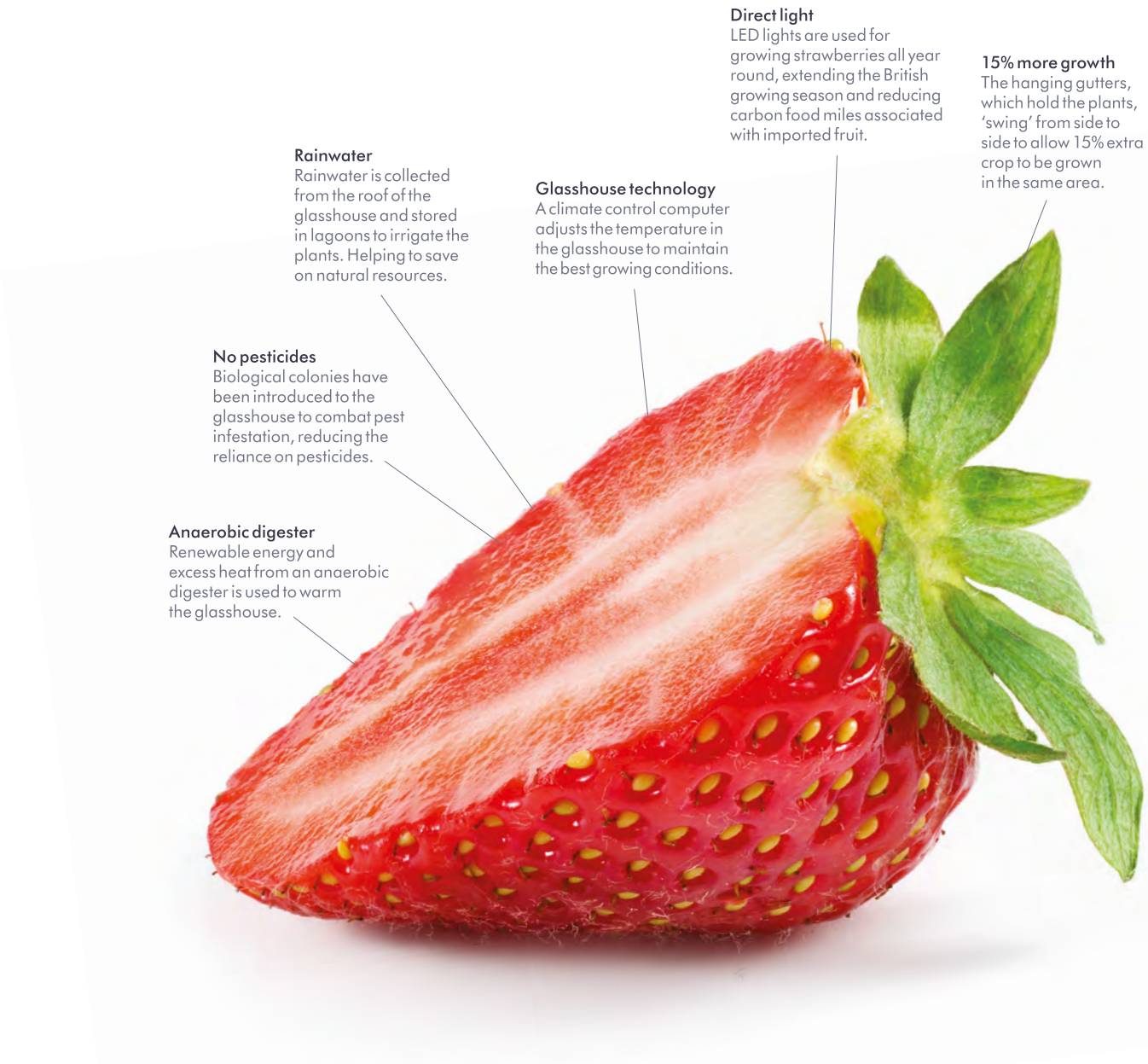
THE JAMES DYSON FOUNDATION

TEACHER'S PACK

Key stage 1 and 2
Engineering solutions:
The future of farming



CONTENTS

INTRODUCTION

Dyson Farming is a large-scale farming business which focuses on sustainability and technology-led innovation. They grow a variety of different crops, including cereals and maize and they rear livestock such as cows and sheep. They also generate their own energy to support their circular farming system. Dyson engineers support Dyson Farming by advancing traditional farming practices, ensuring they can be more effective, efficient, and sustainable, allowing them to grow food that is tasty, nutritious and in harmony with the environment.

This teacher's pack will introduce students to agricultural engineering, exploring how design and engineering can be applied to farming. Across six lessons, students will learn about the different roles on a working farm and how engineers can support the farming industry. They'll gain an understanding of where food comes from, including how it's grown, harvested, and produced. They'll explore the environmental impact of farming and how the industry is becoming more sustainable. Finally, students will learn to grow their own strawberry crops, using engineering inspiration from Dyson Farming to grow plants that provide fruit through the winter.

This pack was designed to complement the Science, Geography and Design and Technology curriculums at Key Stage 1 and 2.

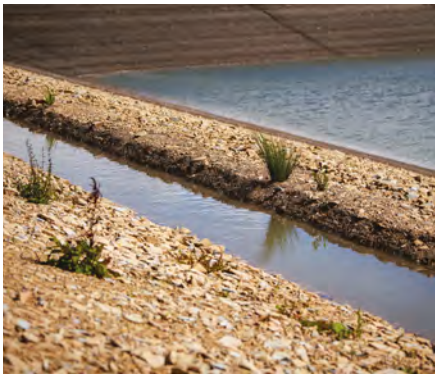
If you follow the lessons provided students will:
Understand the different roles on an active farm
Gain an understanding of how crops are grown and harvested and how livestock is reared, including how this is processed into recognisable foods
Learn how environmental factors, such as weather and soil type, can affect the growth of crops
Be able to recognise renewable energy sources and identify which are used within farming practices
Understand how engineering can improve traditional farming
Use design skills to build a prototype of sustainable strawberry packaging

Please note each lesson ranges between 1 hour to 1 hour and 30 minutes. These lessons can be adapted to suit different timetables – for example, the starter or wrap-up activities can be omitted to reduce each session. Each section can also be taught in isolation if time is limited.

This pack contains posters, lesson plans, worksheets, and videos. It also contains summary information to explain how the lessons relate to the engineering and science of farming and Dyson technology. Please familiarise yourself with this before you start teaching.

Find the videos and posters on our website:
www.jamesdysonfoundation.co.uk

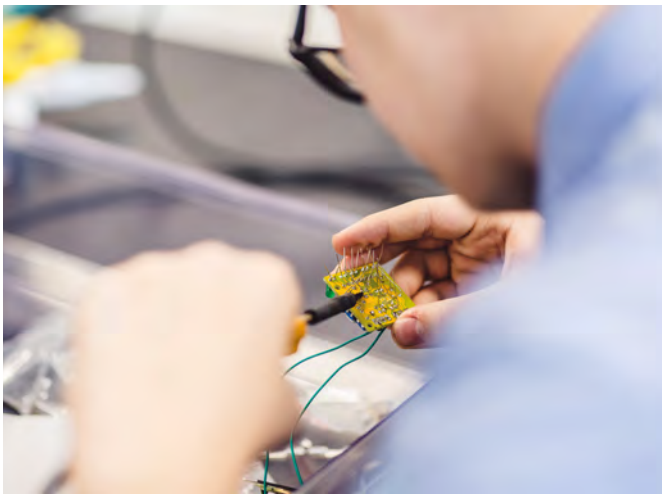


The James Dyson Foundation is Dyson's registered charity. Set up in 2002, it exists to inspire the next generation of engineers through educational resources, workshops and an international design competition.

"Young engineers have the passion, awareness and intelligence to solve some of the world's biggest problems. I set up the James Dyson Foundation to inspire the next generation of engineers with hands-on learning and experimentation, helping them to connect the theory they learn in the classroom with exciting and important engineering problems and solutions in the outside world."

James Dyson



AN INTRODUCTION TO DYSON FARMING

Who

Dyson Farming is a family-owned business, started by Sir James Dyson, who grew up in an agricultural community amongst farms in Norfolk. Sir James purchased his first farm in 2013, in the south of Lincoln.

What do they grow?

Since then, Dyson Farming has acquired 36,000 acres of farmland, producing: 49,000 tonnes of wheat, 11,000 tonnes of spring barley, 16,000 tonnes of potatoes, 6,000 tonnes of vining peas, 750 tonnes of strawberries and 100,000 tonnes of energy crops every year.

The future

Dyson Farming has a vision to benefit future generations through a commitment to sustainable food production at scale.

They strive to be a force for good in farming and leaders in efficient, sustainable and high technology agriculture through the support of their sister company, Dyson, in research and development.

"There's a huge diversity of roles and expertise needed to be part of making sure we can feed the 8 billion people that are in the world today, but also how we deal with climate change and how we do things so they're the right thing for the planet."

Daniel Cross
Managing Director of Dyson Farming

Image:
Dyson Farming Research crop trialing areas

SECTION 01
WHAT IS FARMING?

Students will learn about the history of farming in the UK, providing context on how important farming has been to British history. Students will learn about different types of farming around the world. They will also learn about the different roles that take place on a working farm, including how engineers can support with farming.

A BRIEF HISTORY OF FARMING IN THE UK

Farming is the raising of animals and the growing of crops on a farm. This typically occurs in the countryside because there is larger land space and lower population density.

Farming began in the UK on a small scale, with people growing small plots of wheat and barley near them for individual consumption. As civil engineering progressed in the 1700s, improvements were made in the transport industry, particularly along rivers and coasts. This enabled farming produce, such as meat and dairy, to be brought from the north of England to central cities, such as London. By the 1850s, the population in the UK had nearly tripled to 16.6 million, meaning there were more people to feed. Farming had to be intensified to meet the demand, so farmers began to utilise land in woodland areas and pastures. They also started to shift to more profitable crops, focusing on wheat and rye instead of barley.

