

Carbon Farming in WA

Fact sheet No. 4

PRACTICE: **Managing genetic codes to reduce methane emissions from cattle**

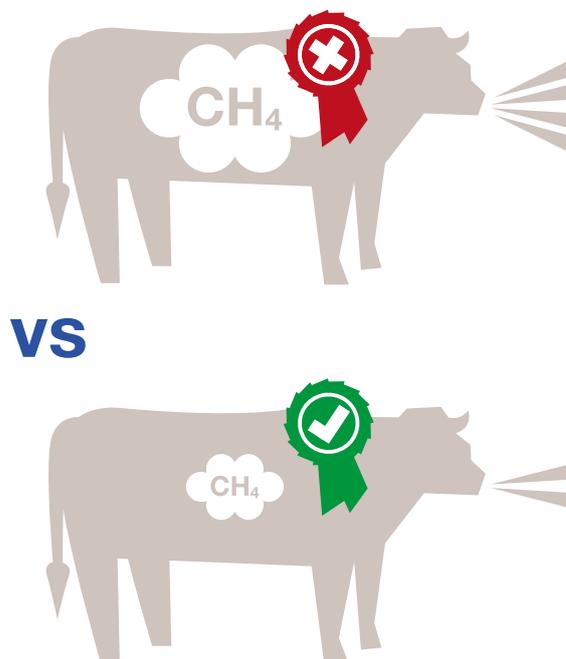
Description of practice

Although methane emissions depend partly on the quantity and quality of feed consumed, differences in individual animal characteristics produce variation in methane emissions between animals. Unraveling the genetics that determine animal characteristics will allow farmers to take advantage of low emissions animals. There are two main research areas that will lead to the development of technology for methane abatement: 1) the discovery of genetic markers or genes in cattle that affect methane emissions; and 2) genome sequencing of methane-producing microbes from the rumen.

The pathway to adoptability will be through estimated breeding values (EBV) with indices for feed conversion efficiency (FCE) and low methane emissions. EBV will be calculated for elite breeding sires using DNA tests for genetic markers that code for FCE and methane emissions.

Outline of procedure

- Genetic markers: FCE is usually thought of as the production output per unit of feed eaten. An animal that eats less than expected is metabolically more efficient. Cattle with high FCE have been observed to emit up to 25 per cent less methane than those with low FCE. For the detection of genetic markers for FCE, DNA samples are taken from animals. The DNA markers and the feed efficiency information are used to develop a set of genetic and biological tests to predict FCE. Ultimately, farmers will be able to use the test to select animals based on their FCE.



The Department of Agriculture and Food is the lead agency and is working with the Department of Regional Development and Lands to deliver this Royalties for Regions funded project.

For more information please refer to agric.wa.gov.au

More Information

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- Genome sequencing of methanogens: how methane is produced. In cattle, methane is produced predominantly in the rumen by microbes called methanogens, which are of the Archaea domain. Methane is formed by methanogens from hydrogen and carbon dioxide, which are released during food breakdown. Methane formation uses about 10 per cent of feed energy that could otherwise be used towards meat production. There are two outcomes envisaged from removing or slowing the activity of methanogens. First, there will be a reduction in methane emissions and second, the hydrogen that is spared can be converted to acetate by other microbes and used by the animal for maintenance and production.
- Using genomics to reduce methane: methane formation in the rumen is complex and difficult to target because of the high diversity of methanogen species. About one per cent of the rumen is comprised of Archaea and within this group it is estimated that there are there are 28 genera and 113 species of methanogens, few of which can be cultured in the laboratory. Genomic sequencing will provide detailed knowledge of the diversity and physiology of rumen methanogens that will be used to identify targets for methane mitigation technologies. Research strategies to emerge from genome sequencing are based on reducing the number or activity of methanogens in the rumen and include the development of a vaccine for harnessing the immune system of cattle; enzyme inhibitors; phage; homoacetogens; defaunation; and feed supplements (Buddle et al. 2011; Gilbert et al. 2010; Wright & Klieve 2011).

Work done to date

- The NSW Department of Primary Industries in Armidale has established herds of high and low methane-producing cattle. The next stage of the research will be to discover genetic markers for methane emissions in the cattle.

