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FoodE

E-Manual

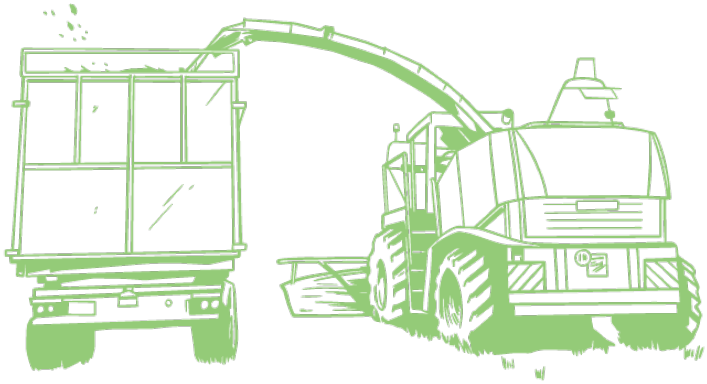

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Table of content

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INTRODUCTION

The jointly undertaken initiative, "FoodE: From Food Loss to Food Entrepreneurship," aims to address the problem of food loss and waste by involving young people in sustainable development initiatives. The initiative focuses on providing practical information, entrepreneurial-oriented knowledge, and action plans to enhance youth's participatory learning experiences.

One of the key components of the initiative is the FoodE handbook, which will analyze solutions and ideas on how young people can develop activities and frameworks. The handbook aims to inspire and guide young individuals in generating business ideas that contribute to reducing food loss and waste. It emphasizes the importance of youth engagement and their role in driving sustainable practices in the food sector.

The purpose of the e-Manual handbook is to equip young people with the necessary knowledge and resources to become active participants in the fight against food loss and waste. It encourages them to explore innovative approaches, establish collaborations, and develop sustainable entrepreneurial ventures that address the challenges in the food system.

By combining the goals and context of the initiative with the objectives of the FoodE handbook, the overall aim is to empower young people to become agents of change, fostering a sustainable and entrepreneurial mindset in tackling food loss and waste. The handbook serves as a practical guide, providing insights and actionable strategies that enable young individuals to develop their own projects and initiatives with a focus on sustainable food practices.

The e-Manual was produced with the cooperation of partners from Poland, Germany, Cyprus, Greece and Spain.

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The first chapter provides an introduction to the topic of food value chains. We will go through the various stages of the food value chain and discuss the problem of food loss and waste occurring in each phase. In addition, we will present the concept of sustainable food value chain (SFVC), which is the focus of our activities.

The next chapter focuses on food loss in the farm stage. We will discuss the differences between food loss and waste, and outline the reasons why we should pay attention to food loss. We will also analyze the main causes of food loss in this phase of the process.

The third chapter will focus on the impact of food loss on climate change. We will outline how food loss contributes to these changes, specifically focusing on greenhouse gas emissions, land occupancy, water consumption and the financial aspects of the problem.

In the fourth chapter, we will discuss different harvesting techniques. We will present the differences between them and examine whether harvesting methods are the same for all types of crops. We will also focus on how harvesting methods affect food loss.

In the fifth chapter, we will focus on ways to minimize food loss. We will present existing solutions to reduce food loss during the primary production phase. We will also explore the role of reuse and recycling in reducing food loss.

The final chapter will discuss best practices around the world that have helped minimize food loss. We will present examples of successful initiatives that can inspire our own efforts.

By working together and taking action on this project, we aim to create a society where young people are engaged in sustainable food entrepreneurship. We are confident that our research and initiatives will contribute to reducing food loss and waste, benefiting both the planet and future generations.

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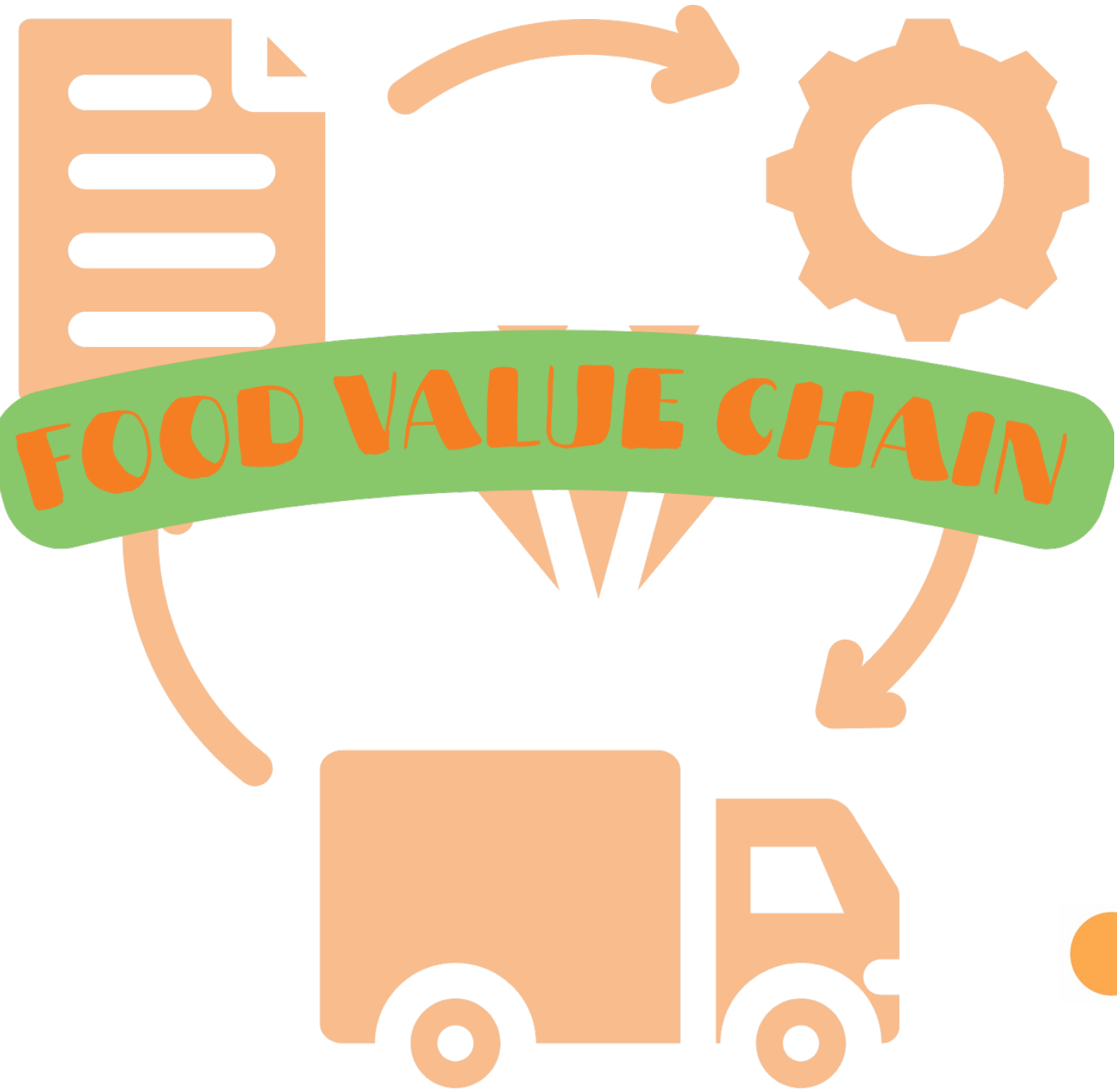

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I. FOOD VALUE CHAIN

1.1. Module Description

The term Food Value Chain (FVC) refers to the entire process in which the food is involved from production to consumption. It must be stated that a sustainable Food Value Chain is extremely beneficial to the society and to the environment as it includes the entire process of food production, processing, distribution, consumption, and also the procedures of managing waste. Reducing food waste requires collaboration across the entire food supply chain. Therefore, the aim of this module is to provide knowledge regarding the topic of Food Value Chain. This module introduces the issues that occur at different stages of food chain, from food production, distribution, to waste of food at the consumption stage. Moreover, it introduces the theme of sustainable agricultural practices, efficient production and processing, and reduced food loss and waste. Therefore, through this module, the importance of learning about the food chain and its implication for the society and the environment is underlined.

1.2. Learning Objectives

- At the end of the training, the student should be able to understand the stages of the Food Value Chain and understand the processes to manage the food waste
- At the end of the training, the student would identify types of food waste at each stage, during production, processing, distribution, retail, and consumption
- At the end of the course, the participant would identify about the importance of implementation of sustainable agricultural practices
- At the end of the training, the student would identify the essence of efficient food production and processing

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1.3. Module Objectives

- To present different stages of food waste in the Food Value Chain area
- To present the idea of sustainable agricultural practices
- To portray how the efficient production and processing can be conducted
- To present how food loss and waste can be reduced

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1.4. Food loss and waste in different stages of the Food Value Chain

1.4.1. Food Production

Throughout the entire food value chain, about one-third of food produced globally is lost. The magnitude of food waste at the production stage can be estimated at around 30% of total food production (FAO). This amount of food is lost before it enters the market; therefore, food waste and loss during the production stage includes the process of agricultural production, which consists of pre-harvest and post-harvest losses.

In terms of pre-harvest losses, it has been estimated by FAO (J.Wong, G. Kaur, M. Therzadeh and others (2021) p. 13) that they can range from 10% to 20% in developing countries. However, the factors that influence these numbers are crops, region, diseases, pests, weather conditions or the used infrastructure. Pre-harvest food loss reduces the availability of crops, and it negatively affects the overall food supply as it potentially leads to food shortages and insecurity. However, this issues can be addressed by providing farmers with training and information on best agricultural practices, crop management, and pest control.

Regarding the post-harvest losses, it has been estimated that in developing countries they can range from 10% to 40% or even more. The main factors that contribute to this are deficient storage facilities, lack of transportation, and limited access to markets. Post-harvest losses reduce the quantity and quality of food available for consumption, contributing to food insecurity. Therefore, reducing these losses requires a comprehensive approach that addresses infrastructure, technology, knowledge transfer, and market access.

Hence, it may be concluded that unfortunately, a huge amount of food that is produced worldwide is wasted, and food waste is a global issue that requires attention as it has negative consequences for the society.

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1.4.2. Food Distribution

Food loss during distribution involves the loss that happens during the transportation and logistics processes that are involved in getting the food from the production site to the consumer.

The causes for food loss are various, and among them are for example incorrect transportation infrastructure, poor handling and packaging, delays that may occur in transit or other issues such as temperature control issues etc. There are several ways to help address inefficient food distribution and contribute to a more efficient and sustainable system. Therefore, addressing these challenges requires collaboration among stakeholders, investment in infrastructure development, improvement in supply chain management practices, adoption of technology and innovation, and policy support to facilitate efficient and sustainable food distribution systems. Moreover, it is necessary to encourage food businesses to adopt strategies that optimize the value chain.

It may be concluded that unfortunately, food distribution systems can negatively contribute to food waste. Hence, implementing certain strategies is necessary for the food distribution system, because in this manner it can become more efficient, reduce waste, and ensure that food reaches consumers in a timely and sustainable manner.

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1.4.3. Food waste at the consumption stage

The loss that occurs at the consumption stage refer to the wastage of food in households, restaurants, institutions, and other places where food is consumed. Unfortunately, it results in the wastage of valuable resources such as water, land or energy used in process of production. Unfortunately, there are numerous reasons for wasting food during this stage. Among them are over-purchasing of products by people who later throw them away, preparing more food than needed, which leads to leftovers that eventually go to waste, inadequate storage practices that can lead to deterioration of food (improper refrigeration, incorrect temperature control, poor food handling hygiene), lack of awareness and knowledge about the proper food handling, storage, and preservation methods.

In conclusion, the food at the stage of consumption is wasted for several reasons, depending on individual behaviours or socioeconomic factors. Nevertheless, it also means that are certain effective ways to avoid wasting food. At households, people can adopt simple yet impactful practices. Among them are meal planning, proper storage, portion control, and creative cooking techniques can all contribute to reducing waste. By becoming mindful consumers, people can make a difference in their households and it enables them to educate others to follow these practices.

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1.5. What is the Sustainable Food Value Chain

1.5.1. Sustainable Agricultural Practices

By adopting sustainable agricultural practices, farmers can promote resilience in food production systems. Therefore, there are certain practices that can be used in order to ensure long-term food security. Also, sustainable agriculture practices can play a crucial role in avoiding food waste throughout the food production and consumption process.

On farms, where food production begins, addressing and reducing food waste is of paramount importance. Introducing farming practices that can use resources more efficiently and minimize their waste is extremely important as it also contributes to the protection of the environment. Reducing food waste in agriculture is an important factor that can contribute to maximizing food production efficiency, conserving resources, and it can be a powerful tool in addressing global food security challenges.

This can be achieved through improving:

- harvesting techniques
- irrigation practices
- storage conditions

Through maintain soil health, introducing proper water management, protecting biodiversity, and ensuring climate resilience, farmers can continue to produce food in a manner that preserves resources for future generations. It may be concluded that sustainable farming is a crucial element for maintaining a proper and comprehensive food chain.

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1.5.2. Efficient Production and Processing

Efficient food production is crucial for meeting the growing global demand for food while minimizing the use of resources and reducing environmental impacts. Sustainable food processing refers to the implementation of technologies that minimize environmental impact, protect resources, and promote social responsibility throughout the food processing chain.

Through sustainable food processing practices, the society can reduce their environmental footprint, enhance efficiency, and contribute to a more sustainable and responsible food industry. In order to minimize waste during food processing, several factors must occur:

- Proper production planning
- Accurate quality control
- Efficient inventory management
- Close collaboration between farmers and suppliers

Therefore, it is of great importance for food processing industries to adopt measures and practices that minimize waste and promote sustainability. For instance, implementing advanced technologies can enhance precision and efficiency, reducing the risk of waste during processing.

1.5.3. Reduced Food Loss and Waste

The issue of the decrease in edible food mass throughout the supply chain is a critical global issue and it has many negative social, economic, and environmental implications. Hence, helpful ways to reduce food waste include:

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- learning about the proper storage of different kinds of foods
- controling food portions, so that we do not throw away much food
- remembering about the expiration dates of certain products
- setting up a composting system to recycle food scraps and organic waste
- when eating out, ordering only the amount of food that we can finish

With regard to the society as a whole, it is of great importance to educate people about the environmental, economic, and social impacts of food waste and provide practical tips on how to reduce it. Therefore, in terms of individuals, they can also play an essential role in reducing food waste through their daily choices and habits. By implementing certain strategies, individuals can significantly contribute to reducing food waste, conserving resources, and promoting a more sustainable food system. It may be concluded that small changes in daily habits can make a big difference collectively.

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1.6. Relevant Policies at EU level

Certain EU policies and initiatives are essential in raising awareness regarding the consequences of food waste as they are providing a framework for action to prevent food waste. For instance, the EU implemented an initiative knows as Common Agricultural Policy (CAP). According to European Commission, this initiative can be referred to as a partnership that enables society and agriculture to function properly. Therefore, it's aim is to promote practices that lead to reducing food waste. For example, some of the goals of this policy are supporting sustainable farming practices and raising awareness about the positives of donating food. It may be concluded that policies implemented by the EU demonstrate a commitment to addressing food waste comprehensively, from production to consumption.There is also an initiative that has been implemented earlier, known as EU Waste Framework Directive refers to the issues of waste managment, and one of its topics is food waste. This inititative introduces principles that aim at waste prevention, and also tackles issues of recycling and recovery.

