

1 - Title OH

- Thanks for the opportunity. I am addressing how science and technology is helping mitigate the environmental footprint of New Zealand pastoral – that is ruminant – animal farming

2 – OVERSEER

- Let's start with how we manage information on farms. In today's terms that means the use of open source and proprietary software to assist decision-making. I will highlight three examples.
- One of the most widely used – perhaps the most widely used – environmental software tools is OVERSEER. OVERSEER is a form of ready-reckoner that, based on scientific algorithms developed from comprehensive field trials, lets farmers and farm advisers assess how to manage nitrogen and other nutrients on their farm, and to estimate what their greenhouse gas emissions are likely to be under a given management regime.
- OVERSEER has been developed by a three-way partnership between the Ministry of Agriculture and Forestry, The Fertiliser Manufacturers' Research Association and AgResearch. It is provided free of charge for farmers and farm advisers to use.
- The obvious aim is to encourage better decision-making over use of nutrients, which in turn means that less fertiliser is used, that which is used is used wisely and that less nutrient pollution occurs within the landscape.

3 – FARMAX

- Running adjacent to OVERSEER and soon to be formally integrated with it is another software tool that allows ruminant farmers to optimise farm management around the feeding of livestock in particular.
- FARMAX is a decision-support software tool developed by AgResearch and two commercial farming/ farm adviser partners that helps maximise the efficiency with which, amongst other things, farmers and farm advisers turn forage into milk or meat.
- The more efficient a farmer can be the more profit they will make and, provided environmental costs are internalised within farm systems, the lower the relative footprint per kilo or product produced.

4 – RESOLUTION

- The third and final software tool that I want to provide as an example is RESOLUTION, which as you can see is a geospatial mapping tool developed by AgResearch
- The units of management on a livestock farm are typically the animals themselves and land in the form of individual paddocks.
- RESOLUTION is a decision-support software tool that helps farmers and farm advisers manage their farm on the basis of paddocks and their treatment – such as planning precise fertiliser usage at a geospatial level.
- OVERSEER, FARMAX and RESOLUTION are just three examples of an explosion in software products that are helping make farming more efficient with a reduced environmental footprint.
- They work. They also illustrate that precision-farming is upon us. It is a reality.

5 – Deer GPS

- To illustrate that, what you see here is a deer with a GPS collar. This allows scientists to use satellites to track the movement of individual animals across paddocks, which is what the lower picture of red and blue dots represents.
- This teaches us where (and using new technology) when animals urinate and defecate.
- Herbivores tend to congregate and ruminants tend to camp to ruminate. That is where a lot of dung and urine congregates, so we can see where the heavy nutrient loadings occur.
- We can then attempt to manage the associated “pollution” if you will; for example, in less intensive sheep or beef operations where might it be best to use DCD inhibitor compounds that reduce the production of that potent greenhouse gas, nitrous oxide?

6 – Sheep and top dresser

- Likewise, farmers are using precision-agriculture – the use of precise data and information and those software tools I just mentioned - to help guide aerial fertiliser application to paddocks. Again, this is about efficiency.
- A more intractable problem is curbing greenhouse gas emissions from ruminants.
- The most important GHGs are methane – 22 times more potent at trapping heat than CO₂ – and nitrous oxide – 100 times more potent.
- Methane is produced by methanogenic archaea micro-organisms in the rumen of cattle, cows, sheep and deer.
- Nitrous oxide is produced outside of the animal by soil bacteria using nitrogen sourced primarily from the animal’s urine
- Lincoln University developed a class of chemical compounds that disrupt the bacterial biochemistry that produces nitrous oxide. It doesn’t work in every situation, but it certainly works in many, so we have a technology to combat nitrous oxide emissions.
- We don’t yet have a technology to combat enteric methane emissions, but AgResearch and its scientific partners and all the farming industry are working on a variety of means to quell methane emissions, such as disruptive molecules, antibodies, viruses and competing micro-organisms.
- We may also be able to trap or sequester more carbon in soil, although that, like methane, is far from certain.

