
Environmental Innovators
AgriAware
EDUCATE • ADVOCATE • ENGAGE

Supporting partners:

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Introduction

The aim of environmental innovation is to reduce the impact of products and production processes on the natural environment.

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!"

Across the globe, human consumption of the world's natural resources has increased in line with the demand for food. This means that the way our food gets from farm to fork must evolve to meet global sustainability objectives.

Throughout this programme, students will learn of the various challenges that our environment faces due to the food system and vice versa. The programme will highlight Irish, European and global challenges and innovative solutions.

The food system is responsible for 34% of human created greenhouse gas emissions (1). This means one of our priorities for change is the way our food gets to our table and beyond. We must lessen our impact on the environment now so that we can continue to produce food into the future.

The Food System Explained

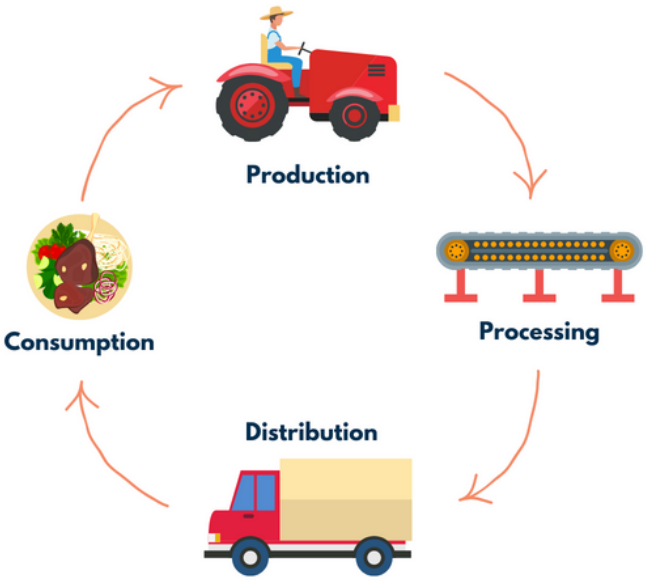
The food system is made up of the different stages of activity that bring food from farm to fork. The four primary stages are production, processing, distribution and consumption. Each stage leads on to the next stage and in theory, cycles back around.

There are huge environmental challenges at every stage and if we are to make changes in this areas, the first step is learning more about the challenges.

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. You will learn of the various challenges associated with this stage associated with this stage includingincluding greenhouse gas emissions from agriculture, loss of biodiversity habitat, food insecurity and limited land use.

The production stage leads on to the **processing** stage. The processing stage prepares food to move forward through the food system. This involves cleaning, preserving, milling, drying and much more. At this stage, food can be lost due to damage or quality control and a lot of energy is consumed. Both of these challenges can effect our natural resource use and generate greenhouse gas emissions.

The processing stage leads on to the **distribution** stage. During this stage, the primary challenge is emissions from the transport sector. Food is transported within countries and exported to different countries and continents.



The distribution stage leads onto the **consumption** stage. This takes into account the consumer activities that are related to food. Food waste and access to quality nutritious food are two of the biggest challenges at this stage.

The link between consumption and production allows us to create a cycle. Some examples of this are the use of food waste to create compost to help crops or grass to grow and the use of bio-digestors to generate energy on farms. Can you think of any other examples?

Figure 1. The Food System - 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.

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, planting trees responsibly can sequester carbon from the atmosphere.

In Columbia, when a person recycles plastic they receive a credit receipt to be used on public transport.

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

Electric vehicles are particularly eco-friendly if the energy they consume is renewable.

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

1 Stucture

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

There are enormous global environmental challenges. Try to choose a 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.

Brainstorm innovative ways to tackle your chosen challenge.

Ask yourself the following questions:

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

2 Submission

Please use the submission portal to upload your entry. Further instruction on how to submit will be send to all registered teachers after the Halloween midterm break.

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

Check out the 2023 entries.

2023 Entries

The National Champions, chosen at the close of the day, will be awarded a grand prize of up to €1000.

The 1st runner-up will receive prize money and a visit from BiOrbic's STEM Escape Room.

The 2nd runner-up will receive prize money and a visit from BiOrbic's STEM Escape Room.

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

A policy is a course of action that is adopted to achieve a particular outcome. For the purpose of this project policies can be drawn up for governments, organisations, schools or individual households.

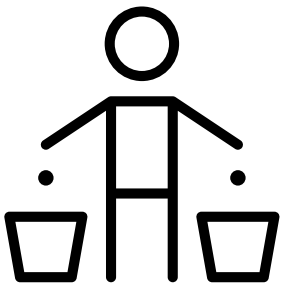
A product is an object that is created in order to supply a consumer. If you choose to design a product, consider how this object fills a gap in the market. Are there any similar products out there and if so, how can you make them better?

