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## THE IMPACT OF FOOD WASTE AND WAYS TO MINIMIZE IT

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**Abstract.** The article addresses the issue of food waste, which presents a global problem that has recently become even more important on the public and political agenda. The importance of this topic will continue to grow, especially given the need to feed a growing world population. At the same time, in the pandemic conditions created by Covid-19, it presents a major challenge at the international level, both from a health and social point of view, enormously affecting the economies and all industrial sectors, including agriculture, food production, and especially food consumption and food waste. Food is a precious commodity, and its production can require significant resources. Current estimations indicate that around one third of food produced worldwide for human consumption is wasted or lost, which generates significant economic and environmental costs. Food waste is a problem that occurs throughout the food chain and therefore measures should target all its components, with potential benefits for all parties involved. Although there are a number of EU policies that can help combat food waste, this potential is not being made the most of and the opportunities offered have not yet been exploited.

**Keywords:** *food waste, food flows, food supply chain, Covid 19 pandemic, sustainable development.*

**Rezumat.** Articolul abordează problema deșeurilor alimentare, care prezintă o problemă globală, devenită recent și mai importantă pe agenda publică și politică. Importanța acestui subiect va continua să crească, mai ales având în vedere necesitatea de a hrăni o populație mondială în creștere. În același timp, în condițiile pandemice create de Covid-19, acesta prezintă o provocare majoră la nivel internațional, atât din punct de vedere sanitar, cât și social, afectând enorm economiile și toate sectoarele industriale, inclusiv agricultura, producția de alimente, și în special risipa de alimente. Alimentele prezintă o marfă prețioasă, iar producția sa poate necesita resurse semnificative. Estimările actuale indică faptul că aproximativ o treime din alimentele produse la nivel mondial pentru consumul uman sunt irosite sau pierdute, ceea ce generează costuri economice și de mediu semnificative. Risipa alimentară este o problemă care apare pe tot parcursul lanțului alimentar și, prin urmare, măsurile ar trebui să vizeze toate componentele sale, cu beneficii potențiale pentru toate părțile implicate. Deși există o serie de politici UE care pot ajuta la combaterea risipei de alimente, acest potențial nu este valorificat la maximum și oportunitățile oferite nu au fost încă exploatate.

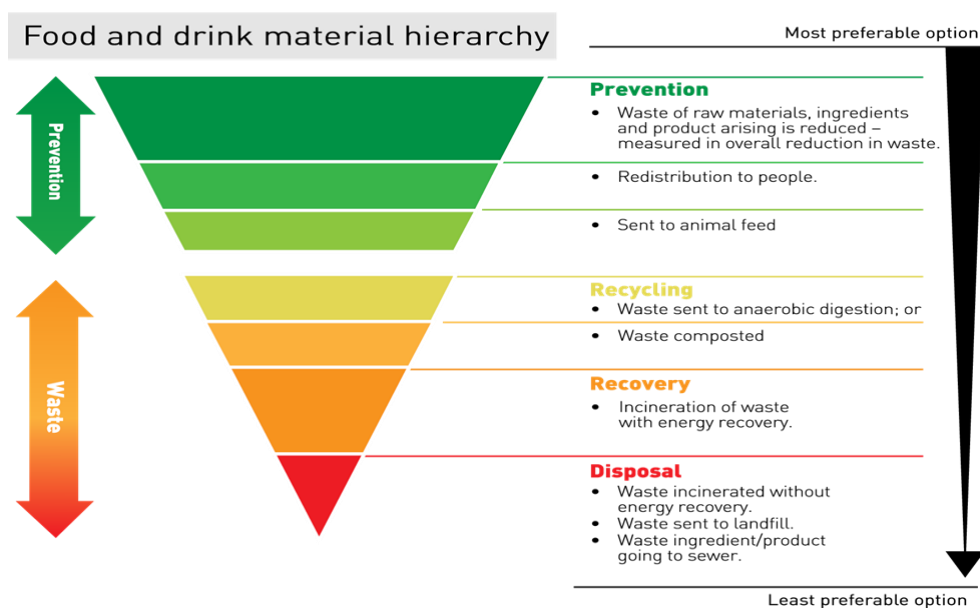
**Cuvinte cheie:** *deșeuri alimentare, fluxuri alimentare, lanț de aprovizionare cu alimente, pandemie Covid 19, dezvoltare durabilă.*

## 1. Introduction.

In the EU, 119.1 million people, a quarter of the population, were at risk of poverty or social exclusion in 2015, and 42.5 million people could not afford a quality meal once in two days [1,2]. At the same time, an estimated 88 million tons of food are wasted annually in the EU and the associated costs are estimated at EUR 143 billion [3,4]. In addition to its important economic and social impact, food waste puts undue pressure on finite natural resources and the environment. According to the Food and Agriculture Organization of the United Nations (FAO), about a third of all food produced in the world is lost or wasted [5]. Food that is harvested, but eventually lost or wasted, consumes about a quarter of all water used in agriculture each year and requires an area of land the size of China [6,7]. Food waste generates about 8% of global greenhouse gas emissions annually.

