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DIDACTICAL GUIDE 1





Introduction

What is ZERO WASTE

ZERO WASTE is a Project whose main objective is to promote social inclusion in rural areas in the field of education, using content related with the reduction of food waste. At the same time it is also focused in improving the professional development of the teachers through the creation of gamified educational tools with scientific content.

This guide is one of the tools openly available as part of the development of the project, so any interested person can access its content and learn from it. All the contents of the guide have been based on the methodological principles and scientific content developed by the IA2 expert committee.

Formative contents that are available on the website work as a support for the present guide, but also as a way to be introduced in new teaching methodologies related with gamification. Among these contents, the following can be found:

- Infographics
- Tips to reduce waste
- Eco-design Workshop
- Escapebox
- Online Escaperoom

The ZERO WASTE project is funded by the Erasmus+ programme and developed by a consortium of 6 institutions of Spain, Ireland, Portugal and Romania.



Justification

According to data provided by the Food and Agriculture Organisation of the United Nations (FAO) in 2011, one third of the food produced globally is lost or wasted every year. At the same time, it is estimated that in 2019, approximately 690 million people in the world will suffer from hunger and almost 3 billion will not be able to afford a healthy diet (which represents over a third of the population).

According to the FAO, if a quarter of the food that is currently lost or wasted was saved, it would be enough to feed 870 million people. However, despite popular belief, this waste is not exclusive to developed countries, as the figures are very similar in all countries regardless of their income level.

That is why among the Sustainable Development Goals (SDGs) established by the UN, number 12 focuses on responsible production and consumption as a way to reduce this food waste. In that respect, the ZERO WASTE project is aligned with this SDG, with a particular focus on rural areas and adult education as part of the awareness-raising work.

Objective

This didactic guide is intended to be an approach to the problem of food waste, focusing on secondary school students in rural areas, who traditionally receive a smaller proportion of resources in the educational sphere. This way, the aim is to give tools to education professionals in this field so that they can raise awareness of the need to take action against food waste.

This first guide will study the origin of waste at each step of the food chain, as well as the effects it has on a global level. It will also deal with food loss and the types of spoilage it can suffer and what information to prevent it can be found on the labels of different foods.

As part of the training process proposed by ZERO WASTE, the aim is to use gamification methodologies that facilitate access to knowledge in a fun and innovative way. Among the activities proposed are a variety of educational games adapted to the educational levels of the participating students.



The ZERO WASTE project aims to help reduce food waste, thus collaborating with the implementation of SDG 12, which seeks responsible production and consumption to avoid it.



Content

Introduction	1
What is ZERO WASTE	1
Justification	1
Objective	2
What is food waste?	4
What do we know about food waste?	4
Starting Kahoot: What do you know about Food Waste?	4
Why is important to address food waste?	5
Kahoot: Is Food Waste that important?	5
Measuring Food Waste	5
Dynamic: Measure your waste	6
Generation and impact of Food Waste	7
Workshop: Where is and where does Food Waste take us?	9
Why do we need to fight against food waste?	10
The food chain: Quality and spoilage	10
The food chain and the quality of food	10
Dynamic: The chain	11
What does food tell us? (Labelling and food composition)	12



Nutritional aspects: Nutriscore	12
Minimum durability date	13
Food spoilage and how to avoid it	13
Food redistribution and its safety	15
Anexos:	16
Preguntas de los juegos de Kahoot:	16
What do you know about Food Waste?	16
Is food waste so important?	16

What is food waste?

What do we know about food waste?



This module will provide an introduction to the problem of food waste, focusing on understanding its importance, impact and origin. Intuitively, we can understand the meaning of the expression "food waste", but there are a number of concepts around this idea that can be useful in dealing with the issues involved.

In order to highlight the need to use this type of concepts and the complexity surrounding this topic, the didactic proposal of this module includes the realization of a previous evaluation with a game of questions hosted on the platform Kahoot, so that participants can have a first approach to the depth of the topic in a fun way.

Among the concepts to be discussed, the most important are the following:

Food: any substance –whether processed, semi-processed or raw – that is intended for human consumption. It includes drink, and any substance that has been used in the manufacture, preparation or treatment of food.