A technique is a way or carrying out a particular task. For example, you will learn about regenerative farming practices. These are all new techniques that benefit the environment and the food system.

A technology is any machinery or equipment that has been developed out of scientific knowledge. One example of this would be wind turbines to generate renewable energy.

- Bioeconomy Map
- Food Vision 2030
- Food Cloud
- Vertical Farming
- DownToEarth
- Mastek
- Renewable Energy Ireland
- Eco Eye: Curlew
- Farming For Nature
- National Food Waste Recycling Week
- Irish Organics Association
- Ireland's Bogs

Chapter 1: Waste



Waste

1.1 Introduction

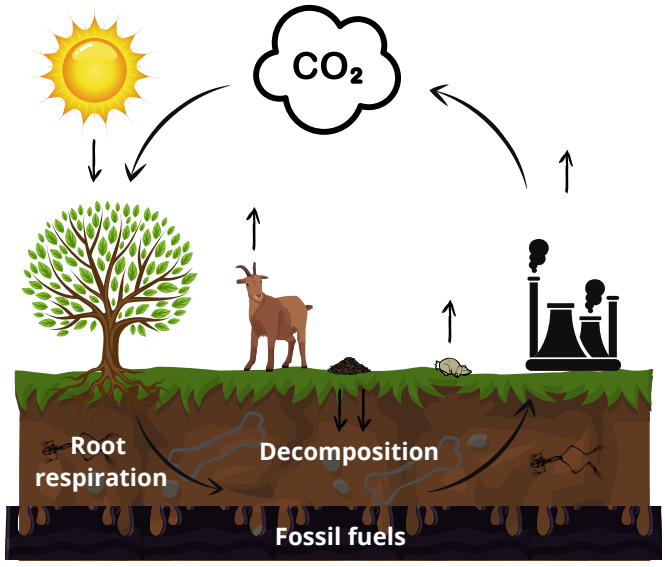
Waste is a human idea. Nature does not produce 'waste'. Over hundreds of millions of years, the earth's complex natural systems have evolved to make sure everything created within nature feeds back into nature. This idea may be familiar from the earth's natural cycles; such as the water cycle, the oxygen cycle and the carbon cycle. 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.

Before You Begin

The following words are key concepts for the upcoming chapter. Write your understanding of the following before continuing with the material. Use a dictionary to aid your understanding.

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

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 though the burning of fossil fuels. Having too much carbon lingering in the atmosphere contributes to climate change. Carbon dioxide or CO2 is the first of the greenhouse gases you will learn about within this programme in the chapter on climate.



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

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. They persist in the environment causing a suite of known and unknown problems for wildlife and, ultimately for humans.

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.

Plastics are used throughout all stages of the food system. As we learned in 'A Brief History of Plastics', plastics have helped advance the availability and reduced the price of products such as furniture. Plastics have also revolutionised the food system but at a huge cost to our environment. We must work together across the food supply chain to prevent plastic pollution.

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.

We use plastics at every stage of the food system. Some of these uses of plastic are necessary and as a long as they are managed responsibly, their use is likely to continue. Although, there are certain areas of the food system that could benefit from moving away from plastics.

Plastics are also used within food processing. Parts of processing machines are made from plastics. There are many benefits to using plastics for this purpose including shock resistance; plastic piping is lighter in weight and can be made **translucent**.