## 2. Waste hierarchy in case of food waste.

The waste hierarchy establishes an order of priority of waste treatment actions, from the most preferable option to the least preferable option, based on criteria related to environmental sustainability. The EU Waste Framework Directive sets out the waste hierarchy applicable in the EU [8]. This hierarchy can be applied in relation to food waste but should be slightly changed to take into account the particularities of food. Several Member States have adapted the food waste hierarchy, opting for the order of preference shown in Figure 1.



**Figure 1.** Waste hierarchy applied in relation to food waste.

## 3. EU food and waste streams.

The main objective of food waste prevention is to act on the source by limiting excess food production at each stage of the food supply chain (ie, production, processing, distribution and consumption). An overview of the analysis of food and waste flows in the EU is presented in Fig. 2 in the form of a Sankey diagram. We notice that the flows of each product group are visualized, starting from the quantities of food produced to primary production and ending with consumption. All flows that enter the supply chain are represented as imports and leave them as exports, by-products to non-food, animal feed by-products, food waste and food consumed by humans.

When a surplus of food occurs, the best destination that ensures the maximum use of edible food resources is their redistribution for human consumption. Food donation not only supports the fight against food poverty but can help reduce the amount of excess food that is industrially recovered or sent as waste to the landfills.

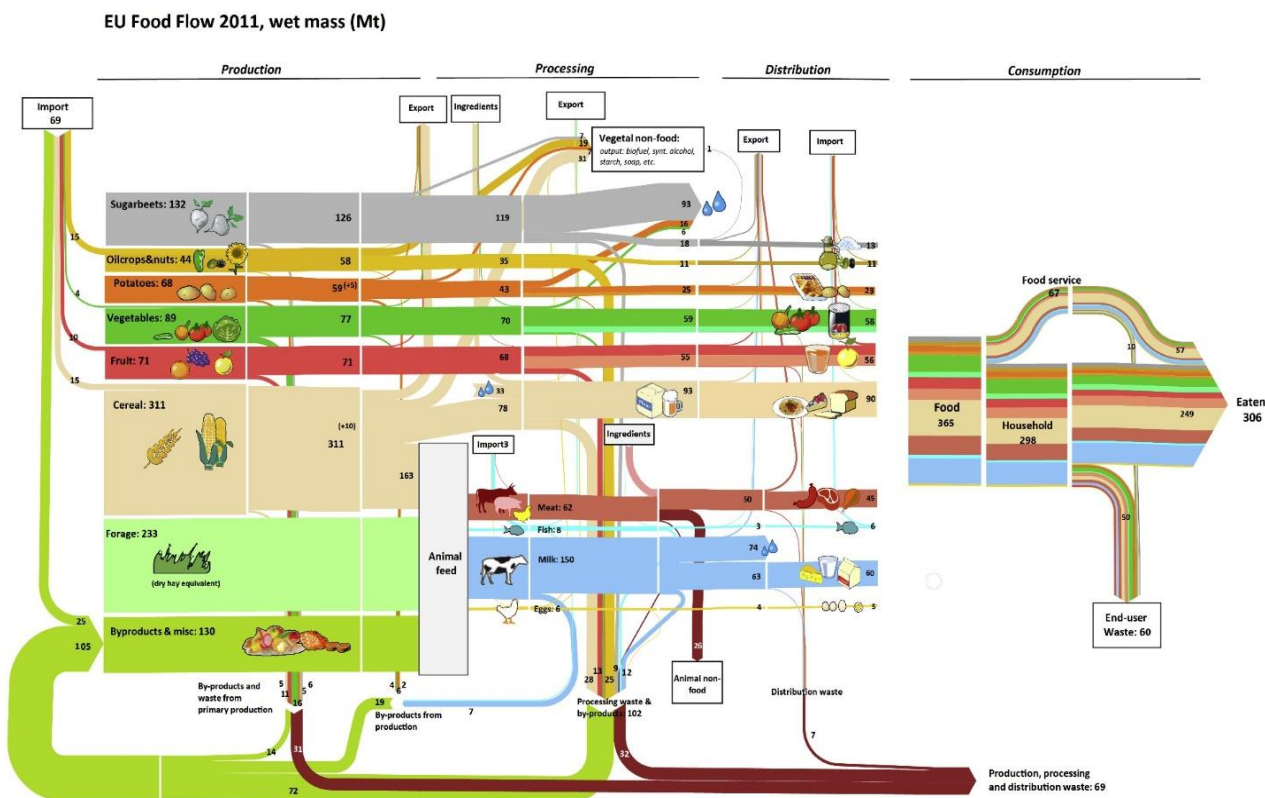


Figure 2. Sankey diagram. EU food and waste streams [9].

However, even if the redistribution of excess food is a growing phenomenon and food producers and retailers are willing to donate their surplus to food banks and charities, the amount of redistributed food is still a small proportion of the total excess edible food available in the EU. For example, in 2016, some members of the European Federation of Food Banks (FEBA) distributed 535,000 tonnes of food to 6.1 million people [10], which is only a small part of the estimated volume of food waste registered annually in the EU.

It should be noted that Member States (MS) and stakeholders have identified for donors and beneficiaries legal and operational barriers to the redistribution of safe and edible food in the EU[11]. Therefore, the action plan proposed by the Commission to promote a circular economy involves clarifying EU food law to facilitate food donation [12].

