Cattle Carers - Session 1

Introduction to British Farming

Context:
Learners are introduced to the types of farms in our country, e.g. arable, dairy etc. and where they are located. They use information presented in tables and graphs to find out more about farming in the UK. They learn about the processes that take place on a dairy farm and begin to recognise the challenges dairy farmers face and how engineers work with them to solve problems.

Engineering focus:
Pupils will be working as an engineer by asking questions to understand more about farms and by identifying problems (Problem finding)

Learning time:
1.5 hours

Suggested age group:
9-11 years old

Curriculum links:
Mathematics
Pupils will be able:

- To interpret and construct pie charts and line graphs and use these to solve problems.
- To use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy.

Keywords
dairy
togographic
agriculture
milk
butter
cheese
yoghurt
lactose
calcium
grazing
milking
udders
pasteurising
processing

Resources:

- NFU Video:Introduction to Dairy Farming
- Cattle Carers Session 1 Presentation
- Access to the internet for mapping exercise

Optional:

- Dairy products (milk, condensed milk, cheese, yoghurt, butter)

Step-by-step plan

1

What do we know happens on farms in the United Kingdom? (5 minutes)
In groups of 3, ask the learners to quick-fire idea storm about things they think happen on farms. Ask them to decide on 4 things that they think happen most often, and challenge them to compose a short poem, ditty or key phrases to share with the class.

Farmers caring for their animals and crops.
Animals grazing.
Rows and rows of crops.
Machinery and tractors get the work done.

2

Where does farming take place in the UK? (30 minutes)
Use Slides 2–8 to introduce learners to the distribution of farms in the UK. The slides engage the pupils in using their maths skills to interpret and present data about land use in England, Scotland, Wales and Northern Ireland.
Learners interpret data in a table, match data to unlabelled pie charts and then construct their own pie charts using a ratio table for support.

3

What sort of farms are near us? (30mins)
Use Slides 9–12 to encourage learners to start thinking about the different types of farms there are (dairy/sheep/cattle/pigs/poultry/arable/horticulture) and what sort of farming takes place in their local area.

Learners carry out a google mapping exercise to identify how many farms are close to their town/city and what sort of farms they are. This can be developed into a data gathering and analysis exercise with learners keeping a tally of the types of different farms and then choosing appropriate charts to display this data.

Learners compare the amount of farmland that is used for dairy farming in their region with other regions in the UK by drawing a bar chart. Data can be edited to include other regions using national farming data from the Department for Environment , Food and Rural Affairs. They use maps to think about where dairy farming is most common and why (slide 13).

4

What products do we use from dairy farms? (15 mins)

Learners collaborate to **list** as many things as they can that they use in their daily lives, that have originated from dairy farms. Writing the separate items on post-it notes will help with the next task (slide 14).

Learners **rank** their list of dairy products into those that they think have the highest lactose content to those that have the lowest (slide 15).

Define the meaning of lactose to the learners and share lactose data (grams per 100g of product) for them to use their data to **check** their ranking of dairy products (slide 16).

Ask learners why dairy produce is important in their diets to connect with prior learning about healthy diets and the importance of calcium. Share calcium data on common dairy products to support learners in considering whether they get their recommended daily amount of calcium each day.

Optional: Bring a range of dairy products into the classroom for learners to taste.

5

What happens on a dairy farm? (10 mins)

Learners watch the NFU video: Introduction to dairy farming.

Ask learners to **summarise** the main processes involved in dairy farming to explain how dairy products get from the farm to the supermarkets (slide 17).

Through watching the video and listening to Farmer Amy describe his/her work, learners should be able to identify multiple problems that he/she faces on the farm.

Encourage learners to reflect on problems related to sustainability and climate change - what have they learnt about how farming might impact climate change? Why is that a problem? Is farming an optional human activity? (Slide 18)

6

What questions would you ask to find out more about dairy farming?

Allow some time for learners to reflect on what they have learnt about dairy farming and the problems faced by dairy farmers. Ask them to think of additional questions they would like to ask dairy farmers to find out more about processes and problems (slide 19).

How do agricultiral engineers work with farmers?

Use the **infographic** on slide 20 to explain the relationship between farmers and agricultural engineers. Key things to note:

- Agricultural engineers design and create innovations to make farming more efficient and sustainable.
- Agricultural engineers work through the Engineering Design Process: they **ask** questions to identify problems on the farm, **imagine & plan** solutions to those problems, **create** designs to solve the problem and then test and **improve** their designs.

7

Optional activities:

- **True or false:** (slide 21/22) Learners collaborate in pairs to decide which of the 8 statements are true and which are false. (Note the false Statements: Cows actually eat 50kg of food a day (equivalent to 300 peanut butter sandwiches), Cows actually like music and research shows it makes them produce more milk and cows actually drink 60 litres of water a day (a whole bath full)).
- **Making Butter**: Explore the NFU STEMterprise resources for processing milk to create a dairy product.
- **How milk gets from the farm to the farm shop video**: This BBC Teach video will provide additional support for learners curious about dairy farming.
- **Welcome to Holly Green Farm video**: In this video Farmer Neil explains how he cares for cows on his farm.

Cattle Carers - Session 1

Introduction to British Farming

Context:
Dairy farming has been part of agriculture for thousands of years. Dairy cows are bred specifically to produce large quantities of milk which in turn is used to produce a variety of dairy products including cream, butter, yoghurt, cheese and ice-cream.

Engineering focus:
Pupils will be working as an engineer by asking questions to understand more about farms and by identifying problems (Problem finding)

Learning time:
1.5 hours

Suggested age group:
9-11 years old

Curriculum for Excellence links:

Second Level:

I can extend my knowledge and understanding of engineering disciplines to create solutions. TCH 2-12a
Having discussed the variety of ways and range of media used to present data, I can interpret and draw conclusions from the information displayed, recognising that the presentation may be misleading. MNU 2-20a
I have carried out investigations and surveys, devising and using a variety of methods to gather information and have worked with others to collate, organise and communicate the results in an appropriate way. MNU 2-20b
I can display data in a clear way using a suitable scale, by choosing appropriately from an extended range of tables, charts, diagrams and graphs, making effective use of technology. MTH 2-21a
When preparing and cooking a variety of foods, I am becoming aware of the journeys which foods make from source to consumer, their seasonality, their local availability and their sustainability. HWB 2-35a

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Resources:

- NFU Video:Introduction to Dairy Farming
- Cattle Carers Session 1 Presentation
- Access to the internet for mapping exercise
- Mathematics support sheets

Optional:

- Dairy products (milk, condensed milk, cheese, yoghurt, butter)

Step-by-step plan

1

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In groups of 3, ask the learners to quick-fire idea storm about things they think happen on farms. Ask them to decide on 4 things that they think happen most often, and challenge them to compose a short poem, ditty or key phrases to share with the class.

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2

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Learners compare the amount of farmland that is used for dairy farming in their region with other regions in the UK by drawing a bar chart. Data can be edited to include other regions using national farming data from the Department for Environment , Food and Rural Affairs. They use maps to think about where dairy farming is most common and why (slide 13)

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What products do we use from dairy farms? (15 mins)
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Learners **rank** their list of dairy products into those that they think have the highest dairy content to those that have the lowest (slide 15).
Define the meaning of lactose to the learners and share lactose data (grams per 100g of product) for them to use their data to **check** their ranking of dairy products (slide 16).
Ask learners why dairy produce is important in their diets to connect with prior learning about healthy diets and the importance of calcium. Share calcium data on common dairy products to support learners in considering whether they get their recommended daily amount of calcium each day.
Optional: Bring a range of dairy products into the classroom for learners to taste.

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What happens on a dairy farm? (10 mins)
Learners watch the NFU Introduction to dairy farming video.

Ask learners to **summarise** the main processes involved in dairy farming to explain how dairy products get from the farm to the supermarkets (slide 18).

Through watching the video and listening to Farmer Amy describe his/her work, learners should be able to identify multiple problems that he/she faces on the farm.

Encourage learners to reflect on problems related to sustainability and climate change - what have they learnt about how farming might impact climate? Why is that a problem? Is farming an optional human activity? (Slide 19)

6

What questions would you ask to find out more about dairy farming?
Allow some time for learners to reflect on what they have learnt about dairy farming and the problems faced by dairy farmers. Ask them to think of additional questions they would like to ask dairy farmers to find out more about processes and problems

How do agricultural engineers work with farmers?

7

Use the **infographic** on slide 21 to explain the relationship between farmers and agricultural engineers. Key things to note:

- Agricultural engineers that design and create innovations to make farming more efficient and sustainable.
- Agricultural engineers work through the Engineering Design Process: they **ask** questions to identify problems on the farm, **imagine & plan** solutions to those problems, **create** designs to solve the problem and then test and **improve** their designs.

Optional activities:

- **True or false:** (slide 22/23) Learners collaborate in pairs to decide which of the 8 statements are true and which are false.
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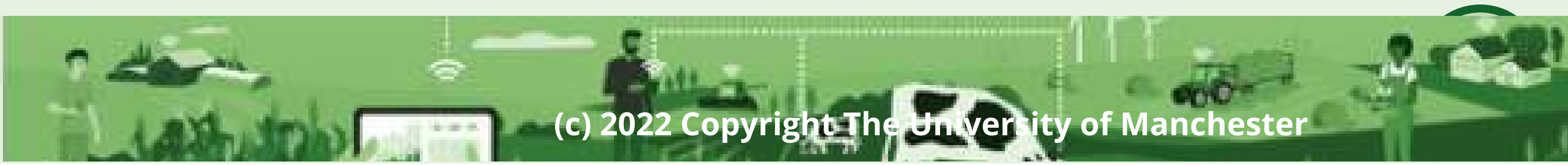
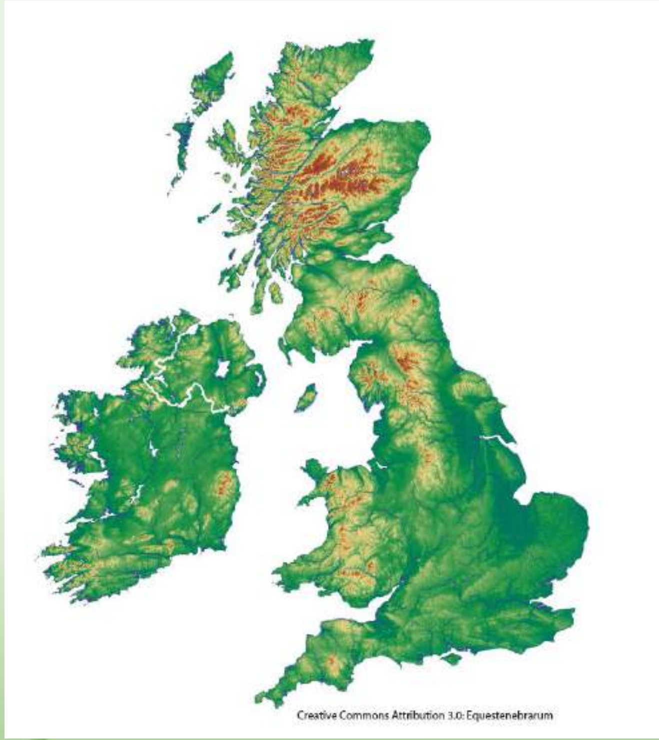


CATTLE CARERS

SESSION 1
Introduction to British farming



Where does farming take place in the UK?

This is a **topographic map** of the UK.

The colours show the **elevation** of the land (the height above the level of the sea).

What do you notice from the map?

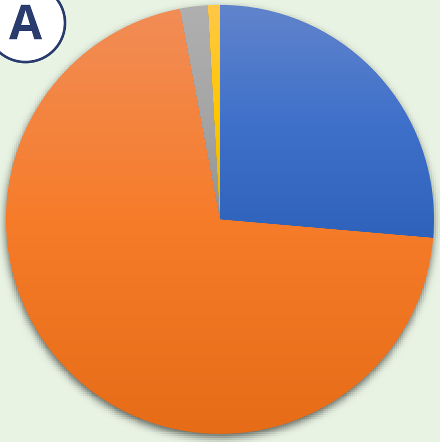
What type of farming do we have in the UK and why? What does the data tell us?

Region	Farmland	Natural	Built on and green urban areas
England	72.9%	14.5%	12.6%
Northern Ireland	72.2%	23.0%	4.8%
Scotland	26.4%	70.6%	3.0%
Wales	59.3%	35.1%	5.6%

Which country has the most farmland?

What interesting things do you notice in this data?

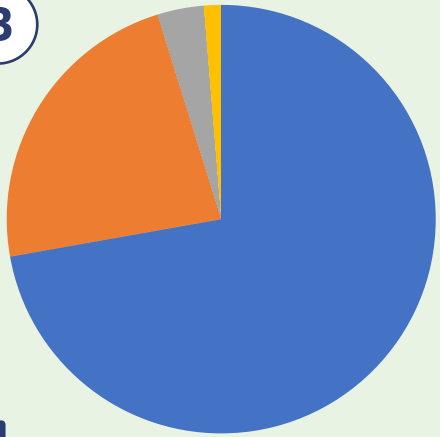
A



Someone has forgotten to label these pie charts showing land use in England, Scotland, Wales and Northern Ireland.

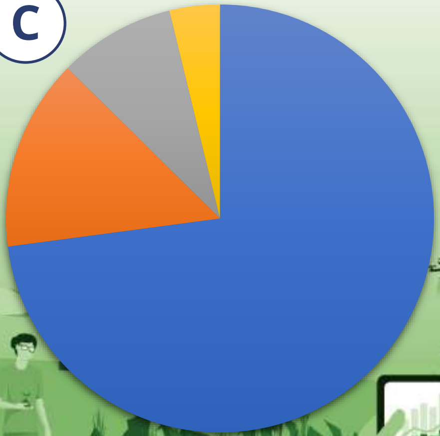
Can you work out which pie chart represents which country? Justify your answer.

B



Region	Farmland (%)	Natural (%)	Built on (%)	Green urban areas (%)
England	72.9	14.5	8.8	3.8
Northern Ireland	72.2	23.0	3.5	1.3
Scotland	26.4	70.6	2.1	0.9
Wales	59.3	35.1	4.2	1.4

C



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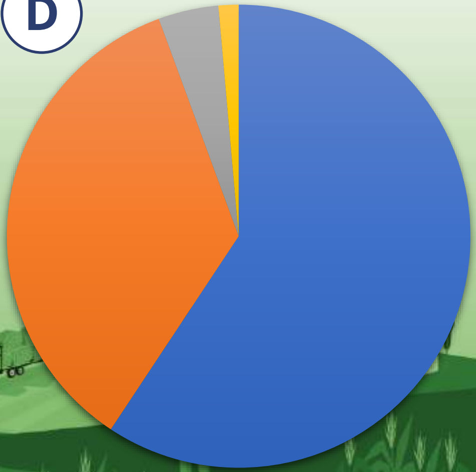


Farmland Natural
Built on Green Urban

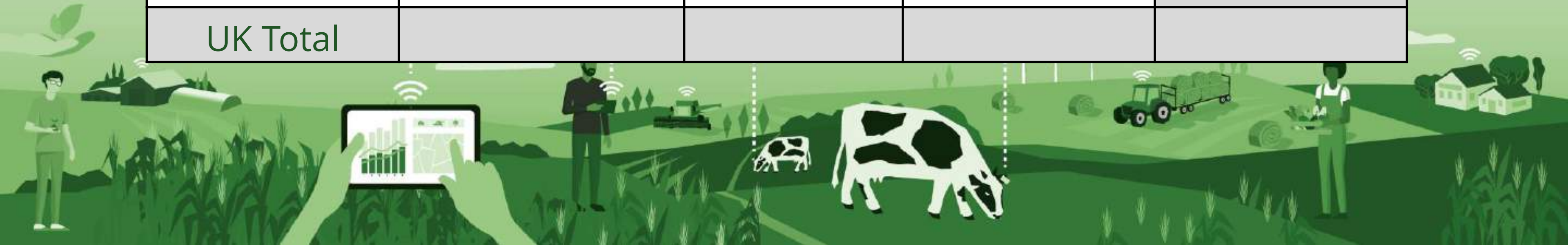
Using the data, draw a pie chart to show how land is used across the entire UK.

Region	Farmland	Natural	Built on and green urban areas
England	72.9%	14.5%	12.6%
Northern Ireland	72.2%	23.0%	4.8%
Scotland	26.4%	70.6%	3.0%
Wales	59.3%	35.1%	5.6%

1. Calculate the UK total percentage of land used per category.
2. Use a ratio table to construct a pie chart.
3. Draw your pie chart with an appropriate title and key.

UK land use by nation
Percentage of land used per category

Region	Farmland (%)	Natural (%)	Built on and green urban areas (%)	Total (%)
England	72.9	14.5	12.6	
Northern Ireland	72.2	23.0	4.8	
Scotland	26.4	70.6	3.0	
Wales	59.3	35.1	5.6	
UK Total				



UK land use by nation
Percentage of land used per category

Region	Farmland (%)	Natural (%)	Built on and green urban areas (%)	Total (%)
England	72.9	14.5	12.6	100
Northern Ireland	72.2	23.0	4.8	100
Scotland	26.4	70.6	3.0	100
Wales	59.3	35.1	5.6	100
UK Total	230.8	143.2	26.0	400

How might this ratio table help you to construct a pie chart to represent the data?

% Land use	**400**	**100**	**1**	**26**	**143**	**231**
Angle size (°)	360°	90	0.9			

Which of these two representations, if any, do you find more helpful?

How else could you construct your pie chart?

231	**143**	**26**
400		
360°		

Are all farms the same?

This map shows what **type of farming** takes place in different areas of the UK.

What do you think might happen on these different types of farms?

What do you notice about where different types of farming take place?

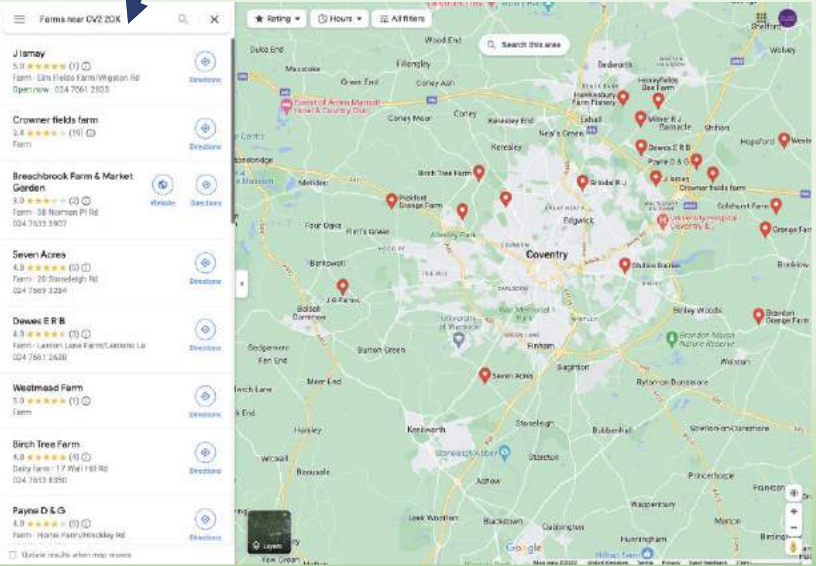
Where are you?

Which region of the UK do you live in?

Have you noticed what type of farming takes place in this region?

Search box

What sort of farms are near you?



Visit https://maps.google.com

In the search box type: ‘Farms near [insert your town or city]’.