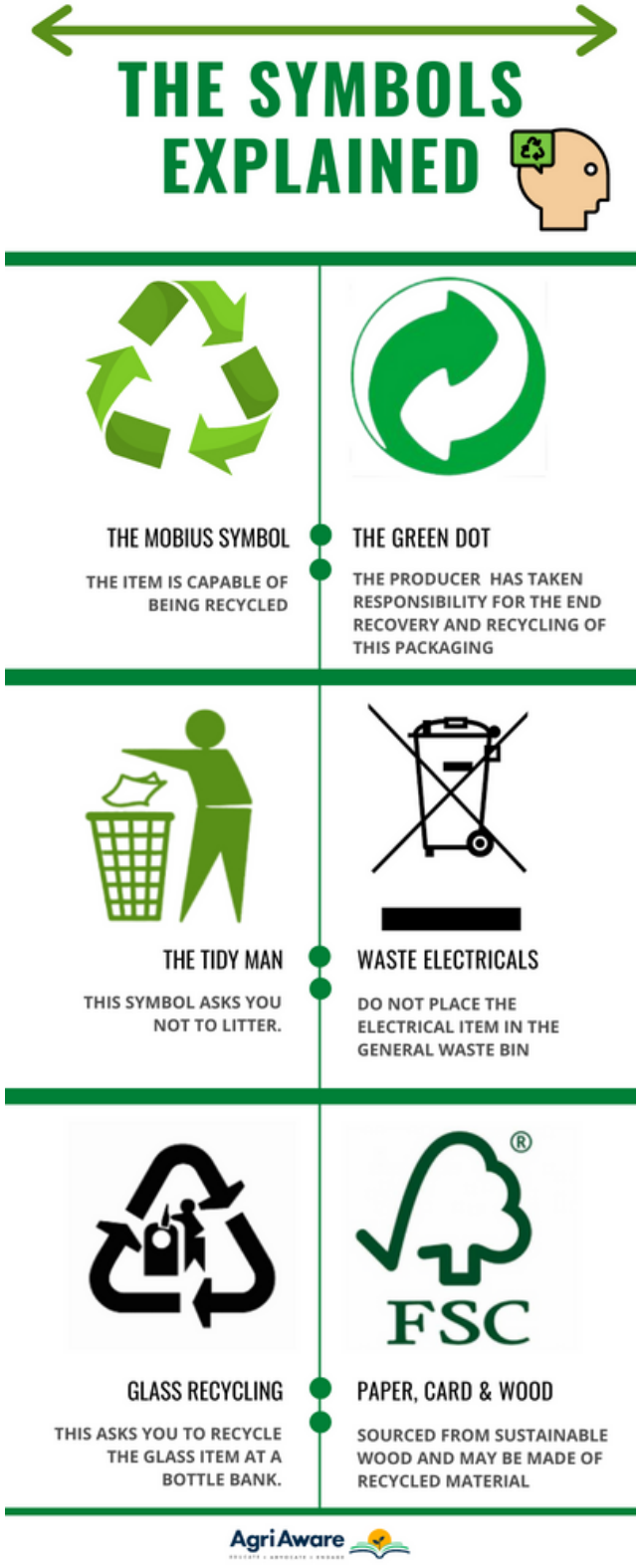
During distribution and sale of food, it is often wrapped in plastic. Fruits and vegetables with inedible skins should not be wrapped in plastic. As a consumer, choosing the unpackaged option sends a message to the retailer. Produce with edible skins can be washed before consumption, avoiding the need for plastic packaging.

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.

Items placed in recycling must be:

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

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.



Task 3 (15 min): Watch the video advertisement produced by the European Commission (EC) and answer the following questions:

1. **What message are the EC 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

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). Considering all of the resources that are required to produce this food, it is unacceptable that we allow so much to never fulfil its intended purpose.

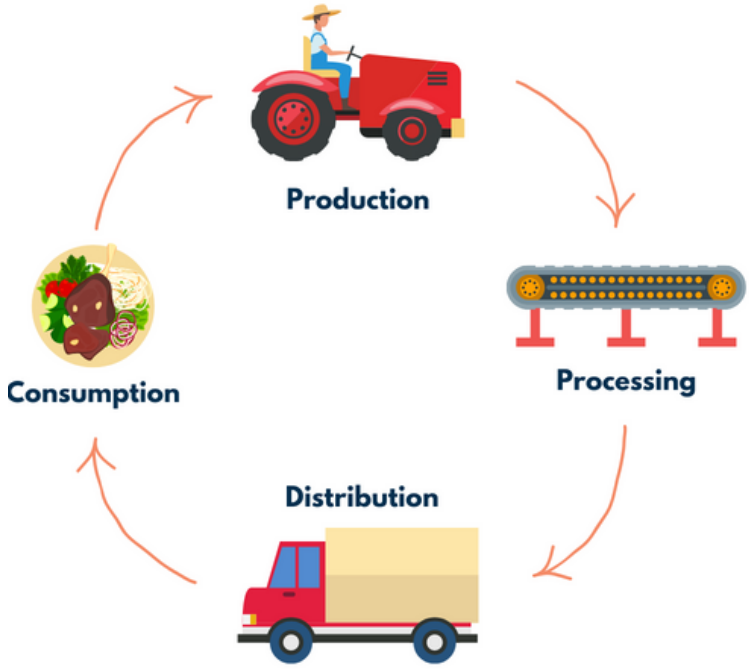
Food loss and food waste occurs at every stage of the food system. Remember! The food system includes the entire route that food takes to get to your home and beyond. A well functioning and planned food system can bring economic, environmental and social benefits. This means that a poorly functioning system can also damage these benefits.

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.



One of Ireland's primary goals for the year 2030 is to reduce food waste in the home and in the service industry by 50% (3). Nearly two-thirds of all food waste occurs at the household level. This means that behavioural change at the **consumer** level is urgently needed.

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.