Before the Second World War, Britain was importing 55 million tonnes of food a year. By the end of 1939, this dropped to just 12 million tonnes. Food rationing in the 1940s led to people growing their own food at home, including potatoes, peas, carrots, onions, and lettuces. Following the war, the Agricultural Act of 1947 was updated to benefit local agricultural activity, giving financial stability to farmers. These changes encouraged farmers to manipulate their crops to maximise the amount of food they could grow.

Supermarkets were introduced in the mid-20th century. The transition from small, local shops which sold specific food items, for example a bakery for bread and a greengrocer for fruit and vegetables, to shops which sold a combination of necessities caused increased competition between farmers.

When Britain joined the European Union in 1973, they became part of the Common Agricultural Policy which provided a support programme for farmers. This helped them find cheaper supplies, such as animal feed and fertiliser, ensuring food was cheaper for their customers, while providing farmers with a good income. Now, Britain produces less than 60% of the food that it consumes, relying on imports from other countries, enabling shops to sell produce from all over the world, all year round at competitive prices.

Decade old practices such as pesticide usage and increased livestock rearing has contributed to the increase of greenhouse gas emissions and loss of biodiversity. These challenges have shifted the focus of contemporary farming towards more sustainable practices.

Through this resource, students will learn how Dyson Farming are introducing new methods and technology into their farming practices to make farming more sustainable.

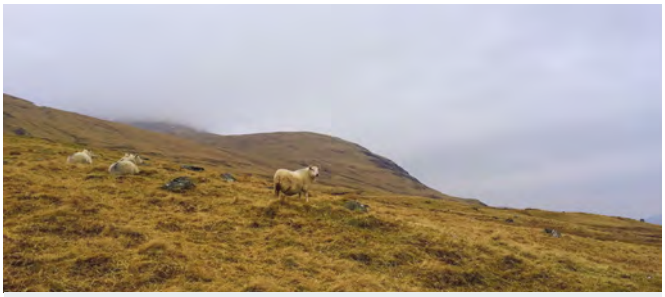
Members of the British Women's Land Army harvesting beetroot in World War Two (1942)

TYPES OF FARMING AROUND THE WORLD

Soil types, landscapes, weather conditions, and accessibility to machinery all contribute to the type of farming which is best suited to each area.

Arable

Arable farming is the growing of combinable crops, such as wheat and barley. Typically, it occurs on gently sloping or flat land which is neither too wet nor too dry. Arable farming requires the use of machinery for ploughing soil and planting crops. Arable farming is most likely to occur in the east of the UK.



Pastoral

Pastoral farming is the rearing of livestock, such as cows and sheep. This usually occurs in colder and rainier climates like that in the UK. Steep, sloping land with a lack of nutrients in the soil is the perfect place for pastoral farming, only heather and grass can grow here; which is perfect for sheep.

Dairy

Dairy farming is the breeding, raising and looking after dairy-producing animals, such as cows, to produce milk. The animals typically prefer flat land with lots of grass to graze on, as opposed to the steep land which sheep can make use of. Dairy farming often occurs closer to towns as the produce can quickly perish.

Mixed

Mixed farming involves growing crops and rearing animals on a rotational basis – a combination of arable and pastoral farming. By combining these types of farming, farmers increase their profit potential by reducing loss of income if poor weather prevents a good crop harvest. For example, if their crops are suffering from a hot summer, their animals are still a reliable source of income and food.

Poultry

Poultry farming is the rearing of domesticated birds, such as chickens, ducks, turkeys, and geese to produce meat and eggs – it's most commonly free range and organic. Poultry farming occurs all around the world, including the UK, United States and across Asia.

Aquaculture

Aquaculture is breeding, rearing and harvesting fish, crustaceans, molluscs, algae and organisms such as aquatic plants. Indoor tanks or outdoor ponds are often used to raise fish. Commonly farmed fish include salmon, trout, sea bass and prawns. Fish farming originated in Eastern and Southeast Asia, Eastern Europe, and South America.

Nomadic

Nomadic farmers will move with their animals from one place to another, searching for land for their animals to graze on and water to drink. This is similar to pastoral farming, but only occurs in countries with hot and dry conditions, such as Africa and Central Asia. Common livestock that are reared this way include sheep, cattle, donkeys, camels, goats, and horses.

Subsistence

Subsistence farming is growing crops and rearing animals for personal use. It's typically small-scale, allowing a farmer to feed their family. This type of farming is typically labour-intensive, using minimal tools and machinery. Subsistence farming is common in Africa, Southeast Asia, and parts of South and Central America.

Commercial

Commercial farming is any large-scale farming operations for the purpose of making a profit. Intelligent machinery and modern technology are used to maximise production and profits. Commercial farms may produce maize, tea and coffee, and typically occur in developed countries, such as the United States, India, France, and Holland.

MEET THE FARMERS AT DYSON FARMING

Tom Storr
Dyson Farming Research Agronomist

"A research agronomist is someone that assesses the health of crops and soils. It's my job to understand the structure of soil, for example, how crumbly it is, the colour, and whether there are pores for the roots to move through. By understanding these key components, it helps to determine both the type and health of the soil, meaning I can establish how to best support the wider environment."

Lucinda Smith
Dyson Farming Agronomist

"An agronomist is essentially a crop doctor. This means I assess the health of the crops for any disease or pests and make recommendations for plant protection products or nutrition which may be required. I look after all the crops that we grow at Dyson Farming, such as potatoes, maize, wheat, barley and oilseed rape. Potatoes are my favourite crop to grow but they're not necessarily the easiest, they require a lot of preparation to get right."

FARMERS TODAY

AGRICULTURAL METEOROLOGIST.
AGRONOMIST.
ANIMAL NUTRITIONIST.
ANIMAL WELFARE SPECIALIST.
BIODIVERSITY SPECIALIST.
BOVINE SPECIALIST.
CROP BREEDING TECHNICIAN.
CROP TECHNICIAN.
DRONE OPERATOR.
GLASSHOUSE MANAGER.
INNOVATION RESEARCHER.
LIVESTOCK BREEDER.
SHEPHERD.
SOIL RESEARCHER.
SPECIAL CROP BUYER.
STRAWBERRY PICKER.
SUSTAINABILITY MANAGER.
TECHNICAL AGRONOMIST.
TRACTOR OPERATOR.
VETERINARIAN.
WAREHOUSE MACHINIST.
WAREHOUSE OPERATIVE.

LESSON 01
FARMERS TODAY

Duration: 1 hour 10 minutes
Resources: Videos: Meet the farmers

Learning objective: To understand what farming is and the different roles that take place on an active farm.

Starter: 15 minutes	
Learning objective	**Activity**
Students will understand farming and the different roles on a farm.	Ask the class what they think farming is. You can showcase some general images of farming here, such as crop fields, tractors and cattle. Hand out paper and pencils and ask the class to write or draw different roles that they think occur on a working farm. Use the list on page 13 for guidance if you want to share some imagery here too. As a class, discuss what they came up with and compile a list.

Main activity: 40 minutes	
Learning objective	**Activity**
Students will broaden their knowledge of roles that may exist on a working farm.	Play the series of **farming and engineer profile videos**. Ask the students to remember one thing per video that they did not know before. As a class, discuss these points and create a new list of all the things they have learnt from the videos in combination with the information they already knew. Discuss whether they were surprised by anything they learnt from the videos.

Wrap up: 15 minutes	
Learning objective	**Activity**
Students will apply their new knowledge of roles on a farm to local farms.	Ask the students to think about a local farm, and whether any farming roles they've just thought about could be present on them. As a class, discuss what they would like and dislike about working on a farm and why.