As mentioned above, food waste is a global issue that has become increasingly important on the public and political agenda in recent years. The importance of this topic will continue to grow, especially given the need to feed a growing world population. Food is a precious commodity, and its production can require significant resources. Current estimates indicate that around one third of food produced worldwide for human consumption is wasted or lost, which generates significant economic and environmental costs [13].

Ensuring the food security of the population is the obligation of each state. The problem of food security, of the access of the population to basic agri-food products of adequate quality, is a major concern faced, to a greater or lesser extent, by all the states of the world, but primarily the underdeveloped or in development countries [14,15]. The problem of food access is a factor that can lead to global instability. Ensuring food security for all individuals contributes to social peace, stability and prosperity [16].

On April 7, 2015, on the occasion of World Health Day, the WHO chose to promote food safety, as foodborne illness kills two million people a year, a significant proportion of whom are children. Foods can contain bacteria, viruses, parasites or chemicals that are responsible for over 200 diseases, from acute diarrheal disease to cancer. There is a vicious cycle between digestive diseases and malnutrition, which primarily affects infants, young children, the elderly

and people with other pathologies. Foodborne diseases can influence socio-economic development by burdening health systems, affecting national economies, tourism and trade [17].

In 2004, the unanimous adoption of the food rights guidelines by the FAO Council was one of the most important steps in the history of the right to food. For the first time, the international community fully agreed on its significance. These guidelines provide a bridge between the legal recognition of this right and its effective realization, providing governments, civil society and other partners with a coherent set of recommendations. They cover economic development policies, legal and institutional issues, agricultural and food policy, nutrition, food security and consumer protection, education and awareness, safety devices, social security, emergencies and international cooperation. It provides a framework for an integrated food security policy at the national level.

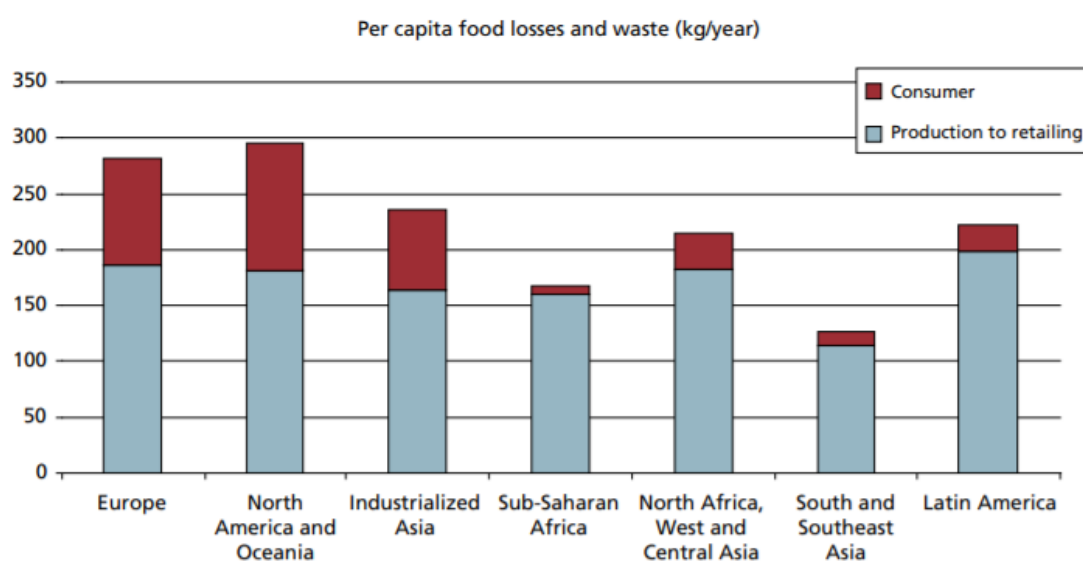
#### 4. Analysis of the situation at international level.

