016 (10.5%) (Dumitru, Iorga and Sanmartin, 2021). The same study shows that 1/5 of the population produces approx. 50% of the total FW in the urban area. Young people under the age of 35, living in big cities, with university studies, buying from retail networks, are the biggest generators of FW. It is also shown (Cantaragiu, 2019b) that gender is an important factor that affects the attitudes and behaviors of individuals regarding food and a potential factor that could affect the amount of FW. The need to adapt FW public awareness campaigns to the specificities of each gender and age is emphasized.

3. Best practices for reducing food waste

Good practices in reducing food waste are activities aimed at reducing the amount of food wasted at the terminal level of the food supply chain, and are meant to lead to a change in food purchasing and consumption habits among the population and the business model of sales of the entrepreneurs and food services.

3.1. Good practice worldwide and in the EU

The United States Environmental Protection Agency (EPA) estimates that 63.1 million tons of food waste were generated in the commercial, institutional, and residential sectors in the U.S. in 2018, accounting for 21.6 percent of total municipal solid waste production.

The recovery of food waste was achieved by using them for: animal feed production, biochemical processing materials, co-digestion/ anaerobic digestion, composting/aerobic processes, controlled combustion, donation, field application, wastewater treatment (Environmental Protection Agency, 2020). In the USA (Kim, Parajuli and Thoma, 2020), it is necessary to incorporate environmental sustainability into food guidelines throughout the life cycle of the food system, with a full accounting of the effects of food loss / waste.

The application of digital technology at all stages of the food supply chain can be of significant importance in avoiding FW and ensuring high-quality food. Evidence in the literature links the sustainability of the food system with digital technologies to reduce FW, recalling: intelligent detection technology to improve food quality and freshness; tracking the IoT-based inventory network to minimize food waste; behavioral modeling based on twin-based digital; monitoring and planning the food supply chain using IoT (Abideen et al., 2021); innovative smart phone applications to promote products approaching their expiration date (Aramyan et al., 2021). The development of innovative technologies can be accelerated by funding research projects and startups. Food waste streams can also be represented by a Sankey diagram, which is an interactive visual tool that can highlight the progress made toward reducing food waste and loss (Szarka et al., 2021).

A number of *projects* have been launched to reduce food waste, such as: *Stop Waste – Save Food* presents international initiatives in this regard (Food Cluster of Lower Austria and the Plastics Cluster, 2020); *Food is Precious* is an Austrian initiative proposing a brand to be

used by FW reduction projects and actions; *Love Food Hate Waste* shows that self-reporting of wasted food reflects on eating habits and encourages behavioral change; *Strefowa-Strategies to Reduce Food Waste in Central Europe* presents 294 good practices for reducing FW in 10 European countries; The initiative *Save Food* proposes a multidisciplinary international alliance to combat food loss and waste.

Food waste control platforms have been developed, for example: *ReFED* (Rethink Food Waste Through Economics and Data) is an initiative of various parties to reduce FW, consisting of evaluating 27 financially beneficial solutions, reducing emissions, water conservation, jobs created and recycled meals, using community-based social marketing strategies; *TRiFOCAL London – Transforming City Food Habits for Life* implemented in the UK in order to change consumer behavior through sustainable food education and food waste reduction; *Eatmosphere* proposes a direct link between farmers, processors, traders, and consumers.

Various *organizations have been involved in volunteering* to collect, reuse, and redistribute surplus food. In developed countries, surplus food is recommended to be donated to food banks and charities so that it can be distributed to those in need. Corporate food surplus donation is due to strategic and moral reasons, but also to concerns about economic efficiency and reduced operating costs (Sert et al., 2018).

Food banks have proven their effectiveness, especially during the current pandemic (Farcas et al., 2021). The European Federation of Food Banks is a network of more than 300 organizations in 29 European countries. In the activity report for 2020, they reported: 45,458 site visitors; 60 videos posted on Youtube; 1 social campaign carried out on World Energy Day; 26 online publications in 22 languages; 860,000 tons of food distributed; 12.8 million people supported; involvement in the development of policies on the circularity and sustainability of the food system. FareShare (European Food Banks Federation, 2021), a scheme for recognizing FSC companies that redirect their food surplus to charities and community groups, has recently been launched. Good practices for food bank management during the COVID-19 pandemic are (FAO, 2020): attracting non-perishable food donations and public and private funding to support food recovery and redistribution; adjusting the collection, distribution, and delivery of food so that it reaches people in need; distribution of fresh and non-perishable food; attracting volunteers and partners to engage in all operations safely.