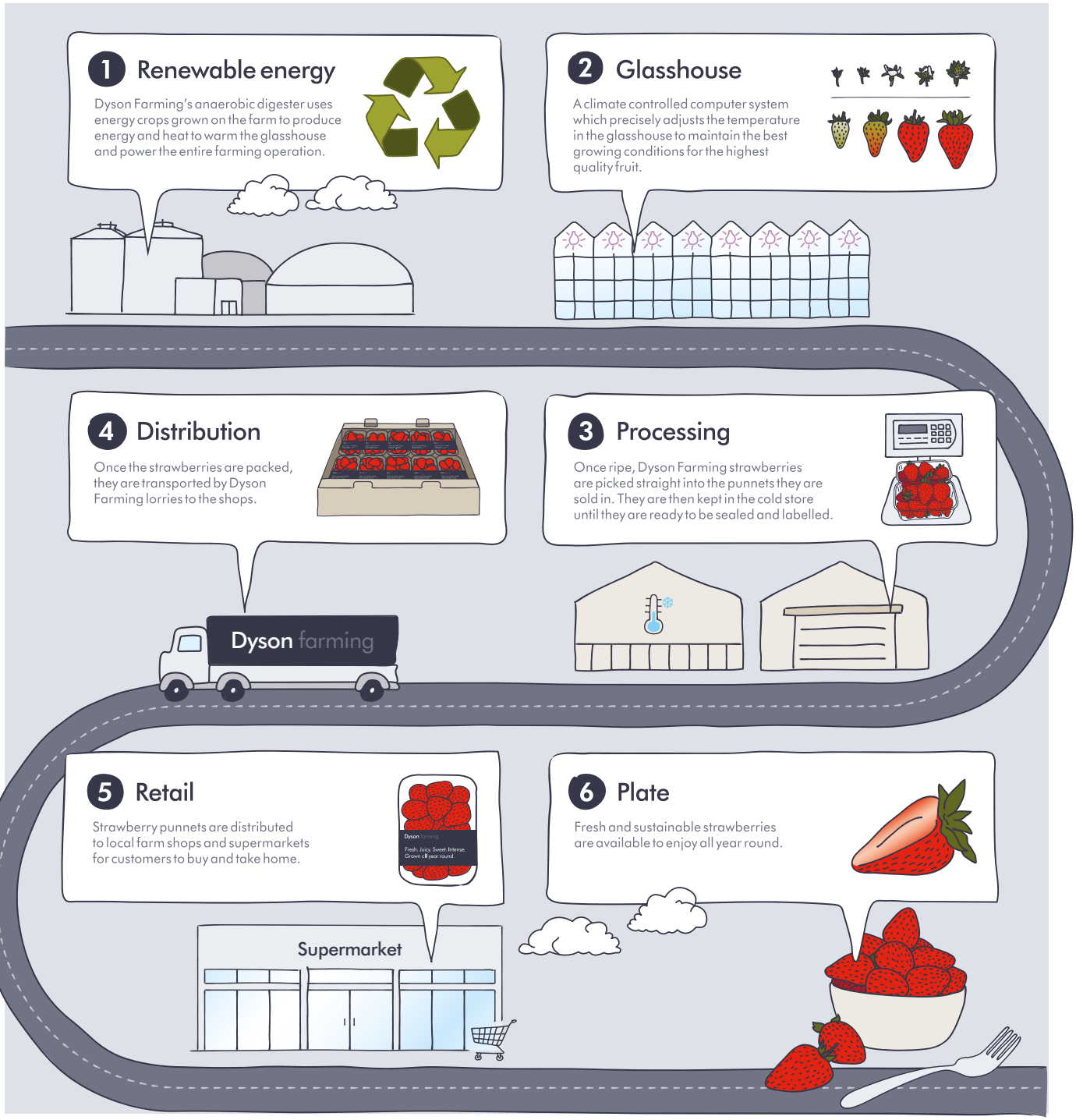
SECTION 02
FROM FARM TO FORK

Students will learn about where food comes from, including which crops and cattle can be farmed. Students will also learn about food production and processing, concluding with how food reaches consumers. This section will take a deeper dive into the crops and livestock that Dyson Farming produce.

FOOD SUPPLY CHAIN

How does our food make its way to us?

All food will begin its journey on a farm. This is where crops are grown and livestock is reared. It then makes its way to a factory for processing. This is where raw ingredients become something that we can eat. Once processed, the food is quality checked and packaged, ready for distribution. It is then passed to the distribution sector. This is when the prepared food is transported to shops where people can buy it. Food finishes its journey in the retail sector: in supermarkets, corner shops or local markets, or straight to restaurants and commercial kitchens.



WHERE DOES OUR FOOD COME FROM?

Food provenance is a term used to describe where our food is farmed. This helps us to understand how our food has been produced and transported, before arriving on our plates.

Food groups that are grown

Fruit, vegetables, herbs, wheat, barley, oats, sugar beet, oilseed rape, and linseed.

By improving the conditions that crops are grown in, farmers can directly improve the yield of their crops. To do this, they will work hard to prepare the soil and sow the seeds at times of the year which is best for each crop. They will ensure there's regular water and plenty of sunlight reaching the crop. Finally, they use control factors, such as wildlife highways to limit damage and disease from wild animals.

Livestock that is reared

Cattle, sheep, pigs, goats, and poultry (chickens, turkeys, ducks).

Farmers can ensure the quality of their livestock by rearing them in conditions and on land which is best suited for them. For example, sheep can be reared in pastoral farming, which means farmers should choose areas with plenty of grass and shade during the summer.

Food that is caught

Fish (mackerel, haddock, mussels, scallops, tuna).

Ways to catch fish:

Trawling: A fishing boat pulls a net along the seabed – this method will catch the maximum amount of fish, but will impact the marine life on the seabed.

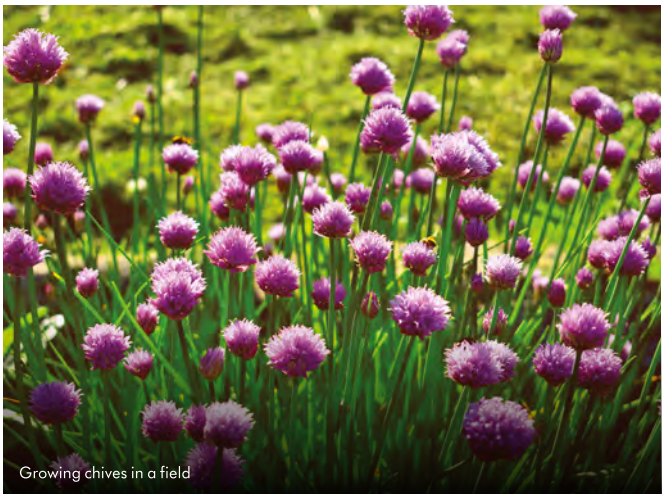
Line caught: This is on a smaller scale to trawling – a fisher will head out on a boat and use a rod, a line, and bait to catch a single fish at a time.

Pots: This is used to catch shellfish such as lobsters and crabs. Pots containing bait are placed on the seabed and are collected by fishers at a later date.

Growing apples in an orchard

Rearing sheep on a farm

Growing peas in a field



Growing chives in a field

FOOD PRODUCTION

Reasons to process food

Almost all farmed produce must be processed before it can be eaten. Food processing refers to the stages that raw ingredients go through to become something that we can eat.

To make it safe to eat

By killing harmful bacteria which could be present.

To provide year-long access to foods

For example, raspberries and strawberries are typically grown from May until June in the UK, freezing them allows us to continue eating them throughout the year.

To make foods easier to prepare

For example, pre-dicing meat, pre-preparing and portioning vegetables, and microwavable foods, such as rice.

To give foods a longer shelf life

Preservatives are chemical substances added to foods to prevent spoilage, which can be caused by bacteria, moulds, fungus, and yeast.

Primary and secondary food processing

There are two types of processing that raw ingredients go through. Primary processing refers to the process which turns raw produce into something that can be used as an ingredient. Secondary processing advances this, taking that ingredient and turning it into something that can be consumed.

Primary input

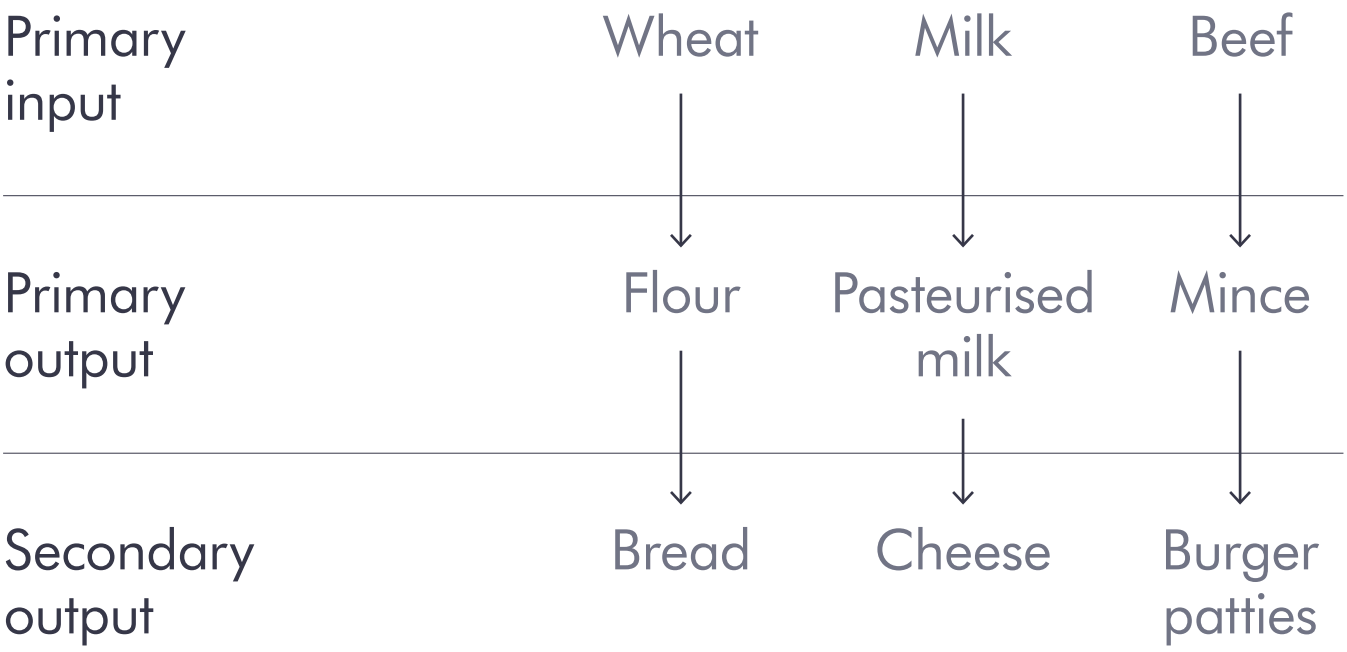
Raw ingredients from a field, factory, or processing store.

Primary output

The first round of processing could turn foods into edible items, or food stuff that can be cooked into meals.

Secondary output

The edible items or food stuff is then processed again, often with additional ingredients, to produce recognisable food items.



DYSON FARMING PRODUCTION PROCESS

Each food type that is grown or reared by Dyson Farming uses a different process before it can be sold to customers.

After processing, it's transported to shops and restaurants using Dyson Farming's fleet of lorries and tractors.

Potatoes

Potatoes are harvested from the field and transported via trailers to a storage shed. They're tipped onto a grading line where mud and stones are shaken out, sorted into size by hand. The potatoes are stored in a state-of-the-art cold store, ensuring they maintain freshness until they're sold to the customer. The potatoes are then packed into bags or boxes and transported to shops, restaurants, and other factories to be cooked, or further processed into other food such as crisps.

Peas

Peas are picked by intelligent vining machines in the field and transported immediately to an off-site freezer to lock-in their nutrients as fast as possible. Once arrived, the peas are washed, packed and frozen, ready to sell to customers.

