

Environmental Innovators



Agri Aware

Supporting partners:



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Introduction

Innovation simply means new! This programme is all about environmental issues related to food and how innovations are helping to solve some of the most complicated challenges of our time.

This programme aims to:

- ① Increase understanding of the challenges and innovative solutions associated with the food system;
- ② Encourage solution orientated and critical thinking;
- ③ Offer supportive material to TYs in their journey towards Leaving Certificate and beyond.



**"Your food
system needs
you - The
Environmental
Innovators!"**

The Food System Explained

The food system includes all of the steps that our food takes to get from farm to fork and beyond; from the **production** on a farm, the **processing** in a factory, the **distribution** through transport systems and the **consumption** in homes and restaurants. Each stage leads on to the next stage and in theory, cycles back around. The food system is part of the bioeconomy, or the economy based on living (biological) things.

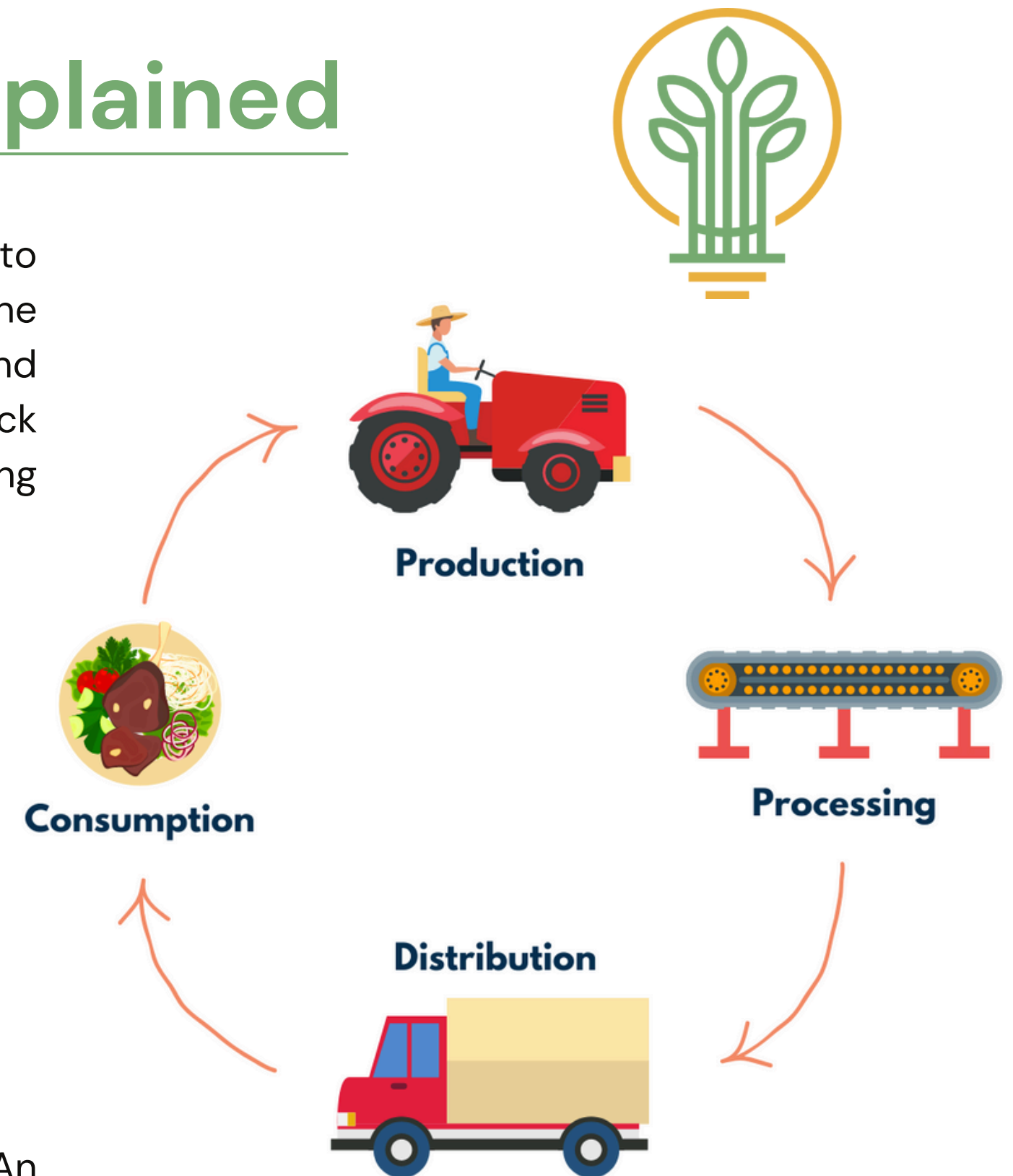
At the **production** stage, plants or livestock are typically grown or farmed. Farmers or growers will produce food to be sent on to the next stage of the food system.

The **processing** stage prepares food to move forward through the food system. This involves cleaning, preserving, milling, drying and much more.

During the **distribution** stage, food is transported within countries and exported to different countries and continents.

The **consumption** stage involves the purchase and use of the product.

The link between consumption and production allows us to create a cycle. An example of this in action is the use of food waste to create compost to help crops grow. Can you think of any other examples?



Project Brief

The food system requires environmental innovators to become more sustainable. This programme presents the various challenges that our global food system faces and invites students to investigate innovative solutions.

Innovations come in many forms such as policy, products, techniques and technology.

For example, Reusable straws, made from a variety of materials, are becoming a popular alternative to the single use disposables.

1 Structure

Research your chosen challenge using various data sources such as websites, television or news articles. Keep a record of the source.

Try to choose an environmental challenge that has an achievable solution. Consider solving an issue in your school, home or community.

Do not attempt to solve climate change but do attempt to tackle an issue in your locality.

2 Submission

Please use the submission portal to upload your entry. Further instruction on how to submit will be send to all registered teachers during the programme.

The finalists will be invited to a Peer Day to speak to leading agri-food stakeholders about their proposed innovations.

"The National Champions will be awarded a grand prize of up to €1000 "

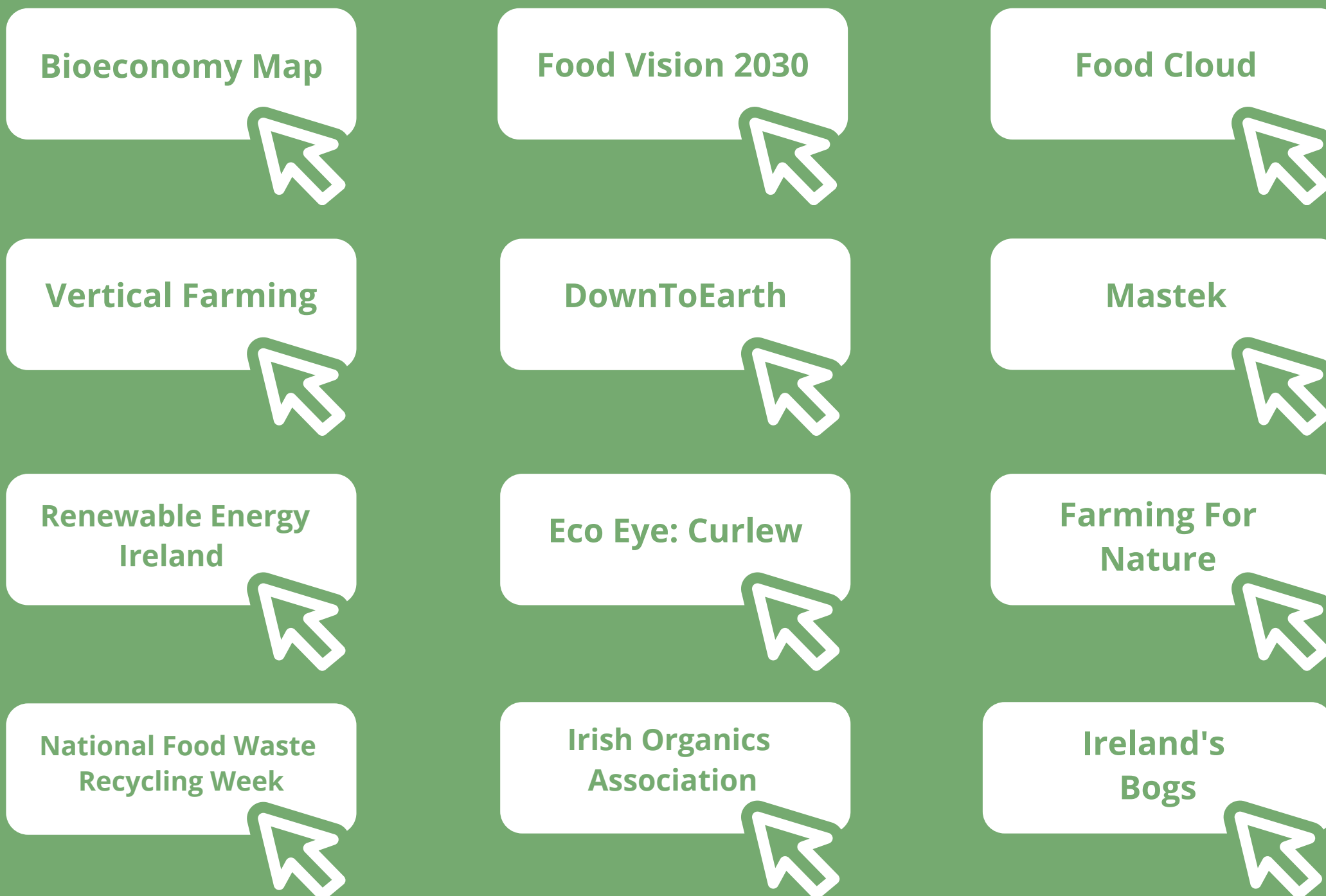
Check out the
2023 Entries

2023 Entries



Project Brief

You will find some useful resources below that should help you with your end of programme project.



"Can your challenge be tackled with a policy, product, technique or technology?"