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1.7. Conclusions

It may be concluded that food waste is a global problem and it constitutes a huge challenge for the society, as it requires urgent attention and taking necessary preventive actions. Hence, combating this problem needs a comprehensive approach involving not only society as a whole but also individual people and their households. By taking necessary actions, it can be ensured that food waste at various stages of the food chain can be prevented. Therefore, it is vital to remember that food loss and waste can be avoided at every stage of handling food in the food value chain. Unfortunately, food waste leads to environmental degradation; hence, learning about food waste contributes to promoting a responsible and sustainable resource management. This module presents not only reasons for waste and a broad perspective on how the food is wasted, but it also proposes solutions and enables to gain knowledge regarding combating this problem.

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1.8. Best practices

Too Good To Go

The "Too Good To Go" company is a mobile platform that connects restaurants, cafes and grocery stores with customers who can buy leftover food at discounted prices. Their best practice is to create a wide network of partners, educate customers about food waste and promote campaigns to combat the problem.

Best practice: Establish a partnership with "Too Good To Go" to provide a platform for entrepreneurs interested in selling food leftovers. Together, local promotional and training campaigns can be developed to encourage more businesses to join the program.

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Fruit Rescue

"Fruit Rescue" is an initiative aimed at fruit growers and farmers who offer fruits and vegetables that are rejected by the market due to their appearance or other factors. The company collects these products and sells them to customers interested in healthy, locally grown food.

Best practice: working with "Fruit Rescue" can involve providing a distribution network for harvested fruits and vegetables. In this way, the waste of these products can be minimized and entrepreneurs can have access to fresh, local ingredients.

Warszawski Browar Jabłkowy

"Warszawski Browar Jabłkowy is a company that specializes in making cider from local, imperfect apples that would normally be rejected by fruit growers. The company focuses on sustainable use of resources and promotes local production.

Best practice: Sharing experience and knowledge with "Warsaw Apple Brewery" can help entrepreneurs in the food sector to use imperfect fruits

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and vegetables to produce innovative products such as juices, preserves and fermented beverages.

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II. FARM-STAGE FOOD LOSS

2.1. Module description

In this module, you will get to know the food loss term as well as the differences between food loss and food waste. This Unit will give you a wide understanding of the food loss causes and the consequences that food loss generates on a global level.

2.2. Learning Objectives

- Understand the differences between food loss and food waste.
- Identify the reasons that cause food loss in the different stages of the food supply chain.
- Raise awareness of food loss consequences.

2.2. Module Objectives

- Young people to get to know the food loss term.
- Be able to distinguish the differences between food loss and food waste.
- To realize the different stages of food production that food loss can occur.
- Understand the consequences of food loss.
- Be able to realize the food loss causes.

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2.3. Differences between food loss and food waste

Food loss is a serious problem that impacts people everywhere. According to FAO, a third of the food produced worldwide is lost or wasted every year (FAO, 2020). This indicates that approximately 14% of the food produced worldwide is lost between harvest and retail in a world where, according to the FAO, about 870 million people lack enough food, these figures are simply intolerable.

The FAO-commissioned study found that if only one-fourth of the food that is lost or wasted were to be saved, world hunger could be eradicated (FAO, 2015). Food loss occurs at every stage of the supply chain, from **production to consumption**, and has a significant impact on the environment, economy, and society. A low-income country, as defined by the UN, is a country that has a GNI (Gross Net Income) of less than $1045 per capita, whereas a medium-income country has between $1046 to $12695 GNI per capita and a high-income country is defined as having more than $12695 GNI per capita (UN, 2022). In medium- and high-income countries food is to a significant extent wasted at the consumption stage, meaning that it is discarded even if it is still suitable for human consumption. Significant losses also occur early in the food supply chains in these countries. In low-income countries food is lost mostly during the early and middle stages of the food supply chain; much less food is wasted at the consumer level.

But what do we mean when referring to food loss and food waste?

It is common to confuse these two terms **"food loss"** and **"food waste."** Agricultural production losses are frequently referred to as "food loss'' due to a number of variables.

a) **Food loss** is typically driven by climate and environmental factors as well as quality, aesthetic, or safety standards. It often occurs at the production, post-

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harvest, and processing stages of the food chain. Food loss is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers, and consumers.

b) **Food waste,** on the other hand, refers to edible food that is intended for human consumption but instead gets discarded or expires. This can occur in many different situations during preparation, sales, or food service. It includes unfinished meals, spoiled food, expired canned food, or undercooked products, and even discarded peels and rinds. It is more directly linked to our behavior as consumers. Such as expired packaged or canned food, unfinished meal, and undercooked products. Let's see the stages of the food supply chain where food loss can occur.

c) **Production and harvest:** Food loss can occur during the production and harvest of crops due to factors such as weather events, pest infestations, and harvesting techniques that damage crops.

d) **Post-harvest handling and storage:** Food loss can occur during the handling and storage of crops after they are harvested. This can be due to inadequate storage facilities, improper temperature control, and handling practices that damage the crops.

e) **Processing and packaging:** Food loss can occur during the processing and packaging of food products. This can be due to inefficiencies in processing equipment, product defects, and packaging that is damaged or not suitable for the product.

f) **Distribution and logistics:** Food loss can occur during the transportation and distribution of food products. This can be due to inadequate transportation

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infrastructure, long transport times, and poor handling practices during transport.

g) **Retail and consumer behavior:** Food loss can occur at the retail and consumer level due to factors such as overstocking, expiration dates, and consumer behavior such as overbuying or improper storage of food.

The Sustainable Development Goal (SDG) 12.3, which set the goal to reduce pre-retailer losses and cut global food waste in half by 2030, gave these initiatives additional significance.

Image retrieved from: https://www.fao.org/newsroom/detail/FAO-UNEP-agriculture-environment-food-loss-waste-day-2022/en

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Figure 1 Image retrieved from: https://elearning.fao.org/course/view.php?id=605

Figure 2 Image retrieved from https://www.fao.org/policy-support/policy-themes/food-loss-food-waste/en/

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2.3.1. Why should we care about food loss?

Food loss is a serious global problem that has an impact on everyone, including people, businesses, and governments. The effect that food loss has on the ecosystem is among the most important reasons why we should be concerned. Let's explore the environmental impact of food loss.

a) **Resources:** Food production requires vast amounts of resources such as water, land, and energy.
With agriculture accounting for 70 percent of the water used throughout the world, food loss also represents a significant waste of freshwater and groundwater resources. Around 3.4 million acres (around 13756 million square meters) of land, which is roughly one-third of the world's total agricultural land area, is used to grow food that is never used and just thrown away.
When food is wasted, all these resources are effectively wasted, leading to unnecessary greenhouse gas emissions and other environmental problems.
By reducing food loss and waste, we can reduce greenhouse gas emissions and mitigate the effects of climate change.

b) **Climate change:** Agriculture is a major source of greenhouse gases (OECD, 2022), which is causing climate change. Each year, unneeded greenhouse gas emissions are released into the atmosphere because of food loss or waste. Loss of food results in enormous greenhouse gas emissions. These emissions occur over the course of the food's life. First, they originate from farm cows' digestive tracts. Methane produced from the gastro-intestinal processes of farm cows is released into the atmosphere and due to the sheer

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number of farm cows present in the world, numbers which exceed 250 million, emissions are significantly increased (FAO, 2019). The energy used to produce, move, store, and cook food—energy that is ultimately wasted or lost—is the second source of emissions. Finally, spoiled food is disposed of in landfills, which are large collections of trash, after being placed in your trash bins.

c) **Carbon footprint - greenhouse gas emissions:** Producing, distributing, and preparing food uses up fuel and energy, and produces greenhouse gases such as CO2, methane, and nitrogen. A huge amount (3.6 gigatons) of greenhouse gases is emitted each year in the production, processing, storage, and transportation of food that gets thrown away and then more greenhouse gases are emitted as wasted food decomposes in landfills.

d) **Water footprint:** Amongst other things, climate change can lead to water shortages, droughts, and desertification in many places on Earth. Countries like Egypt are already suffering from water scarcity. At the same time, food production is the largest user of water in the world. However, when we waste food, we also waste the water used to produce that food. One-quarter of all the water used for agriculture is used to grow food that later ends up as waste. The “water footprint” of food waste is roughly the same amount of water as all the households in the world use per year, and as much as almost half of what the Nile River discharges over the course of a whole year.

e) **Land occupation footprint:** Another concern is the land occupation footprint of food waste, i.e. the amount of land that is used to grow food that is later wasted. Food that is later wasted is grown on about 1.4 billion hectares of land. If we compare this area to the surface of the largest countries on earth, it is the second largest after the Russian Federation. The land used to produce food later wasted is thus bigger than China or Canada.

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f) **Biodiversity:** Biodiversity refers to the variety of life on Earth at all levels, from genes to microbes, animals to ecosystems. All species and organisms contribute something to their common environment, so it is very important to interfere as little as possible with functioning ecosystems. The way we grow food can also be a major threat to biodiversity. For example, forests are cut down to make space for crop fields. Through this process, which is called deforestation, a lot of animals lose their habitat and are ultimately threatened by extinction. Moreover, the plants in these forests are lost, which intensifies the problems associated with CO2 and other greenhouse gas emissions. Food loss can lead to unnecessary loss of biodiversity if we put pressure on ecosystems to produce food that ultimately goes to waste.

Video: Food loss and waste are among the main causes of climate change
Retrieved from: https://www.fao.org/platform-food-loss-waste/resources/multimedia/video/reducing-food-loss-and-waste-plays-a-key-role-in-transforming-agrifood-systems/en

2.3.2. Food Insecurity and Global Hanger

Food loss and waste further worsen the problem of food insecurity.
In 2020, FAO director Jose Graziano da Silva said, “In addition (to) the environmental imperative, there is a moral one: We simply cannot allow one-third of all the food we produce to go to waste when 870 million people go hungry every day.” To stop food waste, changes have to be brought in at every stage of the process – from farmers and food processors to supermarkets and individual customers. As a first step, priority should be given to balancing production with demand. This translates to lesser use of natural resources to produce surplus food that will rot in the field.

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When food is wasted, resources (such as water, land, labor, or capital) that were used to produce it are also wasted, even though it may appear that food waste is just one aspect of resource distribution. Combating food insecurity is becoming more and more important as population numbers rise, and climatic threats become more frequent and significant. It is challenging to end the vicious cycle of hunger and hostility. In the end, by enhancing food security, we are fostering lasting peace and laying the groundwork for an impending future. Tackling food loss is just one of the ways we can help make this objective a reality.

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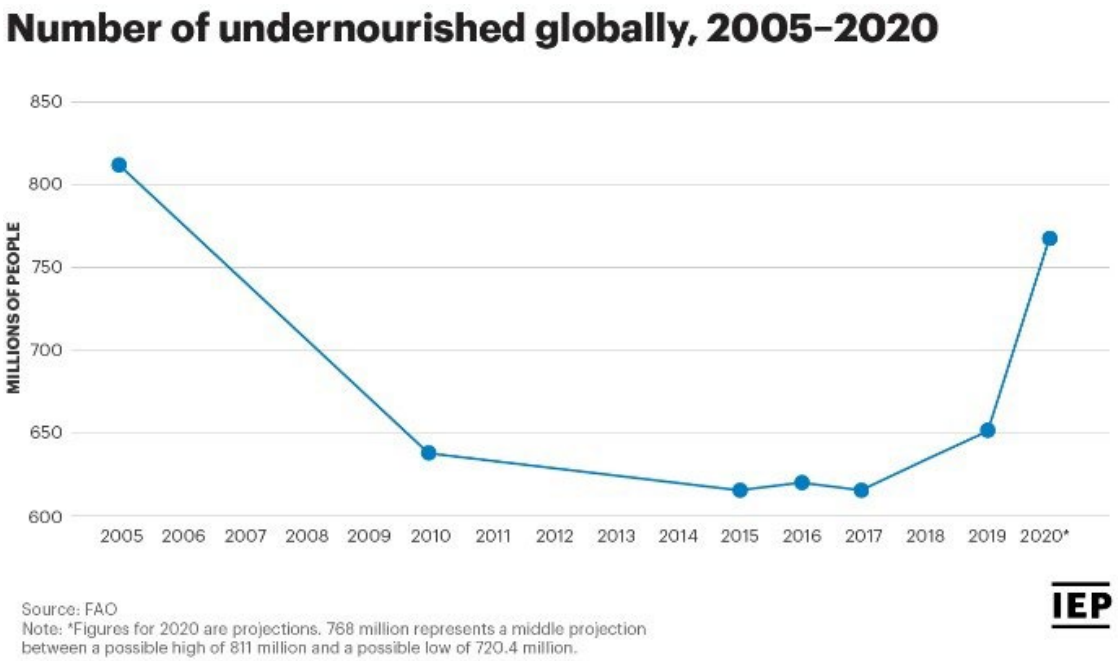

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Food waste and loss cause financial losses for all sectors involved in the food supply chain, including consumers. Additionally, it represents a very inefficient use of resources (such as labor, water, energy, and land), which contributes to climate change, and has other social effects that are all preventable. To reduce food loss and waste, all stakeholders along the food supply chain must work together and form partnerships. It takes investments in infrastructure, technology, and innovation, as well as governance structures, human capital development, and innovation to realize and maximize the benefits of reducing food loss and waste. The economic cost of food loss and waste is significant, with up to $940 billion (over €860 billion) lost each year, representing a considerable loss of resources that could be invested elsewhere.

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2.4. Causes of food loss

a) **Risks of production**

Fear of infestations from pests or extreme weather phenomena usually leads farmers to plant more than what they would need to supply. The higher cost of production is overpassed by the security farmers obtain that they will be able to meet their supply contracts without looking for secondary markets. Floods, droughts, and other extreme weather events can destroy entire crops, leading to food loss and insecurity.

b) **Climate change** is also causing changes in weather patterns, which makes it difficult for farmers to predict when to plant and harvest their crops.

c) **Losses from farm incidents**

Even with proper planning, a disease outburst may cause further losses to farmers than just the costs of initial inputs. A bad quality grain or produce that does not meet the distributors' standards may yield harvesting a crop even more costly and wasteful of the farm's equipment and resources.

d) **Price Volatility**

Prices of fresh produce can quickly rise or fall, especially when compared to other agricultural products. There are times when it may become unprofitable to move produce into the market because prices fall below the cost of harvest, processing, or shipping. When prices rise, growers harvest more intensively (either by hiring more labor or by lowering product thresholds) and may have the incentive to send lower cosmetic-quality products to market, which can then be subject to increased loss further along the supply chain.

e) **Premature harvesting**

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In developing countries and, sometimes, developed countries, food may be lost due to premature harvesting. Poorer farmers sometimes harvest crops too early due to food deficiency or the desperate need for cash during the second half of the agricultural season. In this way, the food incurs a loss in nutritional and economic value and may get wasted if it is not suitable for consumption.

f) **Inefficient agricultural practices**.