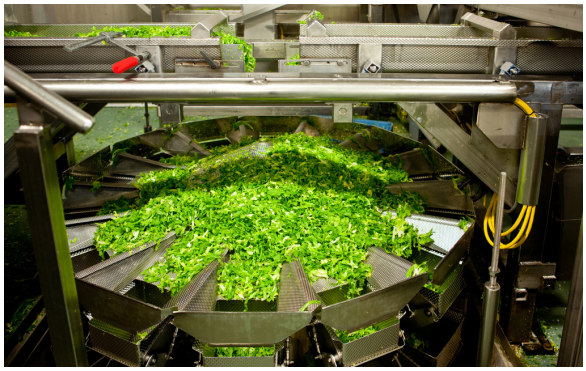
Example: During the production of food, quarantining sick animals may help to reduce the likelihood of illness spreading throughout a herd, reducing food loss.

Waste

1.3 Food Waste

When food is wasted, all of the resources used to produce those foods are also wasted. This is counterproductive for our global sustainability journey. The production of food contributes directly to climate change but we must produce food in order to survive. Therefore, the production of food is non-negotiable. Below are some examples of the resources we use to produce food. When food ends up as food waste, these resources are also wasted.

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. Although there has been movement towards **renewable** sources of energy, such as wind and water, the technologies for electric vehicles remain too expensive for conventional farming and most processors. 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. In **conventional** farming, chemical fertiliser is typically used to speed up growth and the resulting supply of food. 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.

Given all of the above, it is incredibly wasteful to throw away food. If global food waste were a country, it would be the third largest contributor to greenhouse gas emissions in the world (2). A final point to consider is the social-inequity consideration for food waste. There is vast inequality across the globe when it comes to the supply of food. Those who have far less access to food do not waste what they have.

Therefore, food waste can be considered a luxury.

If we redistributed all the food available across the world, there would be food leftover. But it is the poor access to safe, quality, affordable and **resilient** food supplies that causes 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

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

According to the GFSI, Ireland is in a very fortunate position when it comes to the security of our food supply. But we must remember that we are still dependent on other nations for the availability of this food. The availability of food typically depends on the climate, energy supply, economics and politics; all of which require international cooperation.

Our ability to produce food is dependent on the local and global climate, energy supply, economics and politics. Ireland is known for its grass-fed beef and dairy, both of which are vitally important exports for our economy. More than 90% of the food that is fed to cattle is grass and grass derivatives (5), but there are also imported concentrates that are required to meet the energy and protein requirements of our livestock. The production is firstly dependent on climate. For example, protein-based feeds are grown in the Americas (North and South) and in some other EU countries. Without suitable climate conditions, these crops can fail causing feed shortages.

Another serious consideration is the processing and distribution of this feed and the energy that it takes to do this. 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. Ireland does not produce any of the fossil fuels that are required to power these vehicles and furthermore, fossil fuels are a **finite** energy resource.

Finally, the availability of our food is 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.

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

GFSI

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?**

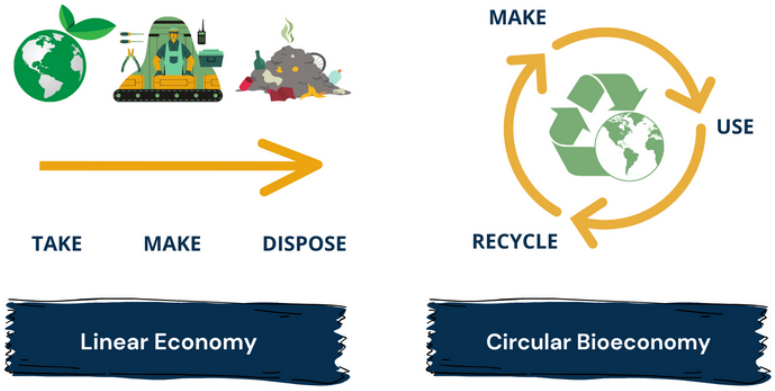
The bioeconomy is the part of our economy that uses biological resources and services from agriculture, forestry, and the marine to produce food for humans, feed for animals and the materials we need to make everyday products and energy.

The Circular Bioeconomy

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

The bioeconomy helps us to apply knowledge and innovation to how we use and consume natural resources, such as those that come from our soils, fields, forests and seas. It is important that our use of these resources respects nature and increases social equality by reducing our use of fossil resources and developing green practices, products and local jobs.

Our current economic model is predominantly a linear model, where we take the resources we need, make products from them and then dispose of them after use. This is not a sustainable model - we must adapt to a circular model, where all resources are reused or recycled (including waste), to make new products.



Case Study One: Biorefinery Glas

Click here to learn more

'Biorefinery Glas' 2014-2020 was jointly funded by the EU and the Department of Agriculture, Food and the Marine. Within Ireland, many of our livestock graze on fresh grass throughout the spring, summer and autumn months. In the winter, grass stops growing so we must feed the livestock alternatives to fresh grass. Some farmers import animal feed that is often made of mixed grains and soybeans. These feeds are less healthy for the animals, relatively expensive and more challenging for greenhouse gas emissions. Biorefinery Glas converts fresh grass into a range of preserved products that are better for our animals, our environment and sustainability.