Cereals

Cereal crops, such as wheat, barley, and oilseed rape are harvested by a combine harvester in the field. They are then transported by tractors or lorries to a grain store. In the stores, heat is used to dry the grain to the perfect moisture level for storage and later processing. The dried cereals are then transported to external companies who process the raw ingredients into foods, such as flour, beer, and rapeseed oil.

Forage crops

Forage crops, including maize, rye, and barley are foraged on-site and transported to silage clamps – huge containers designed to create healthy bacteria. The crops are chopped into small pieces, piled on top of each other and compressed by enormous rollers, preventing them from rotting. Then they're fed into anaerobic digestors throughout the year.

Sugar beet

Sugarbeet is harvested from the fields and transported by lorries to a factory where it's turned into sugar. The process of turning sugar beet into sugar can take around five months.

Strawberries

Dyson Farming strawberries are grown in their purpose built glasshouse. They're individually picked by experts and placed immediately into punnets to be distributed across the country. You'll find out more about this in Section 04. Case Study: Dyson Farming Glasshouse (pg 31).

Cows

During the spring, cattle are bred to produce calves which are cared for by their mother until they're three months old. The calves are then weaned and fed a forage-based diet of grass and cereals which are grown on the farm. Cows typically roam the fields for eight months of the year, staying inside warmer barns for the winter months. With the support of Nutritionists and Veterinarians, Dyson Farming can ensure their livestock are happy and healthy.

Sheep

Sheep are bred to produce lambs in the spring, raised by their mothers for the first 12-weeks. The lambs are then fed a forage-based diet and move fields throughout the year which benefits the soil. Once the lambs have reached the right age and weight, they are sent to an abattoir. The meat is then processed, packaged, and supplied to local customers using their refrigerated delivery vans.

LESSON 02
WHERE DOES OUR FOOD COME FROM?

Duration: 1 hour 40 minutes
Resource needed: Worksheet 02: Eat well guide

Learning objective: To understand which food groups are grown, reared, and caught and how these ingredients can be processed into food.

Starter: 15 minutes	
Learning objective	**Activity**
Students will start to think more about the food that they eat.	Show the class some images of food they may recognise, for example, pasta, sandwiches or salads. Ask them to think about where these foods may come from and how they are made.

Main activity (Part 1): 30 minutes	
Learning objective	**Activity**
Students will understand how their food is produced.	Divide the class into groups and label them one of the following: Grown, Reared, Caught. Ask students to think about the crops or food that may fall into these categories. For example, carrots and potatoes are grown, cows and pigs are reared, trout and cod are caught. Ask them to list as many as they can. At the end of the lesson, come together as a class and discuss what they've come up with. Invite students from the other groups to think of others to add.

Main activity (Part 2): 40 minutes	
Learning objective	**Activity**
Students will consider what types of food they eat and how their favourite meals are made.	Ask the students the following questions: – What is your favourite food? – How would you make this food? Once they have identified their favourite meal, ask them to list ingredients used to cook it. For example; , spaghetti is made from flour, which is made from wheat, and egg. Using **Worksheet 02: 'Eat well' guide** – let the students categorise these ingredients into: – Fruit and vegetables – Carbohydrates – Protein – Dairy and diary alternatives – Oils and spreads – Other, for example, confectionery and sauces.

Wrap-up: 15 minutes	
Learning objective	**Activity**
Students will think more about the food that they eat.	Once the students have categorised the ingredients of their favourite meal, ask them the following questions: – What does this tell you about your favourite meal? – Is this meal healthy? Why? – What could you change to make it a healthier choice?

LESSON 03
SOIL TYPES

Duration: 1 hour 15 minutes
Resources needed: Worksheet 01: Soil types at Dyson Farming, Worksheet 03A: Soil Vs Crop.

Learning objective: To understand how different soil types and weather conditions can effect growth.

Starter: 15 minutes	
Learning objective	**Activity**
Students will understand different soil types and how weather conditions can effect them.	Ask the students what they think soil is. Explain there are lots of different types of soil, listing them on the board. You can use **Worksheet 01: Soil Types at Dyson Farming** to support with this. As a class, list all the different types of weather conditions that occur in the UK. Explain that weather conditions not only effect the types of soil that exist in certain places, but also how crops grow. In groups, ask the students to think about why the weather may effect crop growth e.g. wind and rain may break the crop, too much sun may dry out and burn the crop.

Main activity: 40 minutes	
Learning objective	**Activity**
Students will understand the differences between soil types.	Head to an outside area such as your school field. Select a few areas which may be affected by different weather conditions. For example, choose an area which receives lots of sun or an area close to tree roots and collect soil samples from both. **Use Worksheet 01: Soil types at Dyson Farming** Using the images and descriptions, compare the soils found at your school with soil found on Dyson Farming land.

Wrap-up: 15 minutes	
Learning objective	**Activity**
Students will identify different types of farming in their local area.	**Use Worksheet 03: Soil vs crop,** to determine which crops should be grown in each soil type. Ask the students to reflect on any crops or food that they know is grown in their local area or at home. E.g., oilseed rape (yellow crop), cattle rearing, corn, or fruit and vegetables at home. Evaluate why those crops may be grown there e.g. high/low rainfall.

SECTION 03 ENVIRONMENTAL IMPACT OF FARMING

Students will learn about the environmental impact of farming and how this has changed over recent years. They will begin to understand different renewable energy sources that are commonly used across the farming industry, as well as practices used to protect and promote biodiversity. Finally, students will also be able to understand the advancements that have been made to technology used across farming.

RENEWABLE ENERGY

Renewable energy is generated from sources which do not deplete when used. Examples include sunlight, wind, water, and geothermal heat. The farming industry is one of the largest contributors to CO_2 emissions. To lower emissions, many farmers are turning to renewable energy sources to generate power for their farms, diversifying lots of farm businesses.

Rainwater storage at Dyson Farming

DYSON FARMING SUSTAINABILITY AND BIODIVERSITY

Dyson Farming is continuously investing in infrastructure, soil, biodiversity, and ecology on their farms. They do this through using advanced technology and the latest research to improve crop yields, whilst limiting the negative impact their practices have on the land and environment.

Dyson Farming actively manages 400,000m of hedgerows, 20,000m of newly planted hedges and 17,500m of laid hedges. As well as 11,700 native trees and 250,000m of field drainage ditches, rivers and streams while also rebuilding over 10,000m of dry-stone wall, helping to support with biodiversity and the quality of the land.

On a farm in Lincolnshire, Dyson Farming have built a 50-million-gallon reservoir to support the balance of water throughout the year. The reservoir has a specially designed lip, allowing water to remain available for all wildlife and it's surrounded by 15 hectares of wildflowers, supporting pollinating insects like bees and butterflies.

Since 2018, the work carried out by Dyson Farming to improve habitats and nesting opportunities on their land has enabled them to record 20 species of rare birds, including the yellow wagtail and corn bunting. Additionally, barn owls, which were once in decline in the UK, have begun to flourish on Dyson Farming land. In 2021 alone, they recorded 74 chicks and eggs.

Investments in tilling technology which prepares soil for agriculture, drainage, and irrigation, in combination with a reduction of fertiliser and pesticide usage, means Dyson Farming have significantly contributed to the environmental stability of their farms.

Wild flower borders help maintain biodiversity alongside arable fields

Owlets rescued from fields

A specially designed reservoir helps to balance the water levels

Improved drainage alongside fields reduces flood risk

DYSON FARMING TECHNOLOGY AND MACHINERY

Soil mapping and self-driving tractors

Dyson Farming's combine harvesters, and other field-based equipment, use technology to work the land with incredible accuracy. Dyson Farming use a combination of GPS and beacon systems to give millimetre accuracy for each row of planting. This technology has allowed Dyson Farming to use the minimum amount of chemicals and fuel needed to control weeds such as pernicious black grass and diseases such as yellow rust.