Food waste - means any food and / or inedible parts of food, which are removed from the food supply chain, which must be recovered or disposed of (by composting, anaerobic digestion, bio-energy production, incineration or storage of organic waste) [18].

Food waste is produced along the entire value chain: during the production and distribution process, in shops, restaurants, public catering establishments and households. This is why it is very difficult to quantify them: there is currently no harmonized and reliable method in the EU of their origin and evolution over time. Finding a solution for measuring food waste is an important step towards a better understanding of the problem, a coherent monitoring and reporting process, and effective exchanges of good practice at EU level. The European Commission will develop, in close cooperation with Member States and stakeholders, a common EU methodology for measuring food waste [19].

Food loss - represents the decrease in the quantity or quality of food reflected in the nutritional value, economic value or food safety of all food produced for human consumption but not consumed by humans [20].

Figure 3 shows that the food loss per capita in Europe and North America is 280-300 kg / year. In sub-Saharan Africa and South / Southeast Asia it is 120-170 kg / year. The total per capita production of edible parts of food for human consumption are: in Europe and North America about 900 kg / year and in sub-Saharan Africa and South / Southeast Asia, 460 kg / year.



**Figure 2.** Per capita food losses and waste, at consumption and pre-consumptions stages, in different regions [21].

Food wasted by consumers in Europe and North America is 95-115 kg / year, while this figure in sub-Saharan Africa and South / Southeast Asia is only 6-11 kg / year. Food losses in industrialized countries are as high as in developing countries, but in developing countries more than 40% of food losses occur at post-harvest and processing levels while being industrialized. In several countries, more than 40% of food losses occur at the retail and consumer levels. Consumer food waste in industrialized countries (222 million tonnes) is almost as high as total net food production in sub-Saharan Africa (230 million tonnes).

The graphs of the seven groups of goods below show the percentage of food losses and edible waste parts of food that have been produced for human consumption.

In the case of cereals (Figure ...) wheat is the dominant crop supply in middle- and high-income countries, and the consumer phase is the stage with the highest losses, between 40-50% of total cereal food. In low-income regions, rice is the dominant crop, especially in the very popular region of South and Southeast Asia.

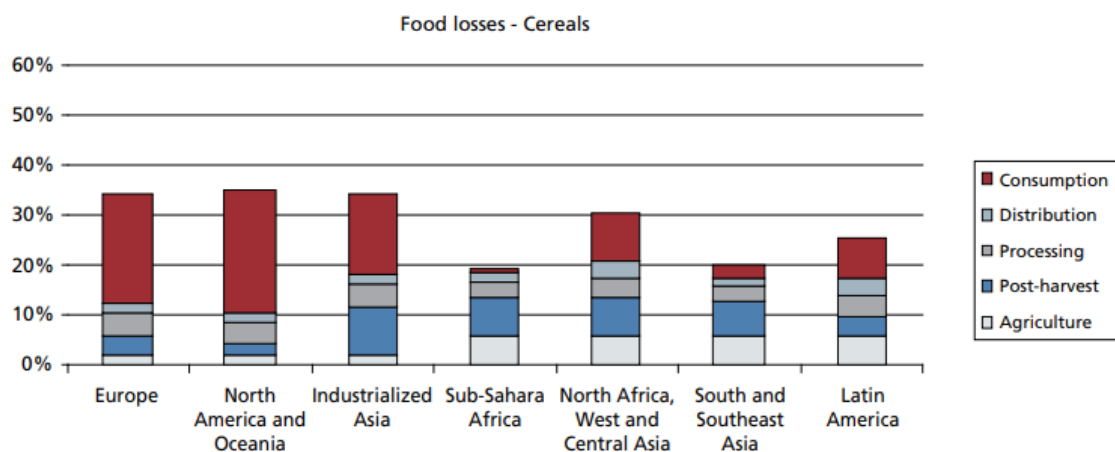
For these regions, agricultural production and post-harvest handling and storage are stages in the FSC with relatively high food losses, as opposed to distribution and consumption levels. In the group of roots and tubers (Figure ...), the potato (sweet potato in China) is the dominant crop supply in middle- and high-income countries.

