Selection for more methane efficient sheep

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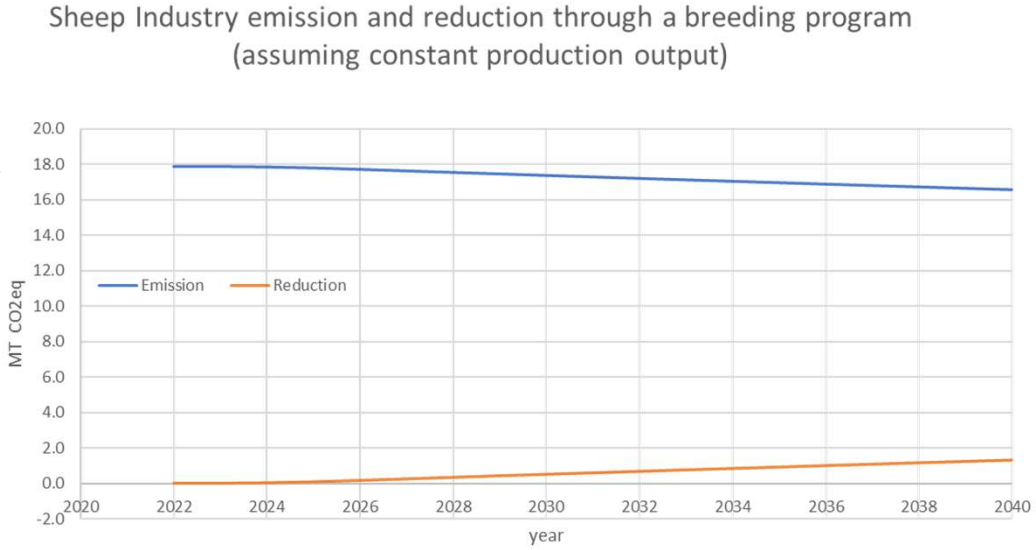
P. PSH.2011 EAP
Selecting for more methane efficient sheep

The Objective:

- Enable Australian sheep breeders to select for reduced enteric methane emissions

18 MT CO_2Eqvt



Assume 1% p/a reduction

Outcomes:

- Permanent and cumulative reduction in CH_4 emissions from sheep by
  - 4.2% (0.8 Mt*CO_2e) 2030; and
  - 15% reduction (2.6 MtCO_2e) by 2040.

Selecting for Lower Methane Sheep

The what?

- Collect: **10,000** phenotypes for methane production
  and **5000** phenotypes for feed intake

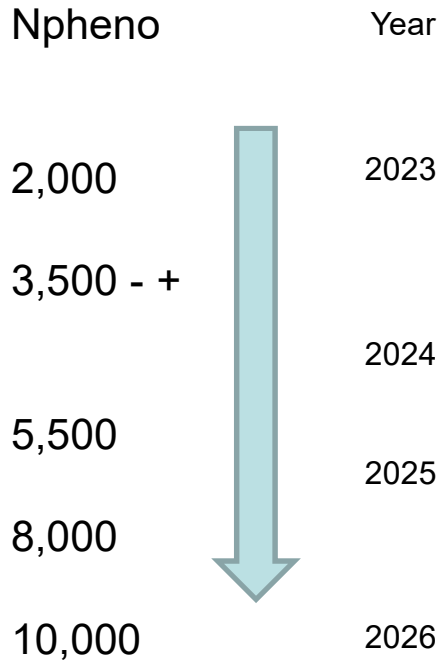
RF lambs
MLP ewes — lambs vs ewes, diets
Breeder's ewes

- Estimate **genetic parameters**, including **genetic correlations** of these traits with **production** and **reproduction traits**, and

- Predict **genomically informed breeding values** of young rams and ewes in order to select for these traits in studs and commercial enterprises:

Path to market: adoption and engagement

- Webinars/meeting to discuss concept, awareness and engage
- Research EBVs (RBVs) developed
- RBVs updated when new data is available
- Full ASBVs
  - Indexes



We can accelerate this!