This is especially happening in low-income nations where farmers have little access to cutting-edge farming methods and technologies. In low-income countries, food losses and waste are primarily caused by technical, managerial, and financial constraints on harvesting methods, storage and cooling facilities in challenging climates, infrastructure, packaging, and marketing systems. Given that many smallholder farmers in developing nations struggle with food insecurity, a decrease in food losses could have a significant and immediate impact on their ability to support their families.
In order to strengthen the food supply chains in low-income nations, farmers must be encouraged to organize, diversify, and upscale their production and marketing. Infrastructure, transportation, the food and packaging industries all require investment.

g) **Lack of cooperation among supply chain participants**

In medium- and high-income countries, consumer behavior and a lack of cooperation among various supply chain participants are the main causes of food losses and waste. Agreements between farmers and buyers on sales may cause some farm crops to be wasted. Due to quality standards that disallow food items with imperfect form or appearance, food can go to waste.

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h) **Lack of infrastructure and poor storage facilities**

Poor storage facilities and lack of infrastructure cause postharvest food losses in developing countries. Fresh products like fruits, vegetables, meat, and fish straight from the farm or after the catch can be spoilt in hot climates due to lack of infrastructure for transportation, storage, cooling, and markets.

i) **Overproduction and overconsumption.**

In developed countries, consumers demand a constant supply of fresh produce and often prioritize appearance over quality. As a result, retailers and producers throw away perfectly edible food that does not meet strict appearance standards. Additionally, consumers often purchase more food than they need, leading to waste at the household level.

In conclusion, food loss is a significant issue that affects everyone. People need to understand that food loss can occur in many stages of the food supply chain, and each one of us is responsible to prevent and act to minimize food loss. Environmental effects can be reduced, financial losses can be prevented, if the farmers follow a more sustainable production system. By raising awareness of food loss and taking initiatives and practices to minimize the problem, we can contribute to a more sustainable ecosystem.

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2.5. Relevant Policies at EU level

According to EC, the EU's Common Agricultural Policy (CAP) initially established in 1962, is a collaboration between agriculture and society, and between Europe and its farmers. It aims to support farmers and improve agricultural productivity, to ensure a stable supply of affordable food; ensure a fair income for the farmers of the European Union; contribute to the management of climate change and the sustainable management of natural resources; preserve rural areas and landscapes throughout the EU; keep the rural economy alive by supporting jobs in agriculture, agri-food and related sectors.

The CAP is a common policy for all EU countries. It is managed at the European level and financed from the EU budget.

2.6. Conclusions

Food loss occurs at every stage of the supply chain. Food loss in the agri-food chain is a significant issue which needs to be addressed further, as the causes of all this waste have a negative impact on the environment, the economy and society. Food loss is a matter which not only needs to be addressed for raising awareness, but also for taking actions. Farmers need to seek innovative solutions in their harvesting methods and new ways to improve the food supply chain.

The food chain starts at the production stage and farmers are the first to take action and find ways to reduce the problem. New technologies can give effective solutions to farmers and less pollutant for the environment.

Alternatively, there are various initiatives around the world happening, which prove that food loss can be an opportunity for businesses and is a win-win situation as not only do they commercialize food loss but also contribute to the reduction of this issue and protection of the environment.

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2.7. Best practices

OLIO

This is a mobile app that connects neighbours and local businesses to share surplus food. Users can post pictures of food items they want to share, and anyone nearby can request them for free. OLIO has prevented thousands of items of food from going to waste.

ReFED

This is a non-profit organization that has created a data-driven platform to reduce food waste across the United States. Their platform connects businesses, government, and non-profits to share best practices and collaborate on food waste reduction initiatives.

FoodCloud

This is a platform based in Ireland that connects food businesses with charities and community groups to redistribute surplus food. They have helped prevent millions of meals from going to waste and have partnerships with several major food businesses in the country.

Zero Percent

This is a platform that connects food businesses with local non-profits to donate excess food. They provide a streamlined system for food businesses to post available food donations, and non-profits can claim them for free. Zero Percent has helped prevent over 2.5 million pounds of food from going to waste.

Zero Food Waste Cyprus

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Zero Food Waste Cyprus started in 2018, through the vision of one person to prevent food from being thrown away, which contributes to climate change and food inequality. Young Volunteers motivated to make a change in their local communities joined and met the local vendors at the biggest food market in Nicosia, Cyprus. Volunteers attended for the first time the Saturday market in February 2018, where they collected fruits and vegetables donated by market vendors. Using crates, cars, and team effort they then transported them to a distribution location giving them out for free to anyone in need. They managed to prevent edible food from ending up in landfills and at the same time donate it to the ones who need it.

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Pictures

https://elearning.fao.org/course/view.php?id=605

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III. THE IMPACT OF FOOD LOSS IN CLIMATE CHANGE

3.1. Module Description

This chapter presents the reader with the concept of food waste and how it is related to emission of greenhouse gasses as well as land occupation and water footprint. The chapter goes on giving data on how the waste is translated to financial costs at European level as well and the effect it has on household income and national economies. Finally, European strategies and initiatives that tackle food waste along with other cross-cutting issues such as climate change, biodiversity etc. are presented including the drawbacks and criticisms. The chapter ends with conclusions and case studies of initiatives that have tackled or responded successfully to food waste.

3.2. Learning Objectives

- Raise young peoples' awareness about food loss impact on climate change.
- Clarify the relation between food loss and climate change.
- Assess carbon footprint through food production chain on an international scale.
- Familiarize with land use footprint concept.
  Raise young peoples' awareness of food loss pressure on water resources.
- Define ecological water footprint feature and its use.
- Develop young people’s skills of converting food loss values into financial terms.

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3.3. The impact of food loss in climate change

According to the Food and Agriculture Organization (FAO) approximately 30% of human food consumption is lost along the supply, at a time when the population is estimated to increase up to 9,1 million in 2050 which will require a 70% increase of food production (Razaei and Liu 2017). Alarming figures coming from the same source (Razaei and Liu 2017) which states that 14% of the total world food production is lost somewhere in between the harvest and the retail market and yet another 17% is lost between retail and consumer levels.

According to the "A Food Waste Urban Approach – To reduce the depletion of natural resources, limit environmental impacts and make the food system more circular" publication elaborated in the framework of the URBACT programme of the European Union the causes of food loss along the supply chain include inadequate storage facilities and techniques, lack of transportation and distribution systems, harvest loss etc (Lopes 2021). The URBACT project promotes positive change through collaboration of local, regional, national and EU governance by tacking challenges in such way that takes into consideration elements such as the economy, the environment and the social dimension (Lopes 2021)

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Retrieved from: https://urbact.eu/

Preventing food loss from initial agricultural production down to consumption stages is going to positively impact the livelihoods, environment, sustainability and efficiency in resource use, etc. . Slowly but surely not lastly, food insecurity among developing countries, but climate change concerns could be alleviated.

3.4. How food loss impacts climate change

What does food have to do with climate change?

According to the UN (https://www.un.org/), climate change refers to any differences in the Earth's weather patterns and its temperatures, mainly caused by greenhouse gas emissions like carbon dioxide and methane, being agriculture, oil and gas some of the major sources of methane emissions and energy, industry, agriculture and land among the main sectors causing greenhouse gas release.

Clearly most of the above mentioned activities take part in food production, which in the words of the World Life Fund (WWF) (https://www.worldwildlife.org/))

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means that when food is lost along the chain, so is the energy and resources that were used to grow, harvest, transport and package it. The same source (https://www.worldwildlife.org/) also indicates that the food that roots in the landfills produces methane, a greenhouse gas that contributes to the rising of the temperatures.

In conclusion, if food waste was reduced (along with the reduction of other losses along the food production chain and the implementation of other needed measures) it would contribute to the reduction of the greenhouse gasses.

At this point, it is worth stopping to stress the fact that there is an interdependence between climate, ecosystems, biodiversity and human society, meaning that the effects of the changing climate will result in the reduction of food availability and security, price increase and as a result, our own livelihoods (Pörtner et al 2022). To make a connection methane emissions have increased the temperatures which have negatively impacted crop yields and on the other hand ocean warming has decreased sustainable yields in some fish populations (Pörtner et al 2022).

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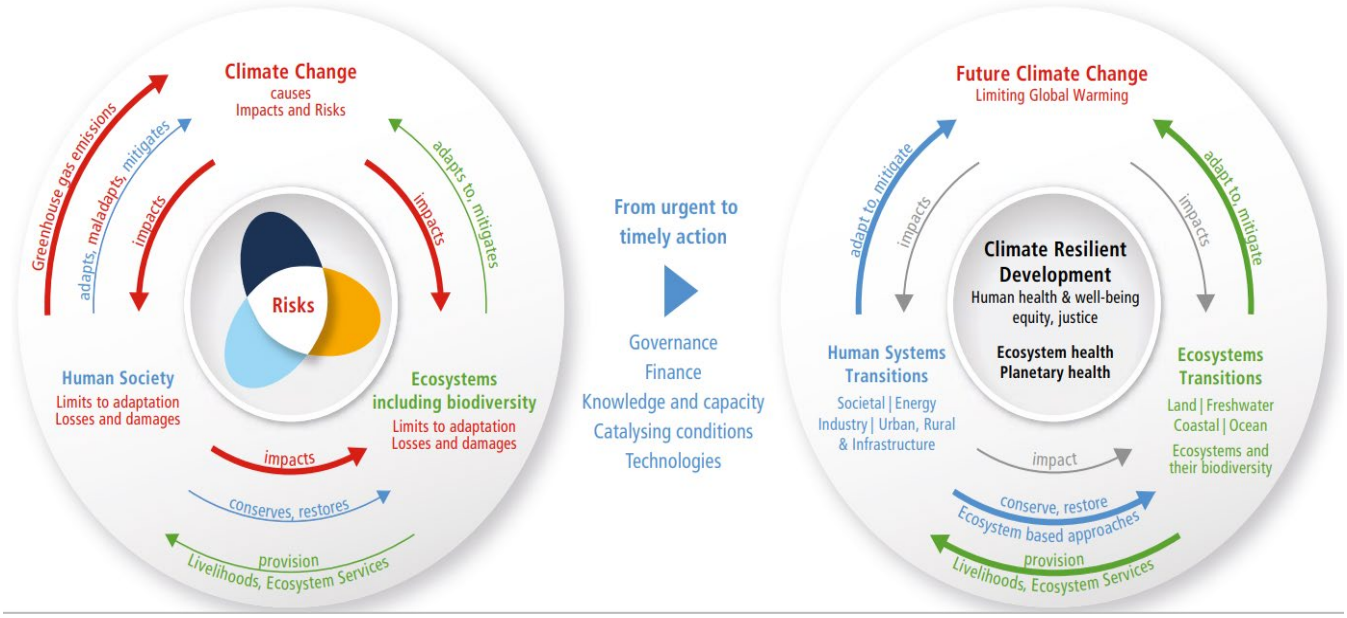

Source: IPCC 2022

Food production requires energy. To produce crops and raise cattle that reach consumer level, there are several conditions that highly depend on sunlight, water irrigation, soil quality, etc. Thus, every food has a direct environmental impact. Be it an overripe banana, moldy loaf of bread or a meal, when any of them is thrown away, it produces a wastage not just of food.

Therefore, it becomes crucial for changes to take place that will contribute to the limitations of global warming and the increasing of the resilience of the planet, its ecosystems and ecosystems.

3.5. Greenhouse gas emissions

What are greenhouse gases?

The National Geographic (https://education.nationalgeographic.org/) describes greenhouse gases (also known as GHGs) are gasses (such as carbon dioxide, methane, nitrogen oxide and fluorinated gases) found in the Earth's atmosphere that let the sun's light in and trap the heat creating an effect similar to than of a

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greenhouse which helps keeps the climate at a good temperature that allows species and lifeforms to live and multiply.

While the presence of these gases in the atmosphere is natural and beneficial for the continuance of life in the planet, what happens when the release of these gases is multiplied by human activity? The UN explain (https://www.un.org/), that the generation of greenhouse gases is done by the generation of power (such as electricity and heat) that is generated by burning coal, oil or gas which release carbon dioxide and other gases that trap more heat, causing the temperatures to change. Other activities that contribute to the release of GHGs and good manufacturing, cutting down forests, using transportation that run on fossil fuels, food production, powering buildings and overconsumption (https://www.un.org/).

According to the same source (https://www.un.org/) food production is one of the main industries that cause emissions of carbon dioxide and methane in activities such as clearing forest land for agriculture cultivations and grazing, livestock digestion, use of fertilizers and manure to grow crops, fossil fuel energy use for facilities and equipment and food distribution. Within the food production industry animal-based foods (red meat, dairy and farmed shrimp) and related to the highest emission of GHGs and plant-based foods to the lowest (https://www.un.org/).

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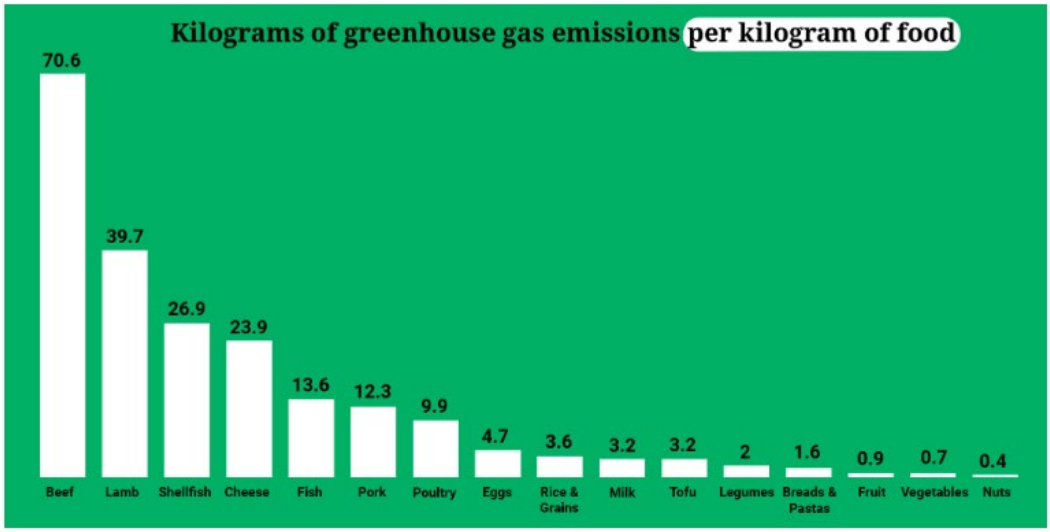
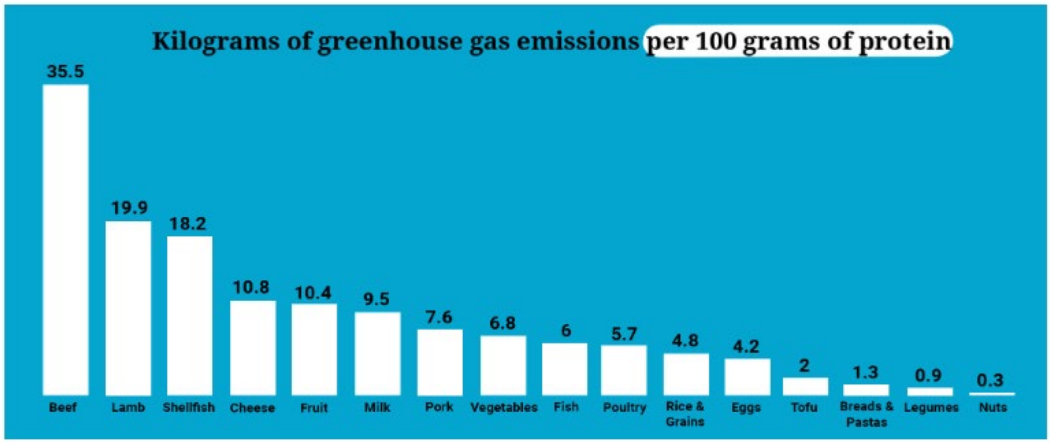
The graphics below show a comparison between the two:





Source: The United Nations

In a practical example putting a mean in our tables requires 10 kg of soil, 1,3 of gas, 800g of water and 0.3 grams of pesticides, all this process resulting in 3.5kg of CO_2 emissions (El Economista)

Food loss and food waste are unequally distributed, their values greatly vary from one country to another. Overall, industrialized countries account for higher amounts of food waste, whereas developing countries have a huge food loss problem,

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which happens on account of financial, administrative, and technical limitations (FAO 2011). To give an example, food waste generated per person 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 (idem)

In conclusion, both factors will cause the requirement of more food production, which will cause the food industry to produce more and more often, causing the emission of more GHGs, contributing to climate change which will backfire to the exacerbation of natural resources, yields and food security itself.