Numerous *mobile applications* have appeared (Fecioru, 2020) which aim to reduce FW and promote a Zero Waste generation. Digital tools allow the creation of platforms that make a direct link between food supply and needs, allow donations for charities, or offer discounts for customers (La Lorraine Romania, 2020). Such digital tools are: *Karma*, launched in Sweden and expanded in France and the United Kingdom, offers low-priced products that are close to expiration date and are consumed fresh; *Olio*, with the motto 'share more, waste less', is available in the UK and proposes to redistribute excess food; *Too Good To Go* is an app that offers a basket of surprise products that were not sold that day; *RESQ Club*, founded in Finland by retail and food service operators and extended to Sweden, Poland and Germany, offers 50% off products and dishes; *Phenix* available in France, users can choose from the shopping cart products offered by retailers, with subsequent pick-up from the store; *HopHopFood* and *Geev* (France) propose food donation; *Foodsharing App*, is an active platform in Germany, offering the possibility to donate surplus food; *The Green Egg Shopper*, available for the iPhone, allows users to organize their shopping lists, view food on

the expiration page, and connect to a store; *Winnow* is intended for use in crowded kitchens to signal food waste. It uses a smart trash can connected to a computer, which allows companies to reduce the costs of FW; *222 Million Tons* allows users to make a menu list for a week, associated with the necessary ingredients, depending on the number of people in the household; *Leloca* is meant to reduce FW in restaurants, giving users the opportunity to receive discounts of 30-50% for empty seats, offers being available for 45 minutes; *NoFoodWasted* signals products in nearby supermarkets that are approaching their expiration date; *Food Rescue U* has been active in the United States since 2011, making connections between those who have a surplus of food and those in need (United Nations Environment Programme, 2021a).

A hierarchy of food waste can also be approached through the prism of *social innovation*, with current practices focused on human reuse of FW rather than prevention (Lombardi and Costantino, 2020). In Italy, the innovative social model (www.avanzipopolo.it) for reducing FW proposes interventions in three directions: education and awareness activities on the impact of FW (public events, workshops, and educational programs); connecting the actors in the final part of the FSC with charities, kitchens, and NGOs that redistribute food, and community involvement that allows locals to exchange food directly (Lombardi and Costantino, 2021). The results obtained through this innovative social model for 2021 are: recovery of 64,751 kg of food, connections between 198 FSC operators with 78 beneficiary non-profit organizations, 1,110 food recovery operations; 200 students involved in educational programs (Avanzipopolo 2.0, 2022).

Another important way to reduce waste is to *educate and raise awareness*. The current period of FSC dysfunctions caused by the COVID-19 pandemic has highlighted major changes in food buying and consuming habits (Borsellino, Kaliji and Schimmenti, 2020) and the need for stronger and more equitable partnerships between farmers, producers, retailers, and citizens, along with the need for transparency (Kleineidam, 2020). Overall, there has been a reduction in household food waste during the pandemic and a positive consumer attitude toward the prevention of FW (Berjan et al., 2021). Babbitt et al. (2021) shows that those behaviors that target self-sufficiency, bulk food purchasing, and storage have been significantly correlated with increased food purchases, which has led to increased waste (Babbitt, Babbitt and Oehman, 2021). Today, more than ever, it is necessary to understand the behavioral changes related to FW, as a basis for designing effective mitigation strategies (Guarnieri et al., 2021; Music et al., 2021). Aldaco et al. (2020), studying how the COVID-19 pandemic affected food loss and waste (FLW) in Spain, shows that strong fluctuations and short-term changes in eating habits can have major consequences for the generation and management of FLW and gas emissions with greenhouse effect (GES). In Italy, a study conducted among 1,142 households shows that 70% of people waste 370 g of food/week, the most wasted being fresh vegetables, bread and soft drinks (Scalvedi and Rossi, 2021). Some authors such as: Soma, Li and Maclaren (2020); Wharton et al. (2021), showed that online educational and awareness interventions (through podcasts, infographics, videos or online games, with points and rewards) are also effective in reducing FW.