- The Rutherglen Research Centre at the Victorian Department of Primary Industries is discovering genetic markers in cattle for FCE.
- At the conclusion of the Beef CRC in 2012, the Queensland Department of Agriculture, Fisheries and Forestry had identified families of methanogen-producing microbes from the rumen using genetic screening techniques. Methanogens that are peculiar to Australia will be added to a catalogue of reference genome being developed under the Hungate 1000 project.
- The Hungate 1000 project is part of a worldwide undertaking for the genomic sequencing of the rumen microbiota, which includes methanogens. The research has been established through the Global Research Alliance and led by the New Zealand Greenhouse Gas Research Centre at Palmerston North.

Current level of adoption

The genetic technology practices described here for reducing methane emissions from cattle have not been adopted because they are in the early stages of development and are not commercially available.

Industry activity

Pfizer Animal Genetics has a commercially available DNA test for FCE using genetic markers (GeneSTAR). Pfizer Animal Genetics advises that new molecular value predictions will add to what is offered through EBV because FCE and methane traits are economically important but difficult, expensive and time consuming to measure using traditional methods. Several farms in Western Australia are currently using the GeneSTAR DNA tests.

Carbon benefits

Currently none.

Co-benefits

- The development of genetic markers for low methane and the inhibition of rumen methanogens should indirectly produce animals with better FCE. Inhibiting

rumen methanogens potentially allows more feed energy to be available to the animal.

Opportunities

- The practice of improving cattle genetics to directly or indirectly reduce methane emissions is relevant to all beef enterprises including *Bos Taurus* and *Bos indicus* breeds in Western Australia. Most of the 2400 farms in Western Australia would be available for uptake of genetic marker technology. However, genetic technology that emerges from inhibiting rumen methanogens may require a higher level of implementation at the farm scale, which will exclude some enterprises.
- Methane reductions of up to 25 per cent have been observed in FCE trials. If it is assumed that in practice a 10 per cent reduction is possible using genetic technology and that a mature animal produces 2t CO₂-e per year, there will be a reduction per animal of 200 kg CO₂-e per year.

Risks

- The Emissions Reduction Fund (ERF) currently has no registered methodologies for the reduction of methane from cattle.
- Development of genetic technology is in the early stages and not currently available for commercial applications.
- Price fluctuations for carbon credits and meat will change selection indices preferences by breeders. If the price of carbon falls, the rate of genetic gain for methane emissions will slow as breeders focus on other desirable traits.
- Technologies for reducing ruminant methane emissions must target all rumen methanogens or unaffected methanogens will grow to fill the niche and methane emissions would continue.
- Technologies implemented may inhibit other rumen microbes, which in turn will inhibit normal digestive function.

Case study

A beef enterprise in Western Australia with 400 head of breeding cows, heifers, steers and bulls emits about 800 tonnes of CO₂-e of methane per annum. If the enterprise adopted a genetic technology practice that reduced methane emissions by 10 per cent—without adding cost or reducing profit—the reduction in emissions will be 80t CO₂-e per year.

Key contacts – Australia

- Paul Greenwood (University of New England, Armidale, NSW)
- Robert Herd (NSW Department of Primary Industries)
- Ben Hayes (Department of Primary Industries, Victoria)
- Mark Morrison (CSIRO Livestock Industries, Brisbane)
- Athol Klieve (Department of Agriculture, Fisheries and Forestry Queensland)

Key contacts – international

- Hungate 1000: this project presents an opportunity to accelerate rumen microbial genomics research through a global network approach to target methane mitigation. The project aims to produce a reference set of rumen microbial genome by sequencing the genomes of available cultivated rumen bacteria and methanogenic Archaea. The information will help to develop methane mitigation strategies.
- The New Zealand Agricultural Greenhouse Gas Research Centre is taking a lead role in genome sequencing and the development of novel technologies for methane mitigation, piecing together the rumen methanogen puzzle.

Stakeholders

- Farmers
- Research organisations and universities
- Meat & Livestock Australia
- Department of Agriculture and Food, Western Australia (DAFWA); Department of Environment and



Conservation's Office of Climate Change; Department of Regional Development and Lands

- Department of Agriculture, Fisheries and Forestry (DAFF)

Next steps

Future work in the area of animal breeding will involve the establishment of an EBV methane index following discovery of genetic markers or genes in cattle that affect methane emissions. The seed stock elite herd at NSW DPI in Armidale will be DNA tested and screened for genetic markers for low methane emissions. It is forecast that this process will be completed by 2016.

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