There is also data from WA

Measuring methane production

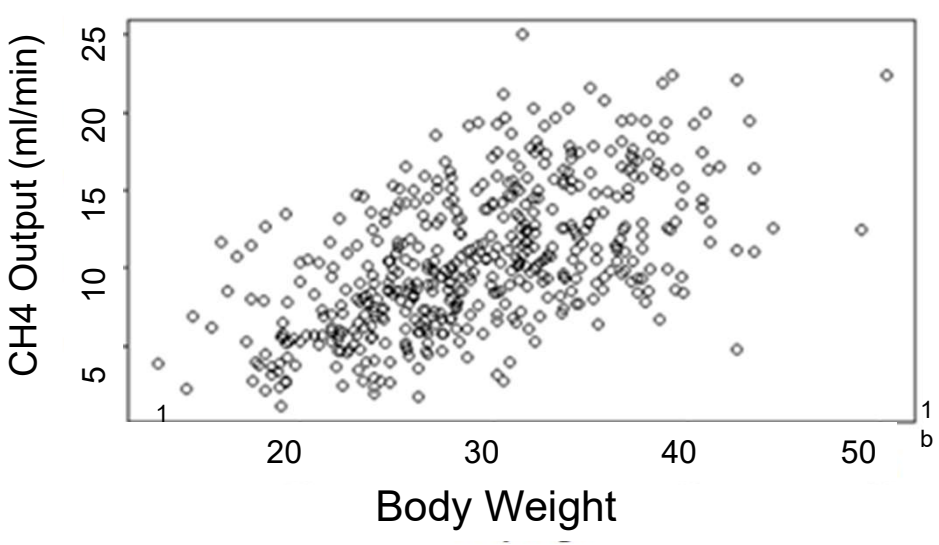
Portable Accumulation Chambers

Methane trait

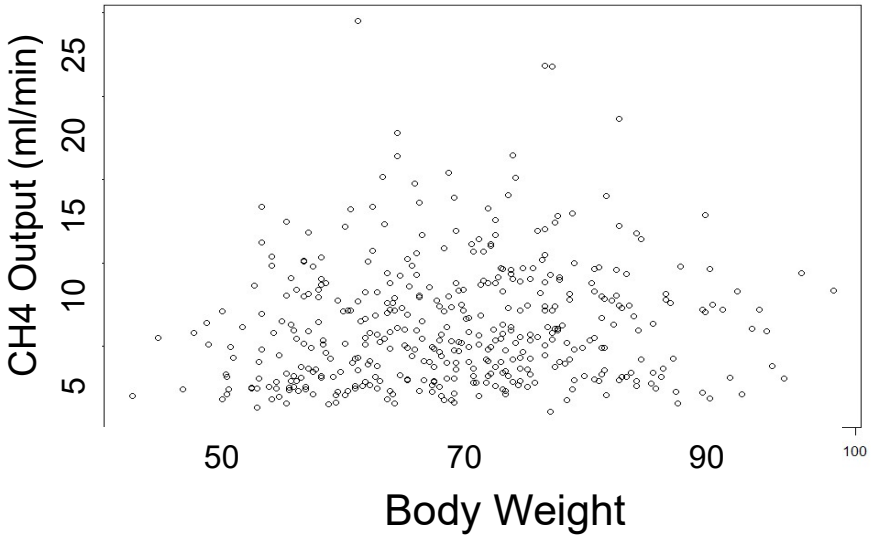
- Measure CH_4 Production (mL/min)
  - Animals taken off feed 1 hour prior to measurement
  - Measure ewes for 40 minutes / lambs for 50 minutes
  - Up to 72 animals measured in a day… 500 in a week
- Measure also CO_2 output and O_2 consumption
- Rumen sample post PAC for VFA and rumen microbiome

There is variation

Lambs



Ewes



- Data can only be used to compare animals -> interested in ranking
- Can't be used to quantify output per day

One day….

Measuring Feed intake

Master yard system - Crown Agriculture

Installing Feed Intake measurement units at Kirby – Armidale

There are also units at Katanning: other units, other project, but RF lambs

Feed intake trait

- 250 head measured per batch (may be able to do more)
- Resource Flock lambs, ewes
- 7 weeks on feed – aiming for 30 days of valid data

Bio-economic Modeling

- We need to reduce methane from livestock
- Genetic selection is slow but cumulative and long lasting

➢ How much can we achieve?

➢ Will we want sheep that produce less methane? – per head?

Selection for more methane efficient sheep

Aim is to produce less methane from sheep

Akin to using less feed resources for sheep → Feed efficiency

Defining the trait: with feed we have

- Feed Intake — How much they eat
- Feed Efficiency — How much they grow per kg of feed
- Feed Conversion rate — How much they eat per kg of growth
- Residual Feed Intake — How much they eat, after correcting for how much they grow

With methane? ...

Are we going to need sheep that produce less methane?

is like: Are we going to need sheep that eat less?

Select is best done on linear traits, not ratios; but objective can be define as a ratio
e.g. methane intensity

Research Questions

1. Compare response to selection for sheep selection indexes

2. Compare different ways to define the objective

   - profit per ewe (~~ current index + methane)
   - reducing methane output of the flock (of 100 ewes)
   - minimizing methane intensity (methane/kg lamb)

Note: this is a modeling exercise to support the discussion on what we want
The parameters are still to be estimated!