Food chain: Is the complete process of food production and it is divided into four parts (Primary production, processing and manufacturing, distribution and consumer)

Food loss refers to food that spills, spoils, incurs an abnormal reduction in quality or otherwise gets lost before it reaches the consumer. It typically occurs at the production, storage, processing and distribution stages of the food value chain.

Food waste refers to food that is of good quality and fit for human consumption but that is not consumed because it is discarded before or after it spoils. It occurs most at the consumer stage in households.

Starting Kahoot: What do you know about Food Waste?

Quiz game to evaluate in a gamified way the previous knowledge of the participant students. There are two explanatory slides apart from the questions, so it is recommended to check the Kahoot before using it for the first time.

[LINK TO KAHOOT](#)



Why is important to address food waste?

Food waste is estimated at 1.3 billion tonnes of food per year, according to FAO data. This represents the loss of about one third of global production each year. Despite the scale of these losses, we also find that around 690 million people in the world suffer from hunger.

According to FAO estimates, if a quarter of the food wasted globally was saved, 870 million people could be fed. With the global population expected to continue to grow in the coming years and current estimates suggesting that there will be 9.1 billion people on earth by 2050, it is becoming increasingly urgent to address this problem.

That is why of the 17 Sustainable Development Goals, number 12 is specifically aimed at reducing waste, focusing on responsible production and consumption. To do so, a series of markers and guidelines have been established to facilitate the achievement of this goal.

However, this is not the only one of the 17 SDGs aligned with reducing food waste, as it is a cross-cutting issue. This is why goals 1 and 2, which aim to fight poverty and hunger, also have sections aimed at combating food waste and its effects on people's health and well-being.

Despite this belief, food waste is not concentrated in the richest countries, but is a global phenomenon, with very similar waste between countries of very different incomes, with an average of 79 kg/capita per year of food wasted globally.



In the specific case of Spain, 79% of households admit having thrown away food after having bought it without processing it and 30% after having cooked it, either after having stored it in the fridge or directly from the plate.

Given these numbers, it is clear that the fight against food waste is a problem that needs to be tackled globally and that has a major impact on both the health and well-being of a large proportion of the population, as well as a significant environmental impact.

Kahoot: Is Food Waste that important?



Quiz game to get an idea of the size of the impact of food waste compared to other magnitudes, such as countries' GDP, energy consumption, etc.

[LINK TO KAHOOT](#)

Measuring Food Waste

Under SDG 12, which aims to achieve responsible production and consumption, the goal is to halve per capita food waste by 2030. A prerequisite for achieving this goal is to have a set of unified and universal markers to measure food waste and its evolution. To this end, the following indices have been developed:

- Food Loss Index (FLI): Measures losses from food production to retail (not including retail).

- Food Waste Index (FWI): Covers the last stages of the food chain and allows to compare progress between different countries and to mark the SDG target, considering that all start from 100%.

To construct the FWI for different countries and sectors, a three-tier methodology has been implemented:

- **Level 1:** For countries where there are no measures of their own, modelling and extrapolations are used.

- **Level 2:** (This level is the recommended level for measuring progress in terms of the SDGs). It includes the measurement of food waste in the country by sector, using household and commercial waste surveys, allowing for comparable data over time.

- **Level 3:** Includes additional information on specific sectors and disaggregated data for different socio-economic variables, providing a detailed picture of the situation.

Dynamic: Measure your waste

This activity consists of attempting to measure the amount of food waste produced by each participant over the course of a week. Participants start with an estimate for themselves and another one for their colleagues and then compare it with the data measured over the course of a week.

Duration: 1 week (7 days of measurements and then discussion of results).



Start of the exercise: The students will do the exercise in groups of 3-4 people. Within the group, they will make an estimate of how many kg of food they think each member wastes over the course of a week.

To take the measurements, separate the food waste (organic) from the rest of the rubbish generated at home and weigh it when you are going to throw it away. It is important to bear in mind that you should start the first day with empty rubbish and that we are only looking to measure food waste, so you should throw away separately any food that is not consumed but was in good condition when you bought it. All leftovers from food preparation (peelings, bones, etc.) should be removed from this measure.