For additional guidance, contact us at office@agriaware.ie



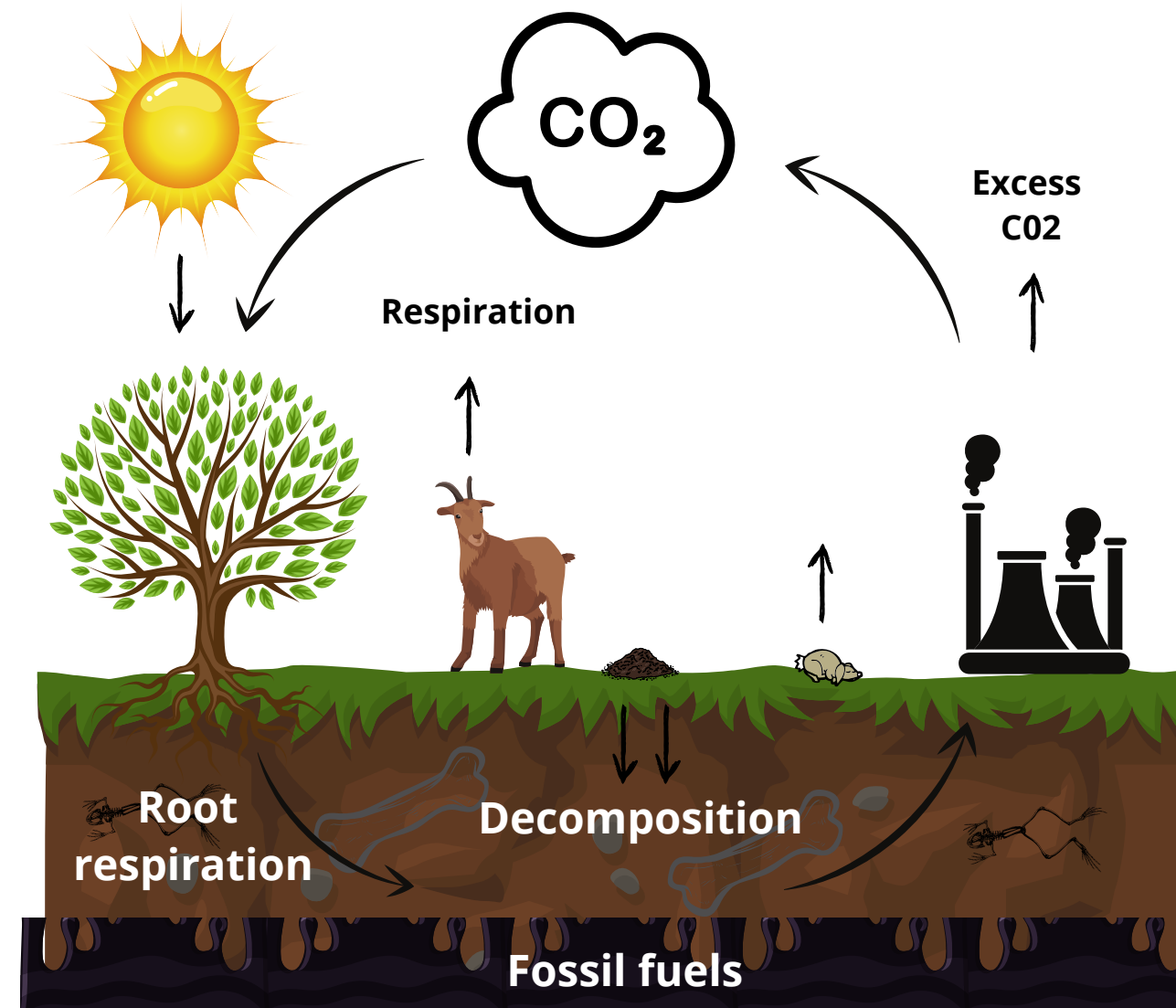
Chapter 1: Waste

1.Waste

Introduction

Waste is a human idea. Nature does not produce 'waste'. Over hundreds of millions of years, the earth's complex natural systems have evolved to make sure everything created within nature feeds back into nature. One important examples of this is the carbon cycle. **Organisms** reuse and recycle carbon. It's movement through the **biosphere** is known as the carbon cycle.

Carbon moves from the atmosphere into plants and is absorbed by animals when they eat the plants. It is released into the atmosphere when living things die, through animal **respiration** and through the burning of fossil fuels. Having too much carbon lingering in the atmosphere contributes to climate change.



Chapter Key Terms

Organisms
Biosphere
Respiration
Decompose
Translucent
Renewable
Nutrients
Conventional
Biodiversity
Resilient
Finite
Volatility
Consumer

1.Waste

Recycling

The majority of products made over the last five decades were made to be used and thrown away, with no consideration of feeding back into nature's systems. Materials, such as plastics, do not **decompose** like dead living things.



Plastics are used throughout all stages of the food system. In 'A Brief History of Plastics', we learned plastics have helped advance the availability of products and reduce their prices. Plastics have also revolutionised the food system but at a huge cost to our environment.

How we deal with the waste we produce is called 'waste management'. Given that humans are the only organisms that produce 'waste', this concept has only been around for a few centuries. Over the past 100 years, our waste has reached unsustainable levels. This is largely due to two key events; the Industrial Revolution and the birth of plastic.



We use plastics at every stage of the food system. Some of these uses of plastic are necessary and as long as they are managed responsibly, their use is likely to continue.

A Brief History of
Plastics

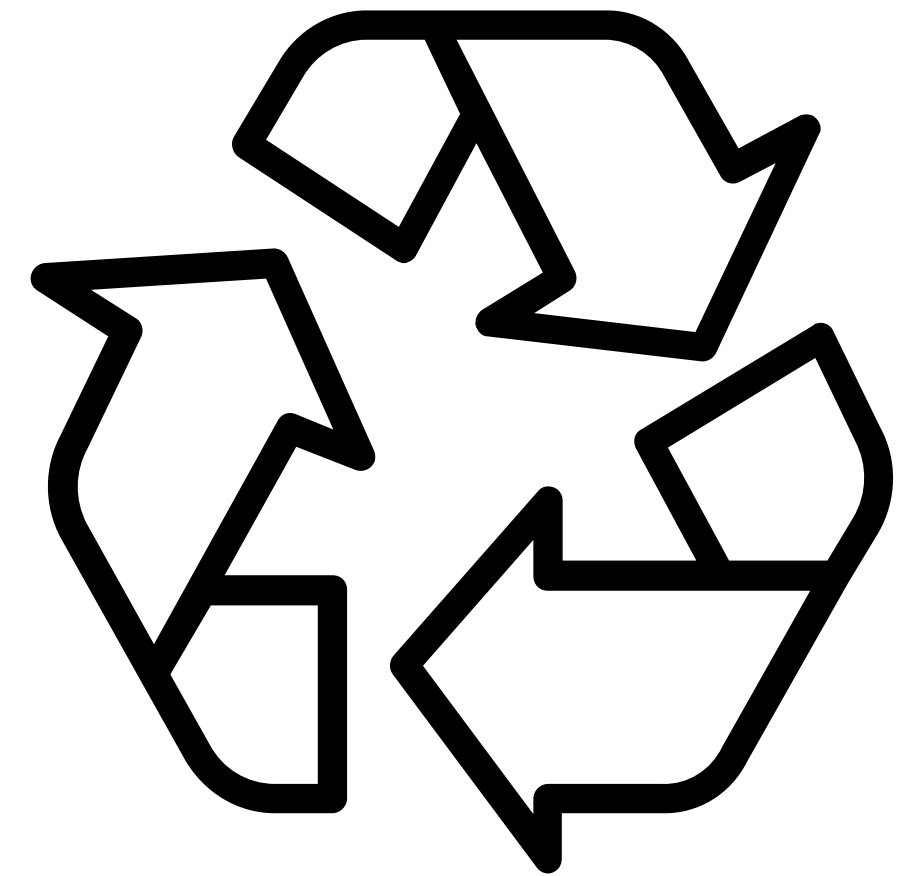


Many plastics are recyclable but just because we are capable of recycling these materials doesn't mean that we do so correctly. Recycling plants have strict rules about recycling materials and in order for recycling to be efficient we must follow them.

It is also important for us to remember that plastic can only be recycled 3 times before the quality is reduced and it needs to be mixed with brand new plastic. This is why less packaging overall is preferred.

Items placed in recycling must be:

- clean and dry
- loose i.e. not stacked inside each other
- free of bin liners





THE SYMBOLS EXPLAINED



THE MOBIUS SYMBOL

THE ITEM IS CAPABLE OF BEING RECYCLED



THE GREEN DOT

THE PRODUCER HAS THE RESPONSIBILITY FOR THE RECOVERY AND RECYCLING OF THIS PACKAGING



THE TIDY MAN

THIS SYMBOL ASKS YOU NOT TO LITTER.



WASTE ELECTRICALS

DO NOT PLACE THE ELECTRICAL ITEM IN THE GENERAL WASTE BIN



GLASS RECYCLING

THIS ASKS YOU TO RECYCLE THE GLASS ITEM AT A BOTTLE BANK.



PAPER, CARD & WOOD

SOURCED FROM SUSTAINABLE WOOD AND MAY BE MADE OF RECYCLED MATERIAL

1. Waste

Food Waste

Roughly 17% of the food produced on the planet goes to waste. The United Nations Food and Agricultural Organisation (FAO) calculated that €931 million tonnes of food was wasted in 2019 (2).

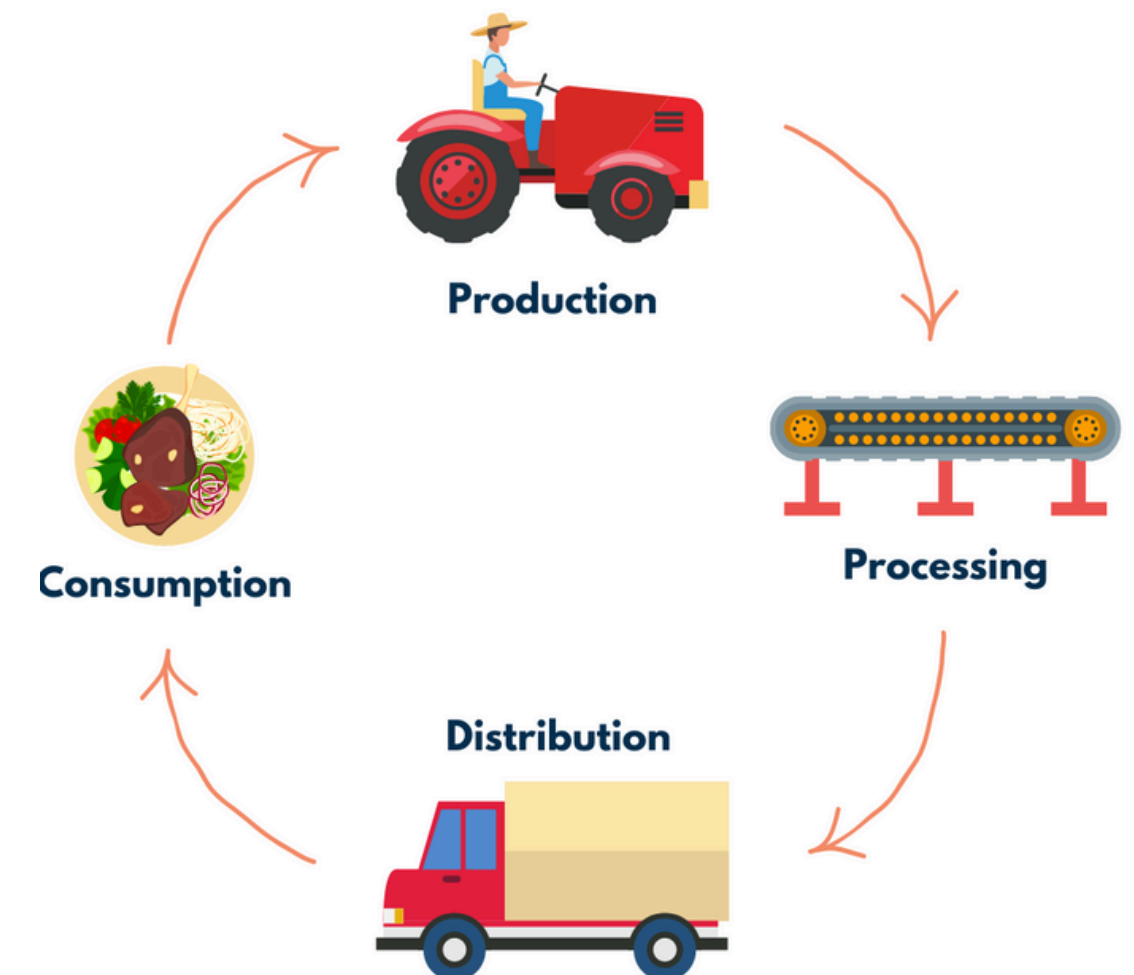
Food loss and food waste occurs at every stage of the food system. Remember! The food system includes the entire route that food takes to get to your home and beyond.