Methods

- Define objective and criteria traits
- Augment with Feed Intake and Methane Production traits
- Calculate economic weights for different overall objectives
  - » profit per ewe
  - » reducing methane output of the flock
  - » minimizing methane intensity (methane/kg lamb)

- Assume genetic parameters, correlations with current traits
- Assume trait measurement
  with genomic selection
- Predict response to (genomic) selection

Assumed parameters

0.30	Heritability
0.70	Genetic Correlation
0.48	Phenotypic Correlation

	PWT	AWT	Fertility	Litter Size	Feed Intake	Methane Production
PW Weight	0.30	0.48	0.29	0.10	0.40	0.30
Adult Weight	0.70	0.40	0.33	0.10	0.70	0.60
Fertility	0.12	0.35	0.06	0.40	0.20	0.10
Litter Size	0.12	0.15	0.60	0.10	0.20	0.10
Daily Feed Intake	0.50	0.80	0.40	0.40	0.25	0.50
Daily Methane Production	0.40	0.30	0.10	0.10	0.80	0.20

Weights in the breeding objective
Value per Genetic SD

Some Key Traits	Three different breeding goals: ↑ profit / head	↓ methane/ head	↓ methane/ kg lamb
Slaughter Weight (kg)	7.84	0.00	1.17
Fertility (pregnancy rate)	2.14	-0.29	0.50
Lambing rate	3.02	-0.41	0.70
Mature Ewe Weight (kg)	2.6	0.00	0.00
Daily DM Feed Intake (kg)	-10.10	0.00	0.00
Methane production (g/day)	-0.77	-1.92	-1.01

Carbon price $40

in $$

Note that these two are not in $$

Genetic change per year for different sheep breeding objectives

		Breeding Goal		
	Current Mean	profit / head ↑	methane/ head ↓	methane/ kg lamb ↓
Slaughter Weight (kg)	47.27	0.88	-0.82	0.74
Fertility (pregnancy rate)	0.75	0.009	-0.011	0.014
Lambing Rate (NLW / lambing)	1.50	0.005	-0.007	0.008
Mature Ewe Weight (kg)	55.00	0.98	-1.12	1.11
DM Feed Intake (kg/day)	1.20	0.011	-0.019	0.015
Methane Production per ewe (g/day)	24.00	0.16	-0.30	0.11
Change in profit (per annum)		$4.38	-$2.77	$3.22
Change in methane /ewe (% of mean)		0.68 %	-1.25%	0.44%
Total 100 ewe flock CO2 Eqvt tonne/yr	42.98	1.1 %	-1.8%	1.2%
kg CO2Eqvt per kg lamb produced	22.60	-2.6 %	+2.5%	-3.5%