The results indicate that all three middle- and high-income regions lose the largest volumes during agricultural production.

This mainly depends on the quantity after harvest classification, due to the quality standards set by retailers. However, food waste at the consumer level is high.

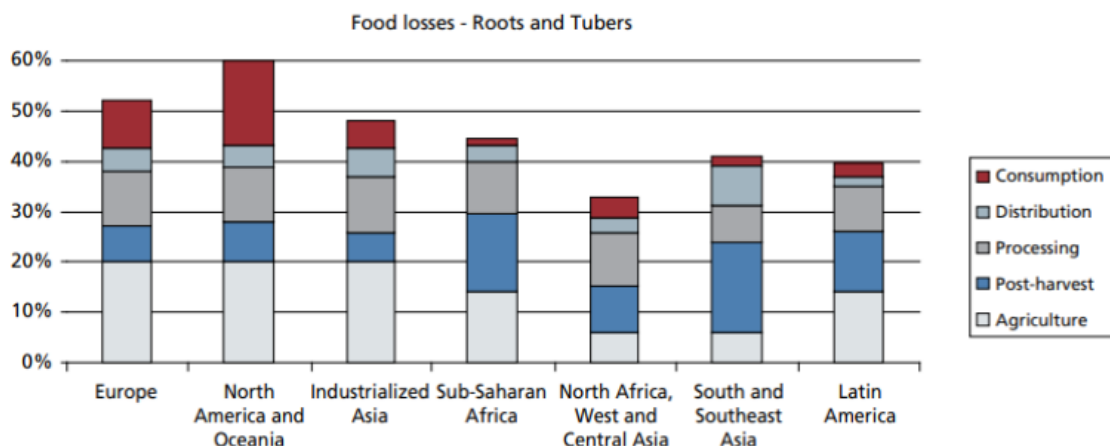
Another important aspect that falls within the food waste is presented by the need for water that is used in the food production that is subsequently thrown away (not consumed).

Thus, the drinking water resources involved in food waste are 215 km<sup>3</sup>/year, which represents approximately 12-15% of global water consumption [22]. At the same time, about 35% of the global population lives with limited access to water [23].



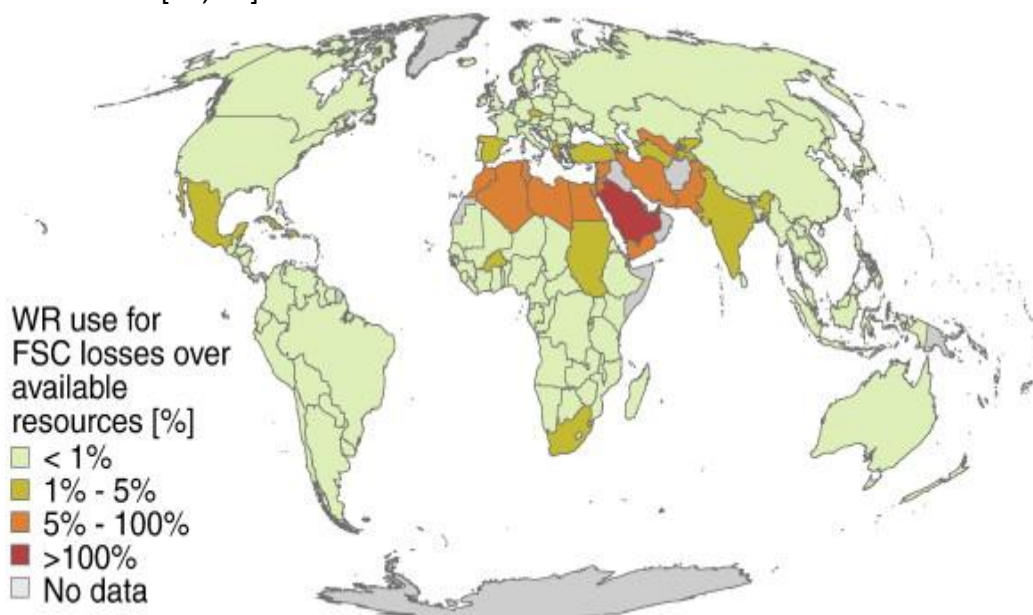
**Figure 4.** Part of the initial production lost or wasted, at different FSC stages, for cereals in different regions [21].

