GOVERNMENT OF WESTERN AUSTRALIA

Department of **Agriculture and Food**
Department of **Regional Development and Lands**

ROYALTIES FOR REGIONS

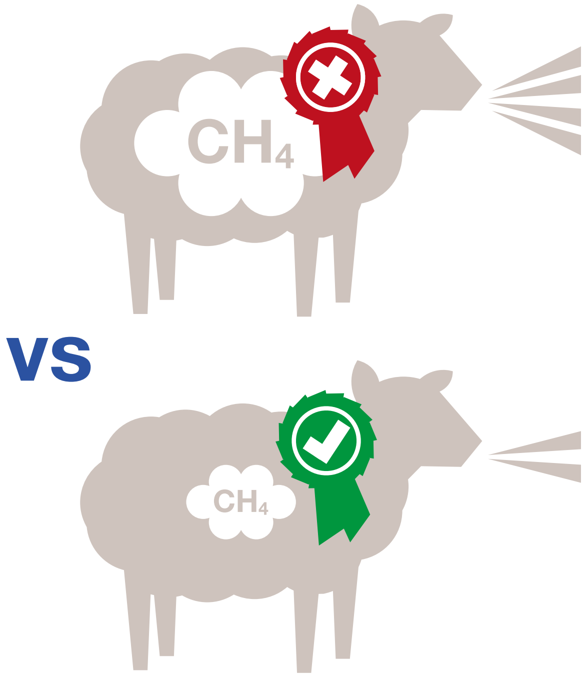
Carbon Farming in WA

Fact sheet No. 10

PRACTICE: **Sheep genetics in methane reduction**

Description of practice

Selective breeding is an option for improving the genetic merit of sheep for economically important traits such as wool and meat production. This can be achieved by selecting superior animals based on their breeding values (see link to Sheep Genetics under key references). For example, selecting animals that genetically grow faster could see lambs turned off quicker with reduced methane (CH_4) emissions. There is also potential to select animals that:



- produce less methane per unit of feed intake (that is, lower methane yield)
- eat less and therefore produce less methane than average for their level of productivity (that is, higher feed use efficiency).

Outline of procedure

Improving genetic propensity for growth is widely adopted by the sheep industry by selecting rams with higher breeding values for weight measured at various ages. Lambs that grow faster eat more; they also reach target market weights sooner and can be sold earlier. This reduces the proportion of feed energy they expend on maintenance and increases the proportion expended on production. Lambs with higher genetic potential for growth will therefore produce less methane. However, higher growth rate potential can be correlated with mature size resulting in bigger ewes, which produce more methane. This will also impact on whole flock emissions, stocking rate and profitability.

There is considerable variation between how much methane individual sheep produce each day (Goopy et al. 2006), methane production per unit

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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of feed consumed and feed use efficiency (Thompson et al., in preparation). Evidence is emerging that some of the variation in these traits between animals is genetic (heritability 0.1 to 0.3). Therefore, direct selection of sheep to improve these traits is theoretically possible but yet to be demonstrated in commercial practice.

It is highly likely that selecting sheep that produce less methane per day without considering other traits will simply select animals that eat less and that are less productive. The preferred traits for genetic selection to lower methane emissions are therefore either direct selection for lower methane yield or indirect selection for higher feed use efficiency. The challenge is to develop systems that can actually measure methane production, feed intake and efficiency on large numbers of animals.

Farmers will need to select rams using breeding values for traits directly or indirectly correlated with methane production. Much research is still required to develop these breeding values and genetic correlations.

Work done to date

- Two major modeling studies of sheep genetics to reduce greenhouse emissions and its impacts on farm profitability have been conducted in Australia (Alcock & Hegarty 2011; Young et al. unpublished). The impacts of genetics on emissions and whole farm profit are variable, depending on the assumptions used regarding stocking rate and mature ewe size. Not surprisingly, both of these studies indicated that a reduction in methane yield reduces total methane production by the same extent and has no effects on whole farm profit. Profit is not affected because total feed intake and production per hectare are not influenced by variability in methane production per unit intake.
- Alcock and Hegarty (2011) reported that improving feed use efficiency reduced methane emissions and increased profit. The higher profits, due to genetic gains in feed use efficiency, were due largely to increased weaning rates from more efficient animals associated with higher condition score at mating. The validity of this result is difficult to explain, as improved efficiency is usually related to reduced fatness, and fatness is positively linked to reproductive performance. More analysis is required to quantify the potential effects of improving feed use efficiency on methane emissions and profit.
- Results from Young et al. showed that profit was increased but methane emissions changed by only a small amount when feed use efficiency was improved because the increased efficiency was offset by a higher optimum stocking rate.

Current level of adoption

We are not aware of any farmers who have manipulated sheep genetics specifically to reduce methane emissions.

Industry activity

None at this stage. Modelling suggests that the impacts of genetics for growth and feed efficiency on emissions and profit will depend on how farmers modify their farming operations to best use the new genetics. Genetic reductions in methane yield can reduce whole farm emissions without influencing stocking rate or profit, but little is known about the genetic correlations between this trait and other economically important traits.

Carbon benefits

Currently none.

Co-benefits

Increased growth rates and feed conversion efficiencies will lead to increased profits without any carbon credits.

Opportunities

- The practice of improving sheep genetics to directly or indirectly reduce methane emissions is relevant to all sheep enterprises in Western Australia—about

6500 farms with 14.5 million sheep, of which 8.6 million are breeding ewes.