Production Crops are lost due to poor weather, pests and disease. Animals are lost due to illness, disease and death of young livestock.

Processing Food that does not meet 'quality standards' cannot be sold. Often misshapen fruits and vegetables are overlooked for not being visually appealing.

Distribution The incorrect storage of foods during distribution or the failing of storage systems can lead to catastrophic food waste.

Retail & Consumption Food is thrown away because it has spoiled or is past its sell by or use by date.



1.Waste

Food Waste

Growing and producing food contributes to climate change, but we must make food in order to live. This means producing food is essential. However, when we waste food, we also waste all the resources used to produce it.

Energy The food system requires energy to produce food. The use of farm vehicles and energy in processing plants requires fossil fuels to power them. When we waste food, we also waste energy.

Water Fresh water is needed throughout the farm-to-fork story. Although water is a renewable resource, the rate at which we use it outcompetes the natural water cycle. Water is needed for animals to drink, to grow crops and to prepare and process food. When we waste food, we also waste water.

Soil Nutrients Soils hold **nutrients** that crops require. When crops are planted in soils they use the available nutrients to grow. Therefore, when we waste food, we also waste soil nutrients.

Space for Nature Biodiversity includes all living things from the smallest single-celled organisms right up to the tallest oak trees. Food production can impact biodiversity negatively. The most direct effect is the amount of space food production takes up. Because we are using space for food production; when we waste food, we also waste space.



1. Waste

Food Security

There is a huge difference in food availability around the world. People with less access to food don't waste what they have.

Therefore, food waste can be considered a luxury.

If we shared all the food in the world equally, there would be enough for everyone. But the problem is that not everyone has good access to safe, quality, and affordable food. This is what leads to food insecurity or food poverty.

Countries are ranked on the Global Food Security Index (GFSI) (4). Food security is based on four attributes:

1. Affordability of food – Ireland is #4
2. Availability of food – Ireland is #15
3. Quality and safety of food – Ireland is #9
4. Sustainability and Adaptation – Ireland is #3

According to the GFSI, Ireland is in a good position when it comes to our food supply. But we need to remember that we still rely on other countries for our food. The availability of food depends on the climate, energy supply, economics, and politics, all of which need international cooperation.



**"Food waste
is a luxury
that many
people
cannot
afford"**

1.Waste

Food Security

Animal feed must be mixed on a huge scale to distribute and feed livestock all over the globe. This distribution also requires energy through the use of fossil fuel-powered vehicles such as trucks, planes and ships.

The availability of our food is also dependent on politics and economics. Price **volatility** is an increasing concern amongst farmers. This can be influenced by politics i.e. the Russian invasion of Ukraine in 2022 caused feed and fertiliser prices to skyrocket. This was due to continued demand for these products while supply dropped.

So given that Ireland is dependent on many other countries to produce its beef and dairy, can we really consider those food supplies as secure as they were once thought to be?

Nonetheless, in comparison to other countries the GFSI considers Ireland to be in a strong food security position. The task below will help you to learn more.



Click on this link to learn more about the Global Food Security Index

GFSI



Building a sustainable circular bioeconomy

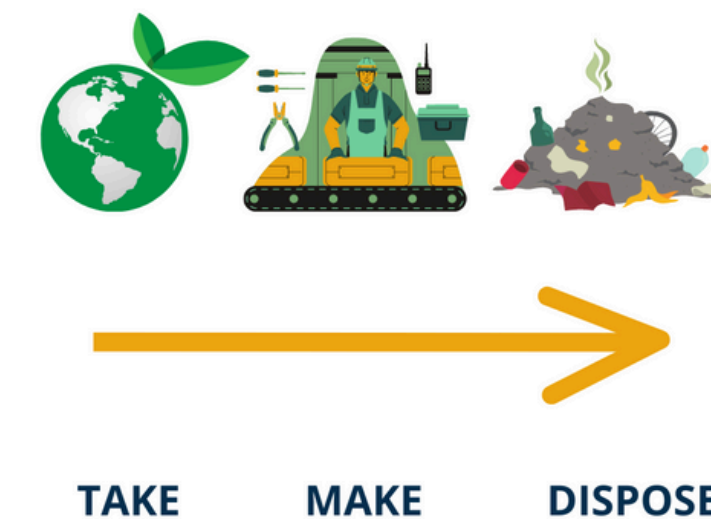
The bioeconomy is the part of our economy that uses biological resources and services from agriculture, forestry, and the marine to produce food for humans, feed for animals and the materials we need to make everyday products and energy.

Many of the products and services we use today are produced using unsustainable fossil resources that can harm our climate, nature & society.

The circular bioeconomy is a different approach that offers new solutions to the difficult challenges. Unlike the traditional linear economy, where resources are used and thrown away, the circular bioeconomy focuses on a closed-loop system, reusing what has been created. This changes something that was once waste into a valuable resource that can be used again, such as products and energy.

One of the ways the circular bioeconomy addresses food waste is through the creation of biotechnologies that convert organic waste into bio-based products. For example, food scraps can be transformed into biofuels, bioplastics, or fertilizers through processes like anaerobic digestion, composting, and fermentation.

The Bioeconomy Explained



Linear Economy



Circular Bioeconomy



Chapter 1: Waste Case Studies, Tasks and Quiz

Case Study One: EBSTAR Project

Researchers from Teagsac are working with Munster Technological University and Lund University in Sweden to transform a common waste product from the dairy industry into usable products. Whey is a bi-product that remains from the cheese making process. 9 litres of whey is generated per 1kg of cheese.

Due to its chemical makeup, it can be hazardous to the local environment if not disposed of correctly. However, it is a liquid which has high amounts of lactose, proteins and micronutrients, with potential for many uses. This is why researchers are looking at ways to reuse this high nutrient bi-product.

EBSTAR is researching ways to sustainably process whey into products such as food additives, bioplastics and biogas.

Click here to learn more



Case Study Two: Bioplastech

Every year, over 300 million tonnes of plastic are produced, leading to significant pollution. Plastics are used everyday within the food system. The most common use is within food packaging. Plastic pollution is one of the biggest challenges of our time.

Biodegradable plastics, like those made by Bioplastech, offer a solution by enabling environmentally friendly disposal methods like composting and anaerobic digestion.

Bioplastech uses biotechnology to create compostable plastics, including PHAs, which vary in properties from hard to rubbery. They've developed and patented processes to produce these eco-friendly materials, helping reduce plastic pollution.

What are bioplastics?



Case Study Three: BiOrbic's Food Waste Challenge

BiOrbic research centre is broken down into many societal 'challenges'. Each societal challenge, (such as food waste), has a team of researchers exploring how we can resolve it. For example, the food waste challenge is looking at innovative ways to turn food waste into commercial products, bringing the waste into the circular bioeconomy. This is called 'valorisation' and simply means 'finding the value' in food waste. It is important because putting waste back into our circular system is key to ensuring our activities are sustainable. Think back to our previous lessons about food waste and how it impacts our resources and how careless it is to throw away 'good' food.

In Ireland, 36,900 tonnes of fruit and 758,650 tonnes of vegetables are wasted each year within the processing sector. This wasted food highlights a valuable untapped source of materials and an opportunity to reduce careless food waste. BiOrbic is working on the development of technology that can convert this waste into new resources such as electricity and fertilisers. One such technology is called 'anaerobic digestion'.

Anaerobic digestion or 'AD' is the process by which bacteria break down organic matter, such as food waste or animal slurry, into energy. This energy can be harnessed and used to power machinery or heat homes. The process is typically very demanding and can take a long time so researchers are currently focused on how to speed this up.

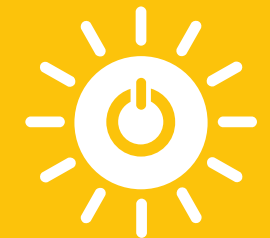
Then there are the by-products of AD. These shouldn't be wasted either and may be used to produce important chemicals (possibly for fertilisers) and additives to fortified animal feeds (vitamins and minerals). In fact, one of the by-products of AD is carbon dioxide (CO₂). The aim is to capture this gas using photosynthetic microbes called algae, preventing any additional emissions.

This challenge addresses Sustainable Development Goals (SDGs) 2, 7, 12. Click on the graphics to learn more.

2 ZERO HUNGER



7 AFFORDABLE AND CLEAN ENERGY



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



Tasks

Task 1 (25 mins): Watch 'The True Cost of Ireland's Waste' to learn more about our waste problem, illegal dumping and waste regulation.

Watch

Task 2 (10 mins): Watch the video and answer the questions below.

A Brief History of
Plastics

1 Who invented the first 'plastic'?

2 Name the material that all modern plastics made out of?

3 When was polystyrene first commercially developed?

4 Name the technique used to insert melted plastics into mould of any shape.

5 List the three priorities for addressing plastic overuse.

Task 3 (15 min): Watch the video advertisement produced by Clare County Council (CCC) and answer the following questions:

1 What message are CCC trying to communicate?

2 In your opinion, is this video powerful?

3 Do you think this video could change peoples' food waste behaviour?

Stop Food
Waste

Task 4 (15 min): Work in groups to come up with strategies for avoiding food loss and waste across the food system. Use the headings of production, processing, distribution and consumption.

Example: During the production of food, quarantining sick animals may help to reduce the likelihood of illness spreading throughout a herd, reducing food loss.

Tasks

Task 5 (25 min): Research the Global Food Security Index (GFSI) of a chosen country and answer the following questions. Consider climate, energy, economics and politics

1 Is your chosen country ranked above or below Ireland for affordability of food? Why do you think this is?

2 Is your chosen country ranked above or below Ireland for availability of food? Why do you think this is?

3 Is your chosen country ranked above or below Ireland for food quality and safety? Why do you think this is?

4 Is your chosen country ranked above or below Ireland for sustainability and adaptation? Why do you think this is?



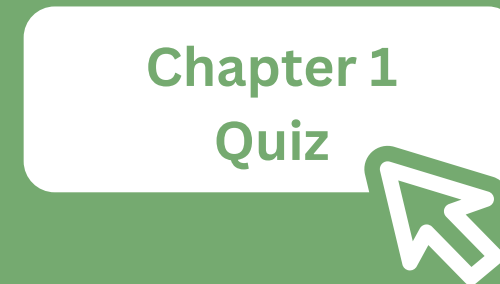
GFSI

Chapter 1: Quiz

This quiz can be carried out through pen and paper or you can click the live link to access the online quiz. The online version will give you a score out of 100.