3.6. Land occupation footprint

29% of our planet is made up of land. According to data from the OECD, over the years, most of the world's habitable land was transformed by human activity. To produce food, people needed specifically assigned lands for agricultural use.

The European Environment Agency (EEA 2008) defines land *"as the surface of the solid Earth, together with superficial vegetation cover, built features and associated water surfaces, both freshwater and marine"* and land use as *" the land surface from the social perspective; it is characterised by some identifiable purpose, or purposes, leading to tangible or intangible products or benefits"*

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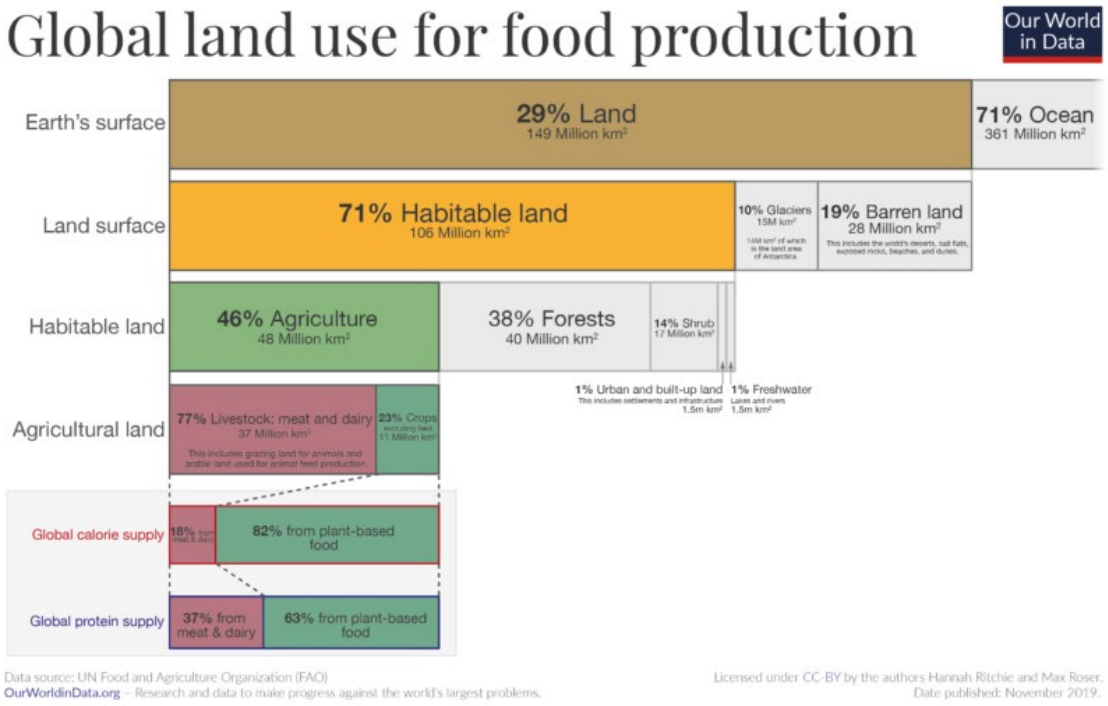

Source: https://ourworldindata.org/land-use

Today agriculture represents a major use of land occupation. 50% of the world's land is used for agricultural purposes, which leaves about 38% for green forests; 11% for grasslands, 1% for fresh-water and surprisingly only 1% for an area made up of man-made installations such as cities, towns, villages, and roads (Ritchie and Roser 2019)

Food loss stands behind a massive impact on the world's environment due to its huge land occupation, being half of the world's soils are used for agricultural purposes. and 30% of agricultural soil occupied by food which goes to waste (Ritchie and Roser 2019) FAO estimates that the land used for food waste is equivalent to the surface of Russia (FAO 2013).

Land use footprint is a tool that allows to calculate land resources needed to produce a service or a product, wherever it is in the world. For example, in the calculation of land occupation footprint, all land resources are considered, including

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the land used to grow the crops eaten by animals to produce a final meal (Ritchie and Roser 2019)

3.7. Water footprint

Water is a crucial element found in nature, not only for human consumption but also for all the industries that manufacture the goods and services we consume such as agriculture, power generation, footwear and apparel industry and so on (Chapagain 2017). Nonetheless, population growth, consumption patterns and inappropriate use have caused water scarcity and pollution in river basins (idem)

The water footprint is a UNESCO-introduced concept from Arjen Hoekstra that refers to "the amount of fresh water consumed by individuals, groups, or companies in order to make goods or provide services used by the community" (Kiran 2017).

According to The Water Footprint Network (established by Arjen Hoekstra with the aim of overcoming the challenges of water use) an increasing interest in water footprint increased rapidly, especially from big players like Pepsi, Heineken, Nestle etc.after the increasing water footprint 's concepts in literature.

Another study goes a bit further in defining water consumption itself is defined as "the volume of freshwater that is evaporated or incorporated into a product and includes any abstracted surface or groundwater that is not returned to the same water resource system from which it was withdrawn" (Zaimes and Khanna 2015). Subsequently, the water footprint is expressed in 3 separate components:

a. Green water refers to the consumption of rain water that does not recharge the groundwater but is stored within the soil but is used for the production of goods and services (Čuček et al. 2015, Zaimes and Khanna 2015).
b. Blue water footprint is referred to the evaporated water or water used by the individual, community or the production of goods and services. This

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amount included water not returned to the same area and water not returned during the same period. (Čuček et al. 2015).

c. Grey water is an indicator or pollution referring to the freshwater volume required to dilute pollutants so that water meets ambient water quality standards (Čuček et al. 2015, Zaimes and Khanna 2015).

3.7.1. How is water footprint related to food production?

Food and particularly food coming from the agricultural sector has a great demand for water and in addition when food is wasted the water, energy and process crops are also wasted (not to mention the GHG emissions and the environmental impact such as toxicity, eutrophication etc. (Hoehn et al 2021).

According to the Water Footprint of Food (https://foodprint.org/) , the water footprint of a food product is the volume of freshwater used to produce the product, measured at the place where it was made and refers to the sum of the water used in all steps of the production. It is important to mention that water footprint can be minimized, but it is generally impossible to bring it down to zero, so, to become “water neutral”, we can do what is within our reach through reduction of existing water footprint and investment into local and global projects aimed at equitable and sustainable water use (https://foodprint.org/).

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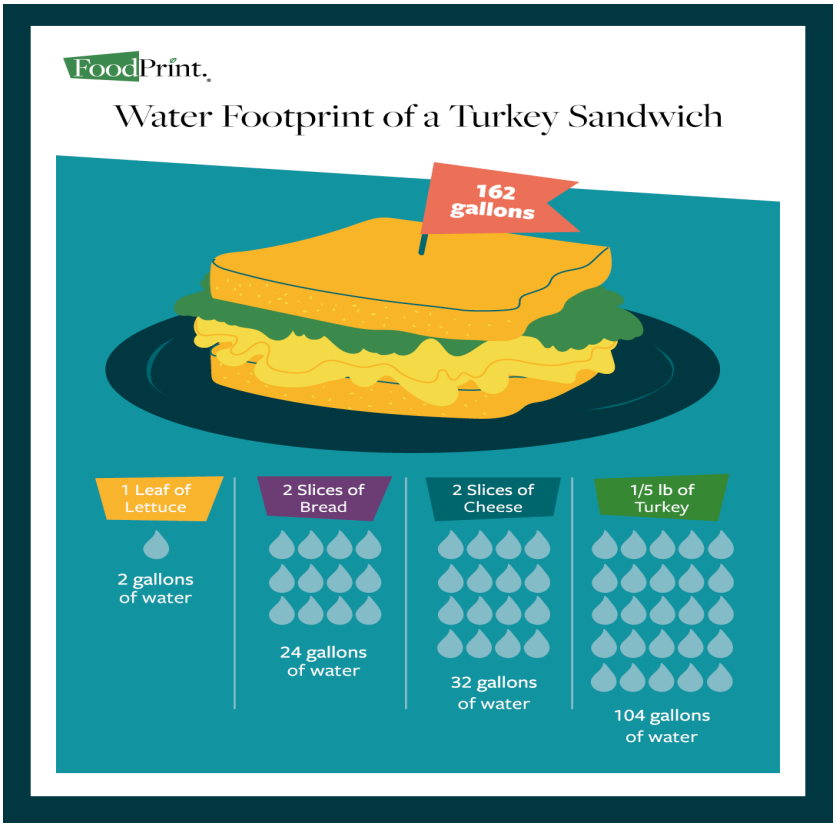

Source: The Water Footprint of Food (http://footprint.org/issues/the-water-footprint-of-food)

There are ways for us as consumers to be more aware of our water footprint. The water footprint calculators calculate our water consumption by retrieving information by our water use habits and consumption patterns. Some of them are as follow:

https://www.waterfootprint.org/resources/interactive-tools/personal-water-footprint-calculator/

https://knowsdgs.jrc.ec.europa.eu/cfc

3.8. Financial aspects

As described in the previous sections, food waste has a high environmental cost, though individuals are not often aware of it. However there are other costs which the society is more sensitive to, such as financial ones. Food does cost money and it is

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an important part of a household's monthly budget, so what is the financial impact when food is thrown away?

In general terms, whatever affects the environment and the climate, has a direct impact on our finances. The Life Foster project (https://www.lifefoster.eu/), a project co-financed by the LIFE Programme of the EU Commission, gathers some unsettling data about food waste and its financial costs in Europe:

- Each year around 88 million tons of food are thrown away in Europe.
- The waste costs the member states around 143 billion euros annually.
- The main generators of food waste are households (42% of the food waste in Europe) and the food service sector (14% of the food sector).

On a global level FAO (2014) alerts alerts in its report Food Wastage Footprint: Full cost-accounting that one-third of the food manufactured for human consumption is lost with an approximate a financial cost of of 900 billion euros.

As we explained in the previous chapters, food waste happens in a larger value chain that is strictly connected to environmental resources and the impact that food manufacturing has on climate, resource depletion, biodiversity etc. When calculating the costs of food waste, research does so from different levels of approximation, including the whole supply chain (from agricultural production to consumption/landfill), the inputs on the supply chain (land, fertilizers, storage, transportation, energy such as electricity or fossil fuels and outputs (pollution, ecosystems, social contexts etc) (Scialabba et al 2014). In addition, wastage takes into consideration:

- The direct internal and external costs of food production created at each stage of the value chain,

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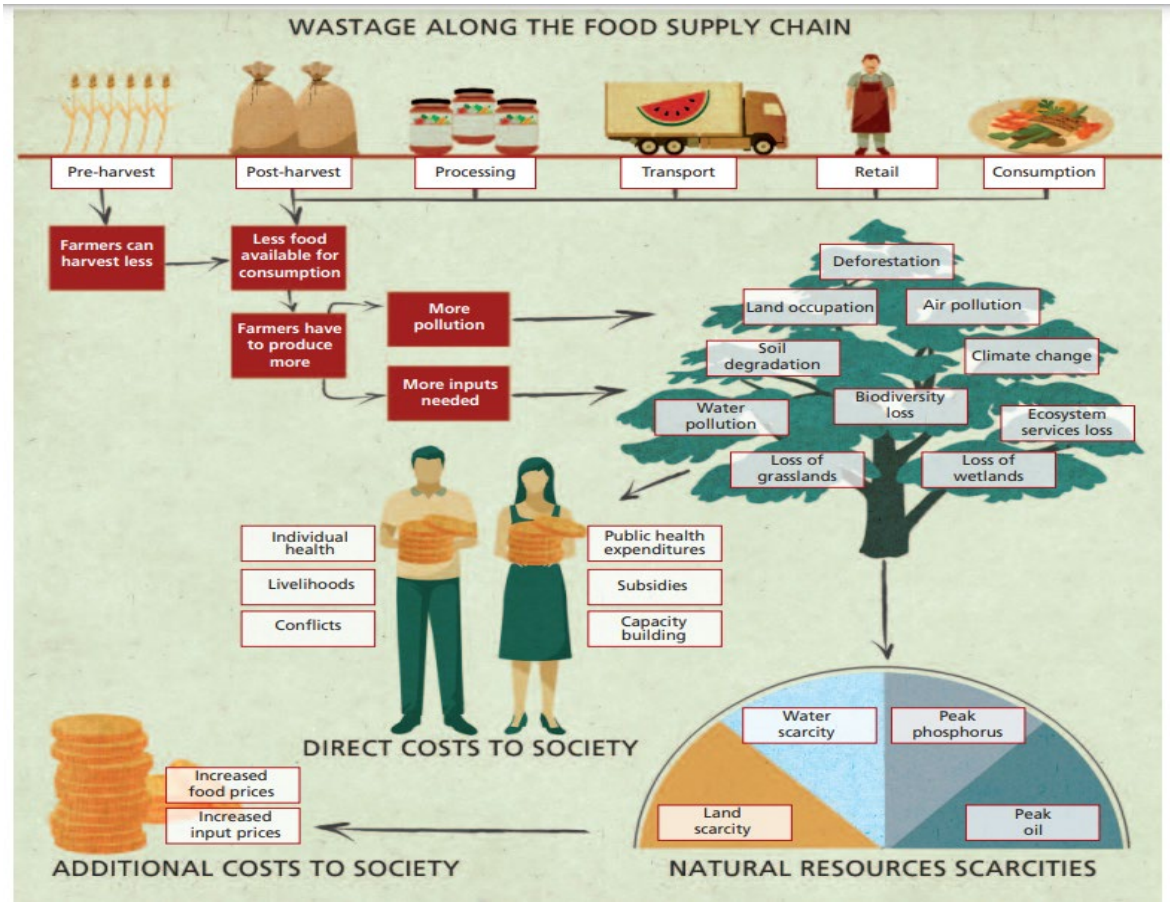

Source: Scialabba et al 2014

- The elevated costs emerging from resource scarcities (where there is a scarcity of resources the prices to have access to them are higher which would translate into a more expensive production process and high consumer price)
- Costs of impact on stakeholder groups. This may include the increase of prices due to wastage having a direct effect on household income and consumption (negative), on farmers (positive)

A visual resume of the direct of food wastage and all the mentioned costs is shown below:

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All studies conducted by international organizations agree that international and national policy must intervene to change the consumption patterns along the value chain in order to decrease food waste.