After a week, all the measurements taken are added up and can be plotted on a graph against the original estimates to see how close or far apart they are. To encourage discussion among the groups, the following questions are proposed:

1. The average food waste in Spain is about 1.3 kg per person per week (about 76 kg per person per year). Did you get a higher or lower figure? Why do you think this is?
2. What do you think of the average compared to your waste?
3. How did it affect you to know that you measured your food waste? Have you tried to avoid food waste more than usual?
4. Do you think there is anything that could make you waste more or less? Could you reuse some of what you throw away so that it would not be waste?
5. How reliable did you think your measurements were, and what could you do to improve them?

To compare your waste with that of other ZERO Waste project participants, you can enter it in this form. The data collected in this form will be used to make a ranking of who has achieved the least waste.

Generation and impact of Food Waste

It has already been mentioned in previous sections that food waste is a global phenomenon, with no major differences between higher and lower income countries. However, there are a number of factors that condition the food waste that occurs in different population groups that can help us to address this problem in a targeted manner:

Economic factors





- o **Industrialization of the stages of the Food Chain** can increase the amount of residues generated, apart from creating kinds of residues different to the ones of a non-industrialized supply chain, related with the treatment of food.
- o **Economic growth** leads to higher spending on leisure and catering, which increases the likelihood of food waste..
- o **Urbanization disconnects people** with food origins and reduces conciousness about its origin and impact. On top of this, food diversity is higher in cities and local products are less common, which also affects the environmental impact that they have and their shelf life.
- o **Globalization** increases the distance between the place where food is produced and their consumption place.
- o **Reduced prices of food** negatively affect producers and increase food waste.

- Cultural and behavioural factors

- o **Consumers' behaviour:** The way consumers behave with regard to a problem depends on how it affects them individually, and the following factors should be taken into account:
 - **Awareness-raising:** It is a key factor in reaching consumers, and to do so it is necessary to know how much food is wasted.
 - **Wasteful behaviours:** Depends on the information consumers have (e.g. expiry date).
 - **Habits:** Acquired behaviours and habits are likely to be repeated, so these need to be taken into account.
 - **Emotions:** Emotions such as guilt can cause consumers to waste less food.
 - **Cultural and social norms:** Cultural and social values influence how food is consumed, for example in some cultures or traditions food is more accepted in a certain form or when they have guests a lot of food is put on the table or even thrown away as part of celebrations.

- Socio-demographic factors

The socio-demographic factors related to food waste are complex and therefore there is currently no consensus on their exact influence, however, the available evidence points along the following broad lines:



- **Age:** Younger people tend to waste more than older people.
- **Gender:** Women tend to waste less food.
- **Household type:** Families tend to waste more food if there are children in the household.
- **Household size:** People living alone tend to waste more.
- **Income level:** The higher the income, the more waste tends to occur.
- **Type of consumer:** Consumers who are more price-conscious tend to waste less.
- Institutional and political problems
 - **Limited availability of data:** It makes it more difficult to quantify the level and trajectory of Food Waste, as many times it is not possible to differentiate the edible and unedible waste with the data or the actual magnitude of waste in undeveloped areas compared to developed areas.
 - **Policy implementation:** Some policies that are carried out seeking the best food safety or improving food nutrition can lead to wasting food.

Based on the variety of factors that affect the production of food waste, it can be seen that it is a complex problem that requires a profound awareness of the population. This complexity is also reflected in the impact of food waste in different fields, which can be classified according to the area affected:

- **Environment:** The production, packaging and distribution of food generates significant environmental impacts, so wasting food also means wasting the resources used. These resources can be further divided into:
 - o **Energy used for production and transport**, which is related to both agricultural machinery and water pumping systems. In the case of transport, it usually comes from polluting sources, which also implies the emission of Greenhouse Gases (GHG). It is estimated that 38% of the energy used in food production is lost or wasted.
 - o **Greenhouse gas emissions**, which mainly come from agricultural machinery and transport, as discussed in the previous point. It is estimated that around 9% of global GHG emissions are related to food that is not consumed.
 - o **Water used in production**, which is an essential and relatively scarce resource for life. Despite this, 24% of the water used globally per year is used for food production, which ends up being wasted.