Quiz Questions

1. The movement of carbon through the biosphere is know as what?
 - a. The carbon cycle
 - b. The carbon circle
 - c. Atmospheric cycling
2. What is the correct meaning of the mobius symbol on packaging?
 - a. The item is capable of being recycled
 - b. The item is sourced from sustainable wood
3. Which of the following is not a natural resource?
 - a. Water
 - b. Soil
 - c. Renewable energy
 - d. Plastic
4. What is anaerobic digestion?
 - a. A process of bacteria breaking down organic matter into energy
 - b. A process of bacteria breaking down organic matter into food



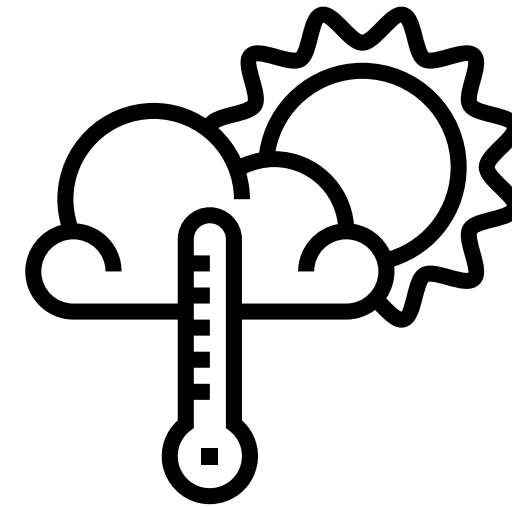


Chapter 2: Climate

2. Climate

What is climate change?

Climate refers to the average weather in a region over a long time. Climate change means that global climates are shifting, making some places hotter and others colder. This affects ocean currents, sea levels, wildlife survival, and our ability to grow crops and raise animals. A big challenge for farming and food production is that they rely on a predictable climate. When natural cycles are disrupted, it makes food production harder.



Most human activities contribute to climate change, including food production. Food production accounts for 26% of GHG emissions. (Our World in Data, 2019). This includes emissions from food production, processing, distribution, and waste. Within this 26%, food production (livestock, crops, and land use) is the biggest emitter of greenhouse gases.

Reducing greenhouse gases must be a group effort. In Ireland, agriculture is a major source of our greenhouse gases, and this is unlikely to change soon. The goal is to reduce emissions in every sector to achieve targets for a more sustainable future. Agriculture will likely remain the biggest contributor to greenhouse gases, but improvements are needed. We will learn more about greenhouse gases and different innovative solutions in the next section.

Chapter Key Terms

Region
Livestock
Greenhouse gas
Sustainable
Innovative
Emissions
Reforestation
Bogs
Photosynthesis
By-product



2. Climate

Greenhouse Gases

Agricultural **emissions** are dominated by methane (CH₄), followed by nitrous oxide (N₂O), with minor CO₂ emissions.

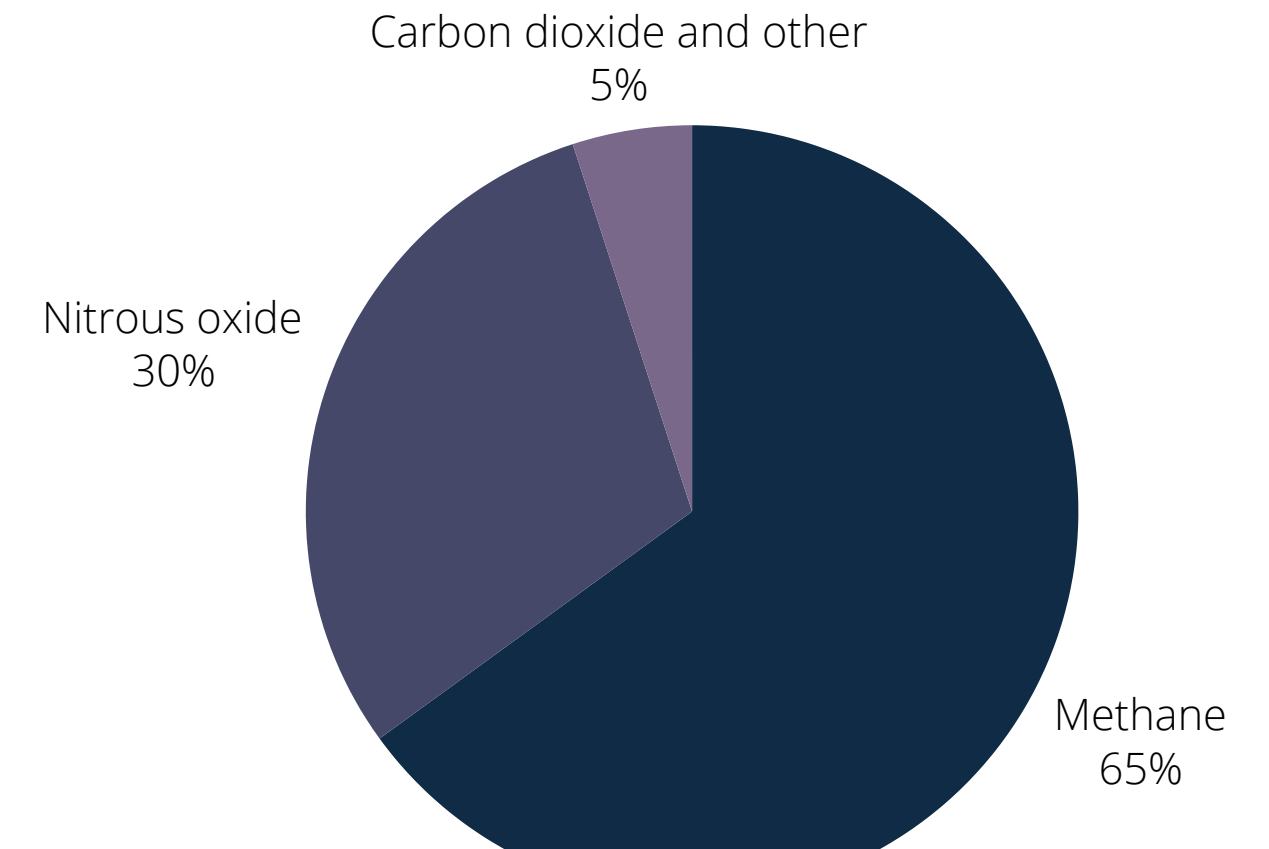
Carbon Dioxide Emissions

Carbon dioxide or CO₂ is responsible for a minor amount of emissions (5.3%) when compared to other gases.

As we learnt in chapter one, nature produces carbon dioxide (CO₂) and recycles it through the carbon cycle. However, humans are over-producing carbon and overwhelming the carbon cycle. Therefore, there is excess carbon dioxide in the atmosphere and this contributes to what we call 'global warming' or 'climate change'.



The expansion of agriculture, which began approximately 10,000 years ago, contributed to CO₂ emissions through the permanent removal of forests and natural grasslands. These habitats typically stored carbon but were removed for the purpose of food production and settlement. The permanent removal of forests is still carried out today in some regions of the world, often due to a growing demand for food and income. Trees have also been planted over time for the timber industry and for **reforestation**.



Understanding greenhouse gas emissions on Irish farms.

Teagasc



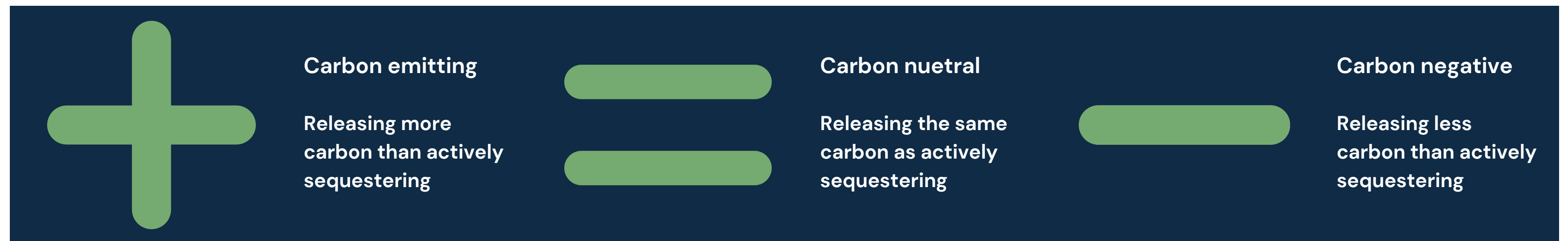
2. Climate

Greenhouse Gases

Carbon Dioxide Emissions continued

Carbon sequestration is an important consideration in the fight against climate change. It is the absorption and locking of carbon within landscape features such as soils, **bogs**, forests, bodies of water and grasslands. Many of these features occur on farmland. This means that while agriculture contributes to carbon emissions, these landscapes also have a key role to play in sequestering atmospheric carbon.

Researchers in Ireland are currently investigating the strength of carbon sequestration on Irish farms. The hope for agriculture is that it can become carbon neutral or net-zero. This is when the carbon emissions from a sector or business are the same as the carbon sequestration efforts. The text boxes on the right further explain carbon terms.



2. Climate

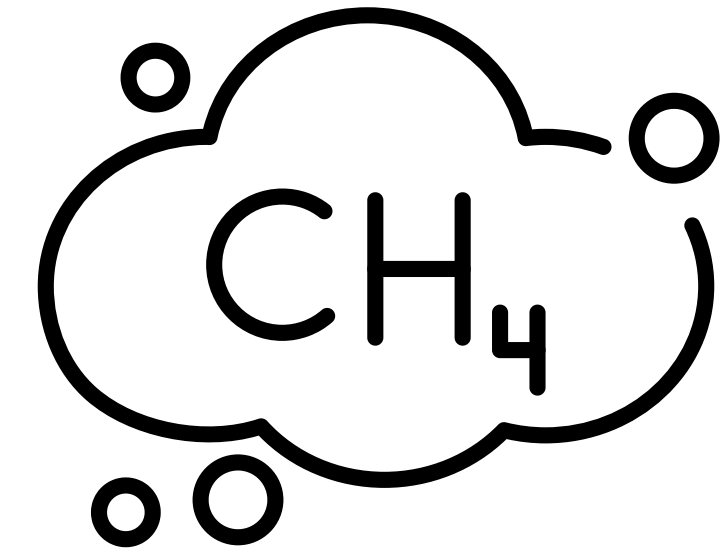
Greenhouse Gases

Methane Emissions

Methane is another GHG, just like CO₂. It is shorter lived than CO₂, but it has a much greater warming potential – meaning that is stronger than CO₂. This is a cause for concern in tackling the climate crisis.

Biogenic methane is a form of methane that is emitted from living sources such as plants and animals. Just as we have seen with the carbon cycle, the methane that is released can be recycled back into the earth, depending on how much is being produced. Cattle consume grass, which contains carbon that has been taken from the atmosphere through **photosynthesis**. As the cattle digest their food, a process known as enteric fermentation takes place. This process involves bacteria breaking down feed in the animal's gut, with methane forming as a by-product of this action. When cattle belch, methane is emitted into the atmosphere.