While on a global level and generic terms, policy to reduce good waste is worthwhile in terms of Gross Domestic Product (GDP), regional investment and market prices , it doesn't come without cost (Friman and Hyytiä 2022). Simulations showed that such reduction decreased the welfare of agricultural households, wages and incomes and the local food production level (Friman and Hyytiä 2022).

This means that the effects of food waste reduction may vary depending on the region and execution therefore national policy should adapt and adjust to the particularities of the area in order for them to be sustainable (idem)

3.9. European Policy that address food waste and loss

In 2019, the European Commission organized a public conference on the occasion of the meeting of the EU Platform on Food Losses and Food Waste to tackle food loss and waste prevention. According to communications from the European Commission the speakers discussed the steps to meet the Target 12.3 of the Sustainable Development Goals in each stage of the food supply chain including key players from public and private sectors alike (EC 2019).

The 2021 “No time to waste” report revealed that the EU imported more 138 million tonnes of agricultural products, costing 150 billion, and wasting 153.5 million tonnes each year, with businesses and households causing 143 million euros of waste a year (EEB 2022).

The above mentioned data was qualified as scandalous, especially at a time where living costs have increased, in addition criticizing the previous EU initiatives that have focused in covering retail and consumer food waste, leaving out waste on

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farms and food processing and service businesses (EBB 2022). Reference was also made to the failure of the EU countries commitment to half food waste with the SDGs 10 years ago, arguing that “it is insufficient to to set ambitious goals without ensuring their achievement with c*oncrete legislative proposals, which need to be drafted by the European Commission” (idem).*

Finally, that the best before date of the “Farm to Fork” strategy should be revisited and approached in an ambitious way (EBB 2022)

Image: No time to waste report cover, retrieved from: https://feedbackglobal.org/

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The Farm to Fork Strategy

Within the framework of the Green Deal, in May 2020 the European Commission launched the Farm to Fork Strategy (F2F) to ensure sustainable development of the economy and make food systems more fair, healthy and environmentally friendly, starting from the reduction of massive GHG emissions, and the change of unsustainable natural resources use, negative impact on human health and food systems. FAO explains that the F2F strategy aims at transitioning from the current system to a more sustainable through legislation that will reduce the climate footprint, strengthen resilience for times of crisis, change the patterns of food waste, overcome food insecurity, increase sustainable farming practices like reducing the amount of pesticides and fertilizers, increasing organic farming, improve animal welfare and so on.

The European Commission views the F2F strategy as accelerator to reach a more sustainable food system through:

- a neutral or positive environmental impact
- mitigating climate change
- reverse of the loss of biodiversity
- ensuring of food security, nutrition and health
- preservation of affordability of food while generation fairer economic returns

Source: The European Commission

In spite of the ambitious objectives, the F2F strategy is not free from skepticism and criticism.

Some of them include that F2F as a part of the EGD reduces agricultural production in the EU, increasing consumer prices and decreasing farmers' incomes as a result (Purnhagen and Alexandra 2022). The same study (Purnhagen and Alexandra 2022) points out that the environmental and human benefits are not

qualified by research and neither is its compensation in the calculated decline in welfare. Other criticism include a questionable food security (due to the reduction in production and increase in prices, a higher exposure to risk for some crops due to the reduction of pesticides, the difficulty of assessing the impact on biodiversity etc (idem).

In spite of all the drawbacks, the EDG and F2F is a solid step into changing resource-depletion patterns into sustainable ones.

3.10. Conclusions

The systems and rhythms of our society are quite intertwined with climate, biodiversity and ecosystems, meaning that all decisions that are taken at community, national and international scale will impact the environment which is subsequently effect industries (especially agricultural production), economy and as a result human livelihood.

Food waste is directly related to climate change as when food is thrown away so is the energy and resources used to produce it (not to mention the energy and

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resources used to produce more quality of the same), many industries release greenhouse gasses during their production process which trap the heat in the Earth atmosphere and cause the temperatures to rise. In addition, food rotting in the landfill releases greenhouse gasses, exacerbating further temperature rise and climate change.

Source: www.freepik.es/

While food has to be produced for approximately 8 billion people, agriculture occupies a major share which counts for 50% of the planet's which's exploitation is pressured by the needs of continuous consumption. Another 30% of soil is occupied from waste, leaving a very small share for natural areas.

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Similarly, water is another resource used in many industries for the manufacturing of goods and services we consume, being agriculture one of the sectors with the highest demand for it. When food is wated (and even more when the processes that manufactured it were not sustainable), so is the water that was used to consume it, which means more water is needed to produce more.

The waste of food which comes at a high cost for natural resources and the environment is also translated in financial terms. Not only does the waste imply financial costs along the whole value chain but it contributes to resource scarcity which restricts access for manufactures due to price increase which will have an effect on consumer price and household income.

The European Union recognizes the serious consequences of unsustainable production and consumption patterns. Some of the its objectives are halving food loss by 2030 and implementing the “Farm to Fork” (F2F)strategy which intends to transition to more sustainable and green practices along the whole supply chain that would reduce among other things, food waste. Though there is criticism on the impact and outcomes of the F2F strategy and the European Green Deal initiative, these firm steps, in spite of arriving later than expected, are considered a gain for the future of the planet.

3.11. Best practices

Zero Espilfarro (Zero Waste) is a strategy that aims to raise awareness and engage to action all the agents of the food chain to review the politics and behaviour and redefine policy, distribution models and consumption habits towards a

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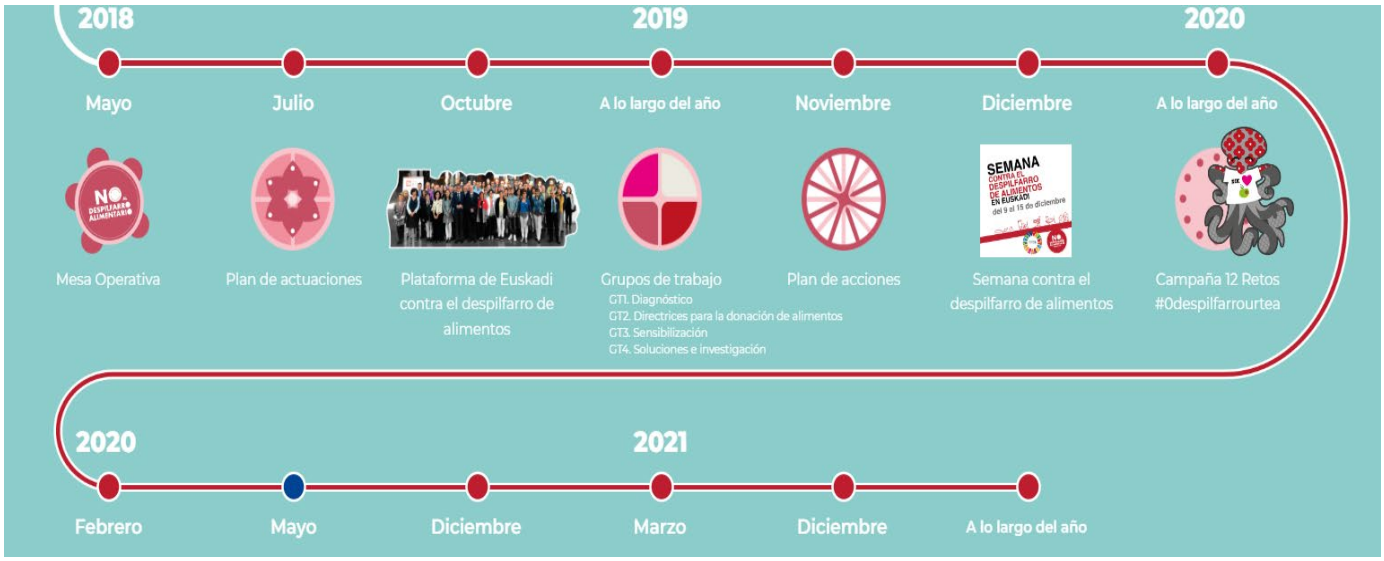
sustainable model that is based in circular economy and brings food waste to 0. This strategy, led by the Basque Country government and ELIKA Foundation.



Source: https://zerodespilfarro.elika.eus/es/estrategia-vasca/

The action plan aims at undertaking specific actions that reduce food waste along the food chain. The plan also aims at facilitating the surplus of human food to be used as animal fees. Other initiatves also include:

- Promoting short circuits of production and commercialization by making a clear differentiation of the local products.
- Define clear research lines concerning sustainable food production.
- Including locally produced food items in public cafeterias
- Encourage ecological production in the Basque Country
- Reach the 0 waste objective
- Implement the Nirea Initiative (an initiative that supports the rural sector to become more sustainable and competitive).

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In order to achieve the action plan the government has created the Platform Against Food Waste which consists in a forum where stakeholders like institutions, NGOs, associations etc intervene in the design and implementation proposed in the action plan.

Its main work lines include:

- Supporting and advising the Basque administration in the implementation of the policy that addresses the reduction of food waste.
- Serve as a forum to share proposals that contribute to the Action Plan.
- Implement the Action Plan through collaboration of all the involved actors.
- Act as an awareness agent for stakeholders and society.

More information: https://zerodespilfarro.elika.eus/es/estrategia-vasca/

Best practices guide for the minimization of food waste in the hospitality sector.

This guide is developed by the government of the Asturias and Cogersa (an entity created by the central government of Asturias and the town halls to provide solutions to the creation of of urban waste).

The guide starts by presenting the main concepts of food waste along with the food items that are generally disposed of more often in the hospitality sector. It continues by giving specific advice on how to correctly plan course preparation, catering and buffets in order to reduce waste during at the steps of the steps of the process (purchase, storage, prepared food storage, order storage, avoiding waste in dish portions, analysis of the recipes waste wise, and proper disposal of waste).

One of the most interesting parts of the guide are the practical advice on how the surplus of some certain dishes can be used as ingredients to be transferred in a new dish (a specific guide is dedicated only to this part, including 40 waste 0

recipes). Finally the guide addressed on how the correct disposal of the waste (division and recycling), along with ideas on how to reduce the package material from the supply.

More information at:

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PRINCIPLES OF TILLING, SEEDING AND HARVEST

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IV. PRINCIPLES OF TILLING, SEEDING AND HARVEST

4.1. Module Description

Key performance indicator for the success of any agricultural crop is its optimum field establishment. This is achieved by tilling and subsequent seeding, which needs to be correspondent to crop needs and soil climatic conditions.

Performing these actions, farmers now have many options to choose between those that respond to economical and soil climatic conditions as well as crop requirements. They can also choose between type and intensity of these options. Currently, innovative, and advanced technology, digital and engineered hardware, has been incorporated in agricultural machinery, making them more efficient and safer, adapting to the everchanging crop conditions, thus achieving optimum practices, lower cost, facilitating at the same time the user.

Efficient harvesting methods and their adaptability to crop and market specific needs is one of the most crucial aspects that could prevent crop losses on a large scale, speed up harvest time, and manage farm resources with precision.

An efficient and adaptable harvesting method needs to consider many parameters such as optimum harvest time, the type of harvesting, and of course reduction of losses. Learning and understanding the current harvest methods as well as current innovations in harvesting techniques and technology, more innovative ideas can sprout and provide solutions to food loss during the agrifood value chain.

Since different countries have different level of harvesting technology applied in their agricultural practices, transfer of know-how, knowledge and good practices can occur between higher and less evolve countries to fit relevant end-user needs and mitigate corresponded constrains.

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Agrifood technology entrepreneurs, start-ups and scale ups working of farm automation, IoT in Agriculture, GIS (Geographical Information Systems), AI / ML & data science in agriculture, agriculture robotics, drones, precision agriculture and agriculture biotechnology will have the opportunity to learn about the specific feature and be able propose solutions, according to their expertise and activity to tackle the issues leading and resulting from food loss.

4.2. Learning Objectives

The purpose of the specific module, as part of the e-manual is to strengthen the strategically targeted knowledge regarding farm stage food loss due to tilling, seeding and harvest methods and techniques and to train future farmers and entrepreneurs to adopt, create or convert to more sustainable practices, tackling the specific issue.

Crop tilling, seeding and harvest, requires knowledge, experience / know-how, attention to details, integrated crop management and proper equipment. Agriculture activities must be implemented only when necessary. Every non-successful intervention contributes to cost increase and soil degradation.

Due to the importance of the specific issues, they were and are subject to intensive research worldwide.

Based on the above,

4.3. Module Objectives

Principles of tilling, seeding and harvest module training with FoodE manual, youth workers should be able to, in terms of knowledge,

- To understand and describe relevant techniques,
- Distinguish between different types of tilling, seeding and harvest,
- To recognize the correct best practices in crop tilling, seeding and harvest,

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- To fully understand the operations and particularities of the specific agriculture activity and the potentials that its targeted, evolved, adaptable and innovative application can provide to food loss reductions.

➢ In terms of skills,

- to differentiate and evolve crop tilling, seeding and harvest,
- to recognize opportunities for the development of new solutions for crop tilling, seeding and harvest,
- to understand the importance of tilling, seeding and harvest in the food supply chain,
- to choose optimal approaches to crop tilling, seeding and harvest.

➢ In terms of stance,

- to adopt a different way of thinking and perspective in matters of crop tilling, seeding and harvest,
- to be fully aware of the real environment in which food loss occurs and to participate more actively in the promotion of efficient and sustainable tilling, seeding and harvest techniques,
- to change the perspective in the part of actions to promote food loss reductions.
- to encourage the participation of all those involved in similar activities and
- to support and adopt collective food loss reduction actions with other direct or indirect stakeholders in the sector.

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4.4. Tilling

4.4.1. Introduction

Tilling is a way of soil management with various means that intents to make the soil surface as proper as possible for seeding, growing and plant growth. These purposes are achieved by primary (main tilling) and secondary (complementary).

Primary tilling is done always before seeding or planting by turning the soil from 15 – 40 cm depth with special equipment called plowers.

Secondary tilling is done always for a depth above 15cm, and I can be applied before seeding but also after seeding or after plant emergence. Secondary tilling is done also with special equipment of a large variety from which each farmer can choose to cover specific needs of his fields.

Tilling is an ancient practice that has been, and still is, the subject of intensive research and has managed to increase the percentage of understanding regarding related problems, build better equipment and improve the technical aspect of the specific practice. During recent years, research and innovation on tilling is focused on reducing the number of interventions on the soil surface mainly for conserving structure and fertility, protection from erosion (sustainable use of resources) and crop cost reduction. Based on these recent research conclusions, new equipment and techniques have been developed that adapt better to field crop conditions and provide to the farmer higher and more stable income.

4.4.2. Purposes of tilling

The purpose of tilling is the reorganization of the soils structure in such way as to accommodate a new crop under the best agronomic and economic conditions. Within these purposes, the creation of optimum porosity and soil aggregates so that proper aeriation, temperature, water flow is achieved. This affect, at first, normal distribution of seeds on the surface and in such depth that can protect them from rain

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and birds, and secondary their proper contact with soil solid particles to acquire the appropriate moisture for emergence. All these features are mandates for good agriculture production and sustainable resource management.

4.5. Seeding

4.5.1. Introduction

Establishment of a crop starts with seeding or transplanting of young seedlings. Following a successful seeding or transplanting procedure a successful emergence should be expected. Main parameters that play key role to this feature is adequate soil moisture, temperature, oxygen, and light. Additional, soil fertility, climatic conditions and all crop handlings that will take place along the crops' duration. Managing all of which has one target. To harvest the best possible quantity and quality of produce.

