



PRESENT AND FUTURE OF HOLISTIC WASTE MANAGEMENT

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Abstract

The Present and Future of Holistic Waste Management Report aims to draw attention to the global waste problem, focusing on food loss and waste along with non-food industries such as plastic, textile and chemicals, and to highlight the importance of adopting a sustainable and holistic approach in food waste management. The fundamental elements in building holistic waste management systems are covered to guide each stakeholder of the supply chain including producers, retailers, private organizations, non-profit organizations, and consumers in achieving the goal of creating responsible food systems while putting an emphasis on the Food Recovery Hierarchy. This report also covers the waste generation statistics of Spain, how its governmental structure affects waste management and the initiatives it takes to reduce and manage waste including the laws and regulations, the campaigns and the measures taken in line with the circular economy model.

Keywords: Climate crisis, Global waste overview, Waste overview of Spain, Waste management, Food loss and waste, Holistic waste management, Sustainable waste management, Technology-based solutions, Circular economy, Sustainable development goals.

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Present and Future of Holistic Waste Management

The importance of adopting a sustainability perspective in how businesses work has been rising and becoming more apparent each day. Communities from all over the world and all ecosystems now face the effects of this ongoing manner and immediate action has become desperately needed because of the global issue: Climate Crisis. In the sixth assessment of Intergovernmental Panel on Climate Change (IPCC), published in March 2023, it is observed that the average global surface temperature has risen by 1.1°C in 2011-2022, compared to 1850-1900, the post-Industrial Revolution period [1]. And human activities lie under the fundamental root of this increase in temperature and the subsequent consequences.

Climate Crisis and Waste Generation

In today's world, humanity lives as if there are 1.7 Earths [2] and drains the capacity of the world to sustain the well-being of all creatures without considering the next generations while affecting all the living ecosystems environmentally, socially, and economically. The rise in human activities following the Industrial Revolution causes an accumulation of greenhouse gases in the atmosphere, leading to the foremost global problem: climate crisis.

It is now known that there is no turning back, humanity is at the boiling point. However, there remains a strong possibility of limiting the consequences of these actions and alleviating the effects: by abandoning the current approaches in production and consumption cycles and adopting to a more sustainable manner holistically, profoundly, and progressively.

According to the Emissions Gap Report 2022: The Closing Window – Climate crisis calls for rapid transformation of societies; published by United Nations Environment Programme; to limit global warming to 1.5°C, the greenhouse gas emissions are needed to drop by 45% in comparison to the projections based on the nationally determined contributions up to date and it's only possible with an immediate, systemic and extensive transformation [3]. And to enable these actions, tackling climate crisis needs to be perceived as a process requiring a great investment. The Organization for Economic Co-operation and Development (OECD) states that an annual sum of €6.35 trillion is required to achieve the goals set by the Paris Agreement by 2030 [4].

In this sense, reducing waste generation and managing waste by adopting a responsible manner gain immense importance and food industry becomes prominent since food ecosystems in total accounts for one third of the global emissions [3].

Waste Generation and Management Through The Glasses of Sustainability

Waste generation is a multifaceted global problem that has layered effects environmentally, socially, and economically; and it needs to be addressed with multifaceted solution sets.

According to The What a Waste 2.0 Report published by the World Bank , annual municipal solid waste generated is over 2 billion tons globally and at least 33% of this waste is not managed with an environmentally responsible approach [5]. The same report suggests that global waste will increase

by 70% in the coming 30 years because of the increasing population, economic progress and accelerated urbanization and reach an annual amount of 3.40 billion tons generation if the production and consumption cycles continue as they are today [5]. And it is known that waste generation and management have a noteworthy influence on global emissions. Waste generation and inadequate waste management induce the contamination of natural resources such as soil and water and cause environmental pollution through greenhouse gas emissions. Unless groundbreaking measures are taken, the emissions relating to solid waste have the potential to increase up to 2.6 billion tons of CO₂ equivalent by 2050 [5].