- o **Wastewater** and polluted water due to the emission of chemicals related to food production, such as nitrogen compounds that pollute water bodies. Of all the nitrogen emitted into water bodies for food production, 12% is directly related to food that is not consumed.
- o **Land degradation** through intensive land use. Wasting food leads to the need to produce more in order to meet the needs of the population. This leads to land degradation through overexploitation, which in turn leads to desertification and deforestation. It is estimated that around 23% of the cultivated area ends up producing food that is then wasted.
- o **Loss of biodiversity** due to the crops used, related to the waste generated and the use of extensive monocultures, leading to agriculture currently being responsible for the majority of plant and animal threats and risks.
- **Economy:** Food waste implies a decrease in economic value at a global level and unequal access to food resources, which are fundamental for subsistence. At the individual level, it also reduces household purchasing power, as it is a waste of resources.
- **Human welfare:** Food waste increases food insecurity for citizens around the world.



Workshop: Where is and where does Food Waste take us?

Duration: 1 hour

Number of participants per set (mín-máx): 4-10

In this workshop cards representing some of the factors related to waste are given. The cards are to be linked in such a way that they indicate which factors generate waste, what type of waste and what impact each one has. The workshop is divided into three phases and cards are added in each phase. At all times there is a central card which says WASTE in large letters.

If sticky putty is available, it is recommended that they can stick the cards to the blackboard to draw the connections between them. The cards handed out at each stage and the time to sort them are listed below:

- PHASE 1 (5 minutes):
 - o Young people
 - o Low prices
 - o Use of water
 - o Soil degradation
 - o Biodiversity
- PHASE 2 (10 minutes):
 - o Usable soil
 - o Greenhouse gases (GHG) emission
 - o Food security
 - o Families with kids
 - o Industrialization
 - o Economic growth
 - o Living in cities
 - o Desertification



- PHASE 3 (15 minutes):
 - o Wastewater generation
 - o Energetic consumption
 - o High income
 - o Living alone
 - o Globalization
 - o Drought

The aim of this workshop is to see how all the factors related to waste are connected to each other and to visualise the complex web that is formed with them, to understand that food waste is a problem with a large number of factors that affect it in many different ways and that have many different fronts of action.

In each of the phases, once the time is up, participants will have 5 minutes to explain the connections they have made and how each of the things on the table affect the others. After all the connections have been made, a discussion can take place on how each of the effects can be reduced by reducing food waste.

Questions to get them involved:

- Did you expect this number of connection between the cards?
- Would you write any more cards?
- Do you think that all the connection between cards are equally strong? Why?

Why do we need to fight against food waste?

Although we usually focus on the impact of food waste on the health and welfare of the population, we have already seen in previous sections that the problem extends to other areas, both economically and environmentally.

Reducing the amount of food wasted would make more food available to everyone by reducing the amount of food that goes to waste, reducing the number of people who are starving or cannot afford a sufficient or varied diet, thus contributing to global food security.



Economically, the use of these foods helps us to save money along the food chain, which has an impact on both the producing and selling companies and on consumers' households.

Finally, from an environmental point of view, if food waste were a country, it would be the third country in terms of GHG emissions, in addition to the great loss of biodiversity that it represents, and the pollution and deforestation that it generates. Reducing food waste would mean a reduction in total GHG emissions, which means a global benefit in the fight against climate change.

The food chain: Quality and spoilage

The food chain and the quality of food

The food chain is the name we have for the process that food follows from the moment of production to the moment of consumption and consists of four parts, which are as follows:

- **Primary production:** Production of food until their harvest, sacrifice, fishing, milking...
- **Processing:** The process of transformation of the product or its packaging for distribution.
- **Distribution:** Process of sale to retailers to make food available to the consumer.
- **Consumer:** Despite being the last stage, they have the greatest impact on influencing food waste.



This food chain can increase in complexity depending on the field we are studying. For example, in the case of large cities, there are a greater number of steps than in urban areas. In both cases, in order to be considered a functional chain, it has to have the capacity to satisfy the food needs of consumers and allow them to have a healthy and varied diet.

In order to have a protocol to ensure the safety of food and final products, the FAO created what is called the "food chain approach", which differs from the traditional model in that all actors involved in the food production process up to the consumer have a responsibility for its safety. In this way, each actor transmits the necessary information to the next in succession until it reaches the final recipient, who is the consumer.

Even so, one third of all food produced is lost at the different stages of the food chain. This affects food security because it reduces food availability and access (higher prices,



unsustainable use of resources, etc.). In addition, once they reach the last link in the chain with distribution, they still have to meet consumer acceptance criteria in order to be purchased:

- **Security:** Consumers must be confident that the food will cause them no harm.
- **Nutritional values:** They guarantee the consumer that the food has the amount of nutrients necessary to keep a healthy diet.
- **Desirable characteristics:** They are beyond the sensory characteristics, such as purity, utility, shelf life, price...
- **Packaging**
- **Processing characteristics:** Animal welfare, workers security, environmental impact...