So, seeding must be done in such a way so that seedlings can emerge safely and timely of the ground and start developing. By having a percentage between of 50 – 70% of water capacity ensures favourable moisture conditions. This moisture combined with adequate oxygen volume play a significant role and have an optimum analogy for each plant species. This feature translates to proper depth of seeding to expect normal emergence. Another important parameter is the soil temperature which of course is different than air temperature, where most cultivated plant species emergence with temperatures ranging from 0 – 50^{O}C. Some of the species also require light and other do not, so as a logical consequence the depth of seeding must also consider this specific requirement to have a successful establishment of the crop, reduce losses and produce the optimum outcome.

The above all-important parameters can be created prior to seeding and transplanting by applying specific mechanical soil surface processing following a field survey that will allow the estimation of those parameters and whether they need improvement. Soil fragmentation and friability, mechanical structure, degree of compaction and surface crust are parameters that play a significant role and must be

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evaluated when planning a crop establishment and general spatial planning of agriculture land use.

Once the seed absorbs enough water quantity from the soil all metabolic procedures are activated, and the young seedling starts to develop. The water quantity that seeds need to absorb, varies from 25 – 75% of their weight according to plant species. After the emergence of the seedling from the soil surface, first leaves develop and photosynthesis initiates. The root system already absorbs nutrients and plant growth takes its path.

4.5.2. Seeding features

Seasonality

For every plant and region there is an optimum seeding season. Conducting this action earlier or later than this period results in production loss. This period is determined mainly from the requirements of the seed and the plant that will be created, regarding moisture content and temperature, and from the possibility to encounter threats, either biotic or abiotic, during growth stages, as well as financial aspects i.e., market demand.

Many studies have shown that as much as each farmer gets away from the optimum season either earlier or, as more often later, production and food losses. These losses are due to the shortening of growing period, water scarcity, unfavourable temperatures, competition from weeds, and insect outbreaks or disease infections.

Delays often are due mainly to weather conditions, lack of manpower and inability of existing farm equipment to complete the necessary actions in time. The only parameter a farmer has true and direct control is the farm equipment and their suitability.

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Depth and Density

Depth of seeding is one of the most important success factors for all crops. In general, during summer seeds are place deeper than during spring and in lighter soils than heavier respectively. On land surfaces that are uneven and have different properties, the depth must be adjusted accordingly. It has been reported that even during the same day, this feature must get different adjustments.

Depth is also dependable from seed size and as a rule of thumb, depth should be 3 – 5 times the diameter of the seed.

Density on the other hand is what will ensure that land use will produce the maximum overall outcomes and benefits. Every seed that does not emerge, is consider a loss. Mainly, consistency of inline distances is the crucial parameter and the hardest to be achieved. This consistency is affected by the type of equipment and the adjustments it must undergo.

Currently, the most advance equipment used have a deviation of ± 1,5cm, in controlled conditions, but in practice advanced precision equipment have a deviation of ± 3,0cm.

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4.6. Harvesting

4.6.1. Introduction

Last but critical agricultural practice is harvesting. The initiation, length and finalization depend on the state of the crop, earliness, uniformity of maturity, diseases etc. and of course the climatic conditions of each territory and each year.

Carefully planned harvest, at the right time, contributes to the avoidance of losses and protects as much as possible, the quality parameters of the produce.

Main consideration during planning, is the timely acquisition of personnel to complete the harvesting activities within a specific timeframe before the produce optimum state for market distribution or conservation. Also important, calculation and reduction of the total cost with the use of necessary means or techniques that will aid towards that cause.

Harvesting contributes the largest percentage on production cost which for some crops could go up to 50%. In some regions, due to high harvesting costs, traditional costs have been abandoned or replace with others that require less workload.

Nowadays, to cope with the increased harvesting costs and losses of manual methods the following measures are proposed:

1. Means for assisted harvesting. Manual harvesting is assisted with specific tools such as special containers and power assisted harvesting tools.
2. Low level and dense plantations. The produce is at a specific level and density where minimum work is required.

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3. Specific plantation formations to allow mechanical harvesting. According to the crop and how the produce is distributed, relevant formation is applied to reduce the operation costs per unit of production.
4. Self – propelled platforms. For limited extension areas, self-propelled platforms can serve, amongst other agriculture activities, harvesting from high plantations.
5. Full mechanized harvesting. Rapid expansion of the specific method has been seen in the last years, especially in developed countries and is expected to move into more regions in the upcoming years. The reasons behind this expansion are clearly financial and in response to the agriculture workers crisis that enlarged in the post-covid era.

4.6.2. Mechanization of harvesting

The need of mechanized harvesting has been promoted specifically due to the high increase of labour costs and to the scarcity of agriculture workers.

Mechanization of harvesting is not only supported by the development of a suitable machine equipment that will harvest the produce, as it is cultivated today. Factors such as, the way of vegetation and fructification as well as the way of maturation needs to be taken strictly into consideration when designing a mechanized harvesting method or technique.

Designing a mechanized harvesting solution requires the cooperation of many specialists, such as engineers that deal with the design and operation of suitable harvesting equipment, physiologists that deal with the application of techniques to promote simultaneous produce maturation, specialized field agronomists that deal with the crop formation to adapt to the proposed mechanized harvest and agroeconomics specialists to check the viability of the method or technique.

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With the application of mechanized harvesting in an area, the following transformation of production indices occur.

1. Increase of the size of cultivated agriculture area for the investment on high value equipment to be financially viable and productive.
2. Increase of the farmers vocational specialization with the reduction of the variety of cultivated species, focusing on those that are best suited to the harvesting equipment.
3. Increase of capital investments with the purchasing of mechanical equipment for harvesting and packaging.
4. Potential decrease on quality of produce that is small and sensitive in nature by inflicting mechanical damage, transfer of foreign matters such as soil and rocks as well as plant material. For this reason, additional equipment is required for cleaning and screening of harvested produce.
5. Potential transformation of marketable form and appearance to the end user as mechanical harvest tends to differentiate the harvested parts deriving from manual techniques.
6. Increase of specialized workers for handling this equipment.
7. Major reduction of production costs due to the reduction of manual labour.

4.6.3. Types of mechanical equipment

Mechanical vibrators

Vibrators are mechanical equipment used to inflict vibrations to the plants due to which agriculture produce is detached and fall. They were first used with great success for harvesting nuts and later for fruits that is primarily used for industrial processing and very limited for produce to be marketed as fresh.

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Means for accepting and collecting

Produce that is detached must be collected with the minimum costs possible and with the most suitable way to reduce losses and secure quality. For this purpose, various means are used, depending on the kind of produce and the harvesting method. This means vary from very simple to very complicate, which apart from collection they conduct cleaning from foreign matter, screening, and encasing.

Ground collection equipment

Collecting produce from the ground occurs after their detachment either though naturally falling after the end of maturation or by a mechanical mean as described above. This collection happens with vacuum absorbers and mechanical collectors of various types that are specially designed to collect various types of produce from the ground.

Robotic equipment

Harvesting robots are designed to harvest crops such as fruits and vegetables by direct contact consisting of a picking hand or arm. They use sensors and cameras to detect when the crops are ready to be picked, then use robotic arms or other tools to carefully harvest them without damaging the produce. These contact machines are based on the principle of selective picking and may use mechanical fingers, which are flexible and imitate human fingers.

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4.7. New trends and innovations

4.7.1. Farm Automation

Farm automation brings together agricultural machinery, computer systems, electronics, chemical sensors, and data management to improve equipment operation and decision-making, and ultimately, reduce human input and error.

Reduced labor time, higher yields, and the efficient use of resources are driving the large-scale adoption of the technology. Farmers now use automated harvesters, drones, autonomous tractors, seeding, and weeding to transform how they cultivate their crops. The technology takes care of menial and recurring tasks, allowing them to focus on more critical functions.

As with any field (no pun intended), automation can help employees save time, as the technology reduces the need for people to actively partake in a task. Thanks to automation, most farmers now spend more time with their families than before.

4.7.2. Innovative equipment

Smart Seed Firmer

Versatility is vital for farmers. Without versatile machinery and tools, farmers would need a lot more storage space. Fortunately, innovations have made it possible to integrate multiple devices in one, like a smart seed firmer. Traditional seed firmers plant seeds. A smart seed firmer plants seeds, uses an optical sensor to map organic matter, detects soil moisture levels, and can change seed depth. It's a newer and more versatile technology than traditional models.

Box Blade

Box blades also aren't a super recent innovation in farm equipment, but they're still beneficial for the farm. These blades were patented in 2011, and their versatility

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beats any other blade attachment. Those who work in the field in the agricultural industry know they can rely on a box blade for grading and levelling ground to plant crops, terracing fields, levelling land for a building, spreading dirt, and constructing paths around the property.

4.8. Relevant Policies at EU level

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS CLOSING THE LOOP - AN EU ACTION PLAN FOR THE CIRCULAR ECONOMY COM/2015/0614 FINAL.

The action plan focusses on action at EU level with high added value. Making the circular economy a reality will however require long-term involvement at all levels, from Member States, regions and cities to businesses and citizens. Member States are invited to play their full part in EU action, integrating and complementing it with national action. The circular economy will also need to develop globally. Increased policy coherence in internal and external EU action in this field will be mutually reinforcing and essential for the implementation of global commitments taken by the Union and by EU Member States, notably the U.N. 2030 Agenda for Sustainable Development and the G7 Alliance on Resource Efficiency. This action plan will be instrumental in reaching the Sustainable Development Goals (SDGs) by 2030, in particular Goal 12 of ensuring sustainable consumption and production patterns.

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS GREEN ACTION PLAN FOR SMES ENABLING SMES TO TURN ENVIRONMENTAL CHALLENGES INTO BUSINESS OPPORTUNITIES /* COM/2014/0440 FINAL */

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The Green Action Plan aims to contribute to the re-industrialisation of Europe as advocated by the European Industrial Renaissance Communication (COM (2014) 14) and supported by the European Council, by enhancing SMEs competitiveness and supporting green business developments across all European regions, notably in view of the fact that, at this stage, significant differences in resource efficiency exist between sectors and Member States.

Circular Economy Package (CEP)

The European Commission adopted the new circular economy action plan (CEAP) in March 2020. It is one of the main building blocks of the European Green Deal, Europe's new agenda for sustainable growth. The EU's transition to a circular economy will reduce pressure on natural resources and will create sustainable growth and jobs. It is also a prerequisite to achieve the EU's 2050 climate neutrality target and to halt biodiversity loss.

The new action plan announces initiatives along the entire life cycle of products. It targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented, and the resources used are kept in the EU economy for as long as possible.

Waste Framework Directive 2008/98/EC

This Directive lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use. The Directive recalls the general environmental protection principles of precaution and sustainability, technical feasibility and economic viability, protection of resources as well as the overall environmental, human health, economic and social impacts. Member States shall take the necessary measures to ensure that waste management is carried out without endangering human health, without harming

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the environment and, in particular: (a) without risk to water, air, soil, plants or animals; (b) without causing a nuisance through noise or odours; and (c) without adversely affecting the countryside or places of special interest.

COMMISSION DELEGATED DECISION (EU) 2019/1597

The aim of this Decision is to establish a common methodology and minimum quality requirements for the uniform measurement of levels of food waste. It stipulates that the amounts of food waste shall be measured separately for the following stages of the food supply chain: (a) primary production; (b) processing and manufacturing; (c) retail and other distribution of food; (d) restaurants and food services; (e) households. These provisions are set out pursuant to Directive 2008/98/EC, which lays down an obligation for Member States to include food waste prevention into their waste prevention programmes and to monitor and assess the implementation of their food waste prevention measures by measuring the levels of food waste based on a common methodology.

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4.9. Conclusions

Any sector which wastes up to 30% of its products along the supply chain is not only inefficient and polluting, but it also means that it is ripe for disruption and innovation. The agri-food sector is in this category. The level of wastage in the agri-food chain has prompted the development of a range of new technologies which seek to make the agri-food chain more efficient and less wasteful, particularly when it comes to primary production.

Significant value creation opportunities exist in capturing lost value on the farm, in the form of reducing 'avoidable' loss and waste and valorising those unavoidable loss, waste and by products of the production systems. Given that the level of loss and waste is driven, inter alia, by market dynamics, it is essential that the role of the market be addressed in the quest for a holistic solution.

The solutions offered must be commercially viable. They should be compatible with the UN Strategic Development Goals (SDGs) as these underpin a sustainable approach to the management of the biosphere. This includes the delivery of secure and wholesome food supplies for mankind while maintaining biodiversity, soil health and the wider environment. 'Digital agriculture' has a key role to play in the delivery of efficient on-farm operations that can also be verified to the satisfaction of regulatory authorities and the citizen (consumer).

Several key research themes are identified to address mechanisms to reduce food loss and waste on the farm. Central to these is the need to take a multi-actor 'value chain approach' to research on this subject, with an integrated mix of researchers, businesses (large and SME) and the citizen (consumer). The suite of solutions required is multi-faceted and includes both technical and policy as a key driver of change in society. A full-chain approach must be undertaken as on-farm losses are impacted by market 'draw' arising from the consumer and other post-consumer commercial

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valorisation businesses. The danger is that the waste becomes a product and ‘feeds’ a growing waste valorisation market (manifestation of the Jevons Effect).

ICT applied to agricultural production systems and full agri-food chain monitoring and control offers a new frontier in systems operation and control. Agriculture 4.0, the new ‘Digital Agriculture’ era, is dawning and holds out the prospect of enhanced control over on-farm operations and mainstream food chain, from farm to table. This is an area that requires rapid increase in research and innovation, with a high level of engagement with the industry.

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4.10. Best Practice

BAYER CROP SCIENCE

Every seed in a farmer's field has the potential to grow crops. But if a plant fails, that opportunity is wasted. With challenges like insects, diseases, and climate change, farmers need solutions that are specifically developed to withstand these various pressures to have healthy harvests.

Digital farming technologies such as soil sensors and satellites are helping to pre-emptively diagnose and treat various threats to crops before they take hold—helping prevent crop loss from the start. In addition, farmers are utilizing genetically modified and hybrid seeds, along with chemical and biological crop protection tools, to protect their crops' potential.

There are many steps in the food journey from the farm to consumers. The first is harvesting, which can damage crops if done improperly, reducing growth capacity or shelf life. Similarly, loss can also occur if there are interruptions or mistakes as foods are washed, peeled, sliced, or boiled. With improved seed technology and precise harvesting equipment, agriculture is making continuous improvements to help more crops make it off the farm.

Bayer is also looking inward to prolong shelf life. Using a combination of traditional breeding techniques, plant breeding innovations (such as genome editing), and biotechnology, its plant scientists are developing new plant varieties that grow and travel better. With greater resistance to pests and diseases, more efficient nutrient absorption, and improved textures, these new varieties better withstand harvest and distribution—so that markets and grocery stores have enough quality food for

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consumers to choose from. This increased shelf life also gives consumers a larger window in which to enjoy their food before it spoils.

In Bayer's efforts to find new ways to farm better, one approach is to help farmers grow better crops. To do so, its scientists are researching how to harness the capabilities of genome editing tools such as CRISPR—a technology that can alter the genetic makeup of an organism to improve its characteristics. In agriculture, genome editing has the potential to be used to help plants keep themselves healthy through self-immunization against diseases and increase yield.