The insufficient resource control and waste management, and environmentally hazardous choice to dispose of waste including incineration and landfilling put an immense burden on Earth. The Global Waste Management Outlook Report by United Nations Environment Programme estimates that mitigating landfilling as a choice of disposal and turning towards recycling and upcycling options including energy production and other industrial uses, have the potential to reduce global greenhouse gas emission by up to 15% [6]. The report also claims that when further and innovative steps are included such as waste prevention at source, the emission reductions would be up to 20% [6]. To make this possibility come true, every stakeholder of the supply chain; from farmer to the consumer; needs to nurture cooperation and work in solidarity with the same goal in sight.

When the scope is narrowed down in the industries including food, packaging, and textile in terms of waste generation and management; the picture remains the same.

Food Industry and Waste Management

The production of food requires the utilization of natural resources including land and water, the transportation of food emits greenhouse gases, the production and processing of food demands the use of raw materials; and when the food is lost or wasted, all the resources that are used for food production and distribution also are lost and food loss and waste cause environmental pollution if not managed properly. The Food and Agriculture Organization (FAO) of the United Nations claims that agricultural activities require 5 billion hectares of land surface that covers 38% of global land surfaces [7] and states in its Food Loss and Waste and The Linkage to Global Ecosystems report that 30% of global energy is consumed by food systems [8]. It is also stated in the report that 28% of the agricultural land area and 38% of the energy consumed are utilized to produce food that is either lost or wasted [8]. Besides, as mentioned in Climate Crisis and Waste Generation section, the whole food ecosystem accounts for more than 30% of global emissions [3] and food loss and waste generation exacerbate the environmental impact of these systems.

Food Loss and Waste

Globally, more than one third of all food produced for human consumption goes to waste [9]. The economic development level of regions affects the amount of food loss and waste recorded and the stage of occurrence of food loss and waste in the supply chain. While the levels of losses at harvest and post-harvest increase in developed countries due to the high-quality standards of retailers, the levels of food waste also rise mostly due to availability and affordability of food [10]. As opposed to the industrialized regions, in developing and underdeveloped countries, food loss occurs at the processing and distribution stages because of insufficient infrastructure and technologies [10]. This dependence of food loss and waste on economic growth calls for governments to join their advancements and technological developments together to tackle this global problem where every community around the world meets at the same level.

Food loss and waste are among the major contributors of the climate crisis; since they account for almost 8% of global greenhouse gas emissions [8], being the third biggest emitter of the world [10]. When the food is left to rot or landfilled to be disposed of, it releases methane (CH₄) that is more potent than carbon dioxide (CO₂), affecting the chemical proportions of the atmosphere [11]. As the Project Drawdown suggests, to reduce the global level of greenhouse gas emission in the way of limiting the global temperature rise at 1.5°C, the most influential problem to be considered is reducing food waste and developing a sustainable waste management approach [12].

And the impact of food waste is not solely on the environment. The Food and Agriculture Organization of the United Nations estimates that globally, 1.3 billion tons of food that is produced for human consumption is lost or wasted [8] while more than 820 million people suffer from hunger and more than 2 billion people face food insecurity [13]. Behind this gap lies the unfair distribution of food, the varying levels of infrastructure and economic growth in various parts of the world.

Besides the environmental and social effects, food loss and waste also significantly impact economies. The Food and Agriculture Organization of the United Nations' Global Initiative on Food Loss and Waste Reduction claims that the cost of food loss and waste is US\$ 1 trillion [14]. And it is estimated by Boston Consulting Group that annual food loss and waste will rise to 2.1 billion tons by 2030 and the cost of this increase will be \$1.5 trillion [15].