Current advice from climate specialists is to reduce methane emissions, primarily from cattle and other ruminants. Several pathways are being explored.



Reducing
Methane

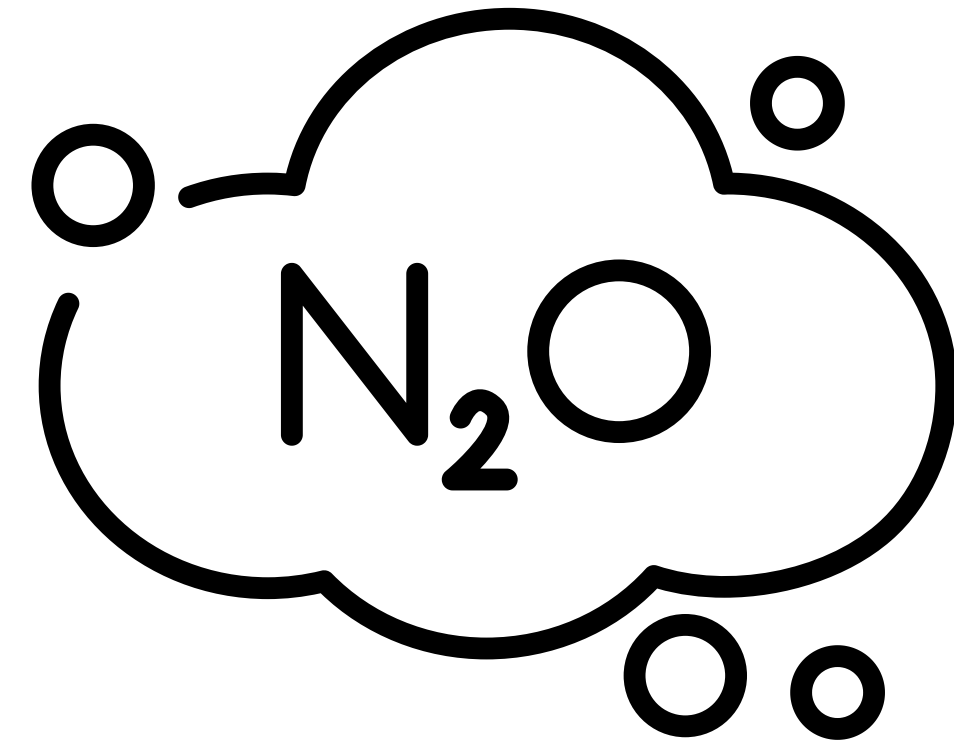


2. Climate

Greenhouse Gases

Nitrous Oxide

Nitrous oxide or N₂O (the gas form of nitrogen) is another GHG that contributes to climate change. Just like methane, N₂O is produced as a by-product of bacterial activity. Within agriculture, the emissions result from the application of artificial fertiliser and areas of livestock excrement hotspots in pastures, slurry and manure. The highest proportion of N₂O emissions comes from the use of artificial fertilisers to grow grass. Reducing the use of artificial fertiliser and using alternatively formulated artificial fertilisers i.e. protected urea, can help reduce these emissions.



2. Climate

Carbon Footprint

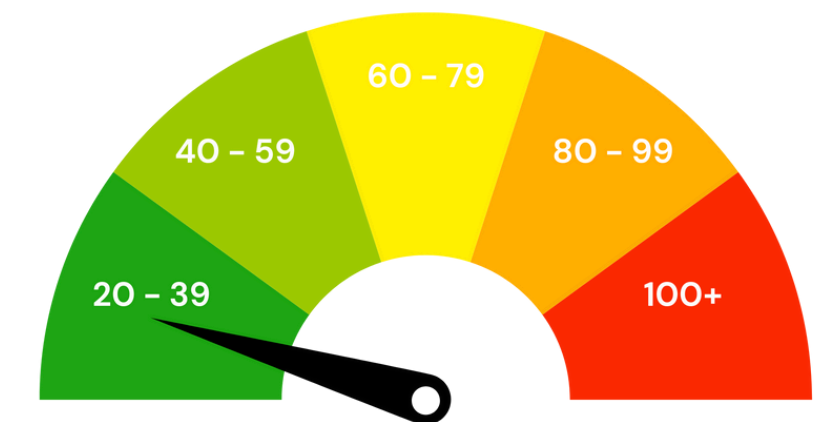
Carbon Footprint

A carbon footprint is the amount of greenhouse gases that are generated because of human actions. They typically take into account household, travel and lifestyle habits to create the approximate amount of carbon dioxide produced by an individual. But despite the name of these calculators, there is more than just carbon dioxide emissions taken into account. The term carbon footprint is used to make it easier to create a numeric total for our actions. The number that is calculated is typically carbon dioxide equivalents (CO₂e), whereby all GHGs are converted to their respective CO₂ equivalents. For example, out of all the GHGs – CO₂ is found in the highest concentrations in the atmosphere but the most potent GHG is Sulphur Hexafluoride (SF₆). Because they are not of the same strength, they must first be converted into CO₂e. If we did not use CO₂e, adding the numbers together would be similar to adding fractions with different denominators – which is something that we cannot do.

Carbon footprint calculators are important because if an individual or organisation knows how much they are emitting, they can make changes to their actions and track any progress made.

We have previously learnt about carbon dioxide, methane and nitrous oxide, but there is another collection of gases that should be considered when learning about the impact of the food system on climate change. Fluorinated greenhouse gases or F-gases are man-made gases used for refrigeration, air conditioning and fire extinguishers and others. EU policy requires that alternatives to F-gases be used where possible and that leakage into the atmosphere be prevented.

The three F-gases are: Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); Sulphur Hexafluoride (SF₆).





Chapter 2: Climate Case Studies, Tasks and Quiz

Case Study: Carbon sequestration on a farm

The Devenish Lands at Dowth is a research farm in Co. Meath, with over 180 hectares of grassland and natural woodlands. It is a sheep and beef farm with the ambition to become carbon neutral by 2025.

In 2017, using special technology called Lidar, Devenish discovered that trees, hedgerows and soils on their farm sequester 656 tonnes of carbon each year. This prompted researchers to investigate ways to increase this carbon sequestration and to investigate ways to reduce GHG emissions on the farm. Some of the research areas include; soil improvement to promote soil carbon sequestration, sowing of multi-species swards to reduce fertiliser inputs and sowing trees within grazing pastures. By sowing trees in the grazing pastures at a rate of 400 trees per hectare, the carbon sequestration could be tripled. This could also extend the length of the grazing season which would reduce feed inputs, housing costs and energy consumption.



DEVENISHTM
Beyond Nutrition

Click the logo above to learn more.

Case Study: Farm Zero C

Farm Zero C is a project that aims to establish the world's first 'net-zero' carbon dairy farm. Farms have the ability to both emit carbon as well as absorb it. For example, the plants on farms such as grasses will take carbon out of the atmosphere and 'sequester' (or store) it in the soil. Therefore to be balanced, a farm should emit no more carbon than its sequesters. If a farm can emit the same amount as it stores, then it can be considered 'carbon neutral' or 'net zero emissions'.

Scientists are looking at ways they can alter farming practices on Shinagh Dairy Farm in West Cork to reach that net-zero goal. Farm Zero C aims to place farms at the centre of the solution and form strategies that can be embraced elsewhere. The researchers are looking into the **carbon sequestration potential** of the farm and the creation of **renewable energy**. Latest results have shown a 27% reduction in the carbon footprint of Shinagh Dairy Farm, with the target of net-zero on track for 2030.



bi**orbic**

To learn more about Farm Zero C, click on the link to the video.

Farm Zero C



Tasks

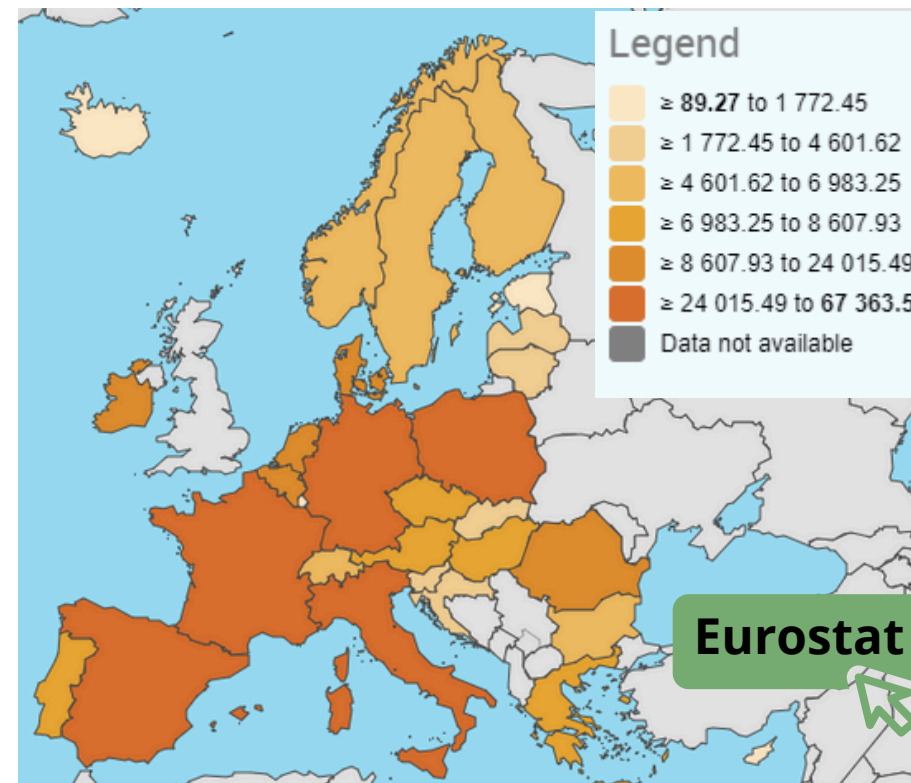
Oppose

Propose

Task 6 (20 mins): Assign groups on either side of the deforestation debate. The videos linked above should help complete this task.

Task 7 (15 mins): Use the map of Europe and the accompanying legend to answer the following questions.

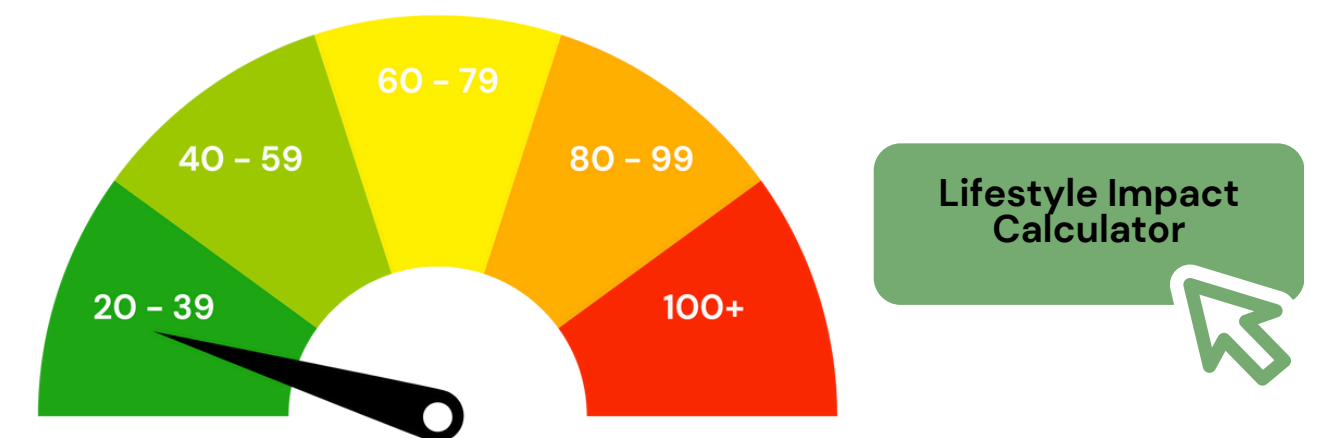
1. Name three countries that are in the highest emitting category.
2. Name two countries that are in the lowest emitting category.
3. Ireland is in the second highest category. Considering what you have learnt so far, is this what you would expect?
4. Name one country that is listed as 'data not available'.