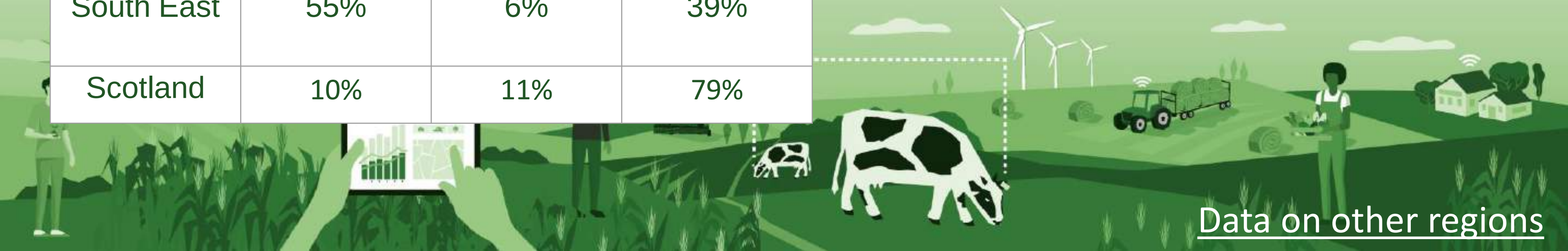
How many farms appear in your search?

Make a tally of the different types of farms near you.

Compare farming in this region with farming in other regions of the UK.

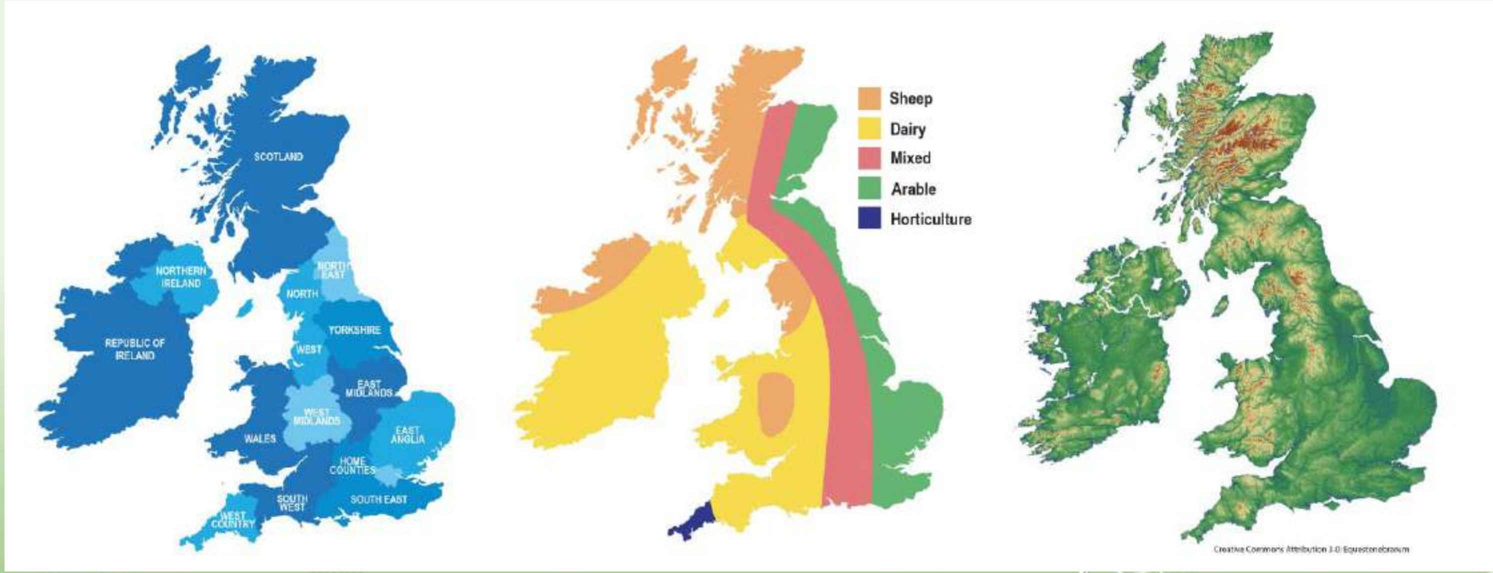
	% of farmland area		
	Arable	Dairy	Other
United Kingdom	49%	9%	42%
North West	52%	14%	34%
West Midlands	21%	25%	54%
South West	41%	39%	20%
South East	55%	6%	39%
Scotland	10%	11%	79%

Draw a bar chart to compare the percentage of land used for **dairy farms** in each region.

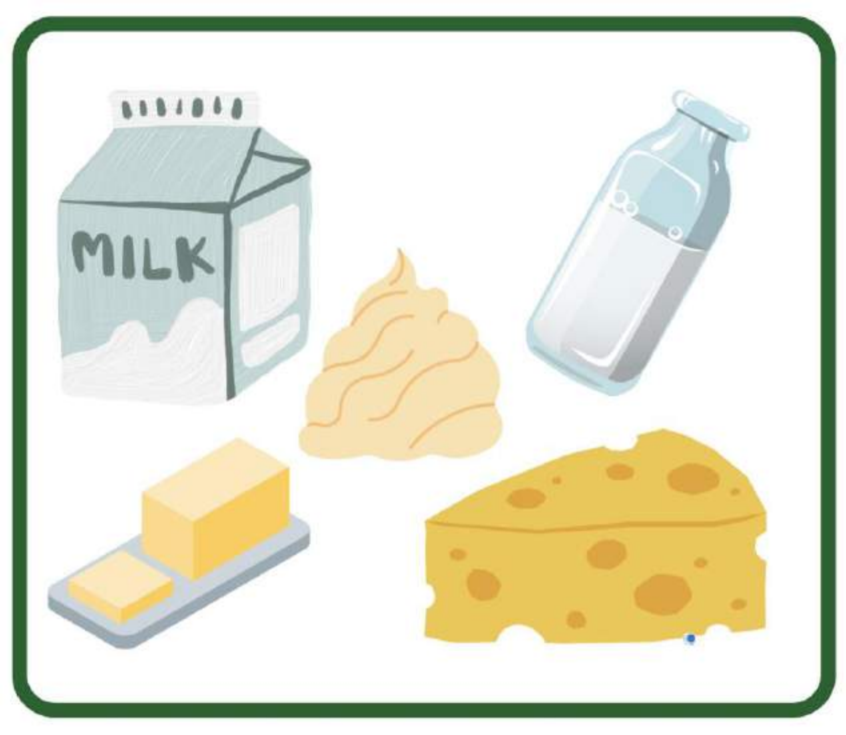


Data on other regions

Look at where we find the most dairy farms in the UK? Why might that be?



Think about the products from dairy farms



How many products can you list that are made from milk?

Rank these products in terms of high and low lactose content.

Product	Lactose content (g/100g of product)
Butter	0.5-1
Cheddar	0.5-0.6
Mozarella	1-3
Cream	4
Milk	4-5
Ice Cream	3-8
Condensed milk	10-16
Milk chocolate	4
Yoghurt	2-7

Lactose – a sugar found in milk and milk products.

Lactose intolerance – when your digestive system can't digest lactose.

Use the data to check your ranking of dairy products.

Product	Calcium content (mg/100g of product)
Butter	24
Cheddar	721
Mozarella	731
Cream	96
Milk	125
Ice Cream	128
Condensed milk	284
Milk chocolate	189
Yoghurt	110

Calcium – is a mineral that we need to eat for healthy bones and teeth. Children between the ages of 9 and 18 need 1300mg of calcium a day.

Draw a bar chart to compare the amounts of calcium in different dairy products.

What happens on Dairy Farms?

"The environment is a big concern with an increasing focus on sustainability. We are looking for ways to give back to the environment as much as we can".

Summarise the main problems that dairy farmers face.

" The most important job for us is to keep cows happy and healthy. They need a constant supply of good food and clean water as well as clean and suitable living conditions, either outside or indoors".

"Costs on the farm are always a problem. It costs money to improve conditions of cows or to introduce new practices to protect the environment as we move forwards as an industry, but we are a business, and we need to keep costs down to be profitable".

Farmer Amy

You are going to be agri engineers that work to solve problems on dairy farms.

What questions would you ask to find out more about what happens on dairy farms?

How do engineers work with farmers to solve problems in farming?

Agri engineers work through the **Engineering Design Process**.

Use the infographic to identify the four different stages in the Engineering Design Process.

A single cow produces an average of 28 litres of milk per day – that's about 128 glasses.

Cows hate music – some studies have shown that if music is playing cows produce less milk.

Cows eat up to 25kg of food a day – that's the equivalent of 150 peanut butter sandwiches.

Cows can drink up to a half a bath tub of water a day or 30 litres.

Cows have almost 360-degree vision, but they do have some trouble looking head-on.

Cows cannot see the colour red. They are red-green colour blind.

British dairy farmers produce around 14 million litres of milk every year – that's enough to fill about 78 million bath tubs.

A cow’s sense of smell is much stronger than a human’s. Cows can pick up scents from up to 6 miles away.

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Cattle Carers - Session 2

How does dairy farming affect our climate?

Context:
Learners build on their learning about the problems that agricultural engineers are finding solutions to on dairy farms. They work scientifically to better understand how changing the diet of cows might reduce the greenhouse gas emissions from dairy farming. The link between science and engineering is key in this session as learners will use their science skills and understanding to consider engineering solutions related to climate action.

Engineering focus:
Learners will be working as an engineer by asking questions to identify and better understand problems (problem finding).

Learning time:
1.5 hours

Suggested age group:
9-11 years old

Keywords
greenhouse gas
methane
carbon dioxide
livestock
ruminate
rumination
fermentation
fungi
bacteria
carbohydrates
sugar
digest
digestion
chemical change
climate

Curriculum links:
Science: *Living things and their habitats, changes of materials, working scientifically*
- Learning how environments can change and this can pose dangers to living things.
- Exploring how diets affect the ways in which animals' digestive system and bodies function.
- Explaining that some chemical changes result in the formation of new materials.
- Developing skills in working scientifically through enquiry.

Resources:
- Cattle Carers Session 2 Presentation

Per group:
- 2 small/medium zip lock bags
- a sachet of yeast
- half a sheet of dried seaweed
- teaspoon
- sugar
- measuring cylinder
- warm water (between 45 -50 ℃
- stirring rod
- thermometer
- camera to photograph changes
- Problem on a page handout - Cattle Climate challenge

Step-by-step plan

1

Odd One Out

Elicit learners prior understanding of greenhouse gases and climate change. Show images of a cow, cars, wind/solar farm and a coal fired power station (slide 2). Ask learners to work in pairs to choose an odd one out and be able to justify their choice.

Take some time for pairs to share their ideas with the group, using prompts to encourage learners to think about the environmental impact of each thing such as "*Think about the impact of these things on the environment*".
Note: Cows, vehicles and power stations all release greenhouse gases that lead to global warming. Wind/solar farms make electricity without polluting the environment.

2

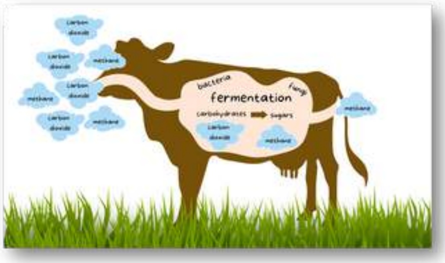
How does farming contribute to greenhouse gas emissions?

Use the NFU infographic to identify the role that farms play in both emitting and capturing greenhouse gases (slide 3). Ask learners to talk to their partner about why we should be concerned about greenhouse gases - allow a couple of minutes to discuss before sharing ideas with the group.
Show the pie chart on slide 4 so that learners can appreciate the significance of the contribution that cows make to greenhouse gas emissions. There are some questions to support interpretation. Explain how scientists use satellite technology to monitor greenhouse gas emissions (slide 5).

3

Why do cows exhale greenhouse gases?

Explain why cows breathe out greenhouse gases, connecting with learners' prior understanding of digestion and linking to ideas about chemical change.



Different chemical changes take place in the stomach which change the chemicals in food into new products. **Digestion** is where the chemicals in food are broken down into smaller pieces that can be absorbed into the body and **fermentation** is where microorganisms such as bacteria or fungi break down carbohydrates into sugars as well as producing gases such as carbon dioxide gas and methane gas. These gases mostly leave the body through burps. Carbon dioxide and methane gas are both greenhouse gases. They trap heat energy from the Sun in our atmosphere which leads to global warming.

4

Working scientifically: Does seaweed affect the rate of fermentation?

Learners collaborate in groups to carry out a simple comparative test to observe the effect of seaweed on fermentation. In this guided enquiry, learners will be following a suggested method but should be encouraged to think about the variables they need to control to make the test fair (quantities, temperature etc) and adapt the method accordingly.

Suggested method (slide 7)

1. Put a heaped teaspoon of yeast (half the sachet) in each zip-lock bag; tear half a sheet of the dried seaweed into small pieces and put inside one of the bags – mix thoroughly with the yeast.
2. Dissolve the sugar in the water and divide between the two samples.
3. Press the bag to remove excess air and seal. Mix the contents together by gently pressing the contents with fingers, ensuring that the bag is completely sealed to prevent escape of gases.
4. Observe and record changes in the bags over time using drawings, video or photographs.

After 60 mins there will be a noticeable difference between the two bags showing that the presence of the seaweed has reduced the rate of fermentation so that less carbon dioxide is formed. Learners can use their observations to draw a conclusion and make a prediction about how including seaweed in a cow's diet might affect gas emissions.

Introduce learners to research carried out with cows in the US to try and find out how the introduction of a red seaweed supplement to a cow's diet affects methane emissions (slide 8) and then share some bar charts of their findings for learners to interpret (slide 9).

5

Optional Activity: How could we capture methane from dairy cows?

Provide learners with the **Problem on a page: Cattle Climate Challenge** and pose the problem 'How could methane be captured from dairy cows so that it can be used as a fuel?' (slide 10).

Leaners collaborate to imagine different ways to solve the problem and prepare to communicate their ideas with their peers through words and drawings. Encourage learners to consider the advantages and disadvantages of each other's ideas in terms of cow wellbeing and the environmental impact.

Cattle Climate Challenge

What's the farmer's problem?

"I want to reduce the methane emissions from my dairy farm to protect the planet and wonder if I can capture the gas to use as a fuel and save money."

Available resources:

- Paper
- Pens
- Laptops/tablets for research

What is the design brief?

Use drawings and/or 3D models to imagine and design a device that will capture the methane from cows breath so that it can be used as a fuel on the dairy farm.

Your device will need to meet the following criteria:

- Prevent methane being released into the air.
- Collect methane gas so that it can be used as a fuel for cooking or heating on the farm.
- Not cause any discomfort to cows.
- Use sustainable and or recycled materials.
- Not have any detrimental effect on the health or wellbeing of cows.

The engineering design task

Can you think of a way that methane could be captured from dairy cows so that it could be used for energy?

Chemical changes in the digestive system of cows lead to the production of carbon dioxide and methane gases that enter the air when the cows burp. These gases are greenhouse gases that absorb heat from the Sun and lead to global warming. there are 1.4 billion cows on the planet which contribute to 9.4% of the worlds greenhouse gas emissions. Methane is also flammable gas which can be used as a fuel.

Top tips to get started:

Think about the features and functions of the device:

- Will your device be used when cows are in a barn or grazing in the field?
- How will you ensure that the cows can still behave in a normal way in terms of moving, eating, drinking, sleeping and interacting?
- How will you collect and store the gas so that it can be used as a fuel?
- How will you ensure you device is safe?
- What materials will you use to ensure the cows comfort? Are these materials sustainable?

Image credit: Keith Weller/USDA

Background Information:

Scientists and engineers have work together to develop different ways of collecting gases from cow burps to test and measure them. Some collect the gases when the cows are eating and others are attached to the cows as they move around the fields.

Engineers successfully designed and built a mask for cows that collects methane and converts it into carbon dioxide and water vapour.
Animal protection organisations object strongly to cows being fitted with face coverings from the age of sixth months.

One engineering company has started imagining and developing huge transparent domes up to three acres in size where gas, water and temperature can be easily controlled. They think this could be the future of dairy farming but their bio domes might also be used for farms beyond Earth when humans build settlements on the Moon and Mars.

Glossary:

Greenhouse gas - a gas in the atmosphere that absorbs heat radiation.
Methane - methane is a colourless gas, lighter than air, that burns easily in air.
Greenhouse effect - the trapping of heat from the Sun on the Earth's atmosphere, increasing temperatures on the planet.
Fuel - a material that can be burnt to release energy.
Fermentation- a chemical change that happens when microorganisms such as yeasts or bacteria breakdown different substances.
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livestock - domesticated animals raised in an agricultural setting that are kept for use of profit.

More information and inspiration!

Get some inspiration from finding out how Ben and Jerry's capture methane from dairy cow manure.

Want to take it further?

Research how to separate mixtures of gases to help develop your ideas to show how the methane would be isolated from other gases so that it could be used as a fuel.

How well did you do?

Use the table below to evaluate how well your idea meets the design brief.

Success Criteria	Score /5
Prevents methane being released into the air.	
Collects methane gas so that it can be used as a fuel.	
Keep cows comfortable.	
Uses sustainable and or recycled materials.	
Maintains cow wellbeing	

Image credit: Karin Higgins/UC Davis/Zelp/Eddie Jim/Fairfax Syndication/Zeeci/

Cattle Carers - Session 2

How does dairy farming affect our climate?

Context:
Learners build on their learning about the problems that agricultural engineers are finding solutions to on dairy farms. They work scientifically to better understand how changing the diet of cows might reduce the greenhouse gas emissions from dairy farming. The link between science and engineering is key in this session as learners will use their science skills and understanding to consider engineering solutions related to climate action.

Engineering focus:
Learners will be working as an engineer by asking questions to identify and better understand problems (problem finding).

Learning time:
1.5 hours

Suggested age group:
9-11 years old

Curriculum for Excellence links:

Second Level:
I can extend my knowledge and understanding of engineering disciplines to create solutions. TCH 2-12a
By investigating some body systems and potential problems which they may develop, I can make informed decisions to help me to maintain my health and wellbeing. SCN 2-12a
By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed. SCN 2-15a
I have collaborated in activities which safely demonstrate simple chemical reactions using everyday chemicals. I can show an appreciation of a chemical reaction as being a change in which different materials are made. SCN 2-19a
Inquiry and investigative skills (see Sciences Benchmarks for further details):
Plans and designs scientific investigations and enquiries
Carries out practical activities in a variety of learning environments
Analyses, interprets and evaluates scientific findings
Presents scientific findings
I can make suggestions as to how individuals and organisations may use technologies to support sustainability and reduce the impact on our environment. TCH 2-07a

Keywords
greenhouse gas
methane
carbon dioxide
livestock
ruminate
rumination
fermentation
fungi
bacteria
carbohydrates
sugar
digest
digestion
chemical change
climate

Resources:
- Cattle Carers Session 2 Presentation

Per group:
- 2 small/medium zip lock bags
- a sachet of yeast
- half a sheet of dried seaweed
- teaspoon
- sugar
- measuring cylinder
- warm water (between 45 -50 ℃
- stirring rod
- thermometer
- camera to photograph changes
- Problem on a page handout - Cattle Climate challenge

Step-by-step plan

1

Odd One Out
Elicit learners prior understanding of greenhouse gases and climate change. Show images of a cow, cars, wind/solar farm and a coal fired power station (slide 2). Ask learners to work in pairs to choose an odd one out and be able to justify their choice.