Non-Food Industries and Waste Management

Plastic

The material being easily accessible created an environment of plastic-dependent production systems and led to the plastic pollution which affects each living creature and all the ecosystems today. While 36% of all plastics produced are utilized in packaging, a considerable portion of this utilization is for single-use plastics and almost 4 in every 5 single-use plastics become waste and are not managed environmentally-responsibly [16]. The From Pollution to Solution a Global Assessment of Marine Litter and Plastic Pollution Report published by United Nations Environment Programme estimated that the amount of plastic waste piling up to date in the oceans is around 75-199 million tons [17]. The report also observed that between 9-14 million tons of plastic waste end up in oceans every year; endangering the sea life and polluting the water; and the projected amount is 23-37 million tons per year by 2040 unless the needed interventions are taken [17]. When considered the 98% of single-use plastics are produced by the utilization of fossil fuels, the environmental impact of plastic industry rises even higher [16]. Now, 400 million tons of plastic waste is generated each year, globally and out of 7 billion tons of plastic waste generated up to date, the recycling rate does not exceed 10% [16].

Textile

The textile industry has an immense impact on the environment that cannot be unheeded; consuming 215 trillion liters of water annually and causing 2-8% of global greenhouse gas emissions [18]. Not only is the production of textiles being a subject of sustainable development but also textile waste generation and management are issues to be addressed urgently. Each year 100 billion pieces of clothing are produced of which 92 million tons end up in landfills [19] and the whole industry accounts for 20% of global wastewater [20]. With the change in production manners and consumption behaviors, the environmental effects of this industry are at stake to rise even higher.

It is estimated that if the business-as-usual scenario continues, the number of waste generation due the fast fashion trend will increase up to 134 million tons per year by the end of 2030 and the emissions textile industry releases will double [19].

Chemical

Chemical waste is a critical issue to tackle since these types of waste are hazardous and have the potential to cause harmful effects on the environment and the health of living beings. Various sectors including cosmetics and pharmacy companies, chemical manufacturers and organizations in electronics contribute to synthetic chemical production and thus hazardous waste generation. It is claimed that when compared to the last generation, the production of synthetic chemicals has increased by 400 times and each second 13 tons of hazardous waste is produced [21]. Research also shows that almost 700 human-made chemicals are found in humans which should not be there originally [21]. Because of its wide utilization and detrimental effects on all living ecosystems, a safe and sustainable manner is needed to manage chemical waste.

Waste Generation in Spain

The Country Profile of Spain, published by European Environment Agency in 2023, claims that in 2020, the municipal waste generation of Spain was calculated as 464 kilograms per capita, and it is lightly below the European average of 517 kilograms per capita [22].

When the regions of Spain are put under the microscope, it is seen that the north side of the country has lower rates than the Mediterranean parts in terms of municipal solid waste generation per gross domestic product (GDP) [23].