The hope is that these products will become an option for conventional agriculture, avoiding the need for less sustainable imported feedstuff.

Case Study Two: Bio-Plastics

Scientists in Ireland are bringing bio-based, biodegradable and compostable plastics to the market. Plastics like these will help to reduce your carbon footprint and slow plastic pollution. At present, there are compostable plastics and there are biodegradable plastics.

Compostable plastics need to be industrially processed at very high temperatures to be broken down.

Biodegradable plastics will break down in the environment but only under the correct conditions.

This means that unless these bioplastics are disposed of correctly, they are just as harmful as any other type of waste pollution. Although they are less toxic, it would still take 450 years for a bioplastic cup to degrade in the ocean!

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. 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.

There are many sources of food waste and many different products we can get from it. For example, your household food waste can be taken to a compost processor and turned into compost that helps us grow more food. Another big area of concern is tackling food waste from supermarkets and the 'processing sector' of the food system.

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 (CO_2). The aim is to capture this gas using photosynthetic microbes called algae, preventing any additional emissions.

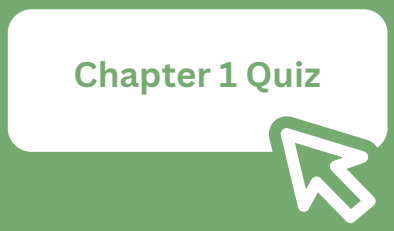
This challenge addresses Sustainable Development Goals (SDGs) 2, 7, 12. Click on the graphics to learn more.

Task 6 (5 min):

Click the graphic below to learn more about anaerobic digesters.

Chapter 1: Quiz

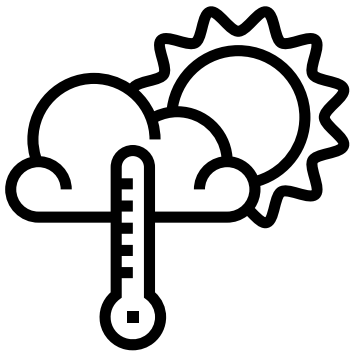
This quiz can be carried out through pen and paper or you can click the live link to access the online quiz. The online version will give you a score out of 100.



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



Climate refers to the average range of weather experienced in a **region** over a long period of time. Climate change is the changing of global climates, meaning that certain geographic locations are getting hotter and others are getting colder. This disrupts everything from ocean currents, sea levels, **survivability** of wildlife and of course, our ability to grow crops and raise **livestock**. A huge challenge for agriculture and food production is its reliance on a predictable climate. So when the earth's natural cycles and functions are disrupted, this challenges our ability to produce food.

Most human activities contribute to climate change and one of those is the production of food. When we look at the global food system, it is responsible for 26% of **greenhouse gas** emissions (Our World in Data, 2019) (6). This includes greenhouse gas (GHG) emissions during food production, processing, distribution and consumer food waste. Within this 26%, food production (livestock, crops and land use) is the strongest emitter of GHGs.

We must consider the challenge of reducing GHGs as a cooperative endeavour. In Ireland, agriculture is responsible for a large proportion of Ireland's GHGs, however this is not expected to change. The goal is to reduce each sector's emissions to achieve targets for a more **sustainable** existence. Out of necessity, agriculture will likely continue to be the largest contributor to GHGs; although improvements are needed. We will learn more about GHGs and various **innovative** solutions in the following section.

Before You Begin

The following words are key concepts for the upcoming chapter. Write your understanding of the following before continuing with the material. Use a dictionary to aid your understanding.

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

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 but we will go through it in more detail regardless.

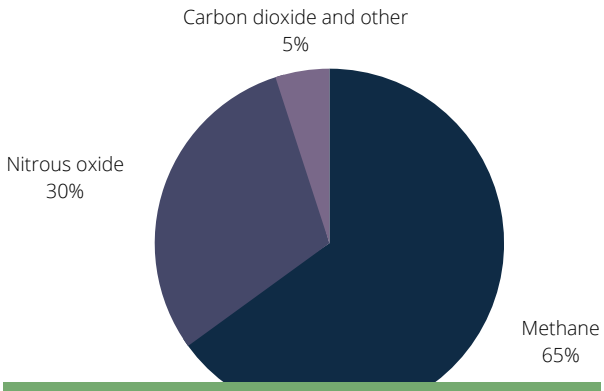
As we learnt in chapter one, nature produces carbon dioxide (CO2) and recycles it through the carbon cycle. However, humans are over-producing carbon and overwhelming the carbon cycle. Therefore, there is excess carbon dioxide in the atmosphere and this contributes to what we call 'global warming' or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