The use of water for food losses as a percentage of the total available freshwater resources is particularly high for the North African countries and West and Central Asia region (more than 5% of the available resources) and in the densely populated South Asian region (about 1-5%) (Figure 6) [24]. In the rest of the world, this percentage is less than 1%, except for Mexico, South Africa, Spain, Turkey and a few small European, African and Caribbean countries. In these countries, the use of water resources for food losses exceeds available resources, namely Kuwait (595% of national renewable water resources), Saudi Arabia (115%) and the United Arab Emirates (222%).



**Figure 5.** Part of the initial production lost or wasted at different stages of the FSC for root and tuber crops in different region [21].

These countries have specific climatic conditions and limited water resources. As a result, they import a large proportion of agricultural products, including food consumed in the domestic market [25]. Another very important factor involved in food waste is agricultural land. Their total use involved in food waste (198 Mha / year) is almost equal to the area of land cultivated in Africa (221 Mha) and is greater than the total expansion of cultivated land worldwide in the last 60 years [26]. Reducing food waste under the "minimum loss" scenario could save 78 Mha of agricultural land, which is more than the area of processed agricultural land in Brazil. It is necessary to take into account that fertilizers that are part of agriculture. Thus their use leads to food waste. These mentions highlight the huge potential of the food supply chain in saving valuable resources [27, 28].



**Figure 6.** Percentage of water resources (WR) use for FSC losses over national renewable water resources. Data source for national renewable water resources: AQUASTAT database.

**5. Top countries with major food waste.**

The **United Kingdom** throws away 14 million tons of food a year. It is currently estimated that 60% of annual food waste could have been avoided in the UK. Although control actions have led to a reduction of 1.6 million tonnes in annual food waste production compared to 2007, the

results are not encouraging. Studies show that food waste can increase by 1.1 million tons by 2025, if no action continues to be taken [29].

In **Germany**, 11 million tons of food are thrown away every year. Research has highlighted that food waste is mainly generated by retailers, which play a key role between producers and consumers. In addition, through store promotions, consumers are attracted to buy more food than they really need, which leads to the creation of a large amount of household food waste. The vision of German Agriculture Minister Christian Schmidt is for food to have smart packaging that informs consumers when they are no longer edible, such as a microchip in a yogurt glass could decide if it is still consumable "We need conscious consumers who know where food is - in the mouth and stomach, not in the trash," he said.

The **Netherlands** has issued the "United against food waste" initiative. The original initiator is the Task Force Circular Economy in Food, which includes a large number of companies, research institutions, civil society organizations and government agencies under the same umbrella. They aim to halve food waste in the Netherlands by 2030 compared to 2015. The Dutch Ministry of Agriculture, Nature and Food Quality will provide seven million euros over the next four years to support this goal by investing in innovation, research, monitoring and education.

In **France**, the problem is similar. According to a report by the French Environment and Energy Agency (ADEME), every year 10 million tons of food are either thrown away or lost, with damage of 16 billion euros a year. The negative impact on the environment is also shocking. In France, food waste produces 15.3 million tons of CO<sub>2</sub>, which is 3% of the country's total CO<sub>2</sub> emissions. In 2017, France became the first country in the world to ban 10 <https://nuaruncapainea.ro/2019/02/15/top-primele-10-tari-cu-cea-mai-mare-risipa-alimentara/> 8 supermarkets to throw away or destroy unsold food. Thus, it forces them to donate food that is about to expire to charities and food banks.