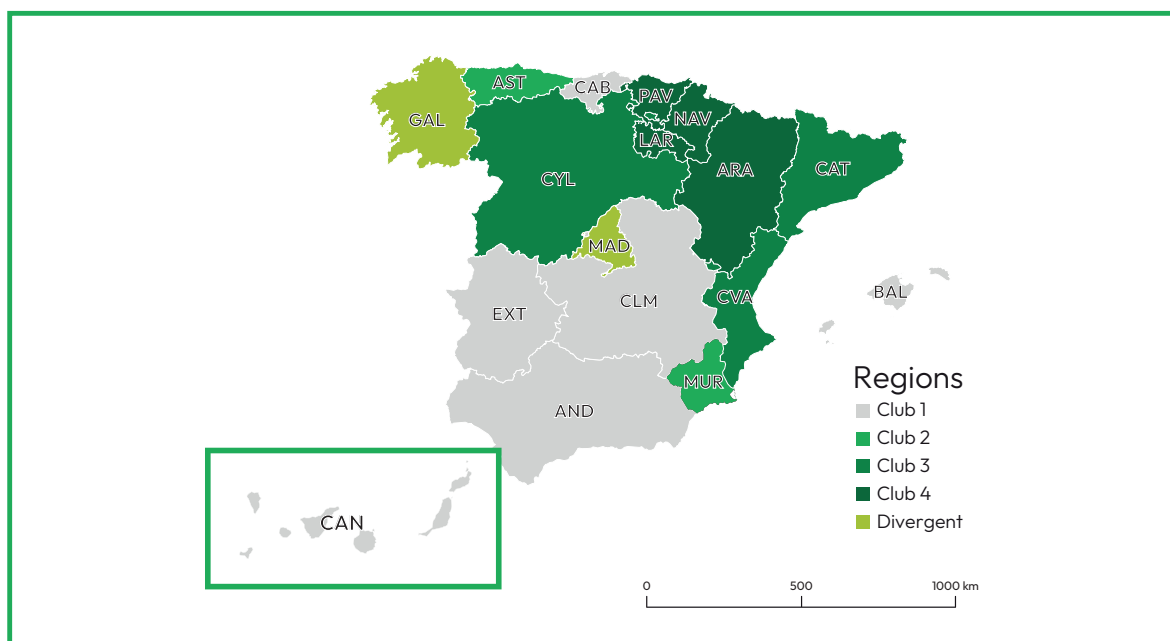


Figure 1: Estimated clubs/areas regarding the Municipal Solid Waste (MSW)/GDP ratios [23]

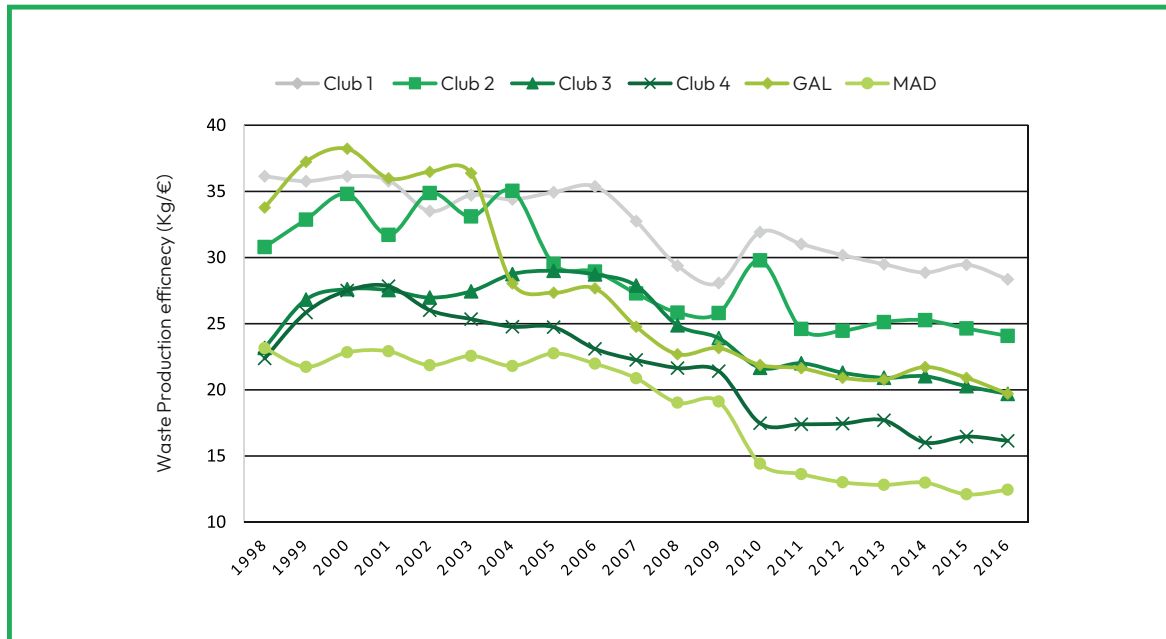


Figure 2: The ratios of MSW/GDP across the regions of Spain [23]

According to the Report on Food Waste in Spain 2022, published in June 2023 by The Government of Spain, Ministry of Agriculture, Fisheries, and Food; the volume of wasted food and drink in total is 1,201.92 million kilograms per liter, compared with the data of 2021, a 6.3% decrease is seen [24]. The same report also claims that the households that do not waste food increased from 26% in 2021 to 29.2% in 2022 [24]. After its peak in 2020, the waste level in house holds shows a decrease which can be a result of the shift in consumption habits in the post-pandemic period, increasing prices and growing awareness. The amount of waste of unused products decreased from 81.1% in 2021 to 78.6% in 2022 while the amount of waste caused by the leftovers increased from 18.9% to 21.4% for the same period [24].