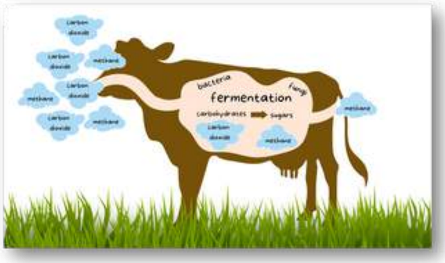
Take some time for pairs to share their ideas with the group, using prompts to encourage learners to think about the environmental impact of each thing such as "*Think about the impact of these things on the environment*".
Note: Cows, vehicles and power stations all release greenhouse gases that lead to global warming. Wind/solar farms make electricity without polluting the environment.

2

How does farming contribute to greenhouse gas emissions?
Use the NFU infographic to identify the role that farms play in both emitting and capturing greenhouse gases (slide 3). Ask learners to talk to their partner about why we should be concerned about greenhouse gases - allow a couple of minutes to discuss before sharing ideas with the group.
Show the pie chart on slide 4 so that learners can appreciate the significance of the contribution that cows make to greenhouse gas emissions. There are some questions to support interpretation. Explain how scientists use satellite technology to monitor greenhouse gas emissions (slide 5).

3

Why do cows exhale greenhouse gases?
Explain why cows breathe out greenhouse gases, connecting with learners' prior understanding of digestion and linking to ideas about chemical change.



Different chemical changes take place in the stomach which change the chemicals in food into new products. **Digestion** is where the chemicals in food are broken down into smaller pieces that can be absorbed into the body and **fermentation** is where microorganisms such as bacteria or fungi break down carbohydrates into sugars as well as producing gases such as carbon dioxide gas and methane gas. These gases mostly leave the body through burps. Carbon dioxide and methane gas are both greenhouse gases. They trap heat energy from the Sun in our atmosphere which leads to global warming.

4

Working scientifically: Does seaweed affect the rate of fermentation?

Learners collaborate in groups to carry out a simple comparative test to observe the effect of seaweed on fermentation. In this guided enquiry, learners will be following a suggested method but should be encouraged to think about the variables they need to control to make the test fair (quantities, temperature etc) and adapt the method accordingly.

Suggested method (slide 7)

1. Put a heaped teaspoon of yeast (half the sachet) in each zip-lock bag; tear half a sheet of the dried seaweed into small pieces and put inside one of the bags – mix thoroughly with the yeast.
2. Dissolve the sugar in the water and divide between the two samples.
3. Press the bag to remove excess air and seal. Mix the contents together by gently pressing the contents with fingers, ensuring that the bag is completely sealed to prevent escape of gases.
4. Observe and record changes in the bags over time using drawings, video or photographs.

After 60 mins there will be a noticeable difference between the two bags showing that the presence of the seaweed has reduced the rate of fermentation so that less carbon dioxide is formed. Learners can use their observations to draw a conclusion and make a prediction about how including seaweed in a cow's diet might affect gas emissions.

Introduce learners to research carried out with cows in the US to try and find out how the introduction of a red seaweed supplement to a cow's diet affects methane emissions (slide 8) and then share some bar charts of their findings for learners to interpret (slide 9).

5

Optional Activity: How could we capture methane from dairy cows?

Provide learners with the **Problem on a page: Cattle Climate Challenge** and pose the problem 'How could methane be captured from dairy cows so that it can be used as a fuel?' (slide 10).

Leaners collaborate to imagine different ways to solve the problem and prepare to communicate their ideas with their peers through words and drawings. Encourage learners to consider the advantages and disadvantages of each other's ideas in terms of cow wellbeing and the environmental impact.

Cattle Climate Challenge

What's the farmer's problem?

"I want to reduce the methane emissions from my dairy farm to protect the planet and wonder if I can capture the gas to use as a fuel and save money."

Available resources:

- Paper
- Pens
- Laptops/tablets for research

The engineering design task

Can you think of a way that methane could be captured from dairy cows so that it could be used for energy?

Chemical changes in the digestive system of cows lead to the production of carbon dioxide and methane gases that enter the air when the cows burp. These gases are greenhouse gases that absorb heat from the Sun and lead to global warming. there are 1.4 billion cows on the planet which contribute to 9.4% of the worlds greenhouse gas emissions. Methane is also flammable gas which can be used as a fuel.

What is the design brief?

Use drawings and/or 3D models to imagine and design a device that will capture the methane from cows breath so that it can be used as a fuel on the dairy farm.

Your device will need to meet the following criteria:

- Prevent methane being released into the air.
- Collect methane gas so that it can be used as a fuel for cooking or heating on the farm.
- Not cause any discomfort to cows.
- Use sustainable and or recycled materials.
- Not have any detrimental effect on the health or wellbeing of cows.

Top tips to get started:

Think about the features and functions of the device:

- Will your device be used when cows are in a barn or grazing in the field?
- How will you ensure that the cows can still behave in a normal way in terms of moving, eating, drinking, sleeping and interacting?
- How will you collect and store the gas so that it can be used as a fuel?
- How will you ensure you device is safe?
- What materials will you use to ensure the cows comfort? Are these materials sustainable?

Image credit: Keith Weller/USDA

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More information and inspiration!

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Want to take it further?

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Image credit: Karin Higgins/UC Davis/Zelp/Eddie Jim/Fairfax Syndication/Zeeci/

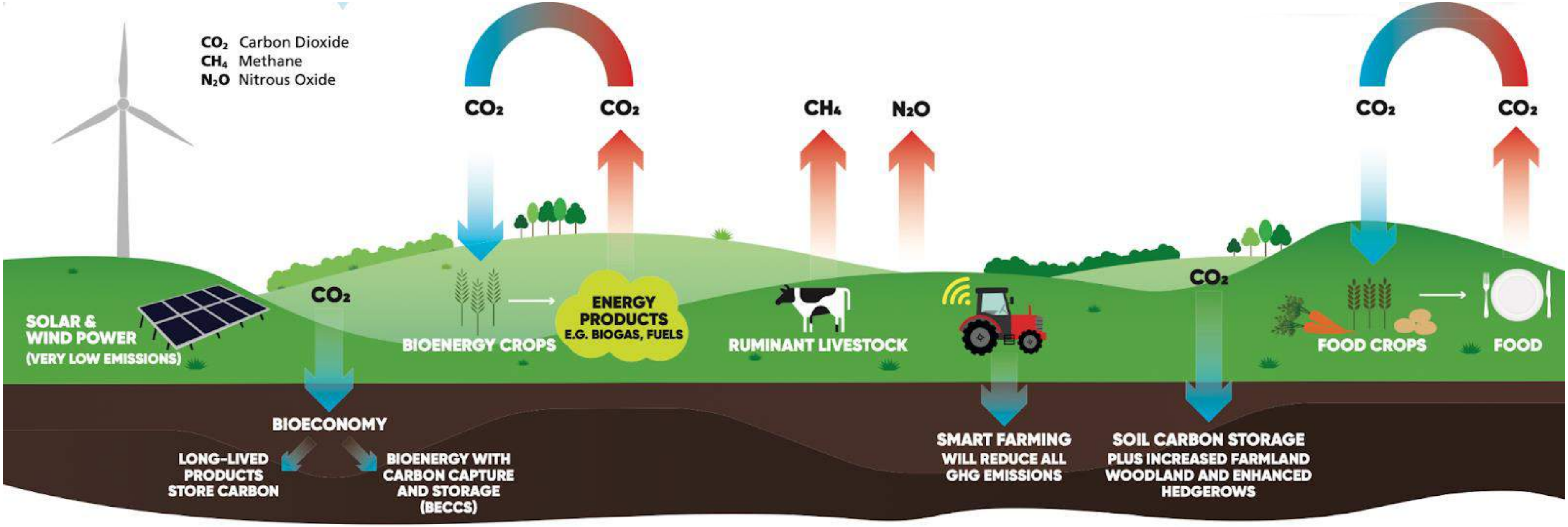
CATTLE CARERS

SESSION 2

How does dairy farming affect our climate?

Which is the odd one out and why?

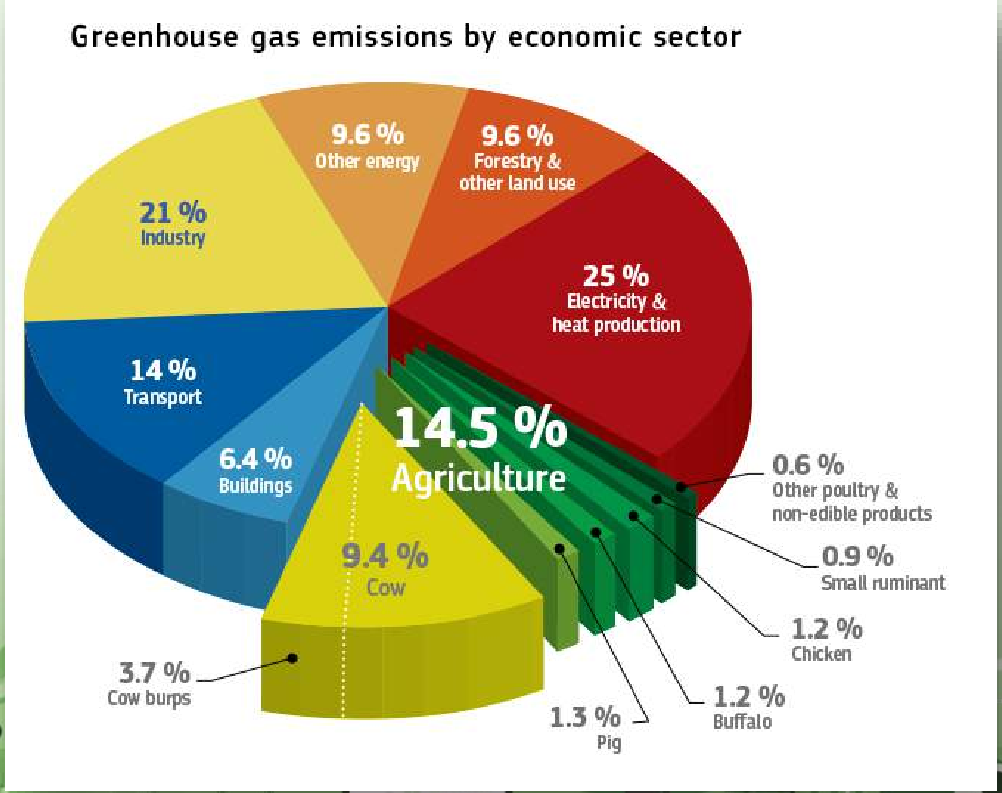
Image credit: Julietvbarbara/Cecilia Piovan/Kenueone/Neil Muir



Farms release greenhouse gases into the atmosphere. They also capture greenhouse gases from the atmosphere.

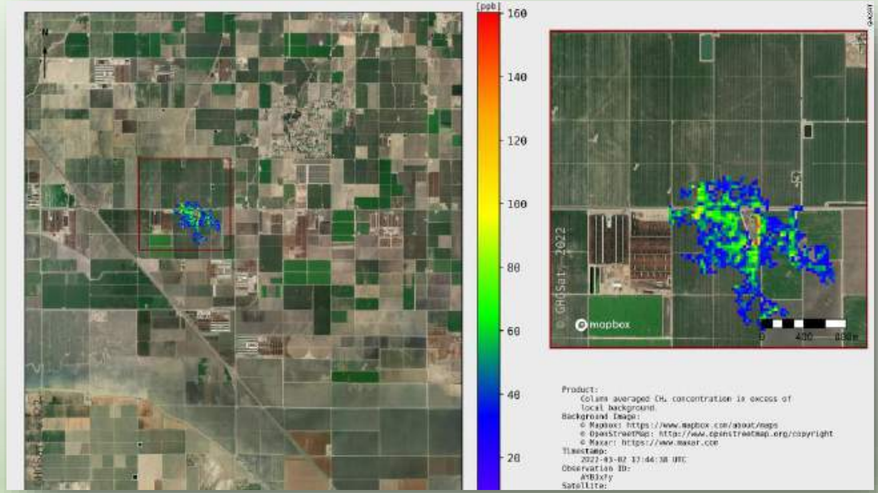
Why should be be concerned about **greenhouse gases**?

Image credit: NFU



1. What percentage of greenhouse gas emissions come from cows?
2. Sort the sources of greenhouse gas emissions into order from the greatest to the lowest contributors.
3. How do emissions from cow farms compare with other types of farming?

Image credit: European Commission



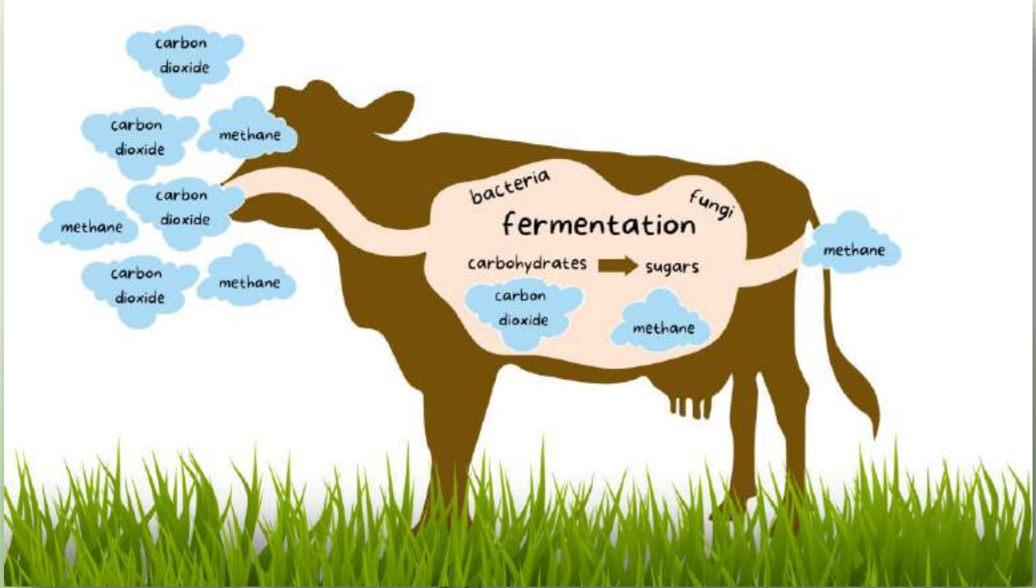
Did you know?

Scientists and engineers work together to build satellites that gather data to monitor the emissions of greenhouse gases across the planet.

These satellite images show the high levels of methane in blue over fields of cattle.

Image credit: ESA/GHGSat

Why do cows exhale greenhouse gases?



Different chemical changes take place in the stomach which change the chemicals in food into new products.

One of these chemical changes is called **digestion** where the chemicals in food are broken down into smaller pieces that can be absorbed into the body.

Another of these chemical changes is called **fermentation** where microorganisms such as bacteria or fungi break down carbohydrates into sugars as well as producing gases such as carbon dioxide gas and methane gas. These gases mostly leave the body through burps.

Does seaweed affect the rate of fermentation?

Suggested method

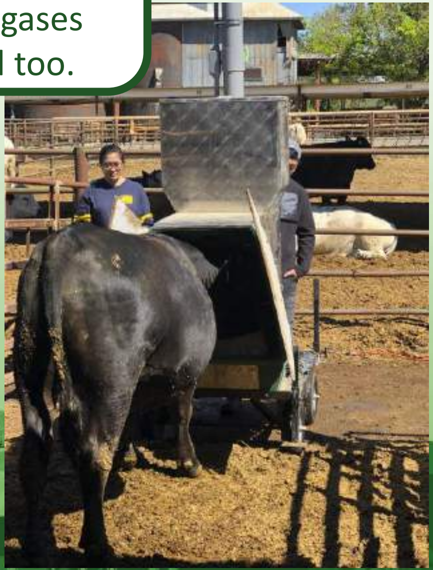
1. Put a heaped teaspoon of yeast (half the sachet) in each zip-lock bag, tear half a sheet of the dried seaweed into small pieces and put inside one of the bags – mix thoroughly with the yeast.
2. Dissolve the sugar in the water and divide between the two samples.
3. Press the bag to remove excess air and seal. Mix the contents together by gently pressing the contents with fingers, ensuring that the bag is completely sealed to prevent escape of gases.
4. Observe and record changes in the bags over time using drawings, video or photographs.

What variables will you control to make your comparative test fair?

How does the introduction of a red seaweed supplement to a cows diet affect methane emissions from cows?

A PhD student fed 21 cows increasing amounts of seaweed supplement – none for 3 weeks, low amounts for three weeks then high amounts for three weeks.

An open-air contraption measured the methane in the cows’ breath as they ate. Other gases were measured too.

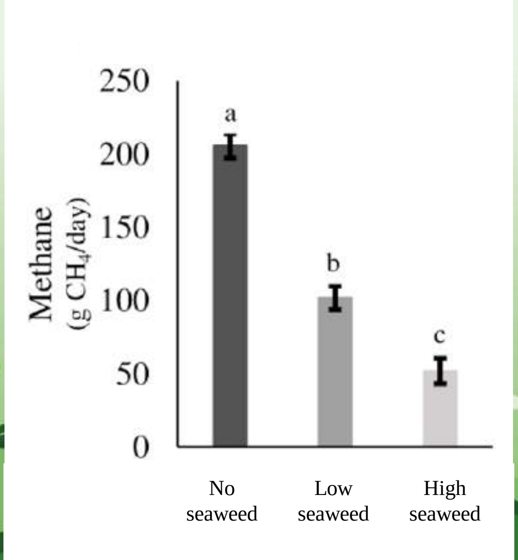


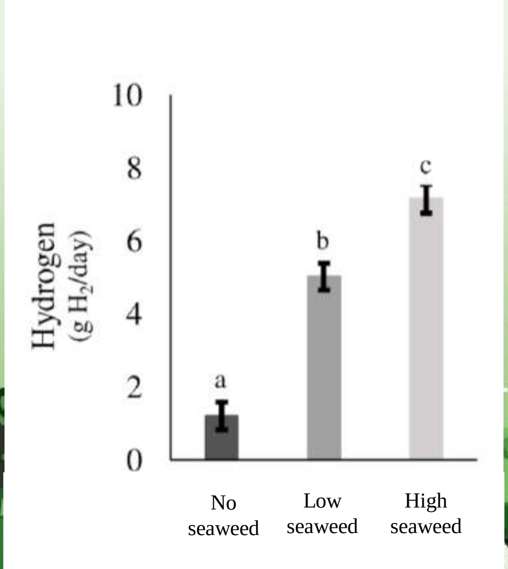
The Professor and his team monitored the health of the cows.

Image credit: Timothy McConville/UC Davis

Use the three bar charts to interpret the data from their study.

1. How did the amount of methane in a cow's breath change if they ate red seaweed?
2. Were there any other changes in the gases that the cows exhaled?
3. Would it be a good idea to introduce red seaweed supplements to a cow's diet?





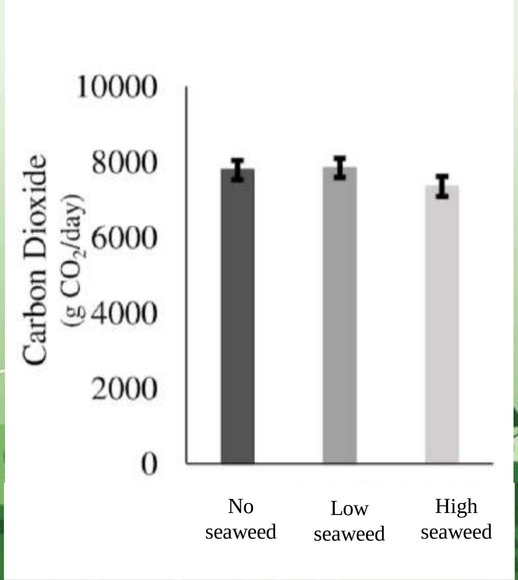


Image credit: Roque et al, 2021

Engineering ideas innovate dairy farming

As well as being a greenhouse gas, methane is a useful gas to use as a fuel.