Oppose

Propose

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



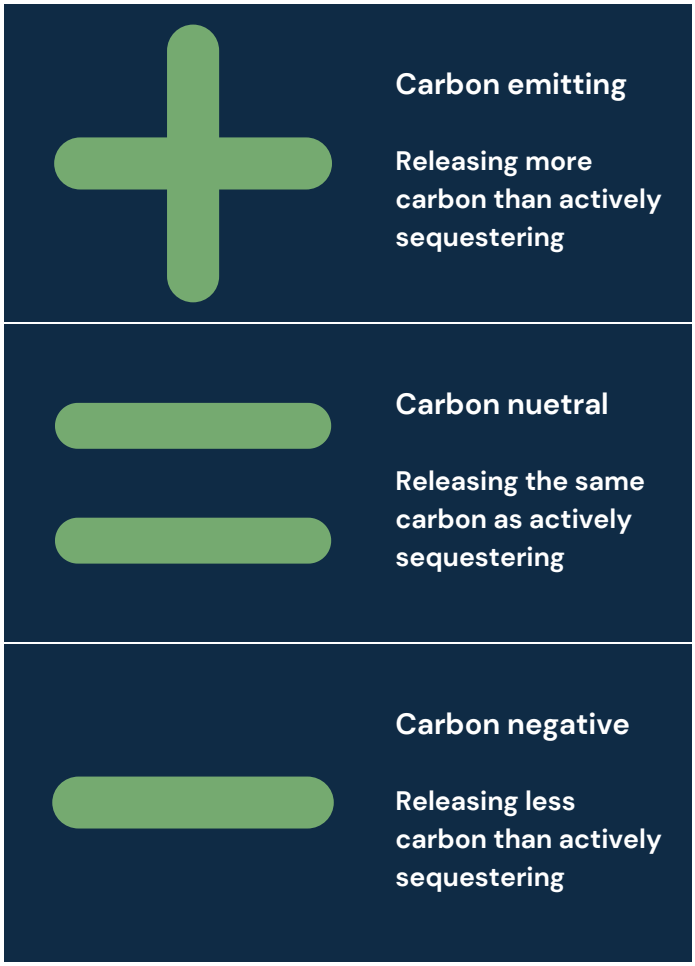
Understanding greenhouse gas emissions on Irish farms. **Teagasc**

Climate action is goal number 13 of the United Nation's Sustainable Development Goals (SDGs). Click the graphic above to learn more.

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.

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.



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.

DEVENISH™ Beyond Nutrition

Click the logo above to learn more.

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.

A much smaller proportion of biogenic methane emissions come from landfills and wetlands, again due to the presence of specific bacteria. Current advice from climate specialists is to reduce methane emissions, primarily from cattle and other ruminants. Several pathways are being explored.

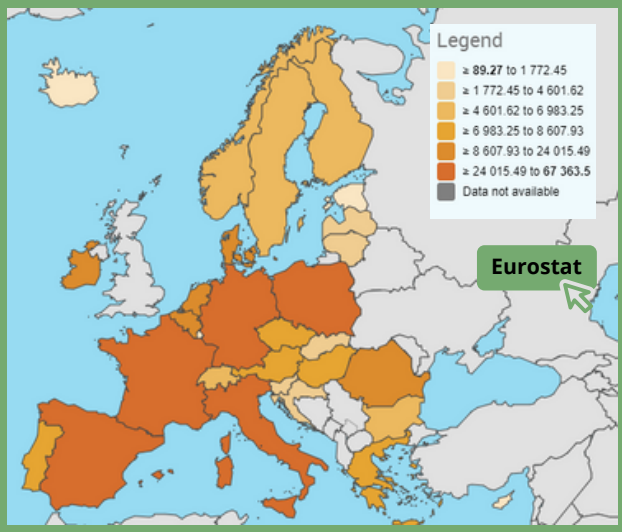
Reducing Methane

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.

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.**



Agricultural greenhouse gas emissions per capita (Source: Eurostat)

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.

Other research areas include:

'Climate friendly animals' - The project scientists are trialing different livestock diets that may reduce methane emissions. They are also studying different breeds of livestock to determine if there is a way to breed 'climate friendly' animals. Breeding involves selecting animals that have desirable traits, such as lower levels of methogenic bacteria, and creating offspring from those animals.

Mixed species grass swards - Legumes, such as clover, can be sown with other grasses. Clover has a special root system that form a symbiotic relationship with soil bacteria. This increases the availability of nitrogen to plants and reduces the amount of fertiliser required. These types of swards are better for soil and animal health.