Even though a reduction is seen in the amount of waste of fruits, vegetables, and milk, the amount of waste of sausages, ready meals and pasta has increased in households [24].

When waste generation outside home is examined, the levels of waste generated decreased by 11.3% in 2022 compared to previous year and the rate of consumers that do not waste is calculated as 53.9% [24]. For outside of homes, the main type of waste remained the same as food by covering more than 50% [24].

Initiatives of Spain to Tackle Food Loss and Waste Problem

Food Loss and Waste Prevention Programs

To tackle the food loss and waste problem, Spain takes progressive strides which includes the HoReCa sector to offer doggy bags to its customers for leftovers and to have separate sales line for food that does not meet with the consumers cosmetics demands [25]. These measures not only

change the way current businesses work but also play a crucial role in raising awareness between companies and consumers regarding food loss and waste and have the potential to initiate a behavioral change amongst them. Besides these waste prevention programs, Spain also prioritizes the human consumption for surplus and encourages companies to resale their surplus and redistribute it by donation operations, in line with the Food Recovery Hierarchy, and requires donation operations to be collaboratively managed by companies and social entities including food banks and non-profit organizations, as mentioned in the draft law on Prevention of Food Loss and Waste [25].

Since Spain has a decentralized government and various groups play distinct roles, a coordination center is needed to have an effective network for donation operations. And the Spanish Federation of Food Banks (Federación Española de Bancos de Alimentos - FESBAL) satisfies this need.

FESBAL

Established in 1995, The Spanish Federation of Food Banks (FESBAL), is a national non-profit organization that builds network of companies and food banks and coordinates the donation operations across the country [26]. The focus of this organization is to organize and support food banks to reduce hunger and food insecurities, tackle food loss and waste and create environmental and social impact. With this purpose, the federation coordinates 54 food banks and over 6.900 charities across the country [27]. Through its network of organizations, FESBAL reaches more than 1.2 million people in need [27] with the help of its 3.500 volunteers [28] supports sustainable development in numerous ways.

Besides regulating the donation operations, FESBAL also has the responsibility to represent food banks before national and international entities and facilitate the processes for food banks [26]. And by raising campaigns to rescue food from becoming waste including “The Great Food Collection” through which 16 million kilos of food were saved and redistributed among more than 1.35 million vulnerable people in 2021 [29], the organization increases awareness between both companies and consumers.

FESBAL also cooperates with educational institutions to raise knowledge on global issues such as climate crisis, gender inequality, hunger and food insecurity, and poverty and aims to reach more people to build sustainable food systems collaboratively.

Circular Economy

As the urgency of sustainability secures its position on the global agenda, many governments, unions, and variety of stakeholders from private sector take growing initiatives from all around the world. These measures include transitioning from linear business models into a circular economy. By adopting this innovative economic model, the perception of waste can be shifted, and overconsumption of natural resources can be prevented with the continuous flow of materials. And this opens the gate to tackle the climate crisis.

With this acknowledgment, a variety of ministries of Spain joined their forces and prepared their agenda in alliance with the model of circular economy. The paper España Circular 2030 consists of a diverse set of principles and strategic guidelines to adopt to a circular model in its current production and consumption approaches [30]. While the guidelines include protecting the environment, decarbonization, cooperation and solidarity of all parts of the supply chain and legal entities, sustainable development, and health protection; one of the main focuses is on waste management and food waste reduction strategies [30].