Task 8 (20 mins): Lifestyle Impact Calculator

All human activities contribute to greenhouse gas emissions, resulting in the greenhouse effect and ultimately climate change. As an individual, your lifestyle impacts the environment – from the food choices that you make to the clothes that you buy. The linked Lifestyle Impact Calculator takes into account your use of devices, waste management, school commute, air travel, food choices and wardrobe. The scoring is for the purpose of the below exercise. It does not calculate your carbon footprint in CO2e.

- Step 1: Use the Lifestyle Impact Calculator to determine your score.
- Step 2: Compare your lifestyle impact scores with the rest of your class and discuss possible reasons for high or low totals.
- Step 3: Create a graph to represent the data.
- Step 4: Discuss strategies to reduce your lifestyle impact score.



Chapter 2: Quiz

This quiz can be carried out through pen and paper or you can click the live link to access the online quiz. The online version will give you a score out of 100.

Quiz Questions

1. What percentage of greenhouse gas emissions is the food system responsible for producing?

- a. 1%
- b. 26%
- c. 65%

Chapter 2 Quiz



2. What is the correct meaning of enteric fermentation?

- a. This process of bacteria breaking down feed in the animal's gut, with methane forming as a by-product
- b. This process of bacteria breaking down feed in the animal's gut, with carbon dioxide forming as a by-product

3. Which of the following are NOT F gases?

- a. Hydrofluorocarbon (HFC)
- b. Perfluorocarbon (PFC)
- c. Sulphur Hexafluoride (SF₆)
- d. Nitrous Oxide (N₂O)

4. What does CO₂e stand for?

- a. Carbon dioxide extra
- b. Carbon dioxide equivalents
- c. Carbon dioxide entries





Chapter 3: Biodiversity

3. Biodiversity

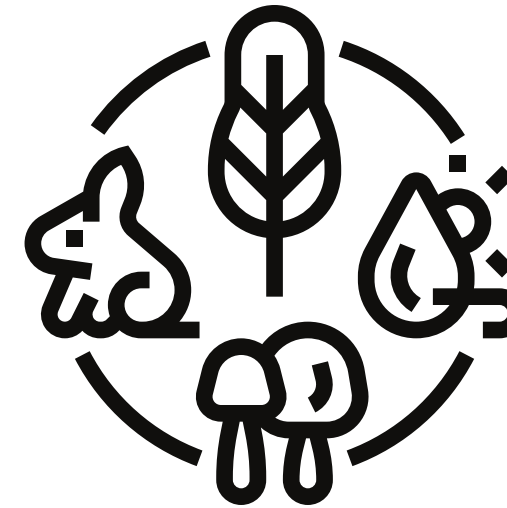
Introduction

Agriculture has changed the world. Without such innovation in the production of food, humans would likely never have had the time to advance in other areas such as science, technology and art. Humans, originally hunter-gatherers, spent a significant amount of time sourcing food. This service is now provided by farmers and others in the food supply chain. Unfortunately, there have been **consequences** to this system shift. Over centuries, natural **habitats** were cleared across the globe to create space for human settlements and the domestication of animals and crops to secure the human food supply.

Biodiversity encompasses the variety of all life on earth. Bio means 'life' and diversity means 'variety'. Every living thing is included in this categorisation including our domesticated plants, animals and even humans. Society has evolved to value one life above all others, with humans being front and centre.

Human-made mass (weight), for the first time in history, now outweighs natural living mass (7). This was proved for the first time in 2020 but has been predicted for decades. Human-made mass includes all living and solid objects that exist on earth, including buildings, surfaces and livestock.

This time period of human dominance is referred to as the Anthropocene. It has put the planet out of balance and impacted biodiversity, natural habitats and the earth's natural cycles.



Chapter Key Terms

Consequences
Habitats
Crisis
Ecosystems
Detritivores
Cattle
Cultivation
Forage
Accustomed



3. Biodiversity

Ecosystem Services

Ecosystem Services

The biodiversity **crisis**, declared in Ireland in 2019, is a little more complex to understand than the climate change crisis. One of the reasons for this is that we do not know how many or exactly what kind of species are required to protect the earth from collapse. For reference, scientists know that global warming must be kept below 1.5 degrees Celsius. We do not have this information for biodiversity.

Each species, plant or animal, has a role to play within the earth's **ecosystems**. These roles are referred to as ecosystem services. Some species supply general services to humans and others supply more unique services. An example of a general service that a species can provide is carbon sequestration by all tree species. An example of a unique service is the dung beetle and its facilitation of decomposition. Dung beetles facilitate the decomposition of cow dung by drinking the liquid. This dries up the animal's waste, preparing it to be decomposed further by earthworms and other **detritivores**.



3. Biodiversity

Natural Capital

Natural Capital

Natural Capital is a term used to describe the land, air, water, soil, living organisms and natural resources that are in our ecosystem which are beneficial to humans. The habitats and ecosystems that are around us provide many positive benefits to us including fresh, clean air and drinking water, materials for manufacturing (like wood), food and an enjoyable environment for recreational activities. If the environment is not healthy, these benefits will either be reduced or disappear entirely.

The positive benefits we get from our surrounding environment are often overlooked in importance as they are provided to us for free. Natural Capital looks at the value of these environmental resources to humans and estimates the amount it would cost to replace them if they were to be lost. For example, if a person swims in the sea for their daily exercise, they are using this resource for free. However, if the sea became polluted and unsafe for the person to swim in, they may have to start using a local swimming pool to continue exercising. This would put a cost of travel as well as the cost of using the pool through membership or gym visit fees. This cost equates to the natural capital value the sea provides to that one person who uses it. This type of calculation can be applied many different aspects of our natural environment. Can you think of other examples?



More on Natural
Capital



3. Biodiversity

Co-existence of farming and wildlife

Wild geese love grazing on grassland that has been created for cattle. In Ireland, the majority of our grasslands have been altered by farming practices in order to feed our livestock a primarily grass diet. This is very fortunate for geese. When farmers graze their cattle late in the summer it keeps the grass sward at an appropriate length throughout winter. The grass is at the perfect height providing geese with a key winter food source. This is, of course, not ideal for the farmer who would rather rest their grass in winter.

In Ireland, the majority of our wildlife habitat is found on farms, making farmland an important source of wildlife habitat. The grazing of **cattle**, maintenance of hedgerows and the **cultivation** of crops, has created a unique set of conditions where certain wildlife species can live and thrive.

Within Ireland, large-scale land-use change ended decades ago and today's biodiversity has grown **accustomed** to its surroundings. However, there is still work that can be done to improve the quality of our existing wildlife habitats.

There are researchers and policymakers all over the world working on the co-existence of biodiversity and farming systems. As briefly explained above, agricultural landscapes can be both a source of habitat for biodiversity and a competitor for space. Let's take a look at the different types of biodiversity habitats on farmland and how farmers can encourage biodiversity both in Ireland and internationally.



Bats may use buildings to roost. They do not cause damage and should be left alone.



Maintaining permanent plants at the side of rivers can catch fertiliser and reduce water pollution and protecting wildlife.



Allowing wildflowers to grow at the sides of fields and at the base of hedges supplies nectar to pollinators and seeds for birds.

3. Biodiversity

Conservation Instruments

There are a number of conservation instruments within Ireland that aim to protect our native biodiversity. Investing in our native biodiversity also invests in human well-being and our food supply now and into the future.

Responsible Outdoor Behaviour

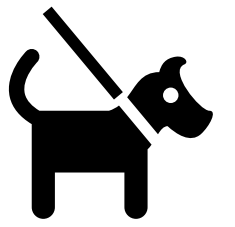
There are several guidelines that should be followed when participating in outdoor recreation. Our environment is a fragile place that should be respected so that people may continue to experience nature.

National Parks

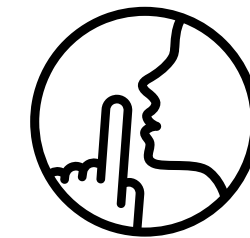
There are six national parks throughout Ireland. They have been designated to protect the biodiversity that lives within them and to protect the ecosystem services that they contribute to people.



**Please
keep to
the path**



**Please
keep dogs
on leads**



**Please
keep
quiet**



**Please
do not
pick
flowers**



**Please
do not
feed the
birds**



**Please
do not
litter**

3. Biodiversity

Conservation Instruments

Protected Sites

Ireland is home to 28 species of land mammals, over 400 species of birds, more than 4,000 plant species and over 12,000 species of insect. If we want all of this to survive, we must ensure that there are enough suitable areas for all these species to flourish. Natural heritage areas (NHAs), special areas of conservation (SACs) and special protection areas (SPAs) are a network of protected sites that are governed under national and European laws.

Agri-Environment Schemes (AES)

These schemes provide funding to farmers that help them to farm in a way that is environmentally responsible. The funding comes from the European Union under the Common Agricultural Policy (CAP).



3. Biodiversity

Introducing the concept of One Health

One Health is a concept that understands the health of humans is closely connected to the health of animals and our environment. It also understands the need to bring together knowledge and information from different areas of society to achieve the best health for humans, animals (domestic and wild), plants and the environment.

The world population is growing and expanding. This increasing populations needs space to live as well as the need for land for food production. This causes the human population to move further into areas where contact with wild animals is more common. The mixing of wild and domesticated animals, as well as the close proximity of humans between the two can lead to the spread of diseases between animals and humans.

When humans and animals are in closer proximity, zoonotic disease spread is much more likely. Zoonotic diseases are caused by germs that are spread between people and animals. Many people make contact with animals in their daily lives and this is where the risk of disease spread lies.

When a problem arises within society (i.e. the COVID-19 pandemic) the response is looked at in a way that considers the effect on each area of our society and environment. It is important that experts are included from veterinary and human medicine, social, biological and environmental sciences. Although science may be needed to remedy an issue, the impacts on the environment and an understanding of the social changes that may need to happen are very important. An example of a social change in relation to a disease outbreak is social distancing i.e. reduce peoples contact with each other in order to minimise the spread of the disease.