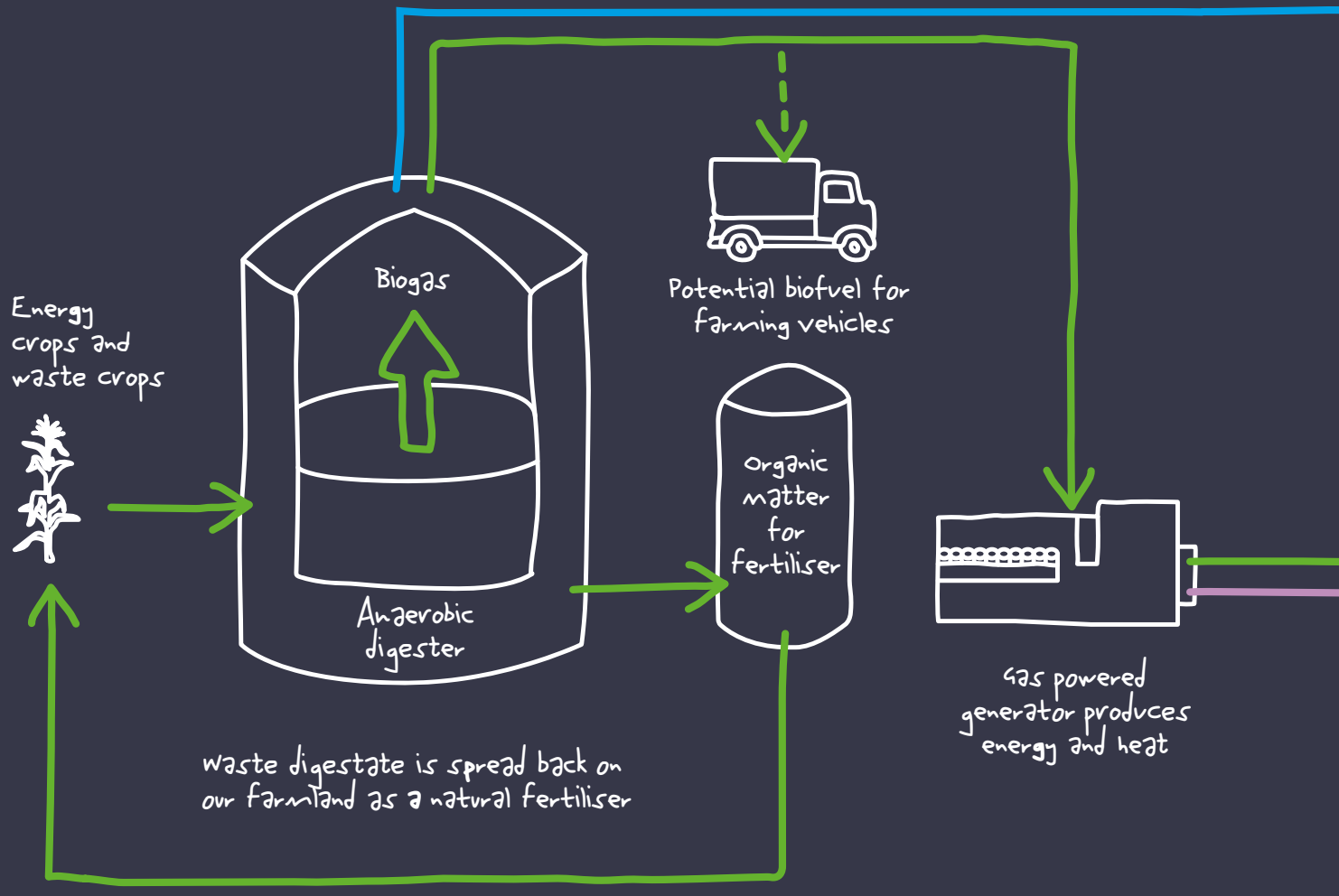
Vision systems on drones

Drones are used to survey the fields from above. With this data, combine harvesters and tractors can be programmed to avoid rare ground nesting birds such as the Marsh Harrier. As a result of using this technology, nesting sites are less likely to be disturbed.

Soil mapping – used to determine how much seed is required in a specific area of the field

DYSON FARMING
RENEWABLE ENERGY GENERATION

Dyson Farming use anaerobic digesters to produce energy for their farming operations. The digestion chambers are a sealed, oxygen-free tank designed for the anaerobic digestion of organic waste and microorganisms to produce biogas. This works much like the stomach of a cow.



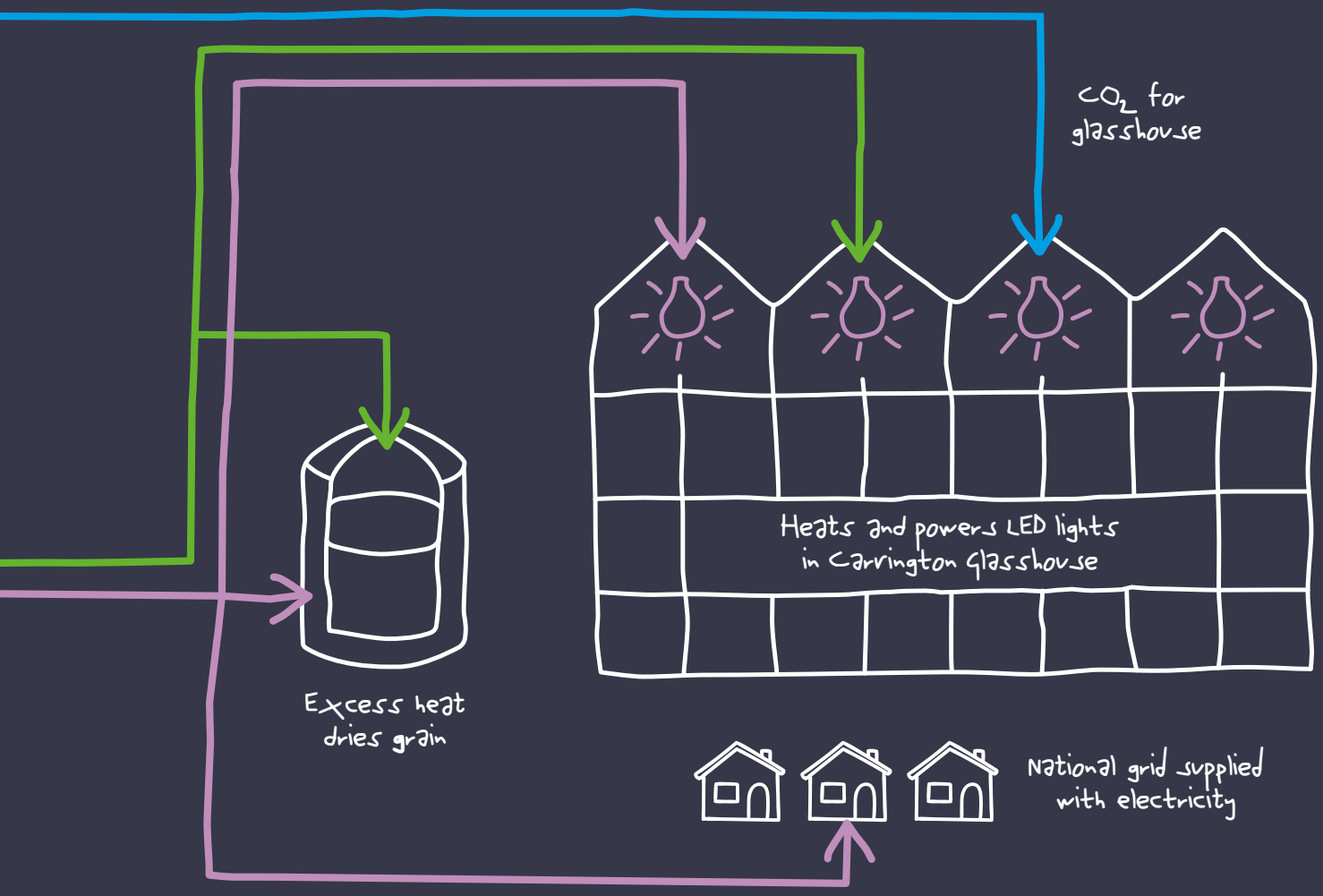
There are two by-products that can come from using an anaerobic digester:

Digestate

This is applied to nearby fields as an organic fertiliser to improve soils and crop yields.

Heat

Using the anaerobic digester enables Dyson Farming to power their farmhouses and machinery, dry and heat their agricultural produce, and fertilise new crops. Heat is also used to heat the glasshouse during off-peak seasons. It contributes to their circular farming system which creates the best environment for their crops to grow in, ensuring they supply high quality produce which tastes good.



"I'm hopeful that we can continue to contribute to the very necessary transformation of agriculture, while protecting the countryside, and that this will drive meaningful advances in sustainability."

James Dyson
Founder

LESSON 04
RENEWABLE ENERGY

Duration: 1 hour 40 minutes
Resource needed: Worksheet 04A: Build a Pinwheel Challenge Card, Worksheet 04B: Build a Pinwheel template, A paper straw, a pair of scissors, a pushpin or brass fastener.

Learning objective: To understand what renewable energy is and how this can be supported by engineering.

Starter: 15 minutes	
Learning objective	**Activity**
Students will understand what Dyson Farming are doing in sustainability and biodiversity on their working farms.	Show the students the following video: **Case Study: Sustainability at Dyson Farming** which highlights some of sustainability practices used by Dyson Farming. Encourage the students to share any other ways that Dyson Farming could be more sustainable. For example, wind turbines, solar panels, a use for farming waste.

Main activity (Part 1): 25 minutes	
Learning objective	**Activity**
Students will learn to build a pinwheel and how to make it more effective.	Share **Worksheet 04A: Build a Pinwheel Challenge Card** with your class, along with the template on **Worksheet 04B**. Ask the students to design and cut their own pinwheel. The context for this Challenge Card was inspired by design icon Heron of Alexandria. Wind has been a vital source of energy for centuries. Heron of Alexandria, a mathematician and engineer, invented a wind-powered organ around 60 AD. Windmills originated in ancient Greece during the 1st century. You may wish to show an image of Heron of Alexandria on the board.

Main activity (Part 2): 20 minutes	
Learning objective	**Activity**
Students will identify what works well on their pinwheels.	Put the pinwheels to the test. Take the students outside to test the durability of their pinwheels. Ask the students to think about what works well.

Wrap-up: 15 minutes	
Learning objective	**Activity**
Students will start to think critically about their pinwheel and how they can improve the design.	Ask the students how their pinwheels could be improved, note some of these ideas down on a whiteboard. Explain that this is how engineers work to improve their designs. Provide some prompts/suggestions here e.g. – The thinner the blades, the faster it spin; – The stronger the wind the faster it spins; – The looser the connecting joint the faster it spins. Encourage the students to think about what they could add or change in the design to make the windmill more efficient. For example, could they use different materials, a bigger fan, make the blades thinner for more speed etc.

Image on the left:
A tractor depositing chopped energy crops into a silage tank

SECTION 04
DYSON FARMING GLASSHOUSE

This section will introduce students to Dyson Farming's glasshouse; the home of their strawberry crops.

This case study will help demonstrate how engineering principles can be applied to farming practices to make farming more efficient. Students will have the opportunity to apply those principles to their own strawberry crops.

BRITISH STRAWBERRIES GROWN ALL YEAR

Dyson Farming has a 15-acre glasshouse in Carrington, Lincolnshire, producing hundreds of tonnes of strawberries every year. The technology in the glasshouse supports the advancement of sustainable farming in the UK, because supplying British fruit all year round avoids the unnecessary food miles that come from importing strawberries during off-peak times of year.

Powered with renewable electricity and surplus heat from Dyson Farming's anaerobic digester, the giant glasshouse is 424m long with 832 rows of strawberries. There are 700,000 strawberry plants which will produce 750 tonnes of strawberries each year for British consumers.