To successfully achieve the stated goals of reducing waste generation and bringing a sustainable approach to waste management, the guidelines promote the use of recovery hierarchy. By the application of waste hierarchy and its directives, Spain can reduce its waste generation, increase the recycling rates, and bring efficiency to its production cycles following the aims to be achieved by 2030 stated in the paper:

- Reducing waste by 15% compared to the levels observed in 2010.
- Reducing food waste throughout the food chain by 50% per person in retail and households and 20% in production and supply chains while taking 2020 as the reference.
- Increasing reuse and reuse enabling activities until reaching 10% of municipal waste.
- Reducing greenhouse gas emissions to under 10 million tons of CO₂eq.
- Improving water use efficiency by 10% [30].

Key Factors to Successfully Build Sustainable Food Systems

Technology-Based Holistic Waste Management

Waste reduction and management needs to be considered holistically to fundamentally transform the current food systems and create long-lasting impact. And there are three aspects to developing a holistic approach when building sustainable food systems:

1. Developing technology-based solutions that enables speed, traceability and enhanced capability
2. Creating a comprehensive solution set that covers all types of losses and waste, and enables the recovery of those
3. Building an ecosystem with high communication and operation lines of which every stakeholder is a part

Technology-Enabled Solutions

Developing technology-enabled solutions is critical to reduce waste generation and ensure a sustainable system throughout the supply chain for several reasons including building precise decision-making systems, increasing the efficiency of the supply chain and optimizing the processes, developing solutions with high added values.

Before acting upon this global problem, the current situation needs to be monitored, thus inefficiencies can be identified and well-informed decisions can be made. Besides the construction of the action plan, technological developments are important since speed and efficiency matter when it comes to waste reduction and management because of the nature of food being a subject to be easily spoiled.

When applying a set of actions, traceability gains prominence to determine bottlenecks and prevent any incompetence throughout the way. This empowers stakeholders to take impactful actions and implement the appropriate solutions. And for further optimization, data-based analyzes play an essential role. Tracking real-time market trends and forecasting the possible demands with minimum error rate can improve production, inventory planning, and draw a better understanding that helps minimize food loss and waste generation.

Holistic Approach

To enable the development of comprehensive solution sets where the focus is on solving the problem itself rather than treating the symptoms, the Food Recovery Hierarchy developed by United States Environmental Protection Agency stands as a guidance.