Biodiversity habitat - Much of the wildlife habitat available in Ireland is located on farms. Shinagh Dairy Farm aims to manage 10% of the farm as natural habitat. This is important for both biodiversity and to restore natural services that biodiversity provide to the farm. We will learn more about these services in Chapter 3.

FARM ZERO C
Farming for a sustainable future

biorbic

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

Farm Zero C

Carbon Footprints

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.

What are F-gases?

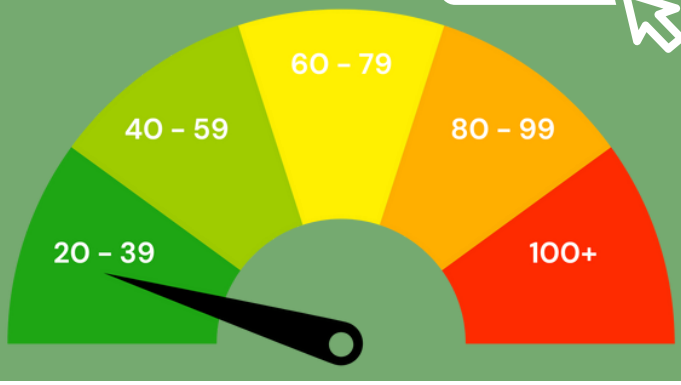
The three F-gases are: Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); Sulphur Hexafluoride (SF6).

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 foot print in CO2e.

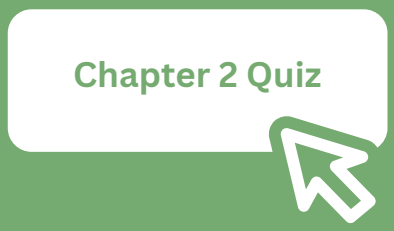
Step 1: Use the Lifestyle Impact Calculator to determine your score.
Step 2: Compare your lifestyle impact scores with the rest of your class and discuss possible reasons for high or low totals.
Step 3: Create a graph to represent the data.
Step 4: Discuss strategies to reduce your lifestyle impact score.

Lifestyle Impact Calculator



Chapter 2: Quiz

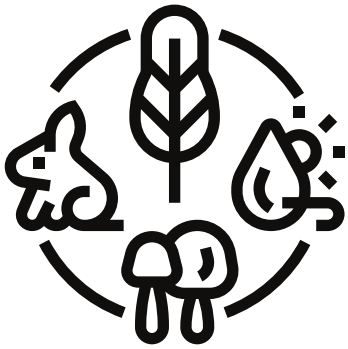
This quiz can be carried out through pen and paper or you can click the live link to access the online quiz. The online version will give you a score out of 100.



Quiz Questions

1. **What percentage of greenhouse gas emissions is the food system responsible for producing?**
    a. **1%**
    b. **26%**
    c. **65%**
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 (N20)**
4. **What does CO2e stand for?**
    a. **Carbon dioxide extra**
    b. **Carbon dioxide equivalents**
    c. **Carbon dioxide entries**

Chapter 3: Biodiversity



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. This has somewhat been achieved - although we must bear in mind that the food that is produced is not shared equally - this means that creating and maintaining habitat for biodiversity is more important than ever.

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.

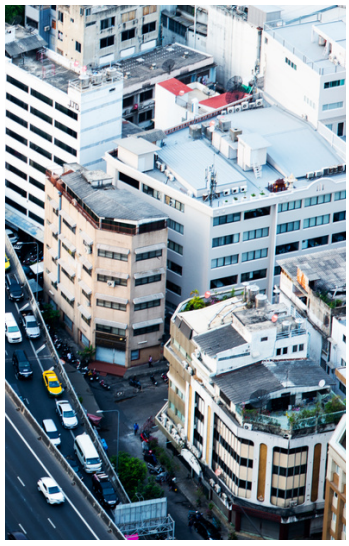
Human-made mass (weight), for the first time in history, now outweighs natural living mass (7). This was proved for the first time in 2020 but has been predicted for decades. Human-made mass includes all living and solid objects that exist on earth, including buildings, surfaces and livestock.

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.

Before You Begin

The following words are key concepts for the upcoming chapter. Write your understanding of the following words before continuing with the material. Use a dictionary to aid your understanding.

Consequences
Habitats
Crisis
Ecosystems
Detritivores
Cattle
Cultivation
Forage
Accustomed



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**.

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

Honeybee
Apis

Bramble
Rubus

Red fox
Vulpes vulpes

Common Pipistrelle
Pipistrellus pipistrellus

Herring gull
Larus argentatus

Robin
Erithacus rubecula

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?

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

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.

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.

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-existance of birds and farming activities.

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.

Maintaining semi-natural forests on farmland provides habitat for many species, including pine martens and red foxes.

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**

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.

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**

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.

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) .