Can you think of a way that methane could be captured from dairy cows so that it could be used for energy?

UK engineers designed a wearable device for cows that converts methane into carbon dioxide and water vapour. Methane in the atmosphere traps 25 times the amount of heat that carbon dioxide does so this invention could slow down climate change.

Image credit: Arthur Edwards/Poole via AP/Zelp

Today we have been working like an engineering by **asking questions** to better understand the problems that farmers face with protecting the environment.

Some of our questions have led to science enquiries where we have **worked scientifically** to gather evidence to answer them.

Cattle Carers - Session 3

How can we redesign dairy living spaces to improve cow wellbeing?

Context:
Learners focus on specific problems related to a cows health and wellbeing when kept in an indoor environment on dairy farms. They learn about normal behaviours for a cow and think about how indoor environments can be designed to encourage cows to exhibit those behaviours. Learners use information provided, additional research and their own creativity and imagination to design a dairy barn that is the ultimate indoor cow environment.

Engineering focus:
Learners will be working as an engineer by imagining and planning possible solutions to the farmer's problem with taking care of the wellbeing of the dairy cows.

Learning time:
1.5 hours

Suggested age group:
9-11 years old

Keywords
herd
grooming
socialise
behaviour
ethogram
ruminating
conditions
freedom
comfort
enrichment
hygiene
trough
stalls
cow brushes
manure robots

Curriculum links:
Design technology: *Design*
- Using research and design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at particular individuals or groups.
- Generating, developing and communicating ideas through discussion, annotated sketches, cross-sectional and exploded diagrams.

Resources:
- Cattle Carers - Session 3 PPT
- Ethogram templates
- Cattle Carer Problem on a page handout
- Poster paper/flip chart paper
- Post-it notes
- Pens, pencils and rulers
- Squared paper

Optional:
- Laptops/tablets with internet access

Step-by-step plan

1

What makes a happy cow?

Find out learners prior knowledge about animal wellbeing and their basic needs by challenging them to work in groups to develop a list of things that a dairy farmer would need to think about when planning for the health and wellbeing of their animals. Display a words search which has clues hidden it for learners who are stuck for ideas.(Slides 2-3)

Take time for groups to share their ideas to build up a collective list of the needs of dairy cows on the board - this will be useful later in developing detailed design criteria for the challenge.

Explain the observable clues that indicate that a cow is healthy and happy (slide 4) and allow learners to put this new learning into action by making careful observations of a dairy cow at a country show and considering its health (slide 5).

2

Where do cows spend their time?

Explain that some dairy cows spend spring and summer outdoors and move indoors for the colder seasons, while others are always indoors (slide 6). Ask learners to discuss in pairs:

- Why do you think that dairy cows live in different places in different seasons?
- How might living indoors be different for the cows compared with spending time in the fields?

3

What is normal behaviour for a cow?

Ask learners to consider how we know cows are 'happy' in their environment. Explain to pupils that in order to understand how to develop the best environment for a cow, it is important to spend some time observing their natural behaviour.Explain when scientists and farmers study animal behaviour they use a tool called an ethogram. The information they collect is useful to inform them and others, like engineers, for a variety of purposes (slide 7).

Learners **watch the short video** on slide 8 and complete their own ethogram, making a list of all the behaviours and actions they observe in the cows. Learners can then compare their ethogram with one produced by scientists (slide 9).

Learners can improve their ethogram and then test it by making observations over time of the two videos on slide 10, keeping a tally of the frequencies with which they observe the different cow behaviours.

4

Imagine and plan the ultimate indoor cow environment.

Understanding normal cow behaviours can help farmers and engineers to work together to design environments for cows that keep them happy and healthy. Learners collaborate to imagine and plan possible solutions to the farmer's problem in the Happy Cow challenge. Provide groups with the Problem on a page: Happy Cow Challenge handout to support them in their problem solving (slide 11).

Encourage learners to collaboratively plan their barn layout using post-it notes so they can move elements around until they are happy with the layout. Each group should have access to a laptop of table to research aspects of their design. Encourage learners to justify their different design choices and layout.

Learners independently create a 2D scaled floor plan of their barn design, using an A3 sheet of paper and a scale of 1cm per 1m. The dimensions of the barn are 20m x 35m. All areas should be clearly labelled and justified on the plan. Encourage learners to look back to their ethogram to help them justify how their design choices will encourage the cows to exhibit normal healthy behaviour. An example is available (slide 12) to share with learners with need additional guidance.

5

How well does your design meet the success criteria?

Allow time for learners to reflect on how well their designs meet the design criteria. Learners can pair with someone from another group and take a few minutes to share their design with their partner, taking it in turns. Students can peer assess each other's ideas - identifying strengths and areas for development.

Learners can then self reflect on their own success using the table of the problem on a page layout.

Take it further

- To learn more about how researchers study the behaviour of dairy cows watch this short film.
- To find out more about how farmers monitor the health of their dairy cows watch this short film.

Make your own ethogram

Behaviour	Description

Ethogram of cow behaviour

Behaviour	Description
Walking	Movement from one place to another without the head near the ground.
Foraging	Grazing or browsing, taking frequent bits of forage.
Standing	Standing still, no movement to another place.
Ruminating	Cow is lying down and chewing the cud.
Drinking	Drinking water from a trough
Grooming	Cleaning or scratching itself.
Social	Interaction with other cows (e.g. grooming, mounting)

What are typical behaviours for happy cows?

Behaviour	Tally	Total
Sleeping/resting		
Moving around		
Eating		
Foraging		
Drinking		
Grooming		
Social (playing & interacting)		

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Curriculum for Excellence links:

Second Level:

I can extend my knowledge and understanding of engineering disciplines to create solutions. TCH 2-12a

I have carried out investigations and surveys, devising and using a variety of methods to gather information and have worked with others to collate, organise and communicate the results in an appropriate way. MNU 2-20b

I can develop and communicate my ideas, demonstrating imagination and presenting at least one possible solution to a design problem. EXA 2-06a

I can use a range of graphic techniques, manually and digitally, to communicate ideas, concepts or products, experimenting with the use of shape, colour and texture to enhance my work. TCH 2-11a

I can investigate how product design and development have been influenced by changing lifestyles. TCH 2-05a

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Eating		
Foraging		
Drinking		
Grooming		
Social (playing & interacting)		

Happy Cow Challenge

What's the farmer's problem?

"I need to house my small herd of 60 dairy cows over winter. I have an open barn that is 20m wide and 35m long but I want my cows to be as happy in the barn as they are out in the fields. "

Available resources:

- Access to the internet for researching ideas
- Poster paper and post-it notes for thinking through ideas and planning

What is the design brief?

Create a 2D scaled floor plan of your barn design, using an A3 sheet of paper and a scale of 1cm per 1m. The dimensions of the barn are 20m x 35m. All areas should be clearly labelled and explained on the plan.

Include the following basic components:

- Resting areas
- Feeding trough
- Water stations

Consider how to enrich the cows' natural behaviour and well-being by allowing areas for:

- Socialising
- Exercising
- Grooming
- Play

The engineering design task

Can you design an indoor environment for the farmer that will meet the cows' basic needs as well as stimulate their natural behaviour?

Cows need spacious homes with clean comfortable beds and plenty of light, this is particularly important in winter, when most cows stay indoors to keep warm and dry. As well as the basic needs of food, water and a space to lie down, the cows' well-being needs to be considered. Farmers know that cows enjoy each other's company and like to move around, so barns should have designated areas for exercise as well as rest.

Top tips to get started:

Think about the barn layout, ensuring enough space for all 60 cows:

- Will you have **loose housing**, where cows move freely around and have communal lying areas, or **bedded stalls** where every cow has their own space to rest when they want?

Think about the basic needs for the cows wellbeing:

- Where will the cows eat and drink? How will you ensure the cows are comfortable?How will you make sure cows don't slip?
- How will the barn be kept clean to ensure good hygiene?

Think about how will you enrich the living space for happy cows, will they be able to carry out all the behaviours and actions you identified on the **ethogram**.

Background Information:

Thinking about stalls?

- Stalls need to be 2.4m long and 1.2m wide to accommodate each cow.
- Stalls are normally organised in rows either double or single formation.
- The passage width between each set of rows should be 4m in between and 5m at the front and end of each row.

Non-slip floors could be textured concrete, rubber mats or any other surface that won't be slippy when wet.

Think about the space for moving around so that cows can get access to the water troughs, grooming brushes and other elements you have included for their comfort.

There are a huge variety of bedding choices to keep cows comfortable: mattresses, paper, compost, sand, sawdust or straw. As well as keeping cows warm, you might want to think about how to keep cows cool if temperatures increase.

Installation of cow brushes can help animals will their grooming. Creative ways that cows can access some of their food such as pinatas provide stimulation.

Research had shown that cows can enjoy music and smells such as lavender. Visual enrichment can be provided with mirrors, colour (yellow, orange and red), large pictures of companions and projectors with moving images of cows in the field.

Glossary:

dairy barn - a building or part of a building used for the sole purpose of housing, feeding and milking cattle.
free stalls –a comfortable place for dairy cows to lie down and rest. Cows are not restrained in the stalls and are able to enter and leave as they like.
trough – a long, narrow open container for animals to eat or drink out of.
manure robot – a device that automatically cleans the barn floor at times set by the user. This can be done by scraping or vacuuming the manure.
enrichment – the act or process of improving the quality or power of something by adding something else.
grooming - brushing and cleaning the cow.
Ethogram- a table of all the different kinds of behaviour observed in an animal.
hygiene - maintaining health and preventing disease through cleanliness.

More information and inspiration!

Take a virtual visit to a farm in Somerset to see how 1000 cows live in year-round housing.
You could research the products different engineering companies provide for barn design.
Explore this article about Creating an enriching life for cows

Want to take it further?

How could you adapt your design to monitor and maintain the health of the cows?

- You might monitor their temperature or their growth.
- What about maintaining hoof health or providing medicine?

How well did you do?

Success Criteria	Score /5
Enough space for all 60 cows to rest	
Cows can eat and drink whenever they want	
The cows will be comfortable	
The cows can demonstrate their natural behaviours.	
Cows will be kept clean and safe.	

Credit: David Dixon/MJ Harrison/

CATTLE CARERS

SESSION 3

How can we redesign dairy living spaces to improve cow wellbeing?

What makes a happy cow?

S	C	E	A	R	F	O	O	D	E	E	F	O	T
C	L	E	A	N	L	I	N	E	S	S	N	E	G
W	M	L	T	T	C	B	E	D	I	M	V	I	N
A	W	O	F	L	P	M	I	T	I	L	E	M	I
T	F	E	E	U	O	I	I	R	E	C	N	O	M
E	S	H	T	D	S	L	P	O	N	S	T	R	O
R	A	A	E	S	R	I	M	F	N	E	I	F	O
F	I	E	A	E	E	G	L	M	S	E	L	L	R
E	R	A	D	E	A	H	H	O	G	C	A	M	G
F	I	T	E	E	O	T	E	C	E	L	T	D	I
I	E	S	I	L	A	I	C	O	S	E	I	C	U
T	E	M	P	E	R	A	T	U	R	E	O	P	E
S	M	E	I	F	F	I	T	U	C	T	N	E	E
E	S	P	A	C	E	L	A	S	R	E	S	T	T

Make a list of things that need to be thought about when planning for the **health** and **wellbeing** of dairy cows.

Credit: Keith Weller/USDA

S	C	E	A	R	F	O	O	D	E	E	F	O	T
C	L	E	A	N	L	I	N	E	S	S	N	E	G
W	M	L	T	T	C	B	E	D	I	M	V	I	N
A	W	O	F	L	P	M	I	T	I	L	E	M	I
T	F	E	E	U	O	I	I	R	E	C	N	O	M
E	S	H	T	D	S	L	P	O	N	S	T	R	O
R	A	A	E	S	R	I	M	F	N	E	I	F	O
F	I	E	A	E	E	G	L	M	S	E	L	L	R
E	R	A	D	E	A	H	H	O	G	C	A	M	G
F	I	T	E	E	O	T	E	C	E	L	T	D	I
I	E	S	I	L	A	I	C	O	S	E	I	C	U
T	E	M	P	E	R	A	T	U	R	E	O	P	E
S	M	E	I	F	F	I	T	U	C	T	N	E	E
E	S	P	A	C	E	L	A	S	R	E	S	T	T

Temperature
Space
Rest
Bed
Comfort
Water
Food
Light
Cleanliness
Ventilation
Air
Grooming
Socialise
Freedom

How do we know cows are happy and healthy?

Hair or coat is smooth and shiny.

Breathing is smooth and regular.

Eyes are bright and alert.

No dribbling or saliva.

Walk easily and steadily with regular steps.

When lying down, can get up quickly.

Ears are upright, move to pick up sounds and flick off flies.

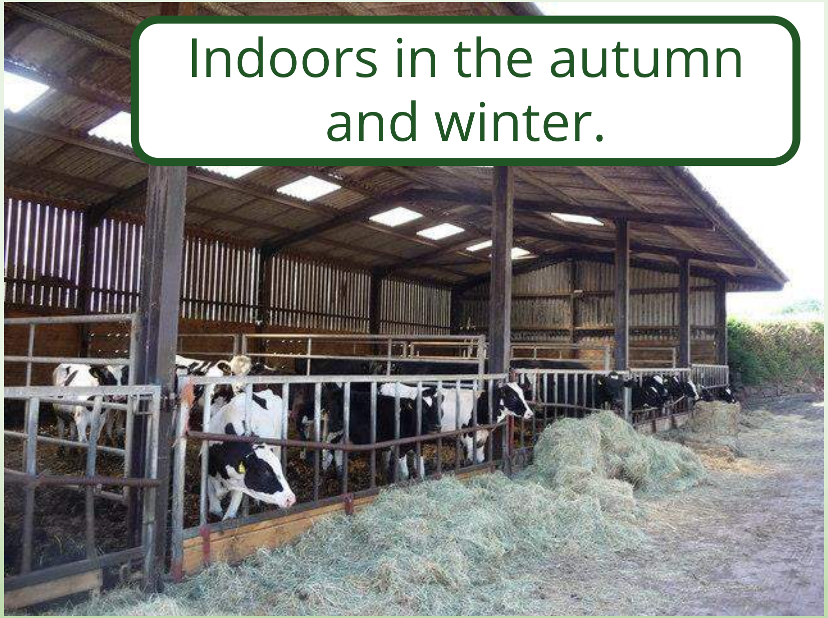
Alert and aware of surroundings.

Credit: Keith Weller/USDA

Is this a happy and healthy cow?

Where do dairy cows spend their time?

Spring and summer in the fields.



Indoors in the autumn and winter.

- Why do you think that dairy cows live in different places in different seasons?
- How might living indoors be different for the cows compared with spending time in the fields?

Credit: Martin Abegglen/Lewis Clarke

How do we recognise a cow's normal behaviour?

An **experimental ethogram** is where scientists or vets make a **list** of all the known **behaviours or actions** for a species. They will make observations over time.

Credit: Farm Sanctuary

Make your own **ethogram** for dairy cows in a field.

Make a list of all the actions and behaviours you see.

Credit: Farming Online

Behavior	Description
Standing head down	Head level with or below brisket
Standing head up	Head above brisket
Standing stiff-tailed	Standing with tail held stiffly away from body
Lying sternal recumbency	Lying on sternum or partially on sternum with hind-quarters to one side
Lying lateral recumbency	Lying on side, fully-recumbent
Locomotion	Walking, trotting
Feeding	Taking hay into mouth and/or chewing hay and/or grazing and/or browsing
Drinking	Consuming water
Ruminating standing	Standing, generally with a relaxed posture with regular chewing and regurgitation movements
Ruminating lying	As above, but lying sternum
Licking standing/lying	Standing or lying on sternum, turning to lick or attempt to lick body (body region noted)
Rub/scratch	Rubbing/scratching head or body against an object
Vocalization	Bellow or low
Teeth-grinding	Grinding molars together
Shiver/tremble	Whole of body shivering, shaking or trembling
Butt	Butt or attempted butt directed at another animal
Charge	Charges at another animal and stops
Push	Pushes another animal out of the way
Chase	Chases another animal (pursuit continues for some seconds)
Retreat	Moves away from butt, charge, push or chase
Grooms another	Licks another animal
Receives grooming	Recipient of grooming

How does your ethogram compare?

- How many different behaviours or actions did you observe?
- Did this scientist observe behaviours/actions that you didn’t see? Why might that be?
- What do you think cows spend most of their time doing?

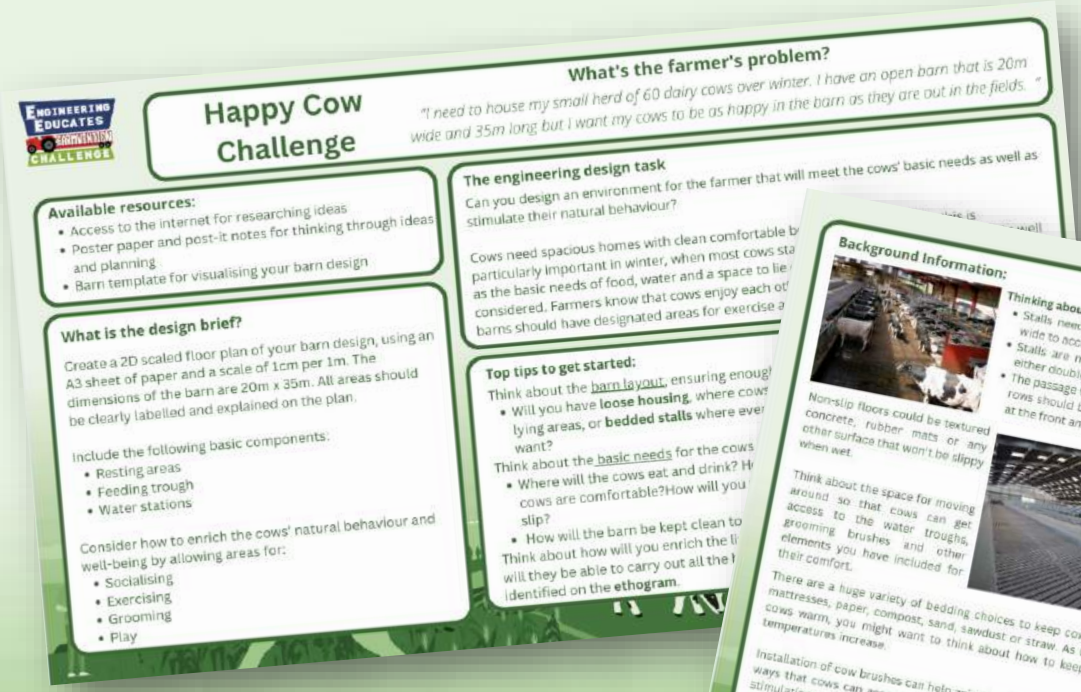
Credit: D.J.Mayer

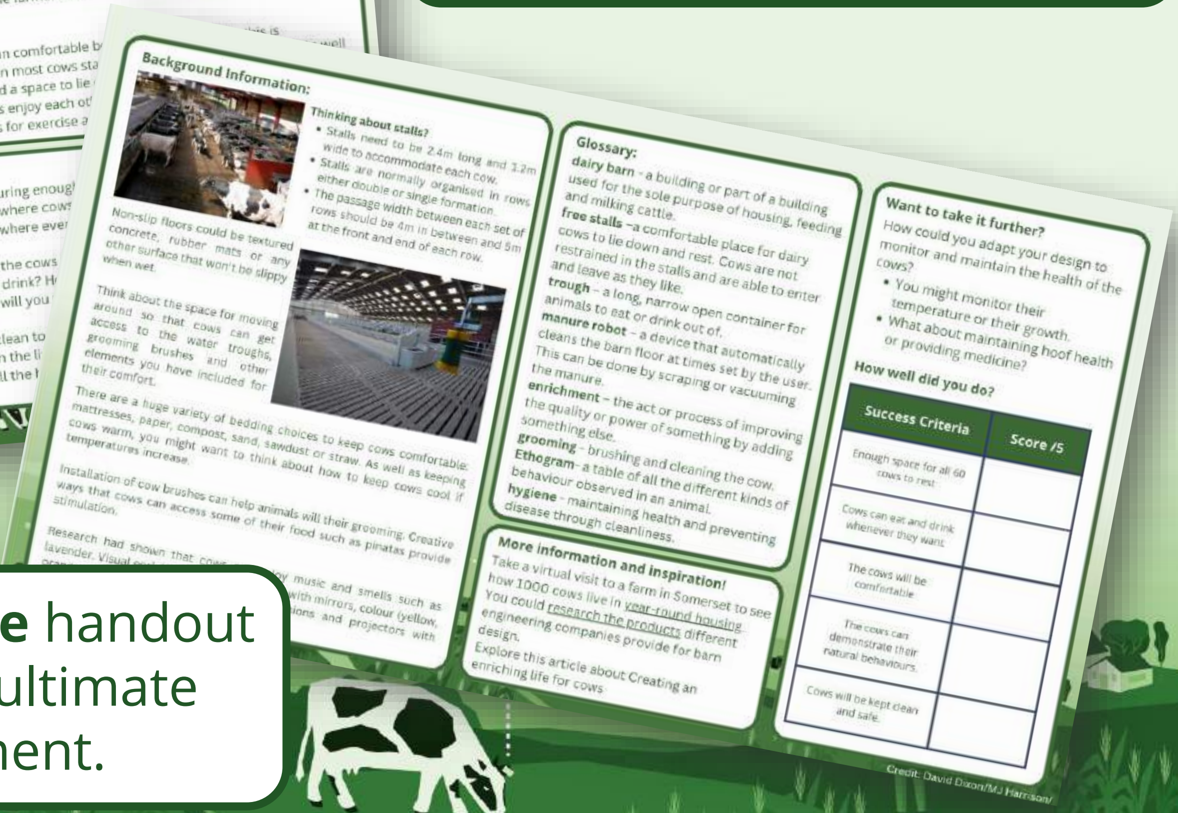
What do cows spend most of their time doing?