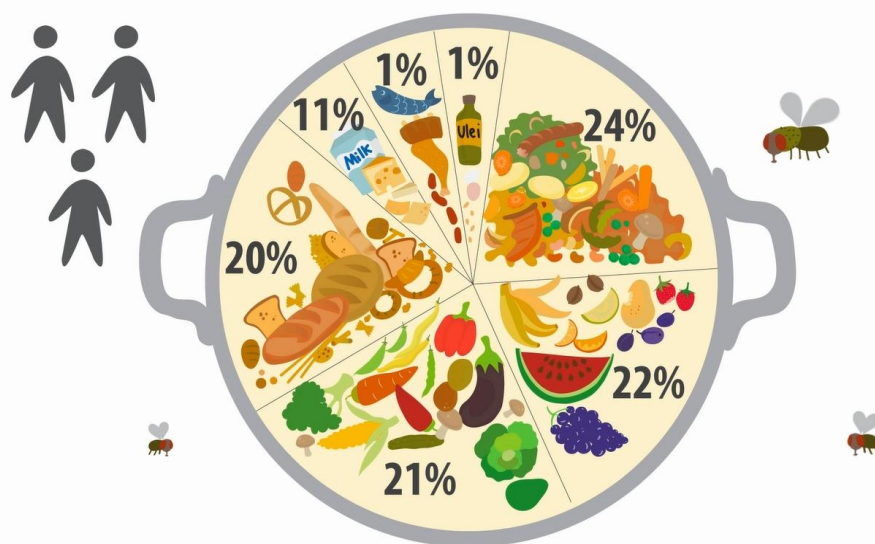
Every year, the population of **Poland** throws away 9 million tons of food. Parliament is working on legislation that limits the amount of waste, followed by other EU countries, while the Polish Senate is drafting a bill on combating food waste. In this context, the question arises as to whether the proposed regulations will reduce this negative phenomenon. In addition, there are many local initiatives in Poland to combat food waste. The best known are the 32 existing food banks. Other initiatives are Outlet Spożywczy, an online platform that sells food near the end of its shelf life, Café Kryzys in Warsaw and others.

In **Italy** - 2013, the Ministry of Environment began working on a national food waste prevention plan, in collaboration with Last Minute Market, a collaborator in food waste management. The main players in the food chain have been involved in the preparation of this waste prevention program. The plan aims to solve the problem of food waste from supply to final consumption. For the time being, animal food waste will not be pursued.

In **Spain**, around 8 million tons of food is wasted every year, making it the seventh largest producer of food waste in the EU. The website "Yo No Desperdicio" and the mobile application, launched in November 2015 and February 2016, are trying to present an alternative to this massive problem. "Yo Nu Desperdicio" is a sharing tool, similar to platforms that facilitate the exchange of trips or exchanges of apartments. This platform (<http://yonodesperdicio.org/>) aims to promote alternative ways of responsible and sustainable consumption, through which we can reconsider our role as consumers, in order to reduce food waste at home, says project coordinator Mari Cruz Martín.

In **Belgium**, two entrepreneurs from Brussels analyzed this problem in their country and came up with an innovative idea: Market Happy Hours, created by Ludovic Libert and Aurélien Marino, to better understand the life cycle of food in supermarkets, logistics in behind processing and handling, as well as ideas for improving the Happy Hours market. "Our desire was to test the distribution logistics to discover constraints that we would not have detected otherwise. We have found that our operational business seems solid, although we still have a lot of work to do. At the end of the week, we collected about 500 kg of food, of which we sold about half. The other 250 kg were given to refugees" - Ludovic Libert.

In **Romania**, food waste amounts to 6,000 tons per day. Romania has implemented the law against food waste, but it is inefficient, because it has rules that "touch" large commercial chains, where food waste is too small compared to that of households. By comparison, 7% of food waste is produced in retail, while 49% is produced in households. Another 37 percent is lost in the food industry, 5% in public catering and only 2% in the agricultural sector. From February 2019, the law on reducing food waste came into force. According to the normative act, the economic agents will have to be more responsible, in order to reduce the food waste, through measures such as the sale at a reduced price of the products close to the expiration of the validity date. 10. The Swedish National Food Agency, in collaboration with the Environmental Protection Agency and the Agriculture Agency, has drawn up the 'More to do more' action plan to reduce food waste, namely one ton per day, on throughout the food chain, from farmers to final consumers. The action plan is part of the Swedish government's commission to the authorities on food loss reduction. The mission extends over a period of three years, starting in 2017, with decision-making in 2019 [30].



**Figure 7.** Percentage distribution of food waste in Romania.

A Romanian throw over 350 grams of food every day, reaching 129 kilograms of food annually. Of this amount, 24% is cooked food, 22% - fruits, 21% - vegetables, 20% - bakery products, 11% - dairy products and 1% - meat. We waste almost as much as the European average, although we have much lower incomes and spend about 40% of them on food [31].

## 6. Food waste and the Covid-19 pandemic.

The Covid-19 pandemic poses a major international challenge both from a health and social point of view, greatly affecting the economy and all industrial sectors, including



agriculture, food production, and especially food consumption. According to the World Health Organization (2020), on June 7, 2020, the Covid-19 pandemic resulted in approximately 6.8 million confirmed cases and over 397,000 deaths globally. In Europe, over 2.2 million cases and over 183,000 deaths. The socio-economic impact, especially due to social distancing, self-isolation and travel restrictions, have led to the blockage of the whole society, millions of jobs being lost or transformed into remote work. Food services for example in hotels, canteens, restaurants, cafes, etc. have been stopped, greatly reduced or reclassified in delivery services [31, 32]. Both food consumption and consumer food behavior have undergone changes due to the Covid-19 pandemic outbreak in early March 2020. The main consequences of the situation have been linked to very large stocks of highly perishable foodstuffs, food chain disruptions, impressive increases in food stocks purchased in large-scale distributions caused by the "stock effect" and "effect stay at home" and a sharp increase in food waste throughout the supply chain with food products, from agricultural stages to consumption [33, 34].