The Nutrition Center in the Netherlands identified three behavioral measures for household consumers: smart shopping, smart cooking by using the right amounts, and better food storage. In the Netherlands, 1.6 million Eetmaatje cups were distributed free of charge to the population to measure different varieties of rice or pasta, marked with volumes suitable for adults, the use of which allows a reduction in FW of rice and pasta by approx. 12.5%, the

change of the cooking behavior and, implicitly, of the FW (van Dooren et al., 2020). Reynolds et al. (2019) indicate effective interventions at the consumer level: shopping planning and meal preparation, excluding impulsive shopping, inventory management, cooking the right quantities, and creativity in using leftovers.

Figure no. 1 summarizes the main causes of food waste at the end of the food supply chain, as well as the good practices identified for their prevention, reduction, and reuse.

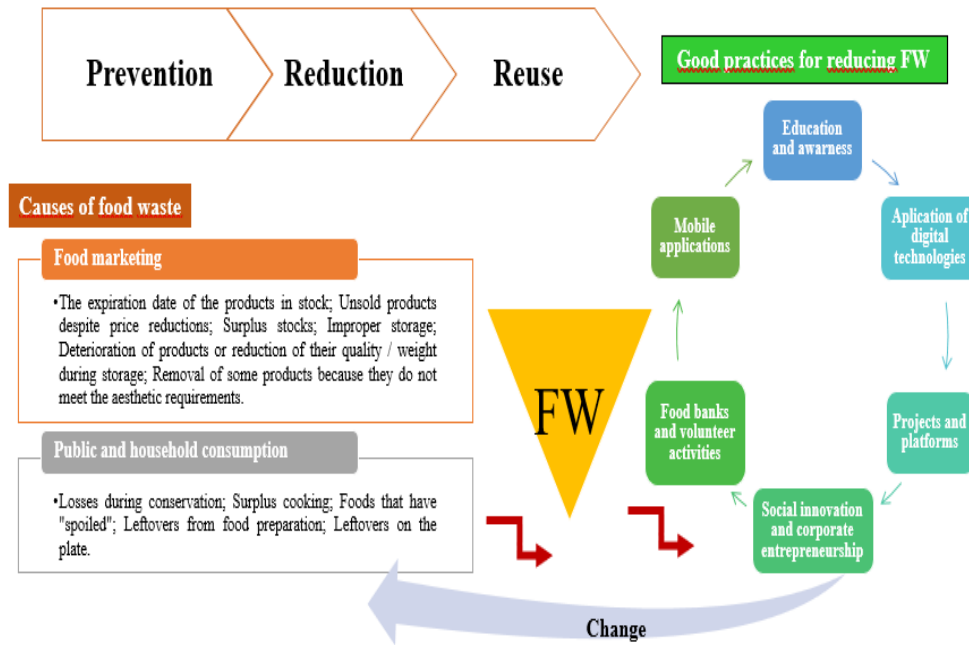


Figure no. 1. The causes that generate FW at the terminal level of the FSC and the identified good prevention and reduction practices

In Spain, using 24 groups interested in reducing FW, (Diaz-Ruiz et al., 2019), identified 48 possible interventions: nutrition education; consumer awareness campaigns; changing habits to reduce FW volumes; courses in schools on FW, promoting food procurement planning, promoting a strategic food access plan. In Hungary, Fogorassy et al. (2020), in a study on 828 organic buyers, shows that wasted food consisted of more expensive and better-quality food, which is significantly lower than in the case of linear or traditional food production-consumption.

EU methods of reducing FW include removing restrictions on food donations and creating a framework for a better understanding of the meaning of labels: best before and use by. The *EIT Food* (FoodFutureMakers) initiative shows that supermarkets have an important role to play in providing examples of reducing FW. Based on the effort and resources involved in reducing food waste (including food donation and composting), it is proposed to give a score to each supermarket, useful for obtaining tax cuts (Giacomino, 2021).

3.2. Good practices on reducing food waste in Romania

An impact study of food waste in Romania, conducted in 2020 by Dumitru, Iorga and Mustatea (2021) in a project funded by the Ministry of Agriculture and Rural Development, mentions that 852 entrepreneurs from different segments of the food chain consider that food waste could be prevented by: investing in new, more efficient technologies; applying a management of sustainable principles in companies; public communication on a larger scale; digitization at all FSC links.