Use your ethogram to make observations of cow behaviour over time.

Credit: holsteincowboy/Storth Ltd

Happy Cow Challenge





Use the **Problem on a Page** handout to imagine and plan the ultimate indoor cow environment.

Example design for a dairy barn

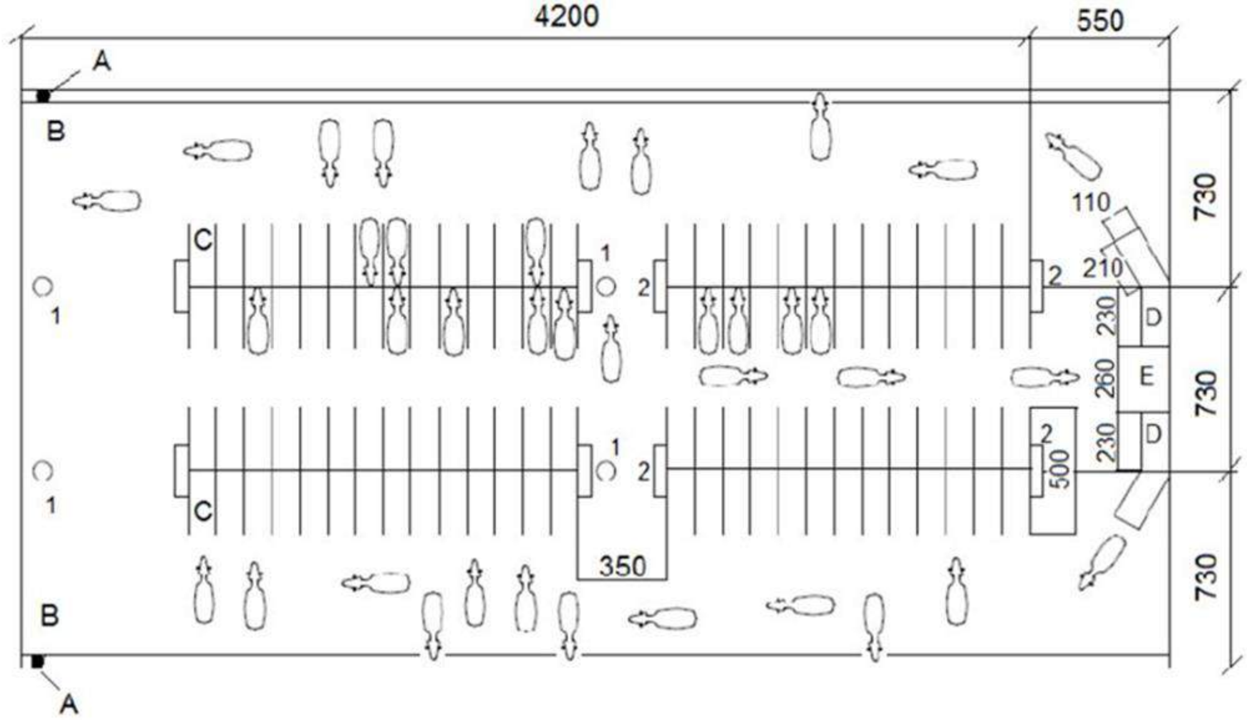


Fig. 1. **Layout plan of the free-type barn where the experiments are carried out (the sizes are in centimeters):** A – Forage line; B – Feeding area; C – Cubicles; D – Robots; E – Waiting area; 1 – Cow brushes; 2 – Troughs

Today we have been working like an engineer by **imagining and planning** possible solutions to the problem of maintaining the cows' wellbeing while living in the dairy barn.

Cattle Carers - Session 4

How can we use simple machines to improve air quality in the dairy barn?

Context:
Learners will learn about the need for housed animals to have access to a constant supply of fresh air if they are to maintain good health and well-being. Effective ventilation in a barn allows the inward movement of clean air and the expulsion of stale air, odours, bacteria and viruses. 'Natural' ventilation relies on the principle that the wind causes a difference in air pressure inside and outside the building, drawing in fresh air and displacing the stale.

Engineering focus:
Learners will be working as engineers to create a prototype system using pulleys or cams, which will raise a window in the roof of a barn and create an outlet for stale air to be released.

Learning time:
1.5 hours

Suggested age group:
9-11 years old

Keywords
gases
air
stale
ventilation
inlets
ridge
eves
outlets
stack effect
dispersed
machine
cam
pulley
movement
force
prototype

Curriculum links:
Design Technology: *Make, Evaluate and Technical knowledge*

- Selecting from and using a wider range of tools and equipment to perform practical tasks accurately
- Evaluating their ideas and products against their own design criteria and consider the views of others to improve their work
- Understand and using mechanical systems in their products [for example, gears, pulleys, cams, levers and linkages]

Resources (per group):

- Cattle Carers Session 4 PPT
- Problem on a page Mechanisms for living handout
- Shoe box or equivalent
- String/thread
- Pulley
- Cams
- skewers/chopsticks
- thick cardboard
- cotton reels
- Tape/scissors/craft knife/cutting board
- Transparent material such as cellophane or laminate pouch

Step-by-step plan

1

What is ventilation and why is it important?

Show learners examples of ventilation they may have come across in their daily lives (slide 2) and pose the question 'What is going on here?' - Encourage paired discussion about the images, what they have in common and why they are important.

Define the term ventilation (slide 3) and pose the questions:

- Why is **ventilation** important for us?
- Why do you think that **ventilation** is important for cows?

Make time for learners to discuss these key questions and ask them to use the key words displayed to develop their answers which can then be shared with the rest of the class.

Explain to learners:

- A mature dairy cow will typically breathe out 22 litres of water each day as water vapour and produce between 600 to 700 Watts of heat – that's as much as an electric fan heater. This warm, moist air may cause cows heat stress and can also provide ideal conditions for germs to thrive. Poor ventilation makes it more likely that the air carries viruses and bacteria which can lead to pneumonia (infection in the lungs) and mastitis (infection in the udders) in the animals.

So why is ventilation so important in the dairy barn?

2

How is ventilation achieved in farm buildings?

Begin my giving a simple scientific explanation of why air moves around, introducing simple ideas about convection currents (slide 4).

Explain what is meant by **natural ventilation** (slide 5) and that for air to circulate through the barn there needs to be air **inlets** and **outlets**. Discuss the different places these inlets and outlets could be positioned and the advantages and disadvantages of them (slide 5). Ask learners to consider why farmers may want to sometimes close and reopen inlets and outlets. Explain that using natural ventilation reduces carbon emissions because it makes the best use of the surround environment rather than using electricity to power fans and air conditioning systems.

Learners watch sections of a video of a dairy farm in Scotland where the farmer explains how he has introduced ventilation into his barn. Encourage them to think about how his ventilation system works and why he has chosen to introduce it (slide 6).

3

How can we use simple machines to improve air quality in the dairy shed?

Learner collaborate in small groups to develop prototypes to solve the farmers problem of introducing outlets in the roof of the barn that can be open and closed. Provide groups with the Problem on a page: Mechanisms for living handout to support them in their problem solving and creating.

Groups will use a shoe box of equivalent to model the dairy barn and then use the resources provided to use simple machines to create a mechanism that can open and close shutters/windows in the roof the allow warm, stale air to escape. This can easily be achieves with simple cams and/or a pulley system.

Encourage groups to go through a brief planning stage, sharing ideas on a whiteboard before they start to create, tinker and fine tune their prototypes.

4

How can we improve out prototypes?

Learners are encouraged to regularly reflect on what is working well with their prototype and what is not working well. They should be encouraged to try new ideas and adapt their designs, tinkering with the mechanism, trying to make it work more efficiently.

This tinkering stage needs time and learners shouldn't be rushed. Take time to talk to each group about what they are doing and what they might try next to improve their mechanism.

5

How well does our prototype meet the design criteria?

Make time for groups to come together and share their solutions, using their prototype to share ideas. They should present to peers:

- What are the essential parts of the system in their lifting device?
- How well does their device meets the design criteria?
- How might their solution help solve the barn's ventilation problem?

Mechanisms for living Challenge

What's the farmer's problem?

"I need to improve the air quality in my barn as there is nowhere for the stale air to escape in the roof."

Available resources:

- Shoe box (representing the barn)
- Additional cardboard
- Wooden skewers/chopsticks/cocktail sticks/lolly sticks
- plastic tubes/cotton reels
- string/splitpins
- scissors/ tape/ craft knife/ cutting board

What is the design brief?

Create a working prototype of a mechanism that incorporates simple machines such as pulleys, cams and levers to open and close ventilation outlets in the roof of the dairy barn.

The mechanism should:

- be able to be **operated by one person** who is **stood at floor level** in the dairy barn.
- the operator should be able to **apply a force** to the mechanism to both **open and close** outlet vents or windows in the roof of the building.
- The mechanism should use **cams and/or pulleys** to lift and lower the outlet vents or windows.
- the prototype should work in collaboration with **well positioned inlet vents** in the dairy barn design that draws in clean, cooler air.

The engineering design task

Can you create a simple mechanism to allow the farmer to open and close outlets on the roof to improve natural ventilation?

Good ventilation is essential for the health and well being of dairy cows housed in a barn. Keeping clean air circulating helps keep the cows comfortable and helps to prevent the spread of infection. Natural ventilation methods are low cost and more sustainable.

Top tips to get started:

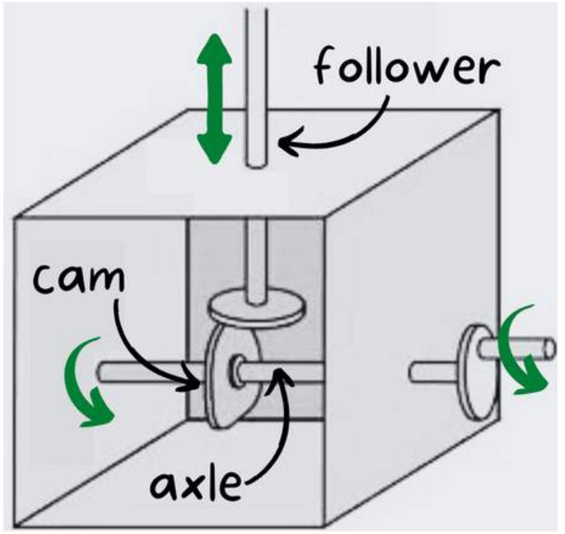
Will your outlet vents be opaque or transparent to also let in light?

Think about the simple machines you have learnt about in science. Which would be most useful for transferring a force from one place to another?

How could turning cams be used to lift and lower an outlet vent? Where would they need to be positioned in the dairy barn? How would the farmer turn the cams?

How could a pulley be used to lift and lower an outlet vent? What sort of structures might need to be added to make this possible?

Background Information:



A **cam** mechanism has two main parts: a cam, attached to a **crankshaft** or **axle**, which rotates and a **follower** which touches the cam and follows the shape, moving up and down.Changing the shape of the cam changes the way the follower moves.

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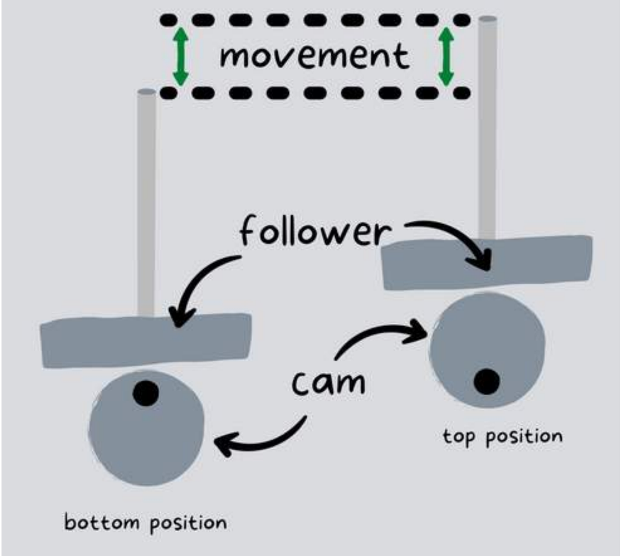

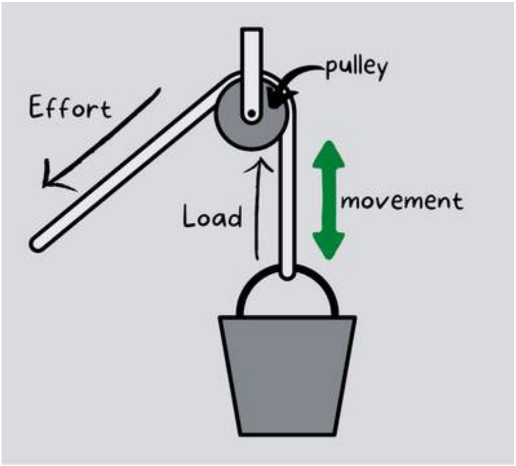

A single **pulley** changes the direction of force, making pulling down easier than lifting up. It doesn't increase the effect of the effort force but it can make it easier to apply a force when it is needed in a difficult to reach a location.

Glossary:

outlet - a vent installed in buildings to allow stale air to leave the building.
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ventilation - the provision of fresh air into a room or building.
prototype - a first version of a device or mechanism from which other forms are developed.

More information and inspiration!

Take a look at this video from NUSTEM that shows different ways cams are used to make automata.

Want to take it further?

Can you adapt your design to be able to open the vent by different amounts to increase or decrease the flow of air? The farmer should be able to fully open, partially open and close the outlet from the ground.

How well did you do?

Success Criteria	Score /5
Operated by one person	
Outlet vent can be opened and closed from the ground	
The outlet vent can be both opened and closed	
The mechanism uses cams and/or pulleys	
The design includes an inlet vent to draw in fresh air	

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prototype

Curriculum of Excellence links:
Second Level:
I can extend my knowledge and understanding of engineering disciplines to create solutions. TCH 2-12a
I can extend and enhance my design skills to solve problems and can construct models. TCH 2-09a
I can recognise basic properties and uses for a variety of materials and can discuss which ones are most suitable for a given task. TCH 2-10a
I can develop and communicate my ideas, demonstrating imagination and presenting at least one possible solution to a design problem. EXA 2-06a

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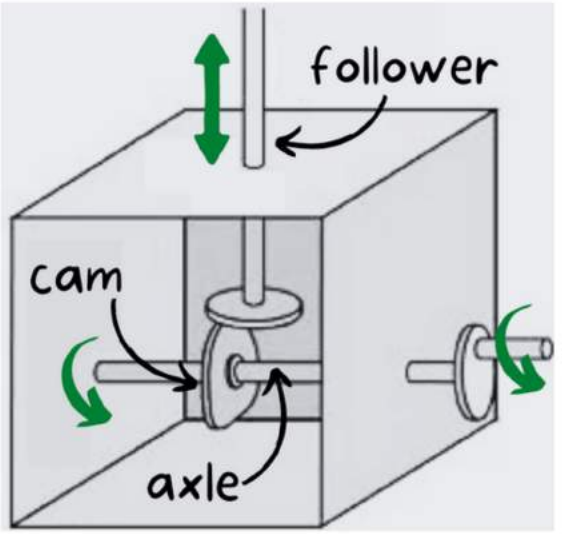

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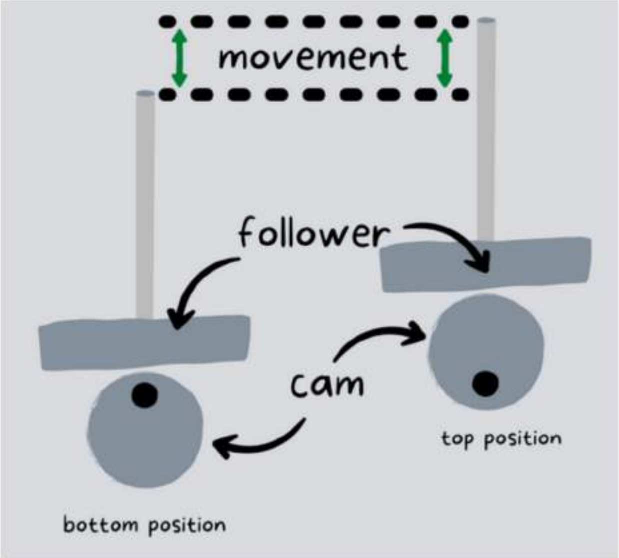

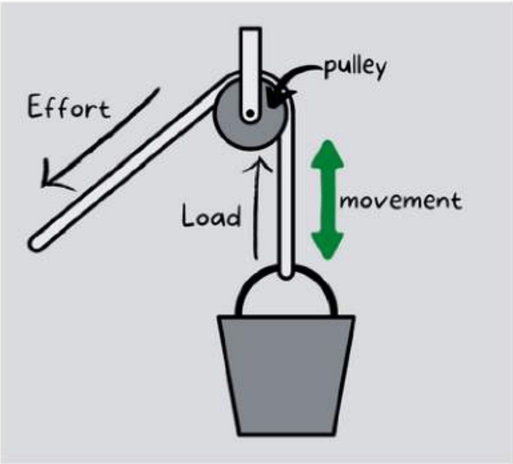

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Take a look at this video from NUSTEM that shows different ways cams are used to make automata.