Chapter 3: Biodiversity Case Studies, Tasks and Quiz

Case Study: Natural Capital assesment for Clew Bay, Co. Mayo

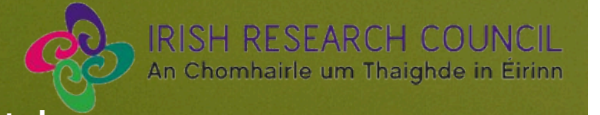
The seafood industry as whole was worth 1.3 million to the Irish economy in 2022. This indicates the importance of keeping our coastal and inland waterways healthy, for both biodiversity and the economy.

Clew Bay in Co. Mayo is an important area for shellfish cultivation. The value of this production is reliant on a clean environment for shellfish production. If the environment in which the shellfish is growing became polluted, the value of the shellfish from that area would vanish overnight. The study is being carried out by Bord Iascaigh Mhara (Ireland's Seafood Development Agency) in Clew Bay is looking at the natural capital value of the oyster, mussle and sea fishing industries to the local area, as well as the impact it has on other surrounding industries and businesses. The project is working to asses the cost of the ecosystem of the bay, as well as improve the sustainability of the businesses reliant on the seafood production within the area. It also hopes to contribute towards the restoration of the Native Oyster population which was destroyed by a parasite in the 1980's.

More on Natural Capital



Case Study: Ground Nesting Birds



Whinchat are a species of bird that take advantage of grasslands and pastures that are maintained by agricultural practices. They use these landscapes to forage for insects, which are in particularly high demand during the breeding season. The birds also uses hay meadows to build their nests and rear their young. The adults use fence posts and trees along the edges of fields to perch and scan for prey and predators. These breeding conditions are created by agricultural activities, indicating a level of harmony for birds and farming; however there are other agricultural activities that can impact the birds negatively.

Because these birds, and many other species that nest on the ground, build their nests in grassland in spring and summer; the breeding season clashes with hay and silage making. This can have an impact on the bird's populations through habitat loss and direct casualties from machinery. Farmers and conservationists are working together to come up with innovative solutions that promote co-existence of birds and farming activities.



Case Study: One Health in Action

Monkeypox is a virus that is found in small mammals, monkeys, chimpanzees and occasionally human populations. There is no known treatment for the disease and death in humans occurs in 10% of cases. The disease is endemic to countries in West and Central Africa. In March 2014, several chimpanzees at a rescue centre in Cameroon fell ill. This caused huge concern for human and animal health. A One Health strategy was implemented to reduce the risk of disease spread. The Ministry of Health in Cameroon assembled a team of people to research the disease online, test all animals at the rescue centre and isolate positive cases and care for the infected animals. The World Health Organisation was notified of the outbreak and the response documented in order to share information across the globe. The successful approach to the disease outbreak resulted in zero human infections and only one chimpanzee death.

Tasks

Task 9 (15 mins): Research the ecosystem services or roles provided by the below species. Consider the types of habitat they live in, what they eat and how they interact with their surroundings to come up with your answers. The linked video should help you with this task.

Biodiversity



Task 11 (10 mins):

CDC

Use the CDC website to further understand how diseases can be spread between humans and animals. Look at the section called 'How do germs spread between animals and people'.

Task 10 (5 mins): Hedgerows are critical habitats for wildlife on farmland. Watch the linked video and answer the following questions.

Hedgerows

1. Name two species of plants that can be found in hedgerows
2. Name two species of birds that can be found in and around hedgerows

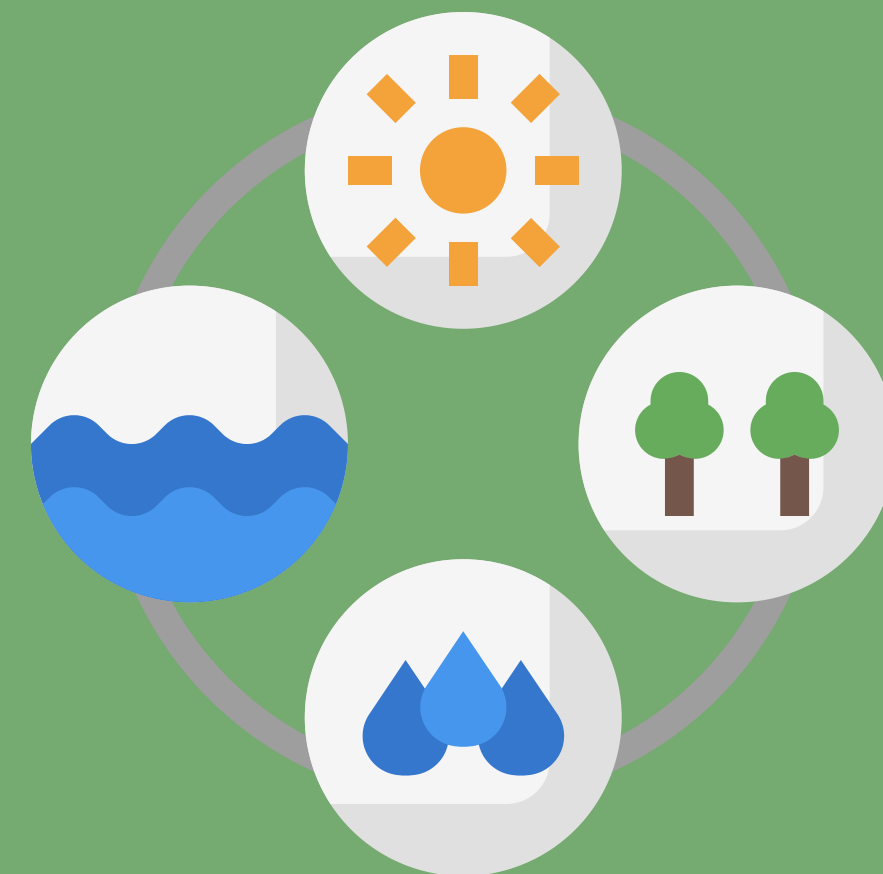
Chapter 3: Quiz

This quiz can be carried out through pen and paper or you can click the live link to access the online quiz. The online version will give you a score out of 100.

Quiz Questions

1. What is meant by the term human made mass?
 - a. The weight of all humans on earth
 - b. The weight of all human made living and solid objects on earth
2. The concept that understands that the health of humans is closely connected to the health of animals and our environment is known as what?
 - a. One Health
 - b. Health United
 - c. World Health
3. Which of the following is not an ecosystem service?
 - a. Carbon sequestration by plants and trees
 - b. Decomposition of organic matter by worms and other detritivores
 - c. The release of greenhouse gases during the decomposition process
4. Choose the odd one out. Which of the following is NOT responsible outdoor behaviour?
 - a. Please keep dogs on leads
 - b. Please keep quiet
 - c. Please do not pick flowers
 - d. Please feed the birds

Chapter 3 Quiz





Chapter 4: Land-Use

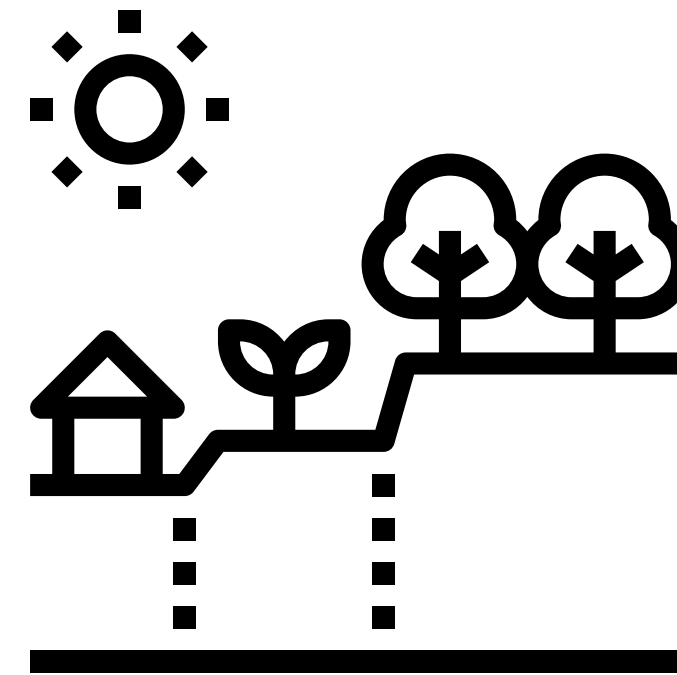
4. Land-Use

Ireland's Land Use

Half of the world's habitable land is used for agriculture. This land is worked in order to feed the world's 8.1 billion people (2023)(8).

Soils and land cover differ in their **capacity** to support certain land uses. As a result, some soils are better suited to grazing cattle and others for growing crops. Crop production is mostly confined to the east of the Shannon, with almost entirely **pasture** for livestock to the west.

The majority of Ireland's land use is used for agriculture (67.6%). The main agricultural class is pasture (55.1% of national land cover), followed by land principally occupied by agriculture (primarily pasture), which is interspersed with areas of natural vegetation (6.9%), and arable land (4.5%) (9). In the task below, there are more categories explored relative to general land cover.



Chapter Key Terms

Capacity

Pasture

Dominant

Silage

Mean temperature

Unparalleled

Revenue

Economy

Enterprise

Adequate

Nutritious

Prohibiting

Regenerating

Imports

Exports

4. Land-Use

Ireland's Land Use

Grassland is the **dominant** land cover type within Ireland. Within agriculture, the purpose of this land use is to feed our livestock; either through grazing or the harvesting of grass to make hay and **silage**. In dairy systems, cows are fed 90% grass and conserved grass. This is called a pasture-based system and is one of the reasons why Ireland's dairy is considered more carbon efficient than other EU countries. Relying on homegrown grass over internationally grown and imported feedstuff reduces dairy's carbon footprint.



Arable land, land under temporary crops, makes up the smallest proportion of our land use. Ireland grows crops for animal consumption (e.g. fodder rape, maize) and human consumption (e.g. potatoes, apples). This is a relatively small proportion of land dedicated to crops to feed people. Ireland is not well suited to growing vegetables and it is unique to roughly 200 farmers in the country. Ireland's mild temperate oceanic climate is better suited to the growth of grass. Our annual **mean temperature** is 9–10°C – grass grows well in temperatures above 5°C.



The production of high-quality grass-based meat and dairy has allowed Ireland to **export** food on an **unparalleled** level. Ireland is known for producing grass-fed and antibiotic-free beef and dairy, benefiting animal welfare and human health. Roughly 90% of the food produced in Ireland is exported (10). This helps secure food supplies in other countries as well as create **revenue** for the Irish economy.

Ireland supplies roughly half of its required vegetables but the rest are imported. This is partly due to climate but also due to the viability of the enterprise. This will be covered in more detail in the next section.

4. Land-Use

Imports and exports

In 2020, exotic fruits such as bananas and oranges made up 11% and 6% of total imports respectively. Potatoes made up 18%, apples 6% and onions 5% (11). Bananas are not suited to the Irish climate, therefore local bananas are not possible. However, Ireland is capable of growing potatoes, apples and onions; so why do we import so many of them?

One reason we import produce that can be grown in Ireland is **seasonality**. Although we have the ability to grow certain items like potatoes and apples in Ireland, we are unable to produce them in large quantities year round. As a result, it is necessary to import them to keep up with demand throughout the season.