By giving plants the capacity to meet their own needs, farmers can spend less time more efficiently on the tractor, use fewer natural resources, and inputs.

ReFED – Optimizing the harvest.

Of the more than 15 million tons of surplus produce generated at the farm level, a staggering 78% reached maturity but was left behind after harvest. Some of this was considered inedible for reasons including rot and insect infestation (although it still could potentially be used for non-food purposes), but more than a quarter of the surplus was left behind, because it was considered "not marketable" – frequently because of overly strict quality or appearance standards established by stakeholders further down the supply chain. And surprisingly, another 23% of what was left behind was considered marketable, but it wasn't harvested for other reasons, including insufficient labour to harvest, or because it was planned surplus for contracts that had already been fulfilled for the season or because the cost to harvest was greater than the selling price. This means that more than half of the produce left on farm was perfectly edible.

"Optimizing the harvest" means aligning what is grown with what is ultimately harvested, by avoiding overproduction and then harvesting as much as possible. Solutions in this action area include finding new ways to sell and donate what's left after harvest, such as developing innovative contract structures that don't incentivize overproduction, and improving systems of communication that relay forecasted

demands back up the supply chain to producers. Additionally, technological innovations that streamline individual, cross-sector, and cross-supply chain data-sharing could amplify the benefits. While these solutions manifest in less waste at production, the opportunities and responsibility to implement them lie across all supply chain actors.

Improved Communication for Planting Schedules

Technology-enabled coordination between producers to minimize surplus planting and to match future harvest quantities with projected market demand.

Sanitation Practices & Monitoring

Practices and oversight that can reduce contamination, microbial growth, pests, and other food safety concerns, which would otherwise lead to waste and disposal.

Optimized Harvesting Schedules

Coordinated harvest planning that integrates weather patterns, demand-forecasting, and growing timelines to maximize product quality and shelf life.

On-Farm/Near-Farm Processing

Immediate post-harvest processing, such as freezing, drying, jamming, or other, to leverage freshness of products, reduce waste of surplus or damaged goods, and/or minimize transportation costs.

Local Food Systems

Collaborative network in which food is locally produced, processed, distributed, consumed, and recycled to support the health and wellness of the community and environment.

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Clear Product Ownership

Defined responsibility for maintaining quality, minimizing losses, and ensuring successful transition of product as it passes hands over the course of the supply chain.

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V. HOW COULD WE MINIMIZE FOOD LOSS?

5.1. Module Description

The module "How could we minimize food loss?" seeks to provide a comprehensive understanding of the issue of food loss and to equip individuals with practical strategies to minimize food loss.

Throughout the module, complex causes, and consequences of food loss, including post-harvest losses, supply chain inefficiencies, and consumer behavior will be addressed. Individuals will gain insights into the environmental, economic, and social impacts of food loss and its implications for food security and sustainability.

Various innovative and practical approaches that can be adopted at different stages of the food value chain to reduce food loss will be addressed. An introduction into learning about proper handling and storage techniques, efficient transportation and logistics, improved packaging, and sustainable consumption practices will be made. The module will also emphasize the role of technology, data analytics, and policy interventions in mitigating food loss.

The modules content can be used for Workshops, where through engagement in discussions, case studies, and group activities, participants can develop a holistic perspective on minimizing food loss and leave with actionable strategies to implement within their own communities, organizations, or businesses. The module aims to empower individuals to contribute to a more sustainable and resilient food system, while simultaneously addressing global food security challenges.

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5.2. Learning Objectives

- Examine existing solutions and strategies that have been successful in reducing food loss during primary production.
- Examine case studies and best practices from different regions or industries that have effectively reduced food loss during primary production.
- Discuss the importance of collaboration among stakeholders, including farmers, policymakers, and consumers, in mitigating food loss.
- Understand the principles of reuse and recycling in the context of reducing food loss and waste.
- Explore innovative approaches and initiatives that promote the reuse and recycling of food products to minimize loss.
- Analyse the benefits, challenges, and potential limitations associated with implementing reuse and recycling strategies to reduce food loss.
- Discuss the role of consumer behaviour and awareness in reducing food loss through reuse and recycling.
- Identify potential opportunities for individuals, businesses, and communities to contribute to reducing food loss through reuse and recycling.
- Reflect on personal and collective actions that can be taken to minimize food loss at the primary production stage and promote reuse and recycling.
- Develop practical strategies and action plans to implement in various contexts to address food loss and promote sustainable practices.

These objectives aim to provide participants with a comprehensive understanding of food loss during primary production, highlight existing solutions, and explore the role of reuse and recycling in minimizing food loss. By the end of the workshop module, participants should be equipped with knowledge and actionable insights to contribute to reducing food loss in their respective spheres.

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5.3. Module Objectives

- Enhance awareness of existing solutions and strategies for minimizing food loss during primary production, specifically focusing on innovative approaches and best practices.
- Emphasize the role of reuse and recycling in reducing food loss, highlighting examples and case studies where these practices have been successfully implemented.
- Encourage critical thinking and problem-solving skills to identify potential interventions and actions that can be taken to minimize food loss in primary production.
- Foster a sense of responsibility and commitment towards sustainable food systems by empowering participants to actively contribute to the reduction of food loss in their own communities or areas of influence.

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5.4. Existing solutions to reduce food loss during primary production.

Existing solutions to reduce food loss during primary production encompass a range of strategies, techniques, and technologies. Here are some of the key solutions:

1. Improved Agricultural Practices:

- Precision Agriculture: Using technology such as remote sensing, GPS, and data analytics to optimize farming practices, leading to precise monitoring and management of variables like irrigation, fertilization, and pest control.

Image #49555340 from colourbox.de

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- Integrated Pest Management (IPM): Employing an ecologically-based approach to pest management that focuses on prevention, monitoring, and control methods, reducing crop losses while minimizing environmental impact.
- Crop Diversification: Growing a variety of crops in the same area to reduce the risk of total crop failure and maintain productivity even if certain crops are affected by pests or environmental factors.

Figure 3: Image #50887151 from colourbox.de

2. Post-Harvest Handling and Storage Techniques:

- Improved Storage Facilities: Upgrading storage facilities to maintain appropriate temperature, humidity, and ventilation conditions, thereby minimizing post-harvest losses.
- Modified Atmosphere Packaging (MAP): Modifying the composition of gases surrounding fresh produce to slow down ripening and deterioration, extending the shelf life of perishable products.
- Controlled Atmosphere Storage (CAS): Precisely controlling temperature, humidity, and gas composition within storage environments for long-term storage of fruits, grains, and seeds.

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Figure 4: Image #55414037 from colourbox.de

3. Innovative Technologies:

- Remote Sensing and Imaging: Utilizing satellite imagery and drones to provide valuable information on crop health, soil moisture levels, and pest infestations, enabling farmers to make informed decisions and reduce losses. Here free satelite images and data by ESA (European Space Agency) could be used :, an example for it is Cloud-free Biomass :

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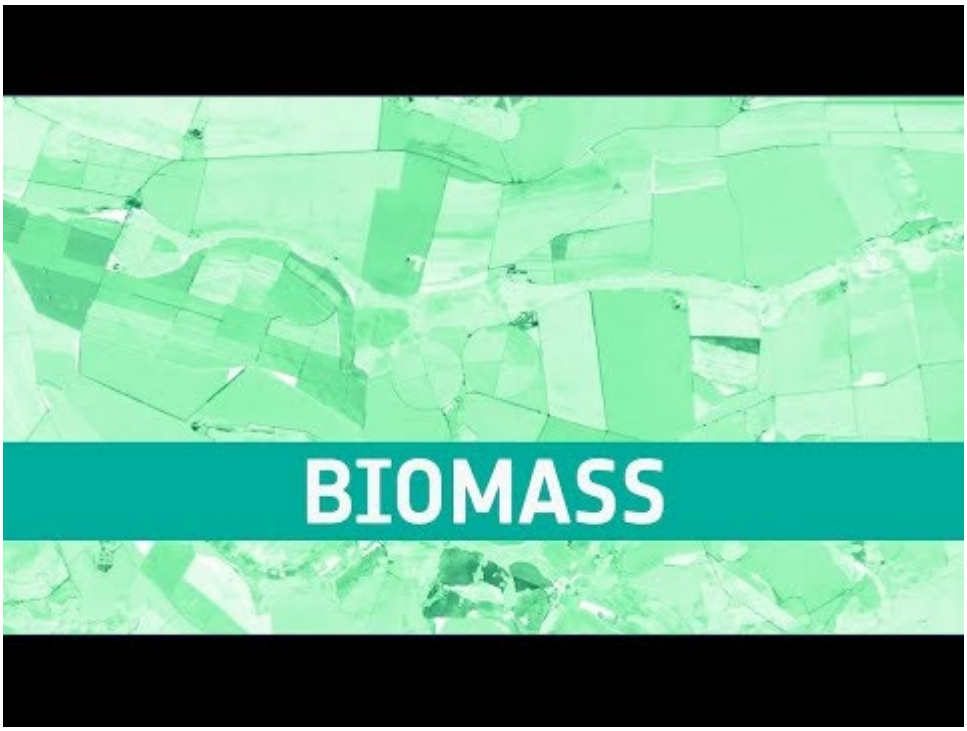
Image Cloud-free crop maps foster sustainable farming. Source: https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-1/Cloud-free_crop_maps_foster_sustainable_farming (last access: 29.06.2023).



Cloud-free Biomass Video available online: https://youtu.be/lwBhAYXVrLw (last access: 29.06.2023).

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- Sensor Networks and Internet of Things (IoT): Deploying sensor networks integrated with IoT technologies for real-time monitoring of parameters such as soil moisture, temperature, and humidity, optimizing resource allocation and enabling timely actions to minimize losses.
- Mobile Applications and Data Analytics: Providing farmers with mobile applications equipped with data analytics capabilities, offering access to valuable information, weather forecasts, pest alerts, and best practices, empowering farmers to make data-driven decisions and improve efficiency.

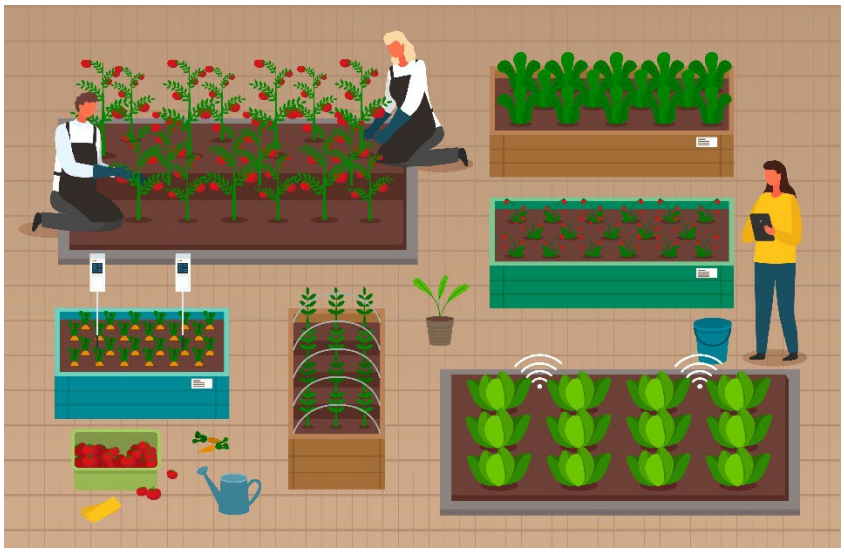

Image #47373181 from colourbox.de

4. Capacity Building and Knowledge Sharing:

- Farmer Education and Training: Providing farmers with the necessary knowledge and skills to implement best practices, make informed decisions, and adopt technologies effectively.
- Extension Services: Strengthening extension services to disseminate information, offer technical support, and facilitate knowledge sharing among farmers, promoting the adoption of sustainable practices and reducing food loss.

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Image #21309835 from colourbox.de

5. <u>Infrastructure Development and Policy Support:</u>

- Investment in Rural Infrastructure: Improving access to transportation, storage facilities, and market linkages in rural areas to minimize post-harvest losses and enable efficient distribution of agricultural produce.

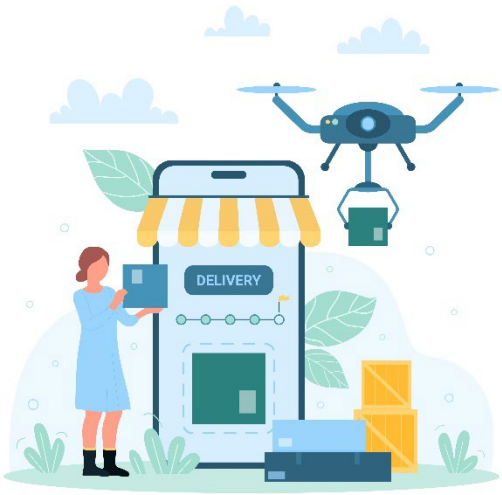

Image #56869739 from colourbox.de

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- Policy Frameworks: Developing supportive policies and regulations that incentivize sustainable agricultural practices, promote research and development, and encourage investment in food loss reduction initiatives.

These solutions, when implemented holistically and adapted to local contexts, can contribute to significant reductions in food loss during primary production, enhancing food security, sustainability, and economic outcomes for farmers and communities.

Image #42803041 from colourbox.de

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5.5. The role of reuse and recycling in the reduction of food loss

The role of reuse and recycling in the reduction of food loss is significant and multifaceted. These practices contribute to minimizing food waste at various stages of the food supply chain, from production and processing to distribution and consumption. Here are the key roles of reuse and recycling in reducing food loss:

a) **Extending Product Lifespan:**

Reuse practices, such as repackaging or redistributing surplus food, help extend the lifespan of food products. Instead of discarding perfectly edible food, it can be redirected to alternative markets, food banks, or community organizations. This reduces the amount of food that goes to waste and ensures that it serves its intended purpose of nourishing people.

b) **Preventing Resource Depletion:**

Reuse and recycling reduce the demand for raw materials and resources required for food production. By reusing packaging materials or repurposing food waste, the need for producing new packaging or generating additional resources diminishes. This conserves resources, such as water, energy, and land, leading to a more sustainable and efficient use of these valuable inputs.

c) **Reducing Environmental Impact:**

Food loss contributes to environmental degradation through the emission of greenhouse gases, land use change, and energy consumption. Reuse and recycling practices help mitigate these impacts. For instance, recycling organic waste through composting or anaerobic digestion reduces methane emissions from landfills, which are potent greenhouse gases. It also generates valuable resources, such as compost, which can be used to enrich soil fertility and support sustainable agricultural practices.

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d) **Promoting Circular Economy:**

Reuse and recycling align with the principles of a circular economy, where resources are kept in use for as long as possible, creating a closed-loop system. By reusing and recycling food and its components, the concept of waste is minimized, and materials and resources are given a second life. This transition from a linear "take-make-dispose" model to a circular approach contributes to a more sustainable and resource-efficient food system.

Image #56434618 from colourbox.de

e) **Addressing Food Insecurity:**

Reuse practices, particularly redistribution of surplus food, help address food insecurity and alleviate hunger. Instead of wasting food, it can be redirected to individuals or communities in need through food banks, shelters, or charitable

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organizations. This ensures that edible food reaches those who are food insecure, thereby contributing to a more equitable and just food system.

f) Creating Economic Opportunities:

Reuse and recycling initiatives create economic opportunities in waste management and recycling sectors. These practices generate employment, support local industries, and contribute to economic growth. For example, recycling facilities that process food waste into compost or energy can create jobs and foster the development of a circular economy ecosystem.