Want to take it further?

Can you adapt your design to be able to open the vent by different amounts to increase or decrease the flow of air? The farmer should be able to fully open, partially open and close the outlet from the ground.

How well did you do?

Success Criteria	Score /5
Operated by one person	
Outlet vent can be opened and closed from the ground	
The outlet vent can be both opened and closed	
The mechanism uses cams and/or pulleys	
The design includes an inlet vent to draw in fresh air	

CATTLE CARERS

SESSION 4

How can we use simple machines to improve air quality in the dairy shed?

What is going on here?

Credit: Edwardx/Donald Trung/Raysonho/Michiel1972/Doggo19292/Gunnar Creutz/Antonio Mette

Ventilation - the provision of fresh air to a room or building

- Why is **ventilation** important for us?
- Why do you think that **ventilation** is important for cows?

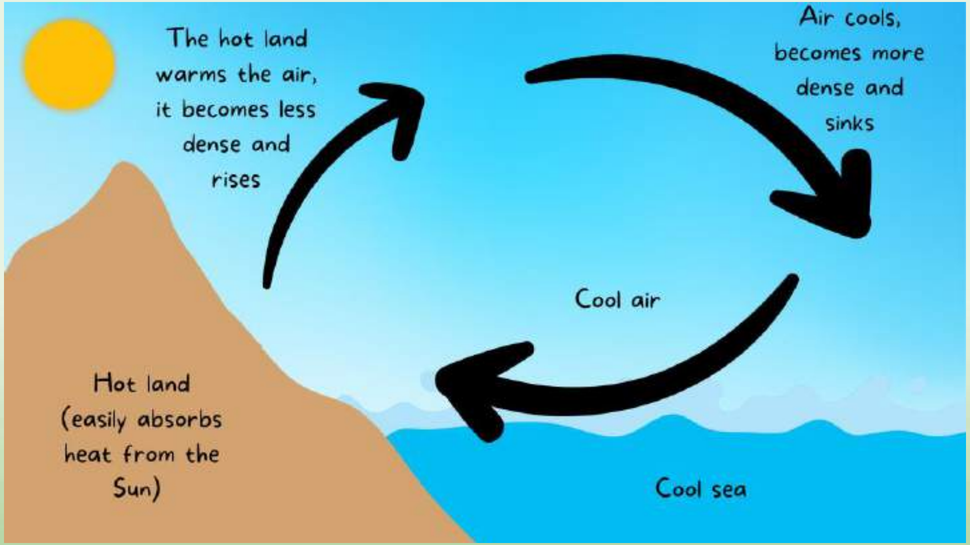
air | oxygen | carbon dioxide | mixture | fresh

temperature | stale | hygiene | harmful | breathe

humidity | water vapour | essential | flow | health

Why does air move around?

- Air is a **mixture** of gases that are always on the move.
- When gases have a **higher temperature** the particles are moving around quickly and they are more spread out.
- When gases are **cooler**, the particles move more slowly and are **closer together**.
- Warm air is less **dense** and rises. Cooler air is more **dense** and sinks.

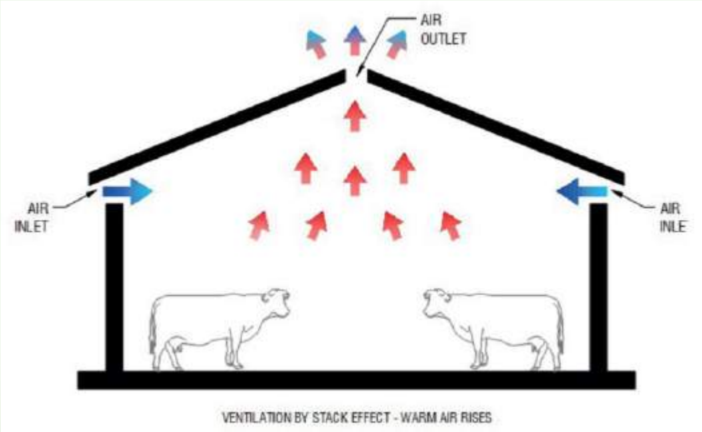


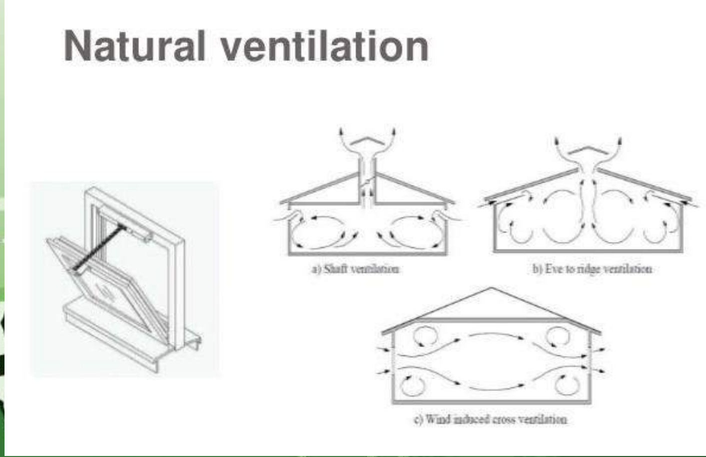
This is why we have sea breezes and why there is wind.

What is **natural ventilation**?

Natural ventilation is a method of supplying fresh air to a building by making use of the wind or differences in air temperature inside and outside the building.

There needs to be **inlets** to draw in cool, clean air from outside. There also needs to be **outlets** so the less dense, warmer stale air that rises upwards can escape.





Credit: FAS/Iowa State Extension

- What are important things to think about when thinking about ventilation in a barn?
- Why is poor ventilation bad for the dairy cows?

Credit: FAS

Mechanisms for living Challenge

Create a prototype of a simple mechanism to open and close outlets in the roof of a dairy barn.

Engineering Educates Challenge

Mechanisms for living Challenge

What's the farmer's problem?

"I need to improve the air quality in my barn as there is no where for the stale air to escape in the roof."

Available resources:

- Shoe box (representing the barn)
- Additional cardboard
- Wooden skewers/chopsticks/cocktail sticks/lolly sticks
- plastic tubes/cotton reels
- string/splitpins
- scissors/ tape/ craft knife/ cutting board

The engineering design task

Can you create a simple mechanism to allow the farmer to open and close outlets on the roof to improve natural ventilation?

Good ventilation is essential for the health and well being of dairy cows housed in a barn. Keeping clean air circulating helps keep the cows comfortable and helps to prevent the spread of infection. Natural ventilation methods are low cost and more sustainable.

What is the design brief?

Create a working prototype of a mechanism that incorporates simple machines such as pulleys, cams and levers to open and close ventilation outlets in the roof of the dairy barn.

The mechanism should:

- be able to be **operated by one person** who is **stood at floor level** in the dairy barn.
- the operator should be able to **apply a force** to the mechanism to both **open and close** outlet vents or windows in the roof of the building.
- The mechanism should use **cams and/or pulleys** to lift and lower the outlet vents or windows.
- the prototype should work in collaboration with **well positioned inlet vents** in the dairy barn design that draws in clean, cooler air.

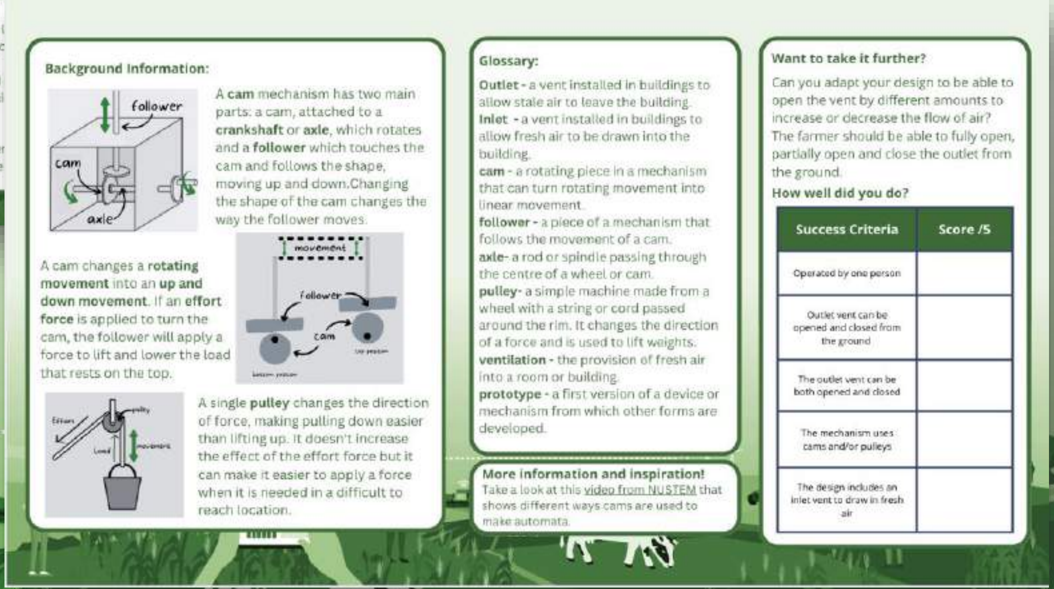
Top tips to get started:

Will your outlet vents be opaque or transparent to also let in light?

Think about the simple machines you have l... would be most useful for transferring a forc...

How could turning cams be used to lift and ... would they need to be positioned in the dai... farmer turn the cams?

How could a pulley be used to lift and lower ... structures might need to be added to make ...



Background Information:

A **cam** mechanism has two main parts: a cam, attached to a **crankshaft** or **axle**, which rotates and a **follower** which touches the cam and follows the shape, moving up and down.Changing the shape of the cam changes the way the follower moves.

A cam changes a **rotating movement** into an **up and down movement**. If an **effort force** is applied to turn the cam, the follower will apply a force to lift and lower the load that rests on the top.

A single **pulley** changes the direction of force, making pulling down easier than lifting up. It doesn't increase the effect of the effort force but it can make it easier to apply a force when it is needed in a difficult to reach location.

Glossary:

Outlet - a vent installed in buildings to allow stale air to leave the building.
Inlet - a vent installed in buildings to allow fresh air to be drawn into the building.
cam - a rotating piece in a mechanism that can turn rotating movement into linear movement.
follower - a piece of a mechanism that follows the movement of a cam.
axle- a rod or spindle passing through the centre of a wheel or cam.
pulley- a simple machine made from a wheel with a string or cord passed around the rim. It changes the direction of a force and is used to lift weights.
ventilation - the provision of fresh air into a room or building.
prototype - a first version of a device or mechanism from which other forms are developed.

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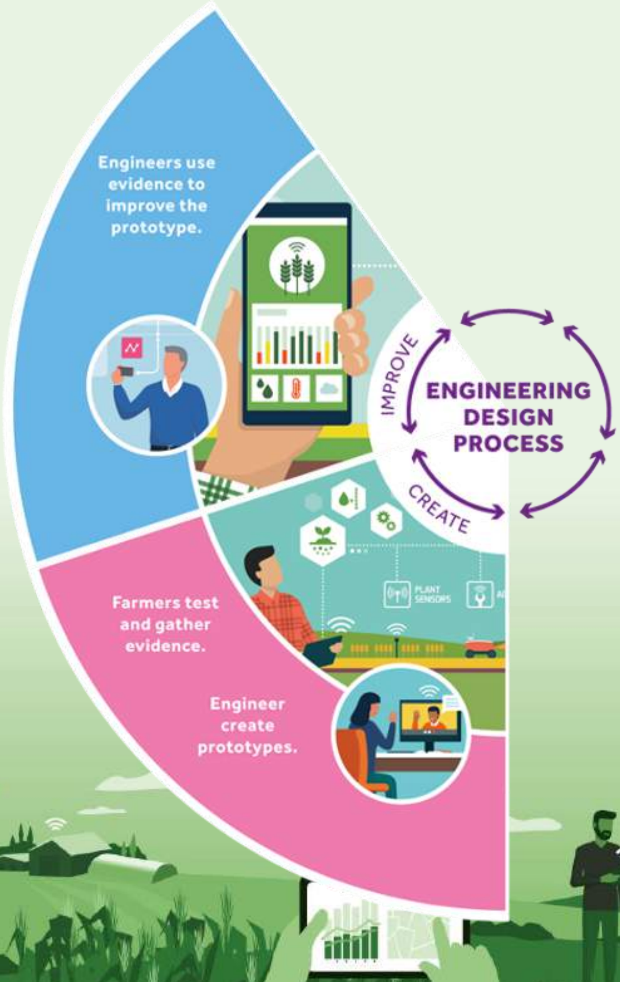


Today we have been working like an engineer by creating and improving a prototype mechanism for a dairy barn to solve the problem of poor air quality.

Cattle Carers - Session 5

How can we use technology to monitor the wellbeing of dairy cows?

Context:
This activity builds on the idea of recycling slurry into mats for cows to sleep on. Learners consider how they can use the micro:bit to monitor whether the mats are improving the quality of the cow's sleep - making a fitbit for cows!
Learners will consider the different environmental conditions and activities that can be monitored in the dairy barn using technology.

Engineering focus:
Learners will be thinking the place of technology in improving engineering solutions to problems on a dairy farm. They will we writing computer programmes to automatically monitor what is happening in the dairy barn.

Learning time:
1.5 hours

Suggested age group:
9-11 years old

Curriculum links:
Computing:

- Designing, writing and debugging programs that accomplish specific goals, including controlling or simulating physical systems;
- Using sequence, selection, and repetition in programs; work with variables and various forms of input

Keywords
automation
sensors
Micro:bit
program
code
debug
monitoring systems
sensor
variable
position sensor

Resources:

- Computer with access to the internet for MakeCode
- Micro:bits or Micro:bit simulator at MakeCode

Note - this lesson uses micro:bits. However if you don't have micro:bits, you can still complete this lesson using the online simulator at https://makecode.microbit.org/

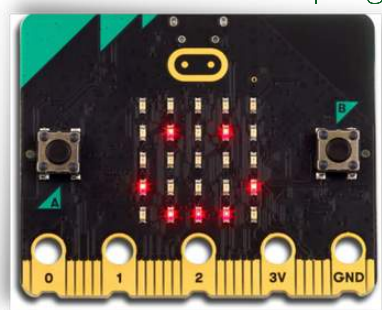
Step-by-step plan

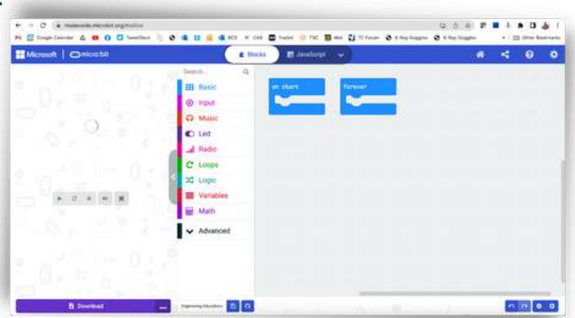
1

What is a Micro:bit and the MakeCode editor?

Display images of a micro:bit and the MakeCode editor, such as those shown below. Lead a discussion with pupils:

- Have pupils used the micro:bit before? If so, what did they create and how did they create this?
- Have pupils used the MakeCode editor before? What does the MakeCode editor remind pupils of? Why do they think this? (Make code looks and functions in a similar manner to Scratch - it is a graphical programming language)
- If pupils haven't used MakeCode before, but have used Scratch, lead a discussion on what they have previously created in Scratch. How did they create and run these programs?





2

How could a Micro:bit help with the health and wellbeing of cows?

Display the picture to the right and remind pupils they've talked about the idea of recycling slurry into mats for cows to sleep on. Explain that in this project we will use the micro:bit to gauge whether the mats are improving the quality of cow's sleep. They will program them to be worn by the cow at night - like a cow fitbit!

Lead a discussion with pupils. How might we tell if the cows are sleeping better? Share a selection of pupils' thoughts and arrive at the idea that we could check to see how often the cows move when they're asleep. Cows that are tossing and turning less should be getting a better night's sleep. We want them to be moo-ving less!

How can we use code to count and store the number of times a cow moves?

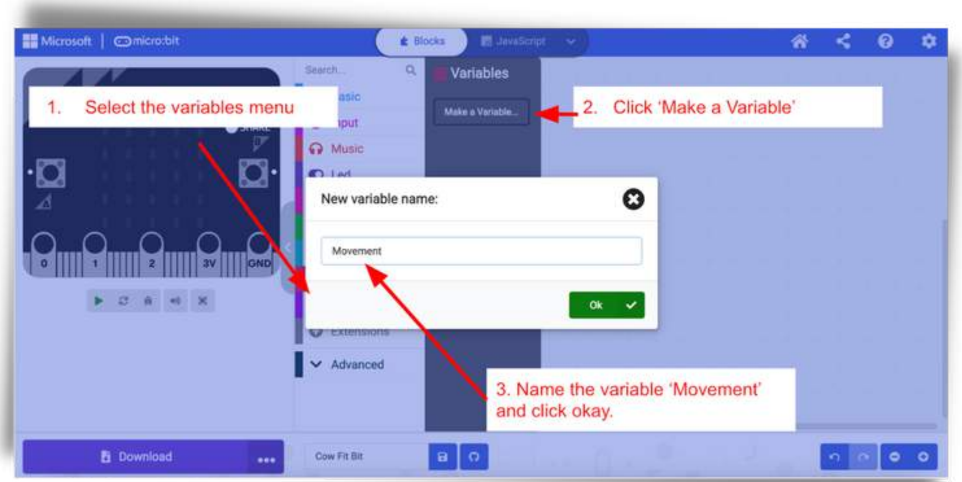
Based on the previous discussion, summarise the challenge we will be tackling with the micro:bits: **Program the micro:bit to act as a cow fitbit which automatically records how many times a cow moves when it is sleeping.**

Do pupils have any ideas on how they might tackle this challenge? Do they know of any programming concepts which might help here? Which features of the micro:bit might we use to help tackle this challenge? Share pupils' ideas to elicit prior understanding and lead into the following concept where possible.

Variables: Conclude with pupils a key feature of our code will be the need for counting and storing the number of times the cow moves. Explain that **variables** are used to store values in programs. Have pupils used variables before? A common use of variables are in computer games where they are used to store and display a player's score.

3

Explain that we will explore some code which uses a variable to better understand how they work. Display the following code to pupils. In this code a variable has been created called 'Movement'. In Make Code, commands relating to variables are red.



We can imagine our 'Movement' variable as a mini-whiteboard. We can write information on this mini-whiteboard to store it. We can also change the information stored on our whiteboard at any point as our program runs - we simply wipe it off and replace it with new information.