The glasshouse enables high-quality strawberries to be grown at scale, in a sustainable way, out of season by drawing on the expertise of the Dyson Farming team. This means the team can grow perfect strawberries during times of the year when they are usually in short supply, such as early spring and through late autumn and winter. To do this, Dyson Farming have combined sustainable farming practices and technological innovation.

A row of strawberries in the glasshouse

TECHNOLOGY IN THE GLASSHOUSE
HEAT. WATER. SPACE.

Technology in the glasshouse ensures Dyson Farming can reliably produce their crops of strawberries.

Warm temperatures

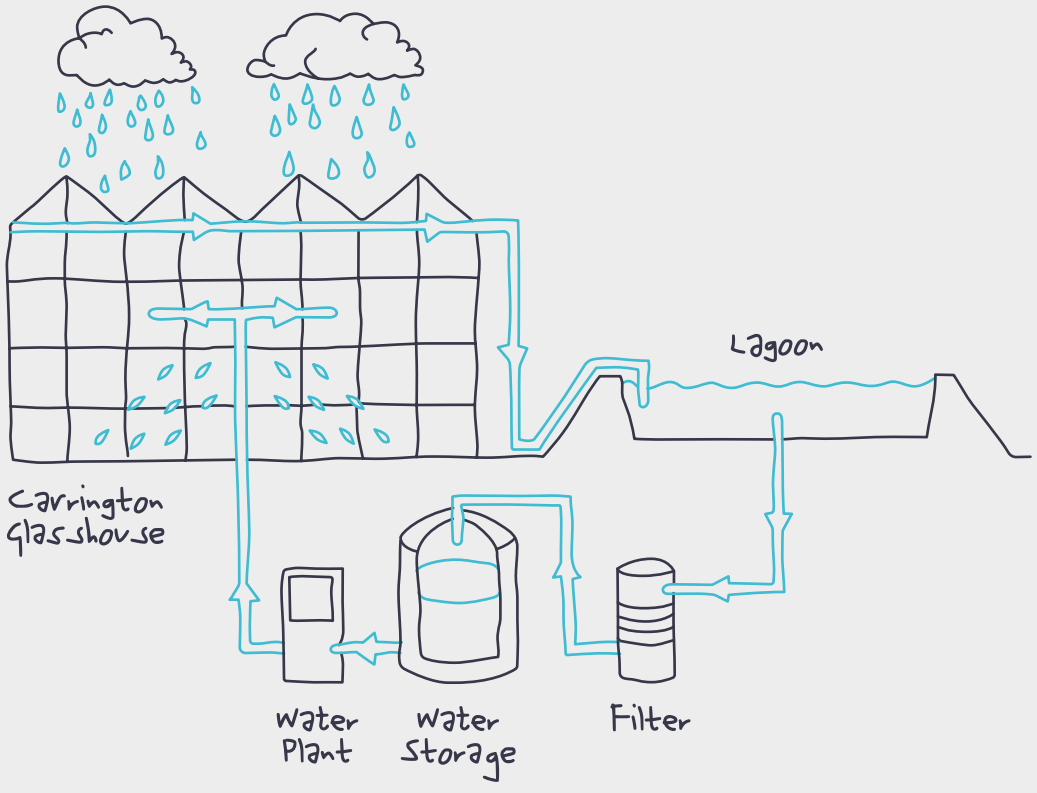
Firstly, there is a climate control computer system which adjusts the temperature in the glasshouse to maintain warm growing conditions for the best quality strawberries.

Adequate water

Secondly, rainwater is harvested from the glasshouse roof, stored in a lagoon, and used to irrigate the plants through an automated dosage system.

Clever use of space for more plants

Thirdly, there are hanging gutters which hold the plants, allowing them to 'swing' from side to side, which enables 15% extra crop to be grown in the same area compared to traditional strawberry planting methods.



TECHNOLOGY IN THE GLASSHOUSE
LIGHT

Lights to grow in the winter

In some areas, LED lights are used in combination with heat from the anaerobic digester to grow strawberries when it's typically too dark in Britain. Two types of LEDs are used:

Far-Red

These increase the growth of the plants.

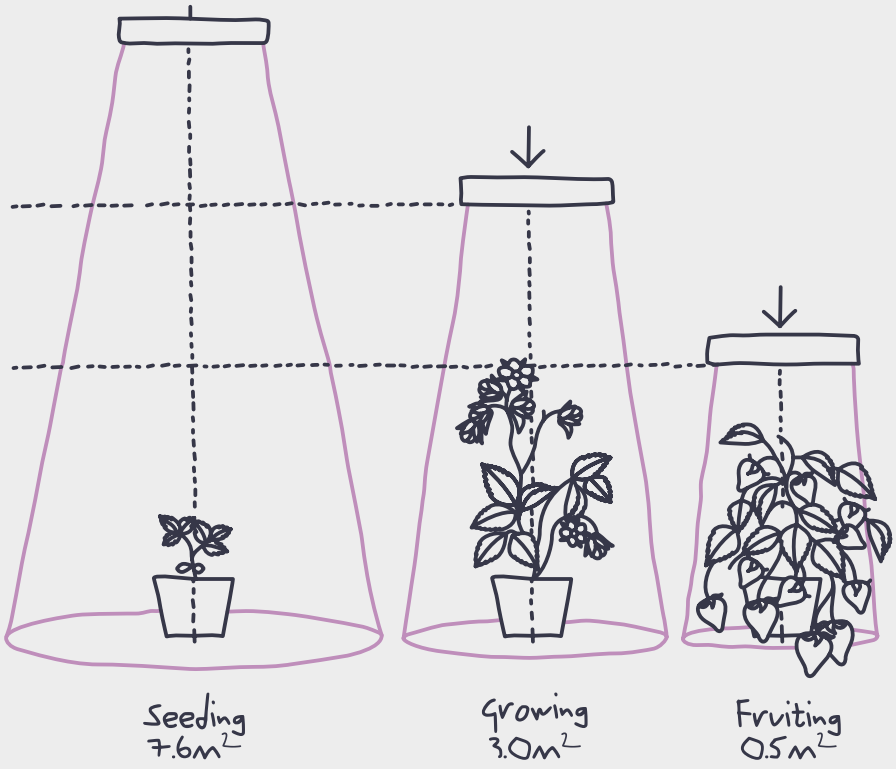
Blue and Red

These produce artificial light to encourage flowering and fruiting.

Height adjustments

The glasshouse team adjust the height of the lamps to help the strawberries grow taller when they're younger and produce more flowers and strawberries when they're more mature.

The LEDs are managed by the Dyson Farming team to ensure the best growing conditions and growth. The lights are typically used in the morning and afternoon in autumn and winter when the hours of natural daylight are shorter. The lights help to mimic the natural environment that strawberries are grown in, during the summer.



GROWN SUSTAINABLY AND AT SCALE

"Sustainable food production, food security and the environment are vital to the nation's health and the nation's economy; there is a real opportunity for agriculture to drive a revolution in technology. Efficient, high-technology agriculture holds many of the keys to our future. Dyson Farming strives to be at the forefront of this."

James Dyson
Founder

GROWN IN LINCOLNSHIRE, ALL YEAR ROUND.

15% more growth
The hanging gutters, which hold the plants, 'swing' from side to side to allow 15% extra crop to be grown in the same area.

Direct light
LED lights are used for growing strawberries all year round, extending the British growing season and reducing carbon food miles associated with imported fruit.

Rainwater
Rainwater is collected from the roof of the glasshouse and stored in lagoons to irrigate the plants. Helping to save on natural resources.

Glasshouse technology
A climate control computer adjusts the temperature in the glasshouse to maintain the best growing conditions.

No pesticides
Biological colonies have been introduced to the glasshouse to combat pest infestation, reducing the reliance on pesticides.

Anaerobic digester
Renewable energy and excess heat from an anaerobic digester is used to warm the glasshouse.

STRAWBERRY PRODUCTION AND PROCESSING

Dyson Farming strawberries are picked by experts on-site. The strawberries are then transported to the cold store to chill before packing, preventing bruising and condensation during transportation. These are then packed on-site and distributed using Dyson Farming's refrigerated vehicles to local farm shops and supermarkets.

Strawberries in punnets ready for distribution

LESSON 05
GROW YOUR OWN STRAWBERRY CROP

Duration: 1 hour 20 minutes
Resources needed: Video: How to plant and grow your strawberry crops, Worksheet 05: Strawberry plant diary.

Learning objective: To understand how engineering principles can improve traditional farming practices.

Starter: 20 minutes	
Learning objective	**Activity**
Students will understand what strawberries are and how they are grown.	Ask the students to describe what a strawberry is. Ask the students how they think strawberries are grown, including equipment they may need to do this e.g., plant pots, soil, sunlight, water. Show the students the following video: **Case study: Dyson Farming Glasshouse**. Explain that the students will grow their own strawberries and understand how engineering principles can help grow more and higher quality strawberries.

Main activity: 45 minutes	
Learning objective	**Activity**
Students will learn how to plant and grow strawberries. **Control crop**: this will be the strawberry plants that you grow only using natural aid e.g. sunlight, human watering. **Engineered crop**: this will be the strawberry plants you grow using the LED lighting rig, water dosage system, and liquid plant food.	Show the students the **How to plant and grow your strawberry crops** video which shows a Dyson Engineer explaining how the equipment is used and how to plant the crops. After watching the video, start to plant your strawberry crops. Decide which trough will contain the 'control crop' and which trough will contain the 'engineered crop'. Have the following equipment laid out ready for the students: – 2x planting troughs and trays – 4x bags of coir – 1x bottle of strawberry plant food – 1x water dosage system – 8x mini trowels – 2x LED lighting rigs – 1x refractometer. Ask the students to identify the equipment. Explain that the LED lighting rig will provide crops with light during darker weather conditions and the water system will ensure that plants have access to the right amount of water when natural weather conditions may cause over or under-watering. **Please note:** It is best to plant the strawberry crops in September so they can grow naturally outside until October. From here, bring both crops inside. Place both by a window which has access to natural light. Add the LED lighting rig and water dosage system to the plant you have labelled as 'engineered' crop. Feed and water the 'control' crop to ensure it can survive to its best ability.