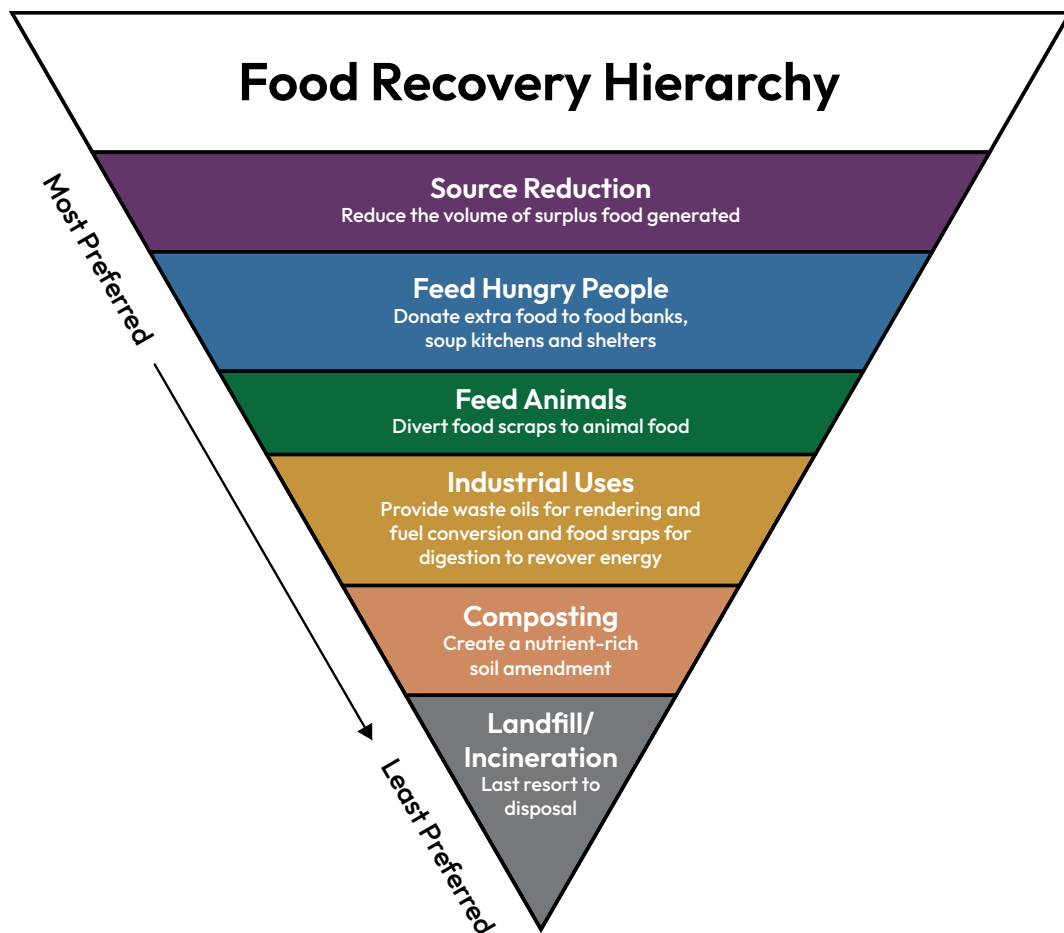


Figure 3: The Food Recovery Hierarchy developed by United States Environmental Protection Agency [31]

This hierarchy arranges the actions to tackle food loss and waste from the most preferred one to the least in accordance with the value created by each of the tiers and prioritizes "Source Reduction" since it creates the highest environmental, social, and economic value. The measures for reducing waste generation at its source include educating corporates and consumers to raise awareness on this issue, encouraging and enabling sustainable options for each stakeholder of the supply chain, improving efficiency in production, distribution and purchasing, implementing adequate infrastructures, and taking advantages from advancing technologies.

And for the last resort of food waste disposal, “Landfilling and Incineration” is placed at the bottom of this hierarchy. These two activities are the least preferred ones since they cause greenhouse gas emissions, especially methane which then accumulates in the atmosphere and induces greenhouse gas effect that warms up the surface of the earth. However, a substantial portion of the food waste generated goes to landfills according to the 2019 Wasted Food Report, published by EPA in 2019 [32].

Since current food systems are more prone to landfilling, adopting environmentally responsible solutions for waste management, and transforming the systems fundamentally require significant effort, cooperation of stakeholders and increased accessibility to advancing technologies. To enable this shift, the Food Recovery Hierarchy sets a great framework.

Building and Managing a Connected Ecosystem

Another important issue in building sustainable food systems is supply chain management since waste management is a labor-intensive and fast-paced area. To reduce inefficiencies in production and inventory management, prevent food loss and waste and enable the recovery of surplus, fast-paced actions are needed and require technology-driven solutions followed by strong operation lines. In that sense, creating an ecosystem of stakeholders that share an effective communication mechanism is crucial.

The Sustainability Trends for 2023 report published by Plan A states that supply chains account for 90% of the environmental impact of a company [4]. This dependence between a company’s ecological footprint and its supply chain points out the importance of managing supply chains and leading each partner towards a sustainable future.

A part of having a holistic approach in waste management requires the interconnectedness of stakeholders to reduce and manage waste with the appropriate solution since food loss and waste is a complex issue. From farm to fork, there are various stages for food to be lost or wasted, and that is why each stage must be considered individually. When a co-operative structure, where each of the players in the supply chain speaks to one another, is built, companies can easily and effectively reduce and manage waste, thus sustainable food systems are ensured.

Social Impact Orientation

Reducing food loss and waste and managing surplus effectively helps businesses decrease their costs and minimize their ecological footprint. Besides these advantages, adopting a social impact-oriented approach allows businesses to help reduce social inequalities, create sustainable food systems, and improve their corporate identities and communications.