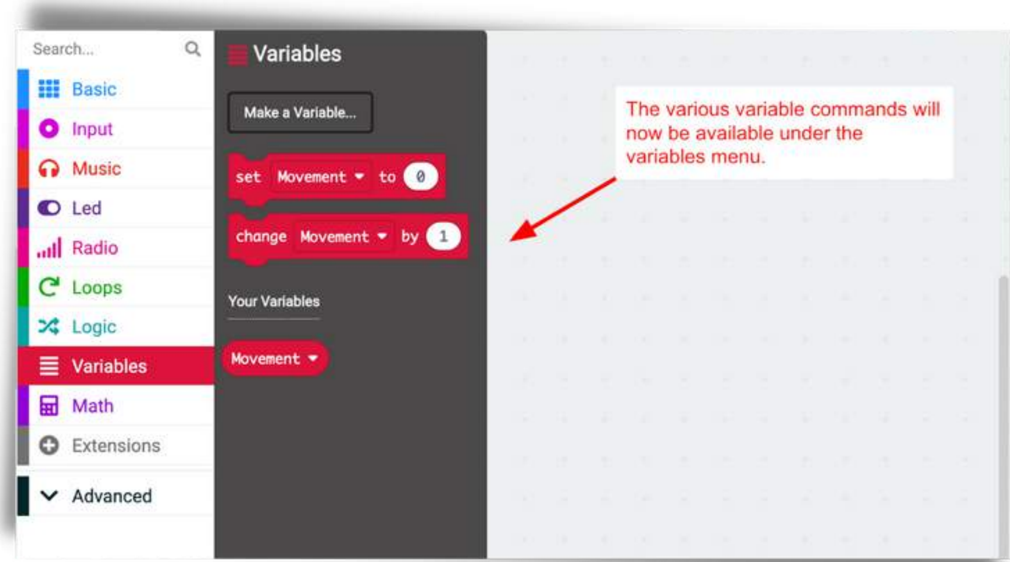
How can we use code to count and store the number of times a cow moves? (cont.)

3

Looking at the code. Can pupils predict:

- What the value of 'Movement' will be when the program is run (on start)?
- What happens to the value of 'Movement' when A is pressed?
- What happens to the value of 'Movement' when B is pressed?
- What happens when A+B is pressed?

Ask pupils to recreate the code in the Make Code editor, to run this and explore pushing the A and B buttons (and A+B) to see if their predictions are correct. To recreate this code, pupils will have to create the 'Movement' variable as shown below.



Answers to what happens when the code is run are as follows:

- When the program is run the value of the 'Movement' variable is set to 0.
- When the A button is pressed the value of the 'Movement' variable is increased by 1.
- When the B button is pressed the value of the 'Movement' variable is reduced by 1.
- When buttons A and B are pressed together, the value of the 'Movement' variable is displayed on the LED display.

Once pupils have had sufficient time to explore the code, lead a discussion on how and why a variable would be useful in our challenge? I.e. It could be used to store the number of times the cow moves.

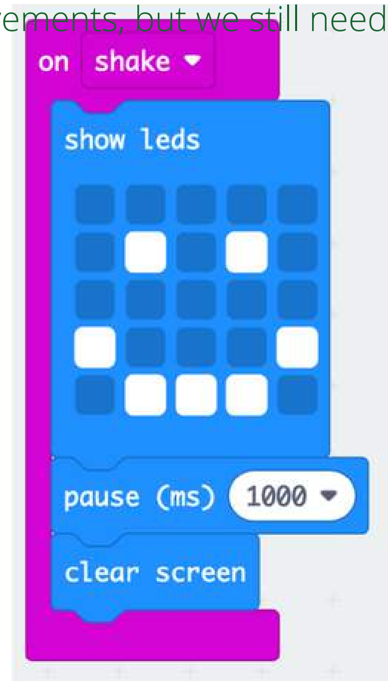
How can we use a Micro:bit to sense movement?

Remind pupils of our challenge: **Program the micro:bit to act as a cow fitbit which automatically records how many times a cow moves when it is sleeping.**

Recap with pupils that a variable, such as the 'Movement' variable we have just been exploring, could be used to record the cow's movements, but we still need a way of the micro:bit sensing these movements.

Explain that we will now explore the 'On shake' command, as this might be able to help us.

Show pupils the following code. What do they predict it will do when run? Why?



4

Give pupils time to add this code to their micro:bit, to run it and explore what happens when the micro:bit is shaken. When shaken, the micro:bit will display a face for 1 second and then go blank. I.e. the micro:bit is detecting when it is moved and triggering something.

The commands and concepts pupils have explored in this resource up to this point should now be sufficient to solve our overall challenge. As such, give pupils time to discuss with a partner how they might combine the use of the 'On shake' command along with a variable to record the number of times the cow moves. Share a selection of pupils' ideas. Lead a discussion to arrive at the general idea:

If the micro:bit is attached to the cow, we could use the 'On shake' command to detect when the cow is moving. Each time a new movement is detected, this could be stored in a variable. We could call the variable 'Movement' so it is clear what it is recording.

Parson's Problem

5

The code to now complete the overall challenge is contained in the Parson's Problem below. A Parson's problem scaffolds programming tasks by providing pupils all the code they need to complete a problem but doesn't show how the code should be combined.

Give pupils time to complete the Parson's Problem by adding the code to their Make Code project and combining the blocks of code to tackle the challenge. Pupils will have to create a 'Movement' variable for their Parson's Problem code as they did previously.

Pupils should test their programs - they could do this by strapping the micro:bits to themselves and pretending to be a sleeping cow with the occasional toss and turn!

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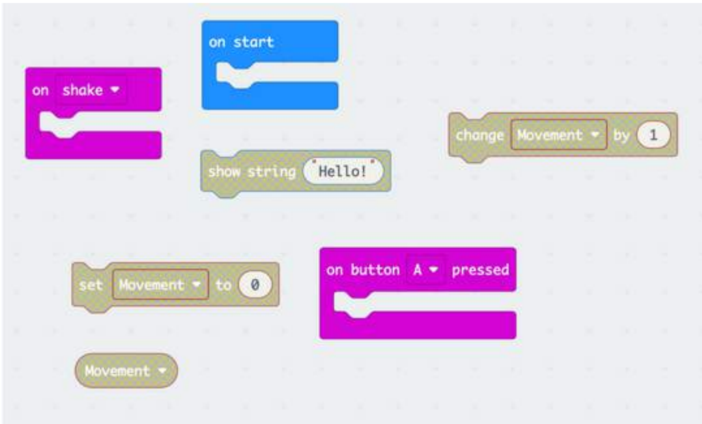

Code solution including comments:

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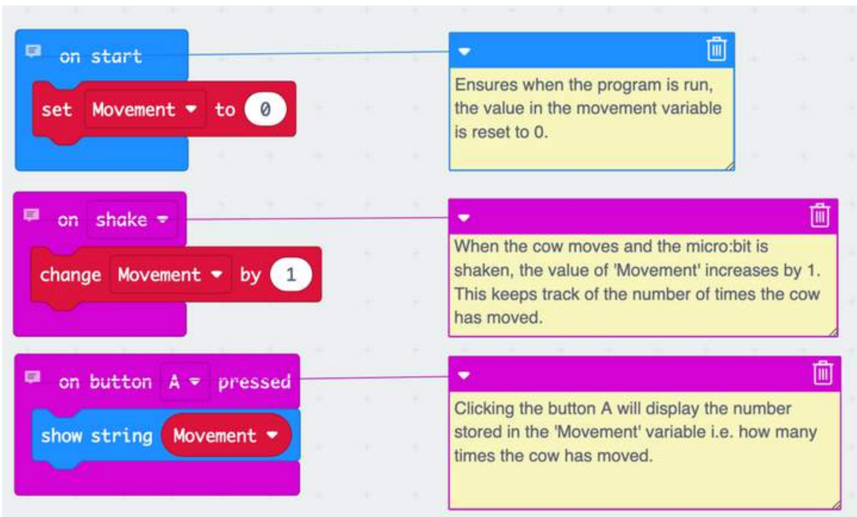

How effective is the programme at monitoring cow activity?

6

Lead a discussion with pupils to evaluate the success of their program. Based on their testing (as they took on the role of sleeping cows!) did their program:

- Automatically log each time the cow moved?
- Store the number of times the cow moved in the variable?
- Display the number of times the cow moved when the A button is pressed?

Discuss with pupils whether they encountered any bugs in their program - what were these and how did they remove them?

Whilst this activity has focused on the development of the micro:bit as a tool for sensing a cow's movement when sleeping, a discussion could now also be had on the scientific enquiry process of now testing if the mat is effective at improving a cow's sleep. What type of test would this be and why? How can we evaluate the effectiveness of the enquiry?

Take it further:

Pupils might find that the micro:bit doesn't log every movement, particularly more gentle movements as the micro:bit doesn't class the movement as a 'shake'.

Pupils could explore the variety of options within the 'On shake' command (shown right) to see if others provide a more accurate solution? Are there any potential draw backs of using other options? - such as the required orientation of the micro:bit.

Further links:

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Cattle Carers - Session 5

How can we use technology to monitor the wellbeing of dairy cows?

Context:
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Learning time:
1.5 hours

Suggested age group:
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Curriculum for Excellence links:

Second Level:
I can extend my knowledge and understanding of engineering disciplines to create solutions. TCH 2-12a
I can create, develop and evaluate computing solutions in response to a design challenge TCH 2-15a

Keywords
automation
sensors
Micro:bit
program
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Resources:
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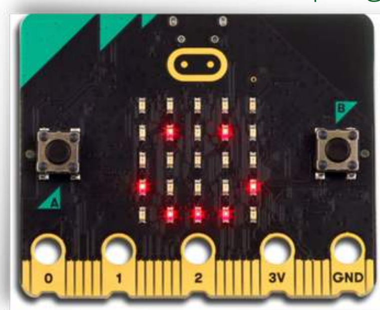

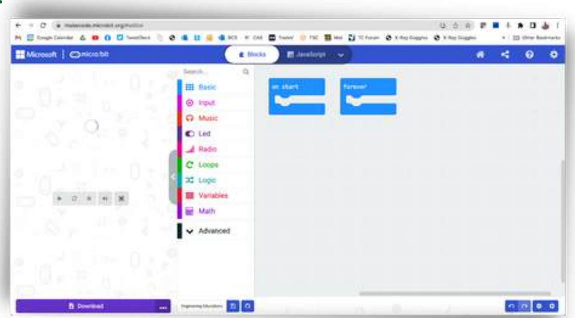

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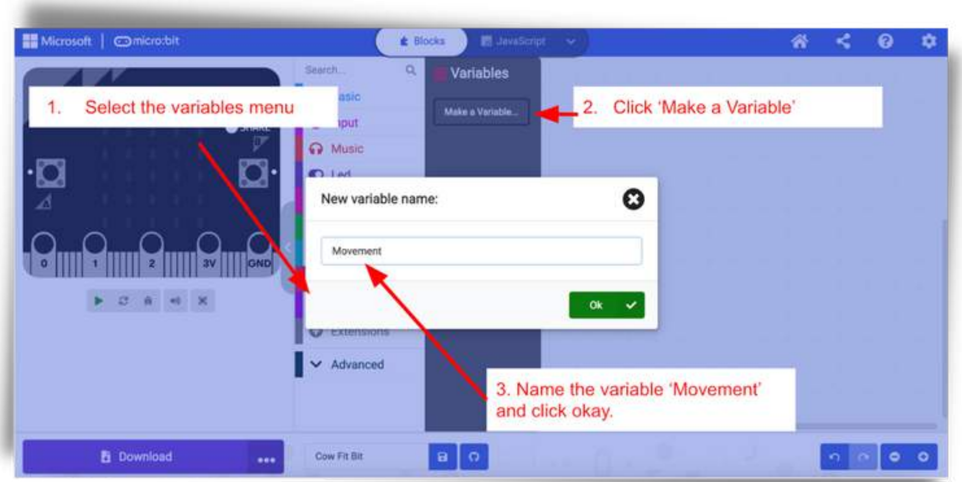

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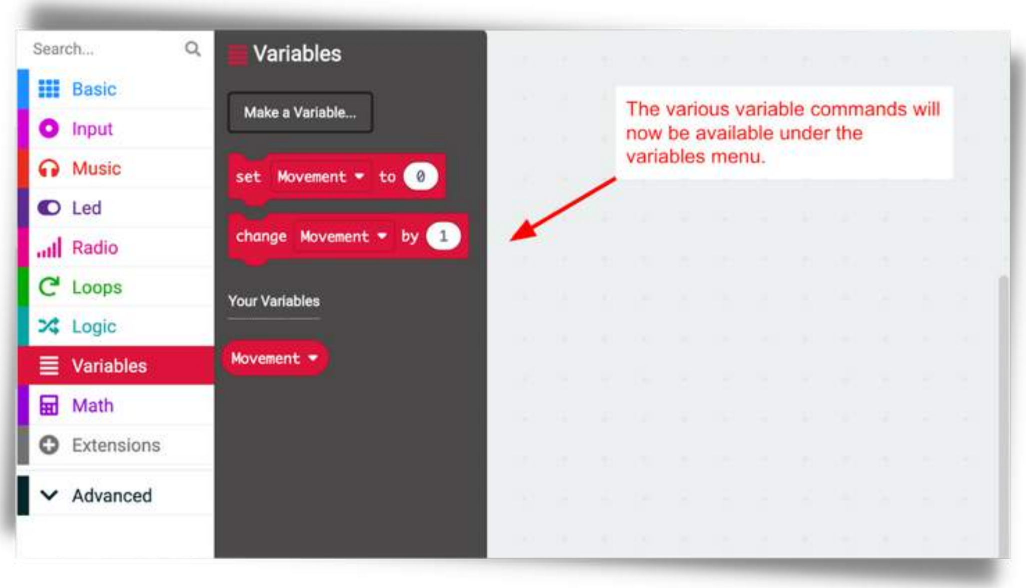

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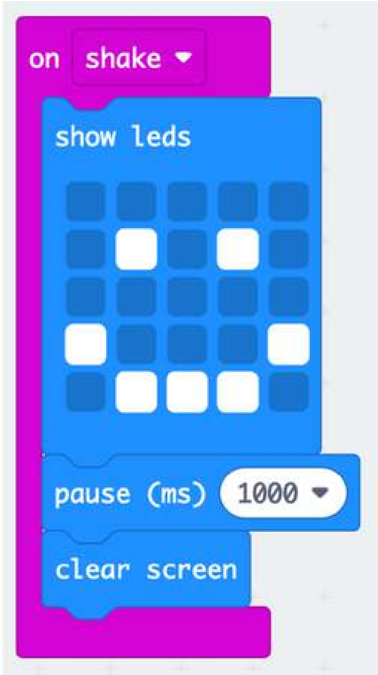

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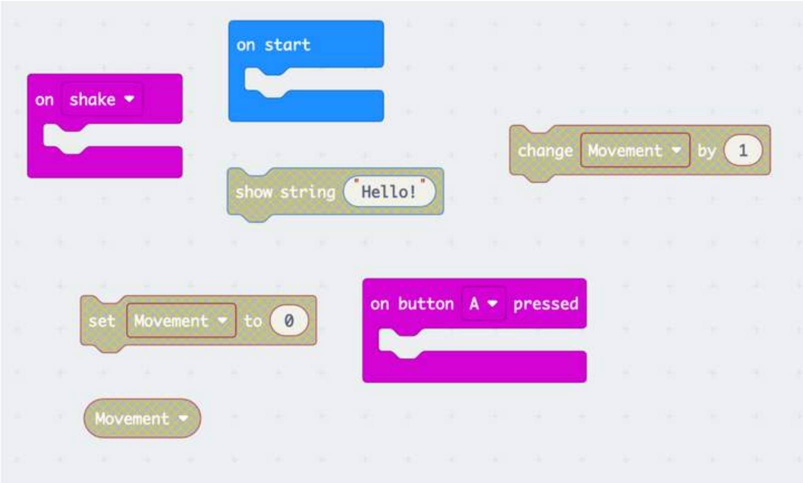
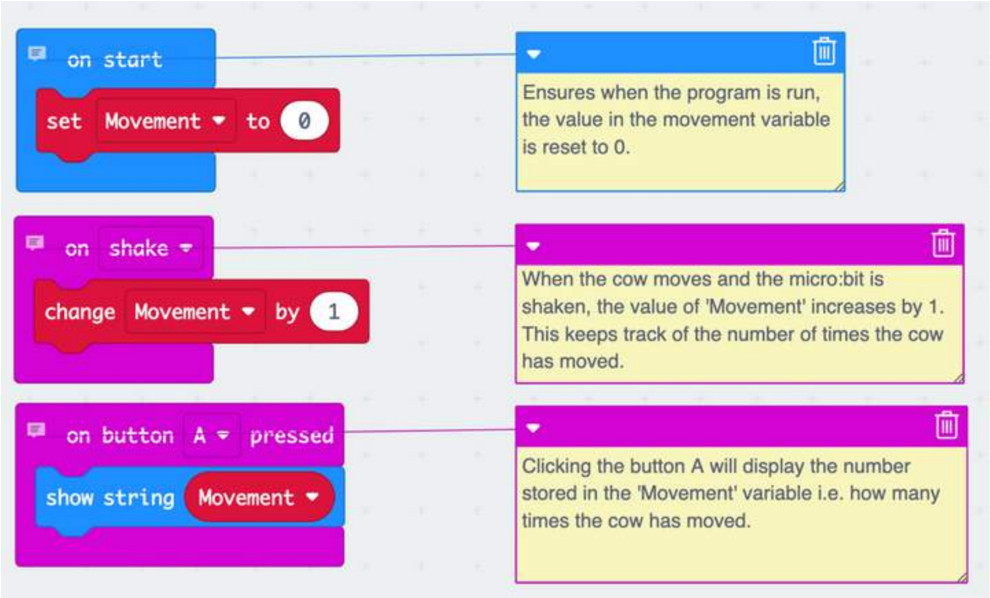


Code solution including comments:



6

How effective is the programme at monitoring cow activity?