In conclusion, reuse and recycling play a crucial role in reducing food loss by extending the lifespan of food products, conserving resources, reducing environmental impact, promoting circularity, addressing food insecurity, and creating economic opportunities. Embracing these practices throughout the food supply chain is essential for building a more sustainable and resilient food system.

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5.6. Relevant Policies at EU level

There are several relevant EU policies aimed at addressing food loss and waste. Some of the key policies include:

a. **Farm to Fork Strategy:** The Farm to Fork Strategy is part of the European Green Deal and sets out a comprehensive framework to make food systems more sustainable. It includes targets to reduce food waste and improve resource efficiency across the food supply chain. European Commission - Farm to Fork Strategy: Visit the European Commission's official website to access detailed information about the Farm to Fork Strategy, its objectives, targets, and measures. Website: https://ec.europa.eu/food/farm2fork_en

b. **Circular Economy Action Plan:** The Circular Economy Action Plan focuses on promoting a circular economy where resources are used more efficiently, and waste is minimized. It aims to address food waste through measures such as promoting sustainable production and consumption patterns, improving food labelling, and supporting innovation in food processing and distribution. European Commission - Circular Economy Action Plan: The European Commission provides comprehensive information about the Circular Economy Action Plan, its goals, and initiatives to address food waste and promote resource efficiency. Website: https://ec.europa.eu/environment/circular-economy/index_en.htm

c. **Waste Framework Directive:** The Waste Framework Directive establishes a legal framework for waste management in the EU. It includes provisions to reduce food waste, promote separate collection of biowaste, and encourage waste prevention and recycling. European Commission - Waste Framework Directive: Access the full text of the Waste Framework Directive, which sets out the legal framework for waste management in the EU, including provisions

related to food waste reduction. Website: https://ec.europa.eu/environment/waste/framework/

d. **Platform on Food Losses and Food Waste:** The European Commission launched the Platform on Food Losses and Food Waste to bring together stakeholders from across the food supply chain to exchange best practices, develop guidelines, and support the implementation of measures to reduce food waste. European Commission - Platform on Food Losses and Food Waste: Learn more about the European Commission's Platform on Food Losses and Food Waste, its objectives, participating stakeholders, and the initiatives it supports. Website: https://ec.europa.eu/food/safety/food_waste/eu_actions/platform_en

e. **Common Agricultural Policy (CAP):** The CAP provides support for the agricultural sector in the EU. The recent CAP reform includes a stronger focus on sustainability and environmental objectives, including measures to promote more sustainable farming practices that can help reduce food losses. European Commission - Common Agricultural Policy (CAP): Explore the European Commission's CAP webpage to understand how the recent CAP reform integrates sustainability objectives, including measures to address food loss and waste. Website: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy

These policies, among others, aim to create a more sustainable and efficient food system by addressing food loss and waste at various stages of the supply chain, promoting circularity, and fostering collaboration among stakeholders.

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5.7. Conclusions

In conclusion, the module "How could we minimize food loss?" provides participants with a comprehensive understanding of the issue of food loss and equips them with practical strategies to address it. Throughout the module, participants have explored the complex causes and consequences of food loss, including post-harvest losses, supply chain inefficiencies, and consumer behavior.

By delving into innovative approaches and best practices, participants have gained insights into various strategies that can be adopted at different stages of the food value chain to reduce food loss. These strategies include proper handling and storage techniques, efficient transportation and logistics, improved packaging, and sustainable consumption practices.

The module has also highlighted the importance of technology, data analytics, and policy interventions in mitigating food loss and promoting a more sustainable food system. By emphasizing the role of stakeholders, collaboration, and knowledge exchange, participants have developed a holistic perspective on minimizing food loss.

Armed with actionable strategies and a deeper understanding of the environmental, economic, and social impacts of food loss, participants are empowered to make a positive impact within their own communities, organizations, or businesses. By implementing these strategies, we can collectively work towards a more sustainable and resilient food system that ensures food security, reduces waste, and supports a healthier planet.

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5.8. Best Practice

SoLaWi Marburg – Example for Community Supported Agriculture

SoLaWi stands for “Solidarische Landwirtschaft“ in German, called Community Supported Agriculture (CSA) in English. Community Supported Agriculture seeks to enable regional, seasonal, organic and sustainable ways of agriculture with less waste and less risk for the farmers, making it a more fair and sustainable way of farming. Normally the CSA associations engage in a long term partnership with farmers in the region, lowering the risk for the farmers, making it possible to plan ahead and take part in decision making. Every SoLaWi/CSA works differently in the details, cooperation and organization, therefore it is important to inform oneself about how exactly the chosen SoLaWi/CSA works before getting involved. it. In this best practice the focus lies on the SoLaWi Marburg, which is located in Marburg – Giessen surroundings, in Germany: https://solawi-marburg.de/.

A video explaining in german how SoLaWi works by the network of SoLaWi’s can be found here: https://www.youtube.com/watch?v=0QndxeDXn-M&t=1s.

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Another insight into another SoLaWi can be found here, with English subtitles available: https://www.youtube.com/watch?v=4tBPIKrTh-k

Further information, videos and movies can be found in the media blog of the SoLaWi Network : https://www.solidarische-landwirtschaft.org/mediathek/filme

How does the concept work at SoLaWi Marburg?

The membership at SoLaWi Marburg is free. Once a Year all members who want to receive vegetables and fruits in the upcoming season decide at a financial round table how much one share will need to cost to cover the costs of farming, transportation, etc. Each member tells how many shares they want and how much they are willing or able to pay for a share (or multiple shares) monthly, covering one season. Depending on how many costs there are to cover, how much people are willing and able to pay, a general monthly fee for a share will be determined at the financial round table. This monthly minimum share fee will apply for all the people who would like a

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share after the financial round table, if there are shares available. Currently the minimum monthly share fee at SoLaWi Marburg for one share per month costs 68 Euro. Additionally, every shareholder is required to help twice at a SoLaWi event or at a harvest (in summer sometimes there is so much harvest to do, that the association helps the farmer).

Image by Giulianna Mändle

When the season starts, every member who has one (or multiple shares) can go to a pickup location once a week and get the quantity of the week's share content. The quantity and content of the weekly share can vary by the seasons harvest. The pickup locations are normally places of SoLaWi members who decided to offer their space as a SoLaWi pick up location, these can be garages, cellars, or other kinds of

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pickup locations. Important to notice that the shareholder decides and communicates which pickup location they would like to pick up from during the whole season.
Beside the vegetable & fruit share, there are also other product cooperations offered by SoLaWi Marburg which can be added additionally to the share: bread, coffee, cheese and be picked up at the prospective pickup location. The SoLaWi Marburg also offers events for their members and share holders beside the harvesting: cooking workshops, etc. These events are announced through the Newsletter and on the website in the members login.

One weekly share content at SoLaWi Marburg

The weekly share content at SoLaWi Marburg can vary, depending on the season, harvest and availability. A preview of the weekly share content with recipe suggestions are uploaded into the members section of the SoLaWi Marburg website, here you can see an example of a preview:

LIEFERDATUM: MITTWOCH, 21. JUNI 2023

Lieferung bearbeiten

LIEFERMENGE	GEMÜSESORTE	ANMERKUNGEN	REZEPTLINKS
1,00 Topf	Buschbasilikum		
1,00 Kopf	Salat		
1,00 Stück	Salatgurken		Zu den Rezepten
1,00 Stück	Fenchel		Zu den Rezepten
1,00 Schale	Erdbeeren		
100,00 Gramm	Rucola		

Screenshot of the Weekly Share Preview with the recipe suggestions.

Examples of one share content in different seasons (Winter/Summer):

- One share content in the week of February 15th 2023: 2kg potatoes, 1kg carrots, 1 white cabbage, 500g beetroot, 125g lamb's lettuce

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- One share content in the week of August 10th 2022: 1 salad, 1 kg Zucchini, 1 eggplant, 1 kg tomatoes, 1 cucumber, 1 pattison ufo pumpkin

Example images of a weekly share content (do not represent the examples given above):

Image by Giulianna Mändle

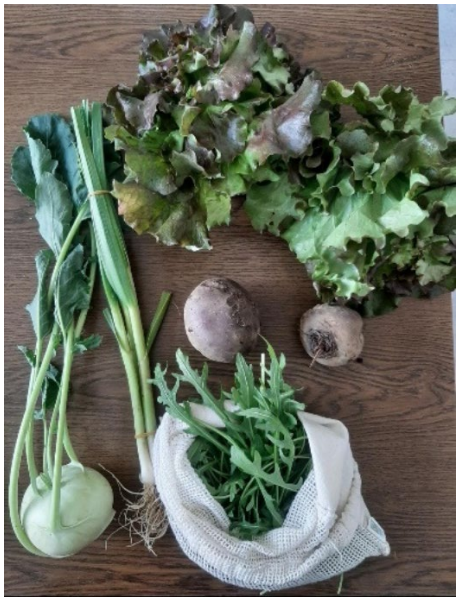

Image by Giulianna Mändle

How does SoLaWi contribute to minimizing food loss?

SoLaWi enables the cooperating farming business to plan ahead, to be able to distribute vegetables and fruits in different sizes, not needing them to be norm sized vegetables and fruit, and the cooperation receives harvesting assistance by the SoLaWi members.

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For example :

In June 2023 there are a lot of strawberries on the field, the cooperating farming business informs the SoLaWi that they are not able to harvest all of them and that SoLaWi members are welcome to harvest them. The SoLaWi informs their members who have a share via e-mail and let them know they can harvest strawberries by themselves for themselves and for their pickup location and only need to give a call at the cooperating farming business to let them know that they are coming.

Image by Giulianna Mändle

These organic strawberries could have been food loss :

Image by Giulianna Mändle

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BIOKEMA

BIOKEMA produces raw materials, candles and firelighters based on the LIPITEC - Biorefinery concept, which stands for maximum sustainability and CO2 efficiency in biomaterial production.

The concept of the LIPITEC - Biorefinery is based on the system of closed cycles, the use of vegetable oils, as well as the residual and waste streams in the extraction of biomaterials. The coupling of a non-fossil oil refinery and the use of residual materials is the first biorefinery worldwide to realize this on a large scale.

The raw material of the BIOKEMA products was developed from the industrial turnaround of petroleum products and by abandoning edible oils, such as soy, rapeseed, palm oil, to sustainable and renewable raw materials.

According to the definition of the Agency for Renewable Resources in Germany (FNR), edible oils are renewable but not sustainable if they are used for technical purposes. (BMEL). Food should remain food. Biomass is a renewable raw material, but at the same time always only available in finite quantities on the market, because the cultivation areas and growth rates are limited. One way out is multiple or cascade use. For the Biokema brand, the claim to use sustainable organic resources is not enough. According to the BMU (German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety), the only way to use organic matter sustainably is cascade use.

The products are made from regional biomass, 100% recycled, renewable raw materials and independent of worldwide transportation. Long and climate-damaging transports are avoided by BIOKEMA from the outset, as all necessary raw materials are sourced on the domestic market. Neither kerosene nor palm oil, which has come under criticism, nor other edible oils such as soy and rapeseed are used in the primary production of their products.

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BIOKEMA focuses on ethical grounds and consistently holds the opinion that vegetable oils are first and foremost foodstuffs. Instead of supporting the clearing of forests for palm oil extraction, BIOKEMA relies on secondary fats in the production of tea lights, candles and other products. These come from the catering industry or food production, for example.

These residual fats and oils from the food industry have already passed through their first and ethically acceptable life cycle and are subjected by BIOKEMA to countless tests and patented cleaning processes upon receipt. The fats are harmless and according to microbiological tests of renowned laboratories of "Food Grade". The fats originally extracted from plants are used a second time as fuel for the BIOKEMA candles and other products. When burned, it gives way to nature in a climate-neutral way without the carbon contained in petroleum, where it rejoins the natural balance of plant growth and the formation of clean air as carbon and oxygen.

food21

What is food21?

food21 is a company based in Germany that focuses on sustainable food production and innovation.

How does food21 contribute to minimizing food loss?

Reduction of food loss and -waste by forecasting and trend analysis for companies, producers and retailers.

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Image #23736273 from colourbox.de

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European Commission - Circular Economy Action Plan: The European Commission provides comprehensive information about the Circular Economy Action Plan, its goals, and initiatives to address food waste and promote resource efficiency. Website.

European Commission - Waste Framework Directive: Access the full text of the Waste Framework Directive, which sets out the legal framework for waste management in the EU, including provisions related to food waste reduction. Website.

European Commission - Platform on Food Losses and Food Waste: Learn more about the European Commission's Platform on Food Losses and Food Waste, its objectives, participating stakeholders, and the initiatives it supports. Website.

European Commission - Common Agricultural Policy (CAP): Explore the European Commission's CAP webpage to understand how the recent CAP reform integrates sustainability objectives, including measures to address food loss and waste. Website.

European Space Agency (ESA): Cloud-free crop maps foster sustainable farming. Link.

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VI. BEST PRACTICE FROM GREECE

IKEA's initiative in Greece to reduce food waste is a part of the company's global sustainability strategy (IKEA Sustainability Report, 2020). As of 2021, IKEA has set ambitious goals to become climate positive and circular by 2030, which includes reducing food waste in their operations. According to their Sustainability Report for 2020, IKEA has already reduced food waste in their restaurants and bistros by 32% since 2016, and they aim to reduce food waste by a further 50% by 2022 (IKEA Sustainability Report, 2020).

To achieve these goals, IKEA has implemented several measures to reduce food waste in their stores worldwide. For example, they have implemented a "food waste tracker" system in some of their stores, which allows them to monitor food waste and adjust production accordingly. They have also introduced new products made from food waste, such as the "HUVUDROLL" veggie burger, which is made from the leftover parts of vegetables that would otherwise be discarded (IKEA Newsroom).

In Greece specifically, IKEA has partnered with Boroume, a leading food bank organization, to donate unsold food from their stores. According to the President of Boroume, Xenia Papastavrou, this partnership has been a "game changer" for the organization, as it has allowed them to collect and distribute larger quantities of fresh produce to those in need (IKEA Newsroom). Since the partnership began in 2018, IKEA Greece has donated over 72,000 kg of food to Boroume, which has helped feed over 60,000 people (IKEA Newsroom).

Furthermore, IKEA Greece has also implemented new procedures to reduce food waste in their stores, such as reducing portion sizes and implementing better inventory management practices. According to the CEO of IKEA Greece, Anna Granath, these measures have led to a 30% reduction in food waste in their restaurants and bistros since 2018 (IKEA Newsroom).

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In conclusion, IKEA's initiative in Greece to reduce food waste is a part of the company's global sustainability strategy, which includes ambitious goals to become climate positive and circular by 2030. By partnering with Boroume and implementing new procedures in their stores, IKEA Greece has been able to make a significant impact on reducing food waste and supporting those in need. As IKEA continues to prioritize sustainability and responsible business practices, it is likely that they will continue to implement innovative solutions to address the issue of food waste in their operations.

https://www.reader.gr/oikonomia/512426_ikea-liftingk-sta-katastimata-kai-parathyro-gia-synergasies-ston-klado-tis-eyexias

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