Dynamic: The chain

A game of ordering a series of actions within their corresponding steps of the food chain to obtain a code, the team that gets theirs first will be the winner. The code will be the empty steps for each of the foods. The actions are as follows:

- Picking up tomatoes
- Grinding and cooking tomatoes
- Packing tomato sauce
- Cooking rice with tomato
- Grape harvest
- Fermentation
- Wine Display
- Meat packaging
- Meat freezing
- Beef stew

What does food tell us? (Labelling and food composition)

The most important form of communication between food producers and consumers is food labelling, where a series of data related to the food, its production and its composition can be found. The mandatory data that must be displayed are the following:

Product name: It must be clearly visible on the package and not give rise to confusion. It must comply with legislation if there is any or be understandable by the consumer.

Ingredients: If it has two or more ingredients they must be listed in descending order of weight on the product.



Allergens: If the food contains any ingredient that is on the list of allergens it must be specifically emphasised or named.

Minimum durability: They must have a "use by" or "best before" date as well as a freezing date, if applicable.

Storage conditions: Any storage conditions that need to be taken into account to ensure the maintenance of their properties.

Instructions for use

Nutritional values which must give a breakdown of the content in the different macronutrients (carbohydrates, proteins, fats, etc.).

Name and address of the producer.

Batch number to facilitate traceability of the food in question.

Apart from the above, which are closely related to food waste, it is also necessary to include for some specific foods the degree of alcohol, a certain quantity of ingredients, place of origin...

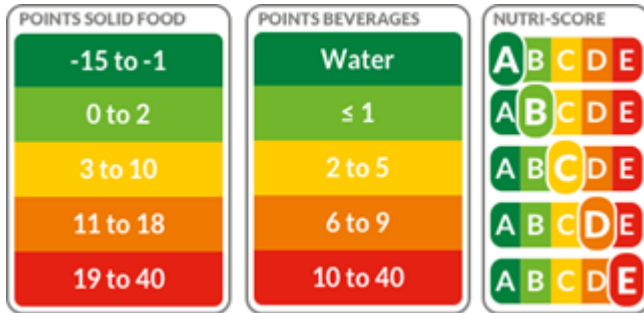
Nutritional aspects: Nutriscore

Food is the source from which we obtain the energy and nutrients we need to carry out our biological functions. Not all foods are equal when it comes to providing energy, because they do not all have the same nutrients composition. In order to classify these nutrients, we divide them into macronutrients:

- **Proteins:** Chains of amino acids that help us to regenerate our entire body.
- **Lipids:** They fulfil many functions in the body, such as giving structure to cells or storing energy.
- **Carbohydrates:** the body's main source of energy.
- **Vitamins and minerals:** These are substances that ensure the proper functioning of bodily processes.

When it comes to labelling, it is necessary to reflect the quantities of each of the macronutrients in the food and how much of the energy it provides comes from each of them. Among other things, this distribution will determine how healthy the food will be.

To make it more visual how healthy the food is, labelling such as the Nutriscore has been developed, which is an optional label that classifies foods by means of a colour and letter code, from most to least healthy.



Minimum durability date

In addition to all this information, it is also compulsory to include the minimum durability date, which can be the expiry date or the best-before date, which sometimes causes confusion among consumers.

- **The best-before date** is the date after which the product loses some of its properties, although it is still safe to eat.



- **The expiry date** is the date used for foods that have a high microbiological activity, which means that after this date, they are not safe to eat.
- Depending on the time it takes to reach these dates and, therefore, the shelf life they have, foods are classified into three types:
- **Perishable:** Foods that deteriorate rapidly.
- **Semi-perishable:** They have up to 60% moisture or ingredients that can promote microbial growth and can be stored for up to 6 months.
- **Non-perishable:** These are usually products that contain less than 12% moisture and can be stored for years.

