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 ^{o}C
- 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

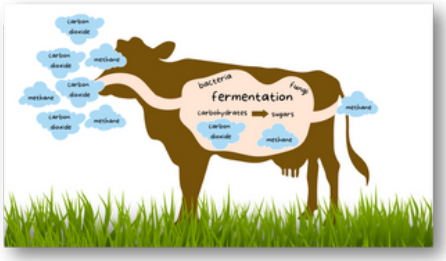
How does farming contribute to greenhouse gas emissions?

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.

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.

4

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

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.
Chemical change - a process when one material is altered into one or more new and different materials.
Rumination - the action of a cow chewing the cud (partly digested food returned from the first stomach for further chewing).
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/