7 – CRW

- One of the bigger threats to considered nitrogen management is clover root weevil. The larvae of this weevil attack the nodules on the roots of clover. These nodules contain the bacteria that fix nitrogen from the atmosphere and make pastures more fertile.
- With wide ranging support from industry scientists at AgResearch have introduced a biological control agent – a wasp that parasitizes the adult weevil and sterilizes it
- Like the DCD compounds that inhibit emission of nitrous oxide from soils, this “technology” (if you can call it that) is not all pervasive. It doesn’t seem to work too well in Northland for example. Neither will it completely eradicate the weevil – why would a parasite want to do that? But it will probably keep the weevil at bay and improve nitrogen management on farm.

8 – SNPs

- Moving then beyond decision-support tools, precision agriculture, GHG emissions and biological control, I turn to the animals themselves.
- A radical new wave of genetic technology is sweeping animal breeding. This is NOT genetic engineering but whole genome selection.
- The overhead talks of single nucleotide polymorphisms – point mutations in the gene sequence of animals – that, when identified in their thousands for an individual animal, let scientists and breeders “triangulate” complex yet desirable, heritable traits.
- An example of such a trait might be the efficiency with which a cow or a ewe consumes feed and converts it to milk or lambs.
- The more efficient cows and ewes are so the smaller the relative impact they will have on the environment
- In a nutshell, whole genome selection massively increases the effectiveness of breeding and the rate of genetic gain in livestock.

9 – Herd Homes

- We have to keep those efficient animals somewhere, particularly those valuable cows. This nest set of slides depicts a home-grown technology, originally developed in Northland by a farming couple with AgResearch’s help and called Herd Homes - to house dairy cows.
- The environmental advantages are many fold and include
 - Reduced soil compaction
 - Better soil water holding capacity
 - Possibly better soil organic carbon content
 - Improved forage production
 - Less heat and cold-stressed cows, so better health and welfare
 - Improved pasture management
 - Better supplement feeding
 - Capture of much urine and dung, and reduced GHG emissions
 - Minimisation of synthetic fertiliser use
 - Easier calving
 - Apparently happier cows
 - More profit

10 – Cows feeding

11 – Cow under shelter – slats + Herd Yards

12 – Endophytes

- So much for the animals. What about the forage plants themselves?
- The biggest scientific breakthrough for years has been AgResearch's understanding of endophytes – fungi that live symbiotically inside grasses. The grass protects the fungus and feeds it. The fungus produces biochemical compounds that deter livestock grazing and insect grazing.
- Certain strains of endophytic fungus allow livestock grazing yet continue to deter insect grazing. These strains of fungi have been commercialised with huge effect.

13 – Endophyte vs non-endophyte

- Look at this. On the left is endophyte infected ryegrass. On the right is endophyte free ryegrass. The grass on the right has been grazed by insects and as a consequence has become far more susceptible to desiccation from drought; and that is what has happened to it.
- The environmental benefit is substantial because pastures do not need to be resown as often and less land is used for food production *per se*.

14 – AR37

- This shows AgResearch proprietary AR37 endophyte in a PGG Wrightson grass cultivar at one of AgResearch's dairy research farms in the summer drought of 2009 alongside an image of a non AR37 pasture. I took those photos myself.

15 – Carbon footprinting

- Finally, with widespread industry support scientists have been objectively measuring the carbon footprints of whole value chains in New Zealand-produced milk, lamb, beef, venison and wool.
- This includes the farm, the processing factory, the transport overseas and the supermarket.
- It doesn't include the consumer driving to the supermarket to buy the goods and drive them home to their fridge, and then throw out up to 25% of the food acquired.
- Or the wastage of food at the supermarket beyond its expiry date.
- What we do know is that most carbon dioxide is produced on the farm through to the supermarket
- We need to remember that producing food for human consumption is a messy business.
- But where would we humans be without it? Extinct.
- I hope you will agree that there is much being done on farm and elsewhere to reduce pollution and environmental footprints. Thank you ladies and gentlemen.