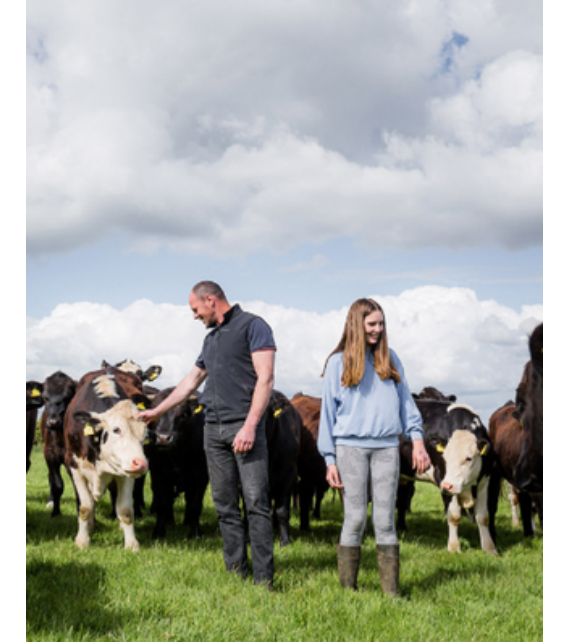
The **economy** also plays a huge role in the decisions to export and import food. Consumers have a role in this but it is unclear if the market leads this or vice versa. Within Ireland, potatoes are not as popular as they once were. Nowadays, it is more convenient to buy long shelf-life pasta and rice. This means the demand for potatoes is relatively low hence, farmers are less likely to commit to a potato **enterprise**.

An overly simple solution to this is to increase the cost price of potatoes to make the enterprise more profitable for farmers. However, this would increase the price consumers must pay for their food and create additional challenges around food poverty.

Food poverty is the inability of people to secure an **adequate** and **nutritious** diet. It affects people in both developing and developed countries.



Organic farming practices are those that aim to produce food using natural substances and processes. Anyone can produce organic food but in order to label food from animals or plants as organic, producers must go through a European Union organic certification process. The organic unit of the Department of Agriculture, Food and the Marine (DAFM) manages the certification process for Ireland.



The hard rules for organic farming include i) **prohibiting** the use of genetically modified organisms (GMOs) ii) restricting the use of artificial pesticides and herbicides iii) prohibiting the use of hormones and restricting antibiotic use to only when necessary. Many of these rules are also adhered to by farmers in conventional farming systems also. Under no circumstances are GMOs or hormones permitted within Irish farming. There are also additional rules for the use of antibiotics for animal health and welfare whereby animals must be withdrawn from the food chain for their period of treatment and recovery.

Along with organic farming, there is another term that is appearing more frequently. Regenerative farming and regenerative practices are those that focus on **regenerating** the natural processes on farms. There is no EU certification process to become a regenerative farm but the methods that regenerative models offer can be integrated into conventional farming. Many regenerative practices relate to soil and one of the main reasons for this is that healthy soils can help reduce greenhouse gas emissions.

**Regenerative
Farming**



4. Land-Use

Land sparing agriculture

As the world population continues to grow, and the demand for food increases with it, we need to develop methods of growing enough food in the decreasing areas of land available. There are many methods of growing food that are now being used to maximise the food output in new and novel ways.

Vertical farming

When we think of farming, we generally imagine open, expansive fields on one level. Vertical farming is a modern method of food production which uses technology to grow food in vertically stacked layers. This means that where traditionally a square metre footprint could produce a limited amount of crops, by expanding vertically the amount of crops that can be produced is only limited to the height the structure can reach.

Hydroponics

Hydroponics is another method of growing crops outside of traditional farming methods and is often used together with vertical farming to produce food. It is a method of growing plants without soil, usually using water and dissolved minerals and salts to grow crops.

There are many benefits to hydroponic systems, most notably the speed at which plants grow using this method. Plants can grow between 30% and 50% faster than conventional farming methods (12). This increase in the speed of growth is because the roots of the plant do not need to use energy to find water and nutrients, all of this is directly supplied to the roots of the plant.





Chapter 4: Land-Use Case Studies, Tasks and Quiz

Case Study: Regenerative Agriculture in Conventional Farming

Thomas Tierney's farm is located next to the River Siur in County Tipperary. He and his family are using regenerative agriculture practices on the farm that aim to put soil health first.

The soil on the farm was last ploughed (tilled) in 2014. Limiting the disturbance of soil is important for soil structure and the storing of carbon. The Tierneys have chosen a no-till system for this reason. Instead of tilling the soil to prepare it for planting, a direct-drill is used to drill the seeds into the soil with very little disturbance.

Approximately 50% of the farm is planted with cover crops ahead of the spring planting season. These cover crops protect the soil and reintroduce soil nutrients.

For soil health and nutrient composition, Tommy uses a combination of chopped straw, slurry and relatively small amounts of urea (nitrogen).

Fungicides are typically required on tillage farms to protect cereals from disease. The Tierneys avoid their use as much as possible by using home-made natural alternatives.

Pollinator strips offer alternative habitat to insects at the edge of fields, keeping pests out and limiting damage to crops. This is a method that protects both insects and the soil.

The tillage farm is being prepared for a future with reduced pesticide and fertiliser use. At present, the crop yields on the Tierney's farm are lower than conventional systems. Tommy hopes this will increase over time as soil health improves.



Origin Green, Ireland's food and drink sustainability programme, collaborates with members across 55,000 farms and 300 leading Irish food and drink companies. The aim is for Ireland to be able to demonstrate and improve the sustainability of the food produced.

Origin Green enables the industry to set sustainability targets and to measure progress over time. Therefore, all targets set by farmers and companies must be measurable.

Farmers, manufacturers, retailers and those in the food service industry are eligible for membership of the Origin Green programme. The programme gives members access to the tools needed to produce food and drink in a sustainable manner.

At farm level, improving sustainability performance under Origin Green is undertaken through the Bord Bia's Sustainability & Quality Assurance schemes across the horticulture, beef, lamb, dairy, eggs and poultry sectors.



Tasks

Task 12 (10 mins): Use World Cover to investigate the land cover across the world and carry out the following tasks.

1. Navigate to Ireland and determine which areas have the most 'built-up' land cover. List the counties there are in.
2. Within Ireland, is there more cropland to the east or west of the country? Give one possible reason for this.
3. Name one country that has less grassland cover than Ireland.
4. Name one country that has more forestry cover than Ireland.
5. What is the dominant land cover type in the Ukraine?
6. What is the dominant land cover type in Sri Lanka?
7. What is the dominant land cover type in Egypt?
8. What is the dominant land cover type in Greenland?

World Cover

Task 14 (10 mins): Watch the EU produced video on The Regenerative Agriculture Revolution and answer the questions below.

Watch

- 1 What are the five key principals of regenerative agriculture?
- 2 List three regenerative agriculture practices you have learnt about.
- 3 Suggest any one barrier to implementing regenerative agriculture in Ireland.

Task 13 (20 mins): Bring in 2-3 clean, empty packaging from food each.

1. Determine the country of origin (most fruit and vegetable packaging will be labeled).
2. Match the country to the continents - Oceania, Africa, Europe, South America, North America and Asia.
3. Calculate the percentage of food from i) each continent and ii) Ireland.

Chapter 4: Quiz

This quiz can be carried out through pen and paper or you can click the live link to access the online quiz. The online version will give you a score out of 100.

Quiz Questions

1. The majority of agricultural land is used for what?

- a. Pasture
- b. Natural vegetable
- c. Arable land

2. Why does grass grow so well in Ireland?

- a. The temperature
- b. The level of precipitation
- c. The temperate climate
- d. All of the above

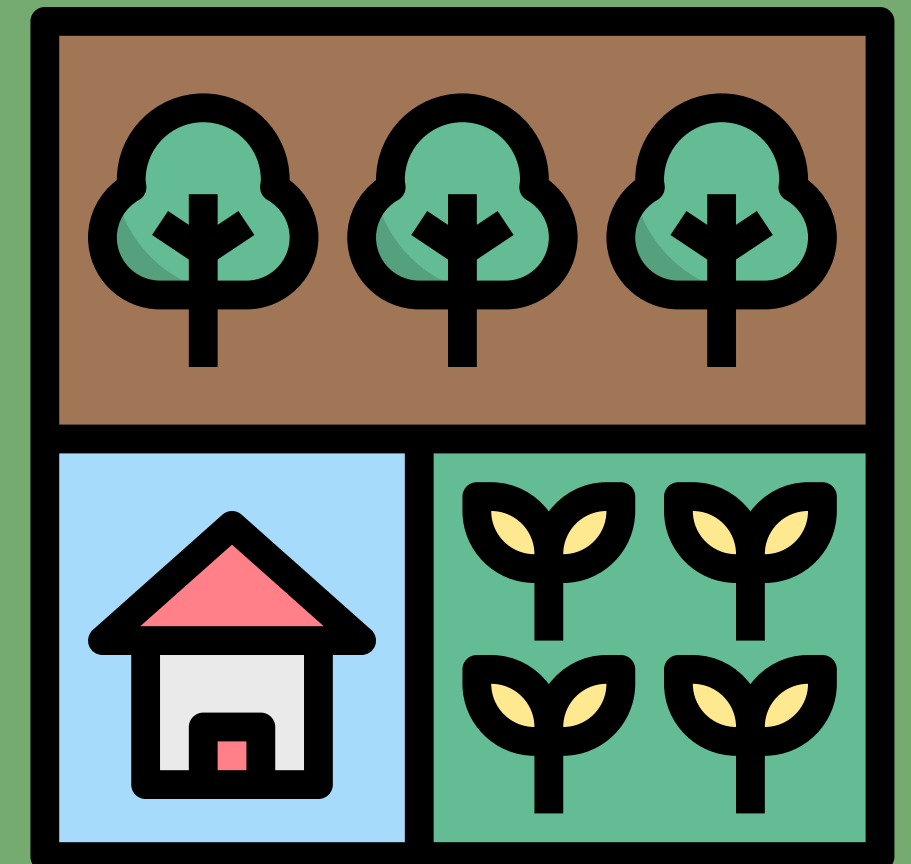
3. True or false? GMOs and hormones are used in Irish farming.

- a. True
- b. False

4. Choose the odd one out. Which of the following is NOT an example of land sparing agriculture?

- a. Vertical farming
- b. Hydroponics
- c. Organic farming

Chapter 4 Quiz



Submission Template

Answer the following questions to help you to refine your project submission idea.

- Which type of food system challenges are you most interested in?
- Who are your stakeholders?
- Do you know anyone who has expertise in your chosen area who can offer advice?

"Can your challenge be tackled with a policy, product, technique or technology?"

Submission Guidelines

We are looking for submissions that address challenges within the food system. Throughout the programme you have learnt about challenges from every stage of the food system from poverty and how this affects a persons access to food to the loss of biodiversity and their associated ecosystem services.

Your submission must address the following points.

- Why does your chosen challenge require a solution?
- Is your solution something that works locally or globally? (Hint: local solutions are easier to comprehend and implement).
- Who can this innovation help?
- How does your innovation work?
- Does your innovation address any of the Sustainable Development Goals?

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