In the context of the above, we can mention that the COVID-19 pandemic has generated a new era in the world. Today, the question of the possible ways of transmitting COVID-19 through food, the involvement of the killer virus in the food supply chain, is becoming more and more topical. For the time being, the possibility of food transmission is poorly outlined and not deeply researched, and the pursuit of SARS-CoV-2 in the workplace is not considered a priority by public authorities. However, the adverse effects on the environment, food systems and people along the food supply chain are already evident. Following some scientific research that has been already carried out, some key findings and conclusions have been made in this field. Thus, as we move "from farm to fork", more safety measures are needed, because more people (and subsequently more potential sources of infection) are involved in the process. For this reason, the need to develop those bioanalytical protocols for food and environmental safety applications is highlighted [36].

### **7. Possibilities to reduce food waste.**

EU research shows that responsibility for food waste lies with:

- 42% of households (households)
- 32% of food producers
- 5% to retailers
- 15% to the catering sector.

The best solution to combat the food crisis is to support family farms. On average, every citizen of the Balkan countries throws away half a kilogram a day. An impressive number of consumers are returning to traditional foods that were part of their diet. For this, family farms, small farms and organic farms are increasingly being developed in response to pesticides and chemicals. People are starting to look for healthy, quality food. Food banks play an important role in reducing waste. There is still much to be done with these banks, including legislative changes. Thus, for such foods, which are donated, no taxes should be paid as for the food sold [29, 31].

At the same time, the economic operators in the food sector represent the natural or legal persons who are responsible for fulfilling the requirements of the food legislation within the food profile enterprise under their control. Among the options that operators have to reduce food waste, the following are recommended:

- Taking accountability measures to reduce food waste in the agri-food chain, starting with the production, processing, storage, distribution and marketing of food, including in the hotel industry and food services sector.

- Taking actions regarding the sale at a reduced price of products close to the expiration date of the minimum durability, according to the legislation in force.

- Taking action regarding the transfer of food by donation, for human consumption, but close to the expiration of the minimum durability date, to the receiving operators, carrying out registered / authorized sanitary-veterinary and food safety activities, assuming responsibility for complying with food safety; the products may be transferred at any time during the last 10 days of validity until the date of minimum durability is reached.

Taking action to target agri-food products that have become unfit for human or animal consumption by composting, in accordance with the veterinary legislation in force on the disposal of animal by-products not intended for human consumption and environmental protection legislation.

- Taking measures for the targeting of agro-food products that have become unfit for human or animal consumption in order to capitalize on them by transformation into biogas, according to the environmental legislation and the sanitary-veterinary legislation in force.

At the same time, it is recommended to implement at least two actions to prevent food waste from those listed above before ordering the neutralization of waste generated. It is recommended to include food waste reduction plans, together with the actions taken and the results obtained, in the annual sustainability reports of food business operators.

### Conclusions

From what previously presented, note that food waste occurs along the entire supply chain, i.e. agricultural production - storage - processing - distribution - management - consumption. As a result, the main responsibility for food security and the adoption of measures to limit food waste lies on the actors in that chain. In some EU Member States it is forbidden to sell food at a price below cost. As a result, retailers do not have the opportunity to sell fresh products (towards the end of the day) at a lower price. This ban amplifies the food waste in the chain presented above. Measures taken by governments against losses and waste must be aimed at increasing the efficiency and sustainability of food supply chains. EU member states have been running public awareness campaigns since 2011 on the causes and effects of food waste. Waste reduction measures are proposed, scientific information related to the sustainability and solidarity of the population is communicated. Legislative measures and good practices promoted by governments aim to improve the efficiency of food chains. These measures are beneficial for the sustainable development of economies and the balancing of flows in world trade in agricultural products. There is a close correlation between food waste and the state of the environment. For every kg of food produced (by processing) 4.5 kg of CO<sub>2</sub> is released into the atmosphere. Given the food waste of about 89 million tons produced in Europe, it would result in an equivalent of 370 million tons of CO<sub>2</sub>, resulting in the greenhouse effect.

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