In Romania, the population on the verge of poverty and social exclusion reported in 2019 reached 31.2% of the total population, well above the EU average (20.9%), being exceeded in this aspect only by Bulgaria (32.8%) (Eurostat, 2021a), and the Food Bank of Romania reported in 2021 partnerships with more than 30 donor organizations, 5,076 tons of food distributed, 9 branches nationwide, and 105 donation campaigns to 400 NGOs (Bucharest Food Bank, 2021).

The organizations involved at national level in programs to combat food waste and in education for a sustainable nutrition and examples of good practices undertaken by them were identified by the project Romania without waste implemented by a non-governmental organization (Asociația Mai Mult Verde, 2017). Other associations with programs, projects, and other actions in reducing food waste were: Bio & Co food solidarity program, with the establishment of a BIO farm and a composting platform with an area of 1,000 square meters, the collection of 290 tons of food waste and the redistribution of 2,000 kg of food (the Workshop without Borders Association); the Rechosen Dishes program has organized cooking workshops and the recovery and reuse of the surplus of products from local shops and markets in Bucharest (Bucharest Community Foundation and Bucharest Carousel Association); collecting and redistributing fresh food from local markets (Society for Responsible Consumption Society); the collection of expired and non-food foods and their sale through a social store (Somaro-Social Shop Association); the educational project Too good to be wasted carried out actions to raise awareness among students and the population of Bucharest (Terra Mileniului III Association); Joy Table project - food collection from two trading partners and their redistribution (Vasiliada Association).

Large retail operators are also implementing FW reduction programs, based on the principles of *corporate social entrepreneurship*, thus contributing to the sustainability of food chains (Cantaragiu, 2019a). The sustainability report published by LIDL shows that in 2020 198 tons of food products were donated to the Romanian Food Bank Network and to NGOs that manage animal shelters, a total amount of 459 tons of animal feed (Lidl, 2022). Reducing food waste in restaurants helps increase cost efficiency, optimize resources, and reduce the resources involved. In this regard, Filimonau (2021) states that in order to address the issue of food waste, the hospitality sector should be integrated into alternative food networks and short food supply chains (SFSCs), with the collaboration of all actors in the supply chain. Regarding the waste generated by this sector, a focus should be on investments in green innovations. Also, Romanian researchers such as: Gruia et al. (2021) propose the application of a multipurpose model of technology and waste management, tested in restaurants in Braşov, Romania. The proposed model - TEWAMA-R ("Multipurpose model of sustainable technology and waste management in restaurants") shows that FW in restaurants is registered in all technological stages of the culinary process, and can be reduced, reused, or recycled.

Conclusions

Reducing food waste requires a combination of technological measures and behavioral changes in consumption patterns. Changing patterns of production and consumption in the food system and introducing them into the circular economy can have positive effects on the economic, social, and environmental aspects.

Understanding the social habits of buying food, managing it in the household and raising awareness among consumers are key actions to reduce food waste. This requires to educate consumers and make them aware to change their behavior regarding alternative food patterns, combining food waste with sustainable diets, with an emphasis on the nutritional value and resources embedded in food in the economic, social, cultural, and environment of each country.

The design of strategies to reduce food waste must be done through a holistic approach to the food supply chain. Strategies to reduce food waste must be based on the collaboration of all stakeholders, community involvement, the circular economy, the use of technological innovations, digital technology, and the necessary regulatory changes. The multidisciplinary approach to food waste, rapid and cross-sectoral interventions, will contribute to the change needed to reduce food waste and develop sustainable food systems.

The main good practices for preventing and reducing food waste, identified and presented in the paper refer to: the use of digital technology, projects and platforms, organizations involved in volunteering, food banks, mobile applications, social innovation, corporate social entrepreneurship, education and public awareness actions.

Highlighting these good practices, the paper helps to identify the causes of food waste, to clarify the existing practices to prevent and reduce it, offering a wide range of models for reducing food waste, with implications for consumers, entrepreneurs, in developing business strategies, as well as for decision makers, who can create up-to-date regulations on food safety, food quality, food supply chains and reducing food waste.

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