To alleviate poverty and hunger and enable sustainable development for communities, having a social impact-oriented aspects plays a vital role. In that sense, collaborating with well-established associations and non-profit organizations (NGOs) is essential. Since these institutions are specialized in specific subjects including social issues, they provide valuable knowledge and resources to tackle waste effectively. Since they focus on rescuing food from various stakeholders of the supply chain including farmers, supermarkets, cafes, and restaurants, their infrastructure for the redistribution of food needs to be far-reaching and operate smoothly. Besides, as the nature of their establishment, these institutions manage a wide ecosystem of partners and volunteers that can be helpful in managing surplus efficiently and reaching out to people in need. To facilitate the collaborations needed, these associations and NGOs can be intermediaries.

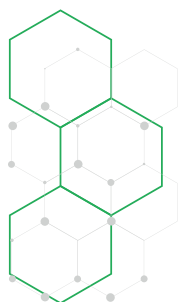
In addition to their powerful network of partners and distinct expertise, these associations also play a key role in policy change and run advocacy and awareness campaigns. Their lobby activities influence both communities and policymakers to act against food loss and waste. Education programs can help strengthen the bounds of communities and drive behavioral change between individuals.

Adopting to The Sustainable Development Goals

Sustainable Development Goals are defined as a blueprint for the prosperity of people and planet by the United Nations and were adopted in 2015 by all United Nations Member States [33]. With these 17 goals and 169 targets, an ambitious vision was set for all forms of lives to thrive, ensuring sustainable development until 2030 with environmental, social, and economic perspectives on sight.



Figure 4: Sustainable Development Goals [34]



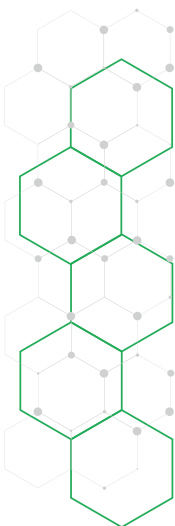
Conclusion

The year is 2023. Eight years have passed since the acceptance of devoting all humanity's resources for achieving sustainable development. The time has already ripped, and the promise remains the same: creating bold, tangible, and positive impact for the good of the world. Humanity is against the clock. The rules of this game need to be changed immediately. By taking the plunge to trigger the systemic transformation the world needs, the gate for an inclusive, fair and sustainable future for the people and the planet can be opened.

Yet, it is still not late. To master the art of saving the world, building a holistic, technology-driven solution set, uniting each stakeholder of the supply chain to work in harmony, constructing effective communication and operation lines and placing social impact at the heart are the key elements. While building such systems, taking Sustainable Development Goals as a compass and aiming to serve all 17 of these goals enable the stakeholders of the supply chain to have a shared vision and foster a livable world for all.

And to attain such an ambitious and meaningful goal, all must unite, take immediate, data-driven, and effective action and transform the way businesses work starting from today while setting sight for expanding their impact more each day.

So, let's come together, join all forces, build a sustainable and fair future and save the world!



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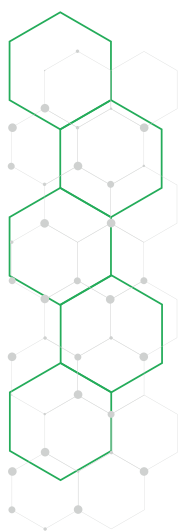
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Appendix

This report was prepared and published by Fazla to highlight the importance of tackling food loss and waste, share the progress in Spain regarding food loss and waste, and highlight the key elements of building a sustainable food system.

Fazla, established in 2016, takes the responsibility of building a sustainable business model while creating meaningful connections throughout the value chain to create impact for the world and become an example for younger generations. By taking the United Nation's Sustainable Development Goals (SDGs) as a compass, the company develops technology-driven, holistic waste management solutions in line with the Food Recovery Hierarchy to reduce waste generation at its source and create the highest value possible out of surplus including food, textile, packaging, and chemicals, preventing waste-borne carbon emissions, contributing to circular economy, and tackling climate crisis. Because of the nature of its business model and with the impact Fazla created, the company is a part of the B Corp movement.