Wrap-up: 15 minutes	
Learning objective	**Activity**
Students will understand how engineering can make farming practices more effective and efficient.	Explain to the students that they will be monitoring the difference between the 'control' and 'engineered' crops. Use **Worksheet 05: Strawberry plant diary** as a template. Complete the first section and note the key differences from when you first planted the crops to their first month of growth. Note further changes to the crops once a week there after.

LESSON 06
SUSTAINABLE PACKAGING

Duration: 1 hour 20 minutes
Resources needed: Paper, pens, and prototyping materials such as cardboard and tape.

Learning objective: To understand how engineering principles can improve traditional farming practices.

Starter: 15 minutes	
Learning objective	**Activity**
Students will start to consider the packaging they see at home and understand whether it's necessary, sustainable, or intelligent.	Ask the students to think about food packaging that they've seen at home. Put some examples of these on the board, e.g., plastic packaging for pasta, plastic punnets for fruit and vegetables, crisp packets. Ask the following questions: – What is it made from? – Can it all be recycled? – Does it keep the food fresh? – How could it be improved?

Main activity: 45 minutes	
Learning objective	**Activity**
Students will learn how to build a prototype considering sustainability.	Explain to the students that they are going to design and build a sustainable packaging prototype for their strawberries. Ask them to consider the following factors: – Is the material they are using recyclable? – Will it protect the fruit from damage? – Does it allow air to get to the fruit to keep it fresh? – Why is their design better than packaging they've seen before? Provide the students with prototyping materials such as cardboard and tape, and explain that their model does not need to be an accurate scale prototype, just something that displays their key ideas for the packaging. They can work in small groups for this.

Wrap-up: 20 minutes	
Learning objective	**Activity**
Students will practice presentation and idea evaluation skills to understand the design process that Dyson Engineers use.	Ask each group to present their designs back to the class. Encourage the rest of the class to ask questions and consider what's good and what can be improved about each other's designs. Explain that engineers do this when developing new ideas and inventions that can change the world.

WORKSHEETS 01–05

WORKSHEET 01
SOIL TYPES AT DYSON FARMING

The following soil types can be found on UK farms managed by Dyson Farming. Farms in the south are typically where cattle are reared, whilst the north is where they grow most of their produce.

Loamy sand over sand
South UK

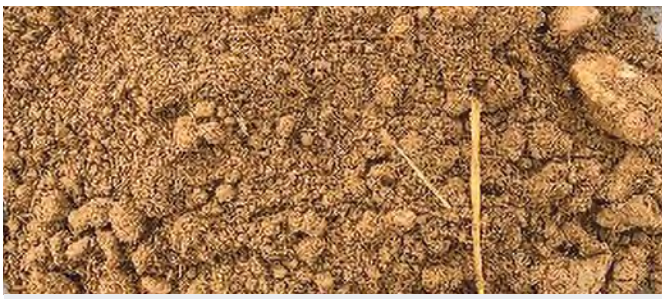
This can feel gritty and may even stain your hands. If you mould this soil together it will stick, but it'll be easy to break this apart.

Sand loam over sand
South UK

Just like Loamy sand over sand, this soil type will feel gritty. However, if you mould this soil together, it will hold its shape much better, meaning it'll be harder to break apart.

Chalk subsoil
South UK

Chalky subsoil often contains chalk or limestone – this means it can be clay-like in texture or or be more gravelly. This type of soil drains water better than others, meaning it's better suited in a climate where rainfall may be heavier.



Calcareous sandy loam
North UK

Calcareous soil is often formed from limestone or in drier environments, carrying higher calcium carbonate ($CaCO_3$). This often means that the soil doesn't carry the nutrients that plants need, causing deficiencies. This type of soil will often feel chalky and gritty due to the sand.

Clay over sandy loam
North UK

Clay is mouldable and damp – this is what makes it sticky. However, it won't stick to your hands. Sandy loam feels gritty but can also be moulded. If you roll sandy loam, it should break apart. When wet, it can be partly sticky.

Sandy clay loam
North UK

Sandy clays bind together well when wet and it's very sticky. You should be able to see the texture of the sand if you smear the soil onto your hands.

High organic matter clay loam
North UK

If soil has a high organic matter, it usually means there's been lots of plant or animal activity, such as earthworms and fungi. Soil of this type is typically darker and will crumble off roots if you pull up plants. The clay will make it feel smooth and greasy. This soil can be moulded.

Calcareous clay loam
South UK

This soil type is similar to the calcareous sand loam, but because of the clay it will be mouldable and much darker in colour. This soil will still be drier than soil that contains clay, due to the limestone/chalk properties.

Silty clay
North UK

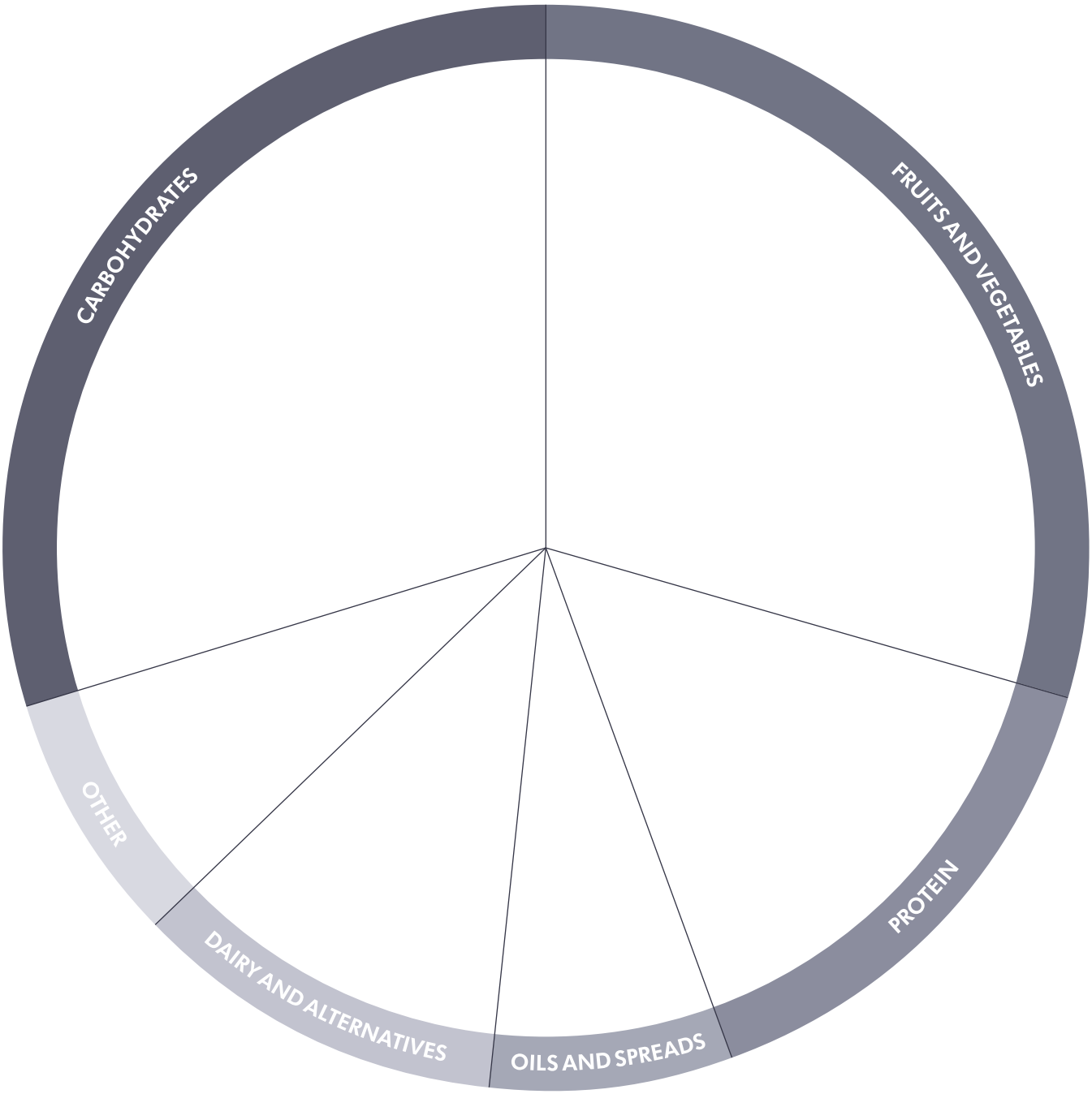
Silty clay will feel very smooth and mouldable. If you were to roll this in your hands, it would hold together well.

Silt loam
North UK

Silt loam has a floury feel to it when it's damp. If you push your finger into it, the fingerprint will stay there. If you tried to mould this into a ball, it would break away easily.

WORKSHEET 02
EAT WELL GUIDE

The Eat Well guide indicates what proportion of your plate should be filled with each food category to maintain a healthy diet. Using this thinking, ask the students to write down the ingredients commonly used to cook their favourite meal into the different categories.



WORKSHEET 03A
SOIL VS CROP

Below details which crops Dyson Farming grow in each of their soil types, in the north and south of the UK.