In order to determine the shelf life of foods, shelf life studies are carried out, which include specifications of the physical-chemical characteristics, mathematical predictive models, tests to evaluate the survival of certain organisms, etc. The most commonly used methods are the following:

- **Direct:** Real-time study of similar conditions during its commercialisation.
- **Accelerated:** The product is subjected to conditions that will cause accelerated deterioration (high temperature, acidity...).
- **Microbiological test:** Specific organisms are inoculated and evaluated under storage conditions.
- **Predictive microbiological test:** Mathematical prediction models are used.
- **Survival:** Based on consumer opinion and acceptance

Food spoilage and how to avoid it

The durability of food depends on the rate at which it becomes undesirable or unacceptable for consumption, that is, the rate at which it deteriorates. There are different types of mechanisms by which this can occur:

Physical: Impacts, changes in the amount of water, crystalline transition temperature, crystallisation or frost damage.



Chemical: oxidation, lipid oxidation (rancidity), hydrolysis, Maillard reaction or enzymatic browning.



Microbiotic: These can be based on bacteria, moulds and yeasts.

In addition, there are a number of factors that can affect food spoilage, which can be classified into two types:

Intrinsic: Such as food structure, composition, water activity, pH or redox potential.

Extrinsic: Temperature, relative humidity or atmospheric composition.

When a food goes through a deterioration process, we say that it is no longer safe, which means that it is no longer suitable for consumption. But not all spoilage processes are the same and therefore, not all pose the same type of danger when consumed. Hazards are classified as follows:

- **Biological:** Bacteria, viruses, moulds, prions or parasites.
- **Chemical:** This type may result in poisoning or long-term illness.
- **Physical:** The product contains any foreign element that may cause problems.

Household food spoilage is one of the major factors affecting food waste, and it is therefore necessary to highlight the importance of food preservation strategies and the different types of technologies available for this purpose:

- Physical processing technologies

Physical treatments are drying, heat treatments (such as pasteurisation and sterilisation), freezing and chilling.

- Biological processing technologies

Fermentation is the most widely used technique in this field, as well as aiding preservation, it improves taste, digestibility and nutritional values.

- Chemical processing technologies

Additives are added to foods to improve their shelf life, they can be natural or synthetic. (Organic acids, salt or sugar, antioxidants, etc.).

- New preservation techniques



These have been created to meet consumer demands and to maintain the organoleptic properties of products (irradiation, antimicrobials, nanotechnology packages...).

However, using these technologies is not enough to guarantee the safety and preservation of food from production to consumption. In fact, since most food waste occurs in households, consumers are the biggest challenge when it comes to food preservation.

To minimise the spoilage of food from the time of purchase to the time of consumption and to ensure food safety, there are a number of guidelines that can be easily followed:

- Buy frozen foods last.
- Separate food from toxic products in the shopping cart.
- When arriving at home, place the products as soon as possible according to their preservation recommendations.
- Cooked food that is not going to be consumed should be kept cold.

Food redistribution and its safety

A fundamental strategy to avoid the waste of food that has already been produced is donation, which allows for a redistribution of food. In order to be carried out safely, they have to comply with the same regulations as producers, with the added difficulty that donations have to meet a number of requirements:

- The shelf life of the product must be long enough to allow it to be safely consumed.
- Packaging must be effective.
- There must be adequate storage conditions.
- Traceability must be ensured.
- Organoleptic conditions must be maintained throughout the process.



Annexes:

What do you know about Food Waste?

1. When we talk about food that falls, gets spoiled or loses quality before reaching the consumer, we talk about...
2. If we talk about food that has optimal conditions and quality for its consumption but is not consumed, we talk about...
3. What does it mean "Sustainable Development"?
4. How many Sustainable Development Goals are there?
5. What is the percentage of wasted food globally?
6. How many people does not have enough food to eat worldwide?
7. Elder people waste more food than young people
8. Living in urban areas is related with higher food waste
9. Families with kids tend to waste more food than families without them
10. People living alone tend to waste less food

Is food waste so important?

1. How much of the wasted food would be enough to feed all the hungry people in the world?
2. How many million tonnes of food are wasted every year?
3. How many trips would the biggest cargo ship need to transport that amount?
4. How many million dollars are estimated to be lost every year due to food waste?
5. How many countries have a smaller Gross Domestic Product than that?
6. What percentage of global CO2 emissions are related with wasted food production?
7. What percentage of farmland is used to produce food that is later wasted?
8. What percentage of the energy used to produce food is lost or wasted globally?