Squelch the Belch 2

- Interpreting the data

Agriculture and greenhouse gases
The most significant anthropogenic (caused by humans) greenhouse gases are carbon dioxide, methane, nitrous oxide and chlorofluorocarbons (CFCs). Farm animals such as sheep, cows and deer belch out large quantities of methane produced by microorganisms in their rumen. This is a major concern in New Zealand where almost half of all greenhouse emissions come from agriculture. In 2002 the Pastoral Greenhouse Gas Research Consortium (PGgRc) was set up to investigate ways of reducing emissions from ruminant animals.

Sheep taking part in a NIWA/AgResearch experiment to determine the rate of their methane emissions
Courtesy: Keith Lassey

Scientific research in the real world rarely produces the neat and tidy results that we read about in text books. A scientist may spend a lot of time investigating a hypothesis that sounded like a good idea at the time but turns out to be just plain wrong. Results that look promising from one experiment may be contradicted by findings from another. Research in biology is especially difficult because living things are so complex. At the same time, it is endlessly fascinating because there is always something new to be discovered round the next corner.

In this activity you will read about some of the research being done in New Zealand and look at some of the problems involved in interpreting the data.

An ecosystem in a bag
A sheep's rumen contains a whole microworld made up of bacteria, fungi, protozoa (single-celled animals) and viruses. Directly or indirectly, these organisms depend on food eaten by the sheep, but, in turn, they are essential for the sheep's survival. In the anaerobic (lacking oxygen) environment of the rumen, fermentation takes place that results in the breakdown of cellulose, and the production of fatty acids that the sheep can use for energy. (Sheep themselves can't make the enzymes needed to digest the cellulose in their diet.) In addition, most of the amino acids that a sheep needs for protein production come from its microorganisms.

It's a huge job just to identify all the different species of microbes in the rumen, let alone to understand how they all interact together. Fortunately there are now techniques, such as genetic fingerprinting, which make it easier to investigate the species present and to find out if the populations are changing during an experiment.

Where does the methane come from?
Microorganisms in the rumen called methanogens replace the two oxygen atoms in carbon dioxide with four atoms of hydrogen to produce methane (CH_4). Cutting down methane production would reduce not only greenhouse gas emissions but also energy wasteage. (The methane still contains a lot of chemical energy — that's why it's such a good fuel.)

Chemical control
Change in diet can affect the amount of methane released, eg sheep fed on chicory produced 37% less methane than those fed on pasture.

Doseage with various chemicals (mitigation agents) has also been trialled. In one experiment, sheep were fed with lucerne chaff to which fumaric acid had been added. At first glance it would seem that this was successful — as the percentage of fumaric acid increased, the amount of methane decreased. However, it turned out that this happened because the sheep were simply eating less — perhaps they just didn't like the taste.

Another experiment investigated the effect of dosing sheep twice daily with coconut oil and/or an antibiotic called monensin.

For more information on these projects and on other research carried out by the The Pastoral Greenhouse Gas Research Consortium:
www.pggrc.co.nz

Effect of mitigation agents on methane emission

Agent	Mass of CH_4 (g day^{-1})
Control	25.1
Coconut oil	24.5
Monensin	20.2
Monensin + coconut oil	18.1

1. What effect does coconut oil have on methane emissions?

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2. Does the coconut oil seem to have any effect on the action of the Monensin?

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3. What would be some practical problems with using this method on a New Zealand farm?

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Vaccination
Other scientists are looking at the possibility of vaccinating sheep against the microorganisms that make methane. They are hoping to get the sheep to make antibodies in their saliva that will kill the methanogens. Early trials have had mixed results.

Effects of anti-methanogen vaccine on lambs given a primary vaccination on Day 1 & a booster on Day 42

Treatment	Feed intake (g day^{-1})			Animal weight (kg)			Antibody levels (mg mL^{-1})			Methane emissions (g day^{-1})		
	Day 1	Day 42	Day 84	Day 1	Day 42	Day 84	Day 1	Day 42	Day 84	Day 1	Day 42	Day 84
Control	1180	1137	1310	33.7	33.8	36.8	1.1	1.6	1.1	22.4	21.7	21.2
Vaccine A	1202	1151	1307	33.9	33.0	37.3	1.4	1.4	1.0	21.5	21.2	21.9
Vaccine B	1216	1184	1265	33.5	34.2	36.3	1.3	1.4	1.0	24.4	23.1	22.4

1. Do either of the vaccines appear to have been successful? Explain your answer.

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2. This experiment only had five lambs in each group. What might the reason for this have been?

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3. Scientists still believe that vaccination could be used to reduce methane production. What are some further experiments that they might want to carry out?

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