	What could grow in these soil types?											
Soil type	Wheat	Rye	Maize	Oilseed rape	Grassland	Potatoes	Sugar beet	Veg	Salad	Beans	Peas	Barley
Clay over sandy loam	✓	✓	✓	✓	✓							
Sandy clay loam	✓	✓	✓	✓	✓							
High organic matter clay loam	✓	✓	✓	✓		✓	✓					
Calcareous sandy loam	✓	✓	✓	✓								
Silt clay	✓											
Silt loam	✓							✓	✓			
Loamy sand over sand	✓	✓	✓	✓		✓	✓					
Sandy loam over sand	✓	✓	✓	✓		✓	✓					
Chalk subsoil	There aren't any crops that can be planted in chalk subsoil because they're often shallow, stony, free-draining, and high in alkaline. This means the soil doesn't retain water long enough for the crop to benefit and the alkaline decreases the nutrients in the soil.											
Calcareous clay loam	✓	✓		✓						✓	✓	✓

WORKSHEET 03B
WHAT COULD BE GROWN?

Using the soil samples that you've found and Worksheet 03A: Soil Vs Crop, it's time for you to investigate what crops you can grow.

Area 01: What soil types did you find?

What could grow in these areas?

Area 02: What soil types did you find?

What could grow in these areas?

Area 03: What soil types did you find?

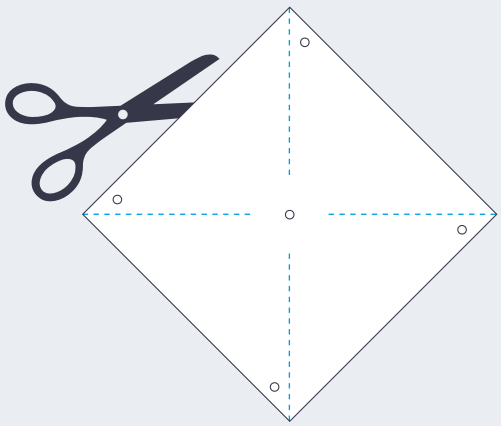
What could grow in these areas?

WORKSHEET 04A
BUILD A PINWHEEL CHALLENGE CARD

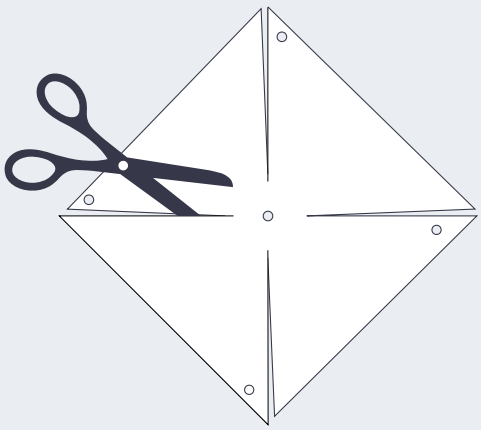
Worksheet objective: Create a pinwheel that will spin when air is blown at it.
Resources needed: Worksheet 04B: Build a pinwheel template, a paper straw, a pair of scissors, a plastic bead and a brass fastener.

How does it work? A pinwheel – like a windmill – has curved blades. When wind strikes the blades, it causes them to rotate around the axis. This causes a shaft inside the turbine to spin. The shaft is connected to a generator which converts the energy from this movement into electricity.

Cut out the square from the template. Pierce the circles on the template with a brass fastener. **1**

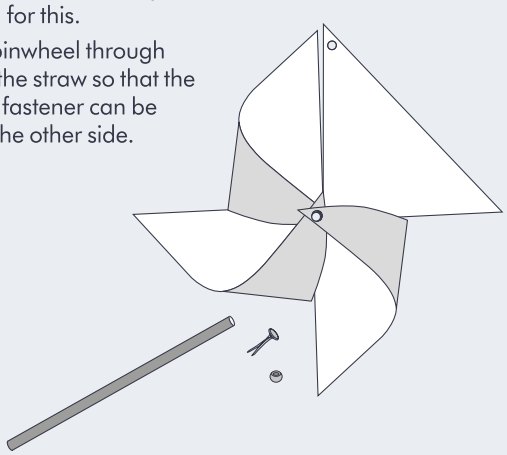


Cut along each line, stopping about an inch from the centre. **2**



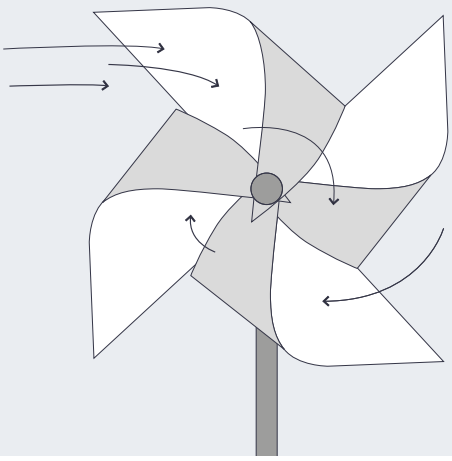
Without creasing the paper, bring the pierced corners to the hole in the centre of the square and push the fastener through it. Slide the plastic bead onto the back of your windmill. Pierce a hole through the straw. You may need adult supervision for this. **3** **4**

Push your pinwheel through the hole in the straw so that the ends of the fastener can be seen from the other side.



Bend the ends of the fastener around the straw to secure the windmill. Make sure this isn't too tight or the windmill won't have room to spin. **5** **6**

Blow air onto the side of your pinwheel to see if it catches the airflow and spins.

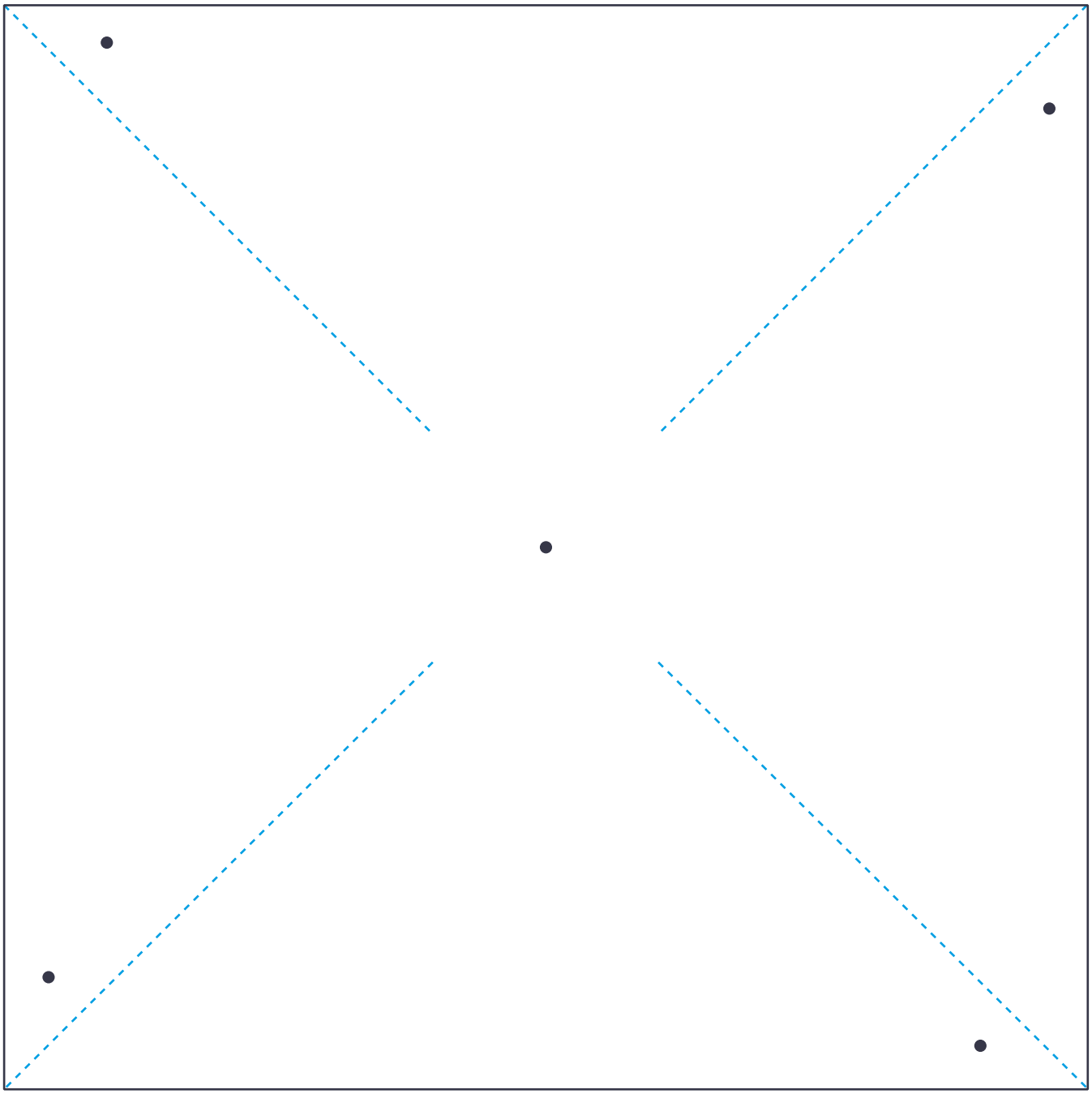


WORKSHEET 04B
BUILD A PINWHEEL TEMPLATE

Cut ————

Secondary cut - - - - - - - - - -

Pierce ●



WORKSHEET 05
STRAWBERRY PLANT DIARY

Week by week, detail the changes you notice in your strawberry plants. Is one growing more leaves or producing more flowers? Is one larger or more green than the other? Strawberry plants typically take a year to produce tasty fruit.

Week no. or date	Height (cm)	No. of leaves	No. of flowers	No. of berries	Observations and comments

Week no. or date	Height (cm)	No. of leaves	No. of flowers	No. of berries	Observations and comments

Week no. or date	Height (cm)	No. of leaves	No. of flowers	No. of berries	Observations and comments

You can find more James Dyson Foundation educational resources online at www.jamesdysonfoundation.co.uk

Share your experiences with us:

THE JAMES DYSON FOUNDATION
INSPIRING THE NEXT GENERATION OF ENGINEERS

The James Dyson Foundation is a charity supported by Dyson Ltd.

dyson