- Commercial potential: Alcock and Hegarty (2011) and Young et al. showed that if farmers use sheep with 10 per cent higher growth rates, methane emissions are reduced by about 3 per cent (but profits were also reduced by 5 per cent due to a reduction in stocking rate associated with larger ewes).
- Both modeling studies reported that improving feed use efficiency by 10 per cent reduced methane emissions by 3 to 10 per cent and increased profit by 9 to 10 per cent due to reduced requirement for supplementary feeding.
- Young et al. found that if there was no change in the mature size of the ewe and no change in sheep numbers, then increasing growth potential actually reduced the CO2-e by 2.8 kg/DSE and increased profit by $0.37/DSE.

Risks

- Selection for reduced CH_4 emissions can have a detrimental impact on farm profit.
- If the stocking rate is increased to maximise profit then increased lamb growth rate leads to an increase in emissions of 9.2kg/DSE.
- The main risks associated with improving sheep genetics to reduce methane emissions are possible changes in the future prices of carbon, meat and wool. These price changes could lead to variation in the best selection indices for breeders, which would alter the rate of gain in methane emissions.

Case study

The typical sheep farm in Western Australia runs 1220 ewes, 560 lambs and 170 wethers and rams. This equates to about 2700 DSE. This farm would emit about 550 tonnes CO_2-e per annum from methane and nitrous oxide emissions. Selecting sheep with 10 per cent lower methane yield would reduce total emissions by 10 per cent without affecting profit, but the carbon credits from adopting this practice would be valued at only about $1000. In other words, the potential benefits from adopting strategies to manipulate sheep genetics specifically for the reason of carbon credits may be limited.

With the current price of CO_2-e at $23/t, changes in CO_2-e emissions and hence the returns from carbon credits from improving sheep genetics for growth, methane yield or feed use efficiency are small compared to changes in profit and absolute profit per hectare. For both analyses, the maximum return from carbon credits from changing genetics resulted from reducing methane yield by 10 per cent. For a 1000 ha farm, this was equivalent to about $4800 of the overall profit of $240 000 (Alcock and Hegarty 2011) and $3800 of the overall profit of $238 000 (Young et al.).

Currently there are no breeding values for direct selection to reduce methane emissions and no genetic correlations between existing traits such as growth and methane emissions. It is not possible to develop a breeding program including reduction in methane yield.

Key contacts – Australia

- Dr Daniel Brown (University of New England, Armidale, NSW)
- Dr Alex Ball (Meat & Livestock Australia, Armidale, NSW)
- Dr Hutton Oddy (NSW DPI, Armidale)
- John Young (Farming Systems Analysis Service, Kojonup, Western Australia)
- Doug Alcock (NSW Department of Primary Industries, Cooma)

The other major collaborator is the Department of Agriculture, Fisheries and Forestry's Filling the Research Gap National Livestock Methane Program (see link in reference list).

International work

- New Zealand Agricultural Greenhouse Gas Research Centre: the centre is the main international group undertaking work related to sheep genetics and methane emissions from sheep production systems. There is significant collaboration already between this organisation and especially John McEwan (AgResearch) and research institutes in Australia, including Western Australia.

- Abacus Bio (in New Zealand) and in particular Dr Peter Amer.
- Several researchers, are also members of the Livestock Emissions and Abatement Research Network (LEARN), which facilitates the development of practical and cost-effective mitigation of agricultural greenhouse gas.

Stakeholders

- Farmers
- State Government agencies and research institutions including DAFWA, Murdoch University, the University of Western Australia and the CSIRO
- Rural Industry Research Corporations (RIRCs): Australian Wool Innovation and Meat & Livestock Australia
- Department of Agriculture, Fisheries and Forestry (DAFF)

Next steps

Major research, development and extension activities are planned under the DAFF national livestock methane program. The most relevant projects in this program include:

- genetic technologies to reduce methane emissions from Australian beef cattle (NSW DPI)
- improving production efficiency and reducing methane emissions in meat and wool sheep (NSW DPI and Murdoch University). This project is still under negotiation.

Key references

AbacusBio, abacusbio.com/index.html

Alcock, DJ & Hegarty, RS 2011, ‘Potential effects of animal management and genetic improvement on enteric methane emissions, emissions intensity and productivity of sheep enterprises at Cowra, Australia’, *Animal Feed Science and Technology,* vol. 166–167, pp. 749–760

Department of Agriculture, Fisheries and Food, reducing emissions, daff.gov.au/climatechange/australias-farming-future/climate-change-and-productivity-research/emissions_reduction2/reducing-emissions-livestock

Department of Agriculture, Fisheries and Food, national livestock methane program, daff.gov.au/climatechange/carbonfarmingfutures/ftrg/national-livestock-emissions-program

Goopy, JP, Hegarty, RS, Dobos, RC 2006, ‘The persistence over time of divergent methane production in lot fed cattle’, *International Congress Series*, vol. 1293, July, pp. 111–14, sciencedirect.com/science/article/pii/S053151310600152X

Livestock Emissions & Abatement Research Network (LEARN), livestockemissions.net/

New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC), nzagrc.org.nz/current.html#Obj1.2

Sheep Genetics, sheepgenetics.org.au/Breeding-services

Thompson , AN, Ferguson, MB, Macleay, CA, Briegel, JR, in preparation 2012, ‘Feed-use efficiency in relation to methane emissions in growing Merino lambs’