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 spead between people and animals. Many people make contact with animals in their daily lives and this is where the risk of disease spread lies.

Task 11 (10 mins):

CDC

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

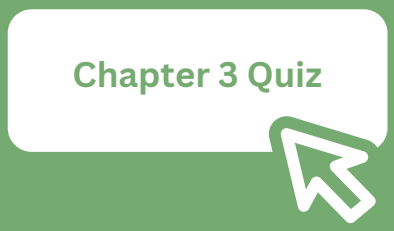
When a problem arises within society (i.e. the COVID-19 pandemic) the response is looked at in a way that considers the effect on each area of our society and environment. It is important that experts are included from veterinary and human medicine, social, biological and environmental sciences. Although 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.

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.

Chapter 3: Quiz

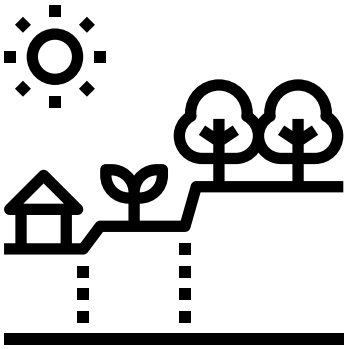
This quiz can be carried out through pen and paper or you can click the live link to access the online quiz. The online version will give you a score out of 100.



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 4: 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).

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.

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.

Before You Begin

The following words are key concepts for the upcoming chapter. Write your understanding of the following before continuing with the material. Use a dictionary to aid your understanding.

Capacity
Pasture
Dominant
Silage
Mean temperature
Unparalleled
Revenue
Economy
Enterprise
Adequate
Nutritious
Prohibiting
Regenerating
Imports
Exports

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 that 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

Land-Use

4.1 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. However, in order for economies to compete at an international level, they must play to their strengths.

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.

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. It is perhaps a chicken and egg scenario. 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**. Farms are businesses and often the main source of income for families. It is easier to import cheap potatoes from multiple countries than to produce them at home where the demand changes frequently. This is why it is so important to buy Irish produce and support Irish producers.

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 a suite of 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.

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.**

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.

Minimum tillage or 'min till' is a regenerative practice that prepares soil for planting in a lesser damaging way than other methods.

Cover crops can be planted before and after a profitable crop. They protect the soil from erosion and re-introduce nutrients for regrowth.

Multispecies grass swards are a planted mixture of grasses, legumes, brassicas and herbs. This creates diversity within grassland, benefitting soil and animal health.

All of these practices can be considered under the umbrella of regenerative practices. They are extremely important for agriculture's sustainability journey.

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.

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.

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. There are many different types of structures currently being used for vertical farming including skyscrapers, warehouses, greenhouses and even shipping containers. This means that areas which would traditionally be unsuitable for growing large quantities of food can now be productive. Plants grown this way need to have carefully controlled temperature, water, light and humidity. This all needs to be provided to the plants. If these requirements do not meet the plant's specific needs, the entire crop can be lost, just like traditional farming.

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.

It can be costly to set up a hydroponics system and they can be difficult to maintain, but as they can successfully grow crops at a faster rate in areas where crop growth would usually be impossible, this system is beneficial to an increasing demand for food into the future.

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. In order to assess if Origin Green is making progress, it must be measurable. 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. These schemes see more than 100 auditors undertake over 650 independent farm audits each week. Farmers get feedback after the audit, which helps them to make more informed decisions on improving their farm's sustainability.

Farm Level Achievements (so far):

SBLAS

1. The sustainable beef and lamb assurance scheme (SBLAS) members recorded a 6.3% average reduction in CO2 per unit of beef (2013-19).
2. Approximately 290,000 carbon footprints have been calculated to date at farm level.

At the manufacturing level, the focus of Origin Green is to help companies to develop a sustainability plan in accordance with the Origin Green Sustainability Charter within three key areas:

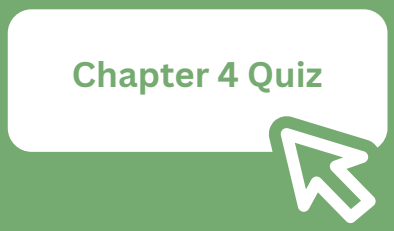
Origin Green

1. Sourcing sustainable raw materials
2. Development of sustainable manufacturing processes such as renewable energy and limiting food waste
3. Prioritising social sustainability in areas such as employee wellbeing, diversity, and inclusion.

Companies can only become members of Origin Green when their sustainability plan has been verified by independent auditors.

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**

Project 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?

The deadline for submission is the Friday 22nd December 2023. After Christmas, finalists will be selected and paired with a mentor in order to prepare them for the upcoming peer day. The peer day will be held in Dublin in mid February. We are looking forward to hearing your innovative ideas.

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