Lead a discussion with pupils to evaluate the success of their program. Based on their testing (as they took on the role of sleeping cows!) did their program:

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- Store the number of times the cow moved in the variable?
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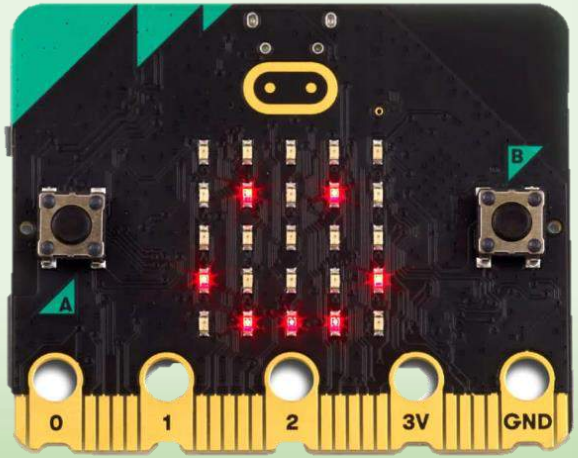
SESSION 5

How can we use technology to monitor the wellbeing of dairy cows?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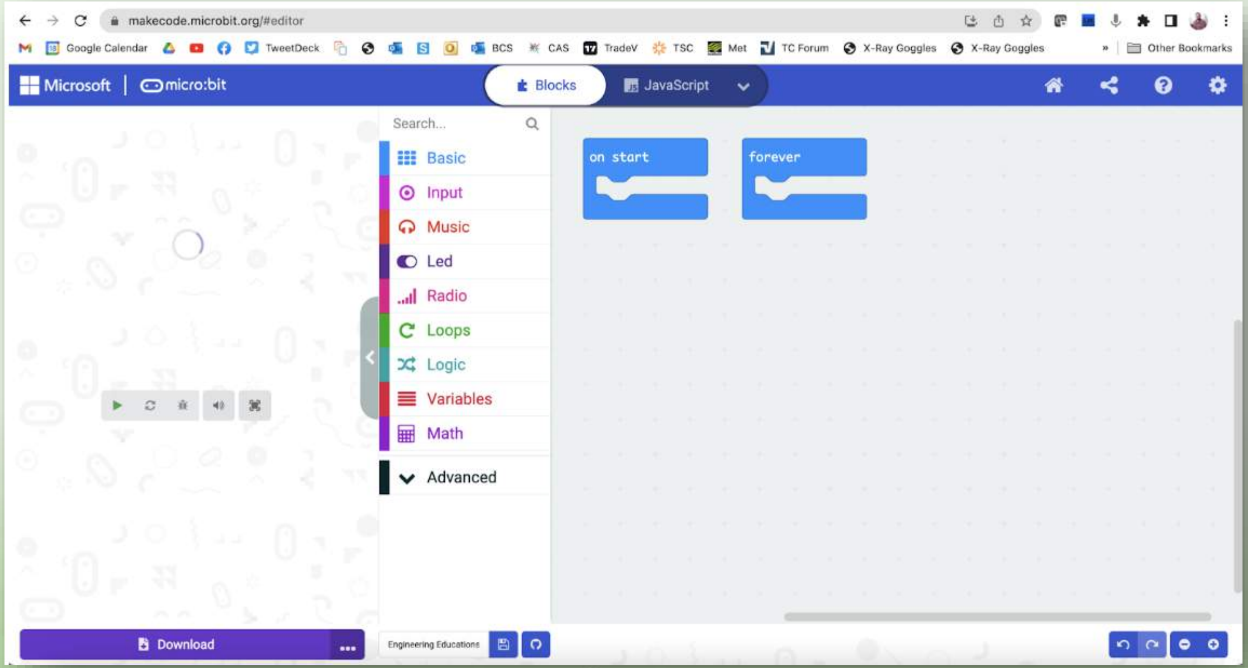
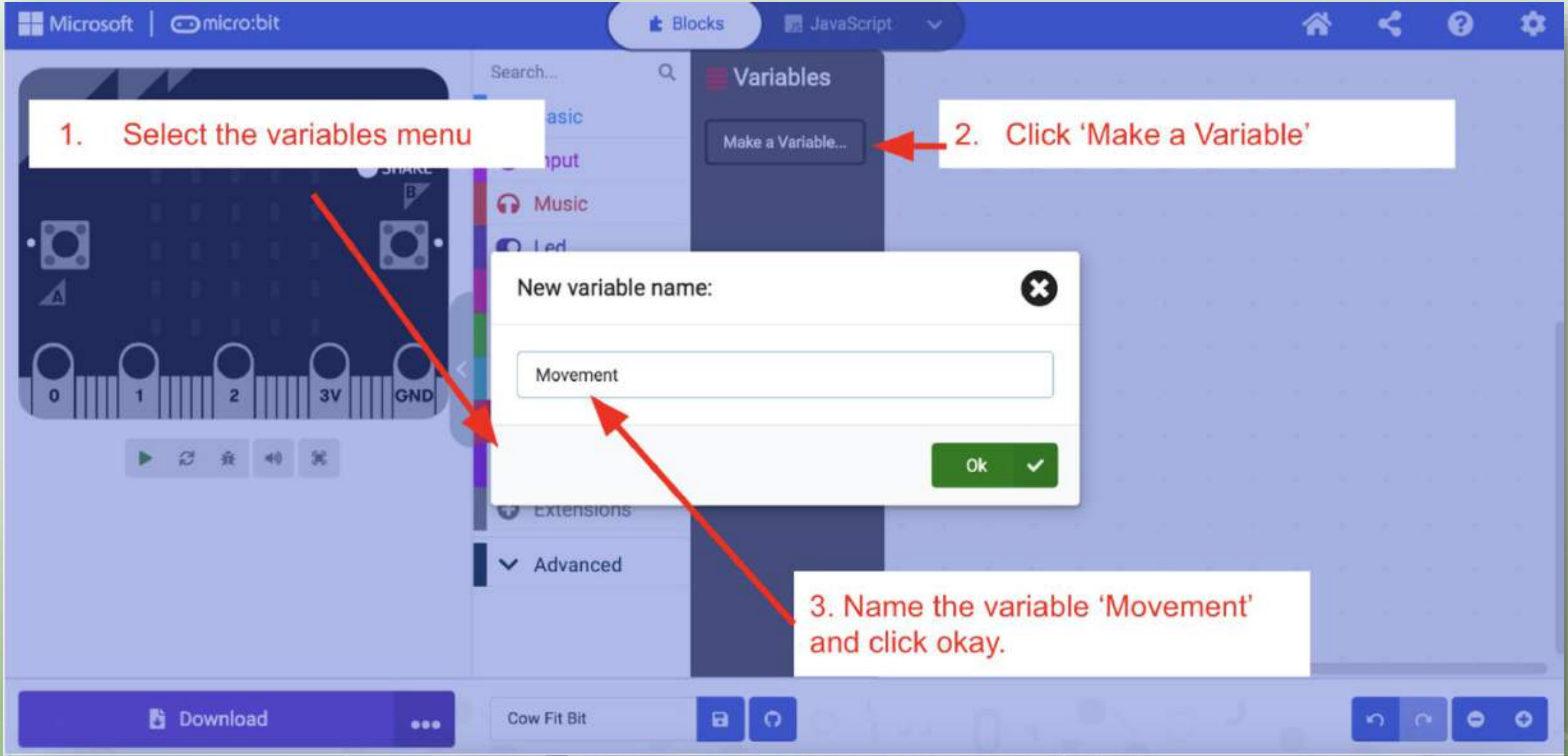
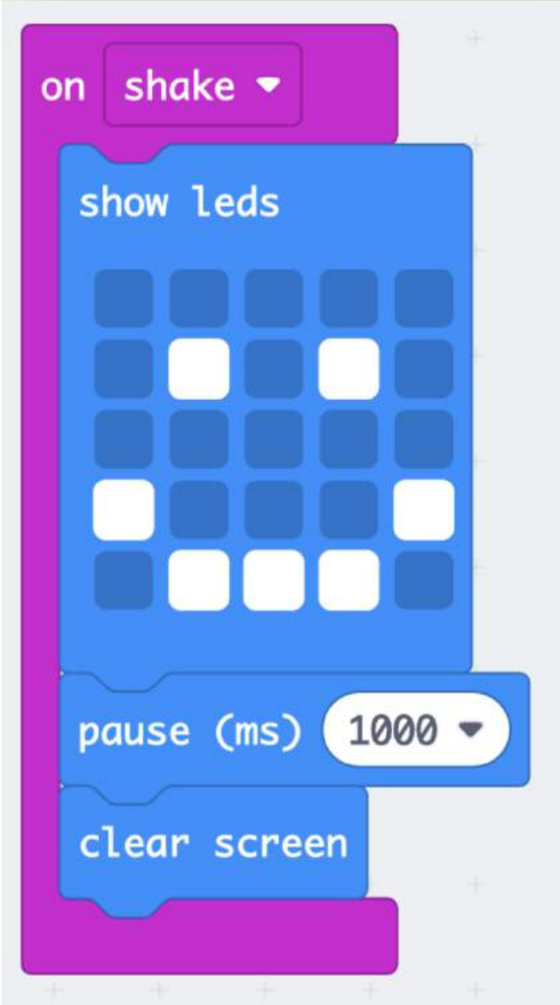
GND


makecode.microbit.org/#editor
Google Calendar
TweetDeck
BCS
CAS
TradeV
TSC
Met
TC Forum
X-Ray Goggles
X-Ray Goggles
Other Bookmarks
Microsoft
micro:bit
Blocks
JavaScript
Search...
Basic
Input
Music
Led
Radio
Loops
Logic
Variables
Math
Advanced
on start
forever
Download
Engineering Educations

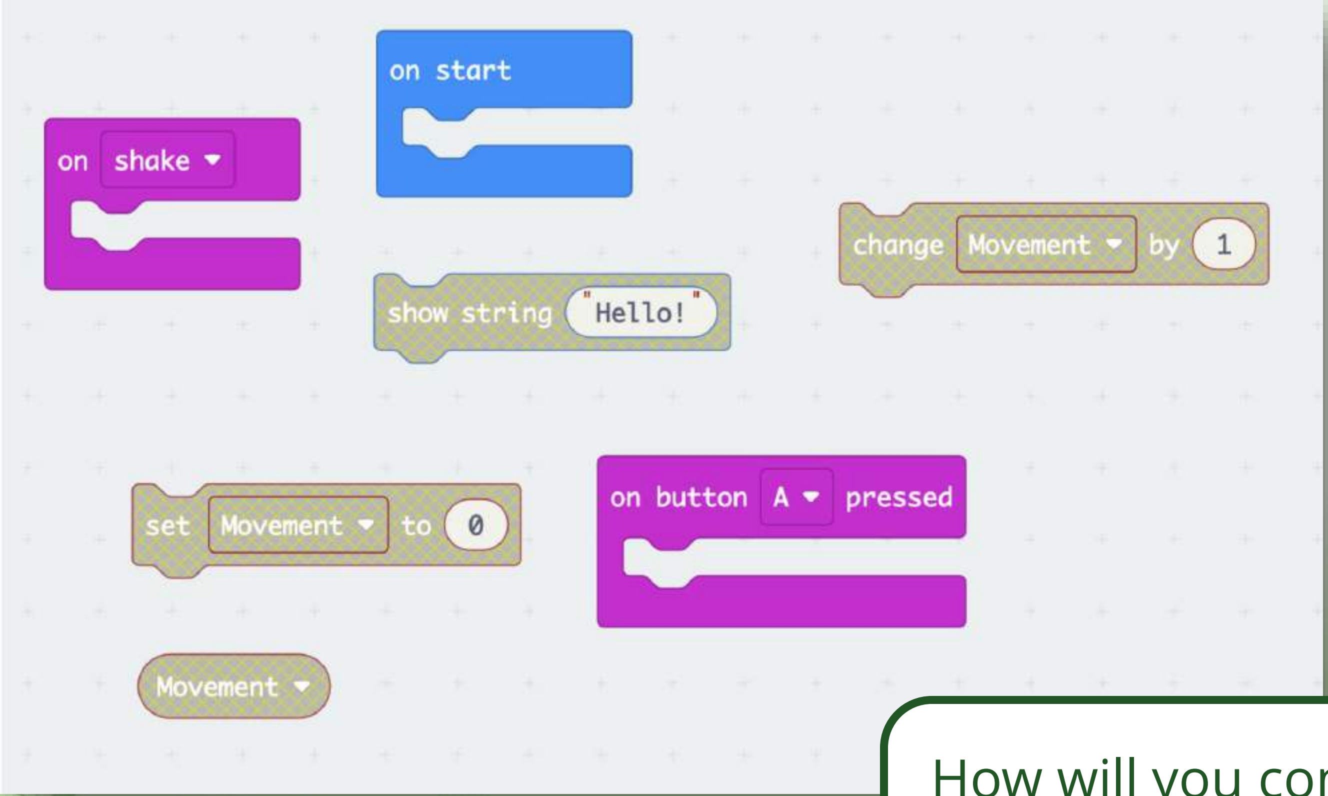
How can we tell if cows are sleeping better on the new bedding?


1. Select the variables menu
2. Click 'Make a Variable'
3. Name the variable 'Movement' and click okay.
Microsoft
micro:bit
Blocks
JavaScript
Search...
Variables
Make a Variable...
Music
Advanced
New variable name:
Movement
Ok
Download
Cow Fit Bit



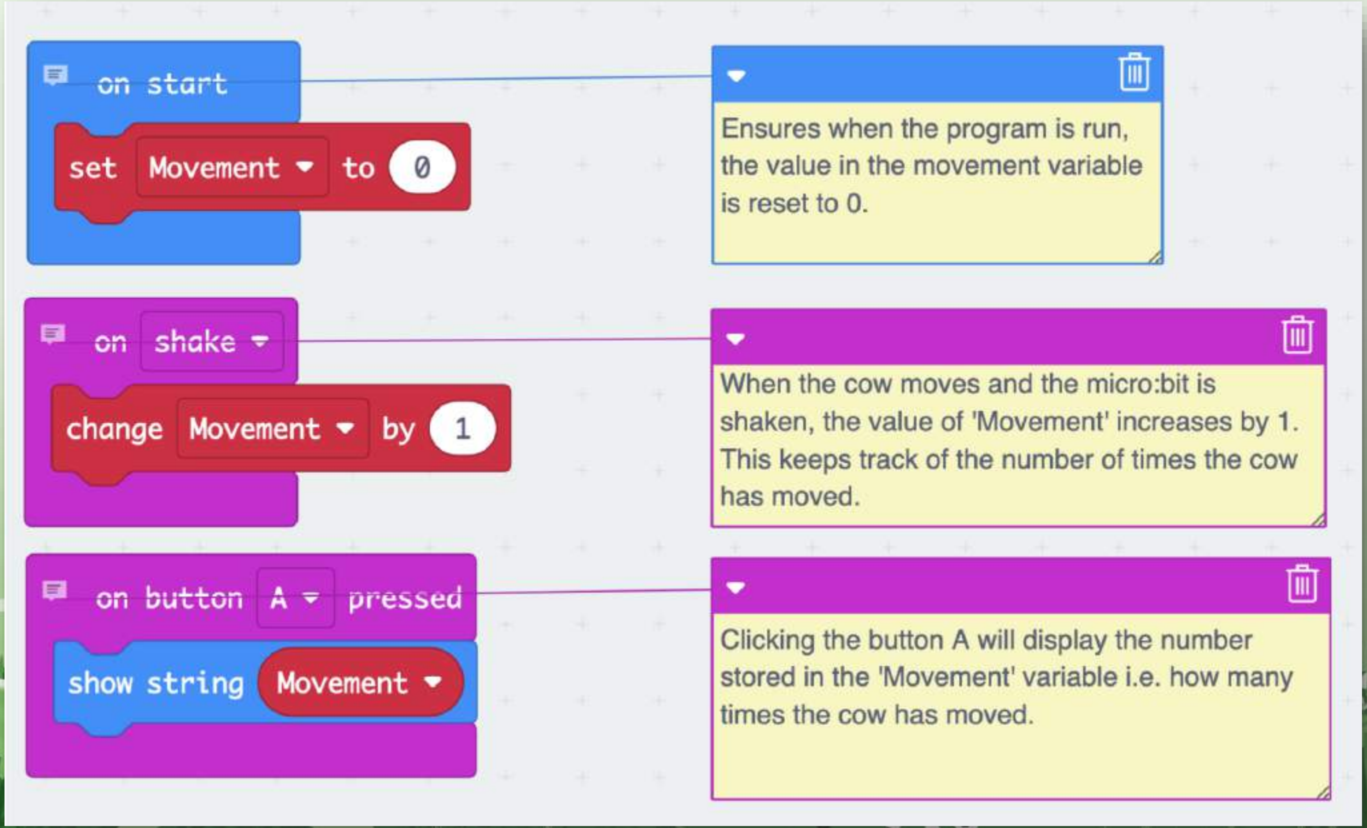
What happens when you shake the Micro:bit?

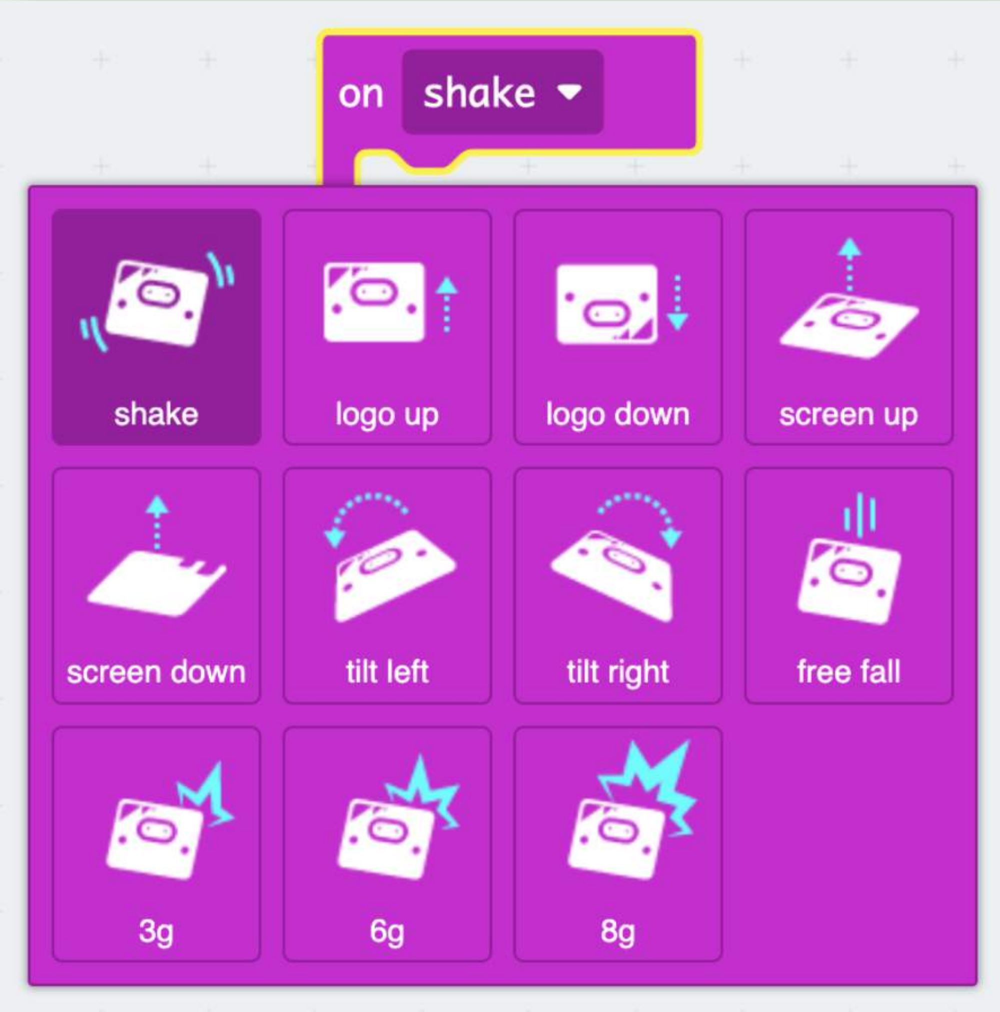
How will this help to monitor cow activity?



How will you combine these bits of code to sense and keep track of cow movements?

Solution


on start
set Movement to 0
Ensures when the program is run, the value in the movement variable is reset to 0.
on shake
change Movement by 1
When the cow moves and the micro:bit is shaken, the value of 'Movement' increases by 1. This keeps track of the number of times the cow has moved.
on button A pressed
show string Movement
Clicking the button A will display the number stored in the 'Movement' variable i.e. how many times the cow has moved.



Super challenge

Is there a more effective way to sense and keep track of a cow's movement?

Cattle Carers Pathway

Full resources list

Session 1

- Access to the internet

Optional:

- dairy products (e.g. milk, condensed milk, cheese, yogurt or butter

Session 2

Per group:

- 2 small or medium zip lock bags
- a sachet of yeast
- half a sheet of dried seaweed
- teaspoon
- suger
- measuring cylinder
- warm water (between 45-50°C)
- stirring rod
- thermometer

Optional

- laptops or tablets for research
- Cameras

Session 3

- Ethogram templates
- poster or flip chart paper
- Post-it notes
- pens, pencils and rulers
- squared paper

Optional

- laptops with internet access

Session 4

Per group:

- 5mm thick corrugated card
- 3mm skewers, dowel or straws
- seeds, beads, or marbles
- PVA glue or masking tape
- scissors
- cardboard tube
- recycled boxes
- A4 sheet of light card
- craft sticks
- rubber bands
- paper cups

Optional access to additional tools:

- glue gun
- craft knife
- cutting board

Session 5

Per group:

- Computer with access to the internet
- Micro:bits (note: this lesson uses V2 micro:bits, but if you don't have micro:bits or only have V1 then you can use the online simulator here https://makecode.microbit.org/

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