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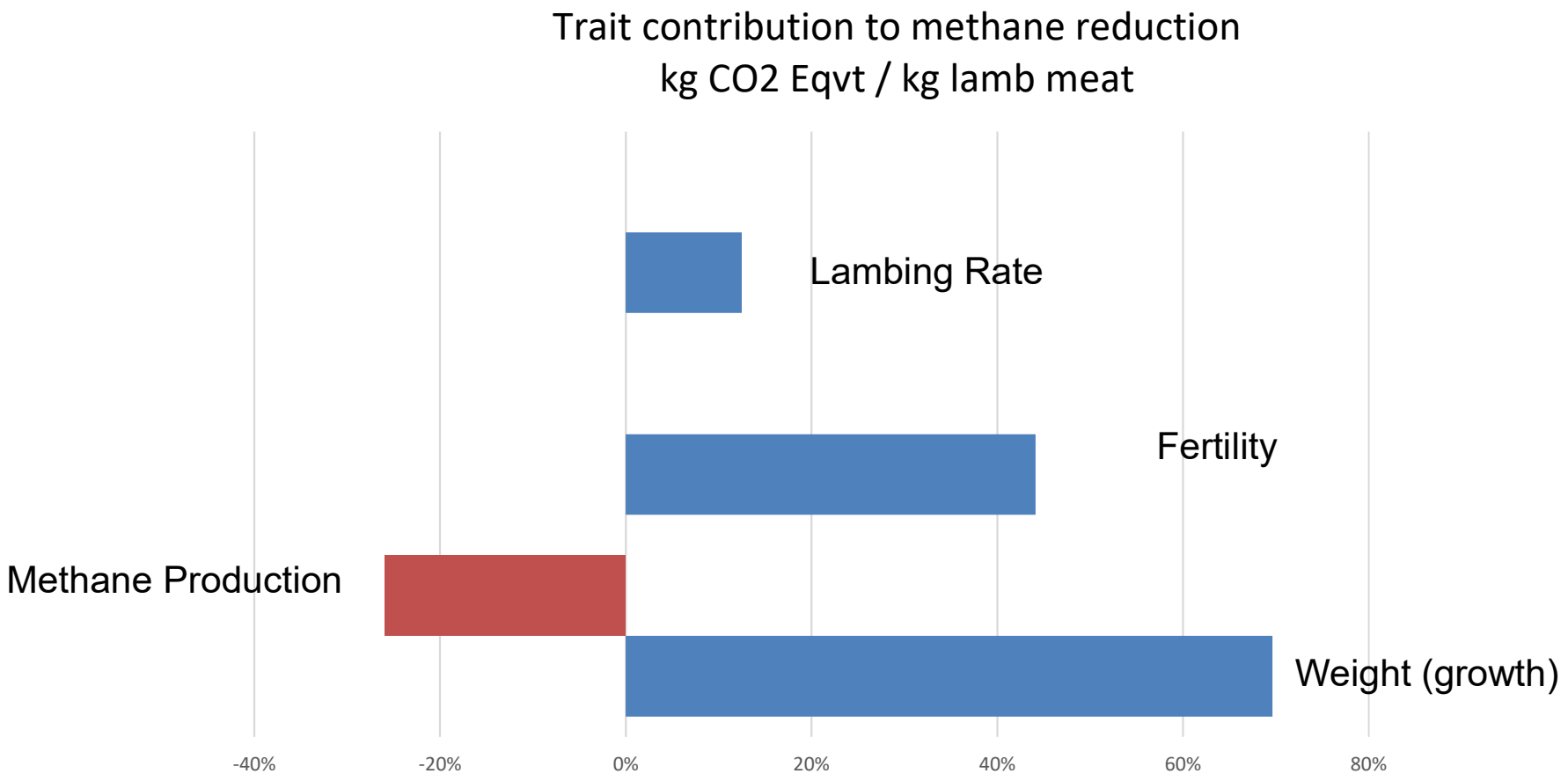
What proportion of improved intensity is due to what trait?



Do we need to measure methane and feed intake?

% change in response with and without reference flock

	Breeding Goal	
	profit / head	**methane / kg lamb**
Slaughter Weight@9 mo (kg)	-3.1%	-2.1%
Fertility (pregnancy rate)	-3.5%	-1.8%
Lambing Rate (NLW / lambing)	-4.0%	-2.1%
Mature Ewe Weight (kg)	-3.1%	-1.9%
Daily DM Feed Intake (kg)	-12.7%	-7.5%
Methane Production per ewe (g/day)	-20.2%	-22.2%
Change in profit	2.2%	3.3%

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With higher genomic selection accuracy more gain

	Breeding Goal: profit / head		
	GenAcc 0.3 - 0.5	**GenAcc 0.5 - 0.7**	**GenAcc 0.99**
Slaughter Weight@9 mo (kg)	0.88	97 %	105%
Fertility (pregnancy rate)	0.009	147 %	235 %
Lambing Rate (NLW / lambing)	0.005	153 %	202 %
Mature Ewe Weight (kg)	0.98	103 %	96 %
Daily DM Feed Intake (kg)	0.011	108 %	92 %
Methane Production per ewe (g/day)	0.16	97 %	60 %
Change in profit (per annum)	$4.38	$5.26	$6.73
Change in methane /ewe (% of mean)	+0.68 %	+0.66 %	+0.41 %
Total 100 ewe flock CO2 Eqvt tonne/yr	+1.1 %	+1.4 %	+1.5 %
kg CO2Eqvt per kg lamb produced	-2.6 %	-3.5 %	-5.3 %

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How does optimal change depend on the price of carbon?

Breeding Goal: profit / head

	Carbon price **$40**	Carbon price **$400**	Carbon price **$4000**
Slaughter Weight@9 mo (kg)	0.88	0.56	-0.72
Fertility (pregnancy rate)	0.009	0.01	0.00
Lambing Rate (NLW / lambing)	0.005	0.00	0.00
Mature Ewe Weight (kg)	0.98	0.58	-0.88
Daily DM Feed Intake (kg)	0.011	0.00	-0.02
Methane Production per ewe (g/day)	0.16	0.00	-0.33
Change in profit (per annum)	$ 4.38	$ 3.83	- $1.49
Change in methane /ewe (% of mean)	0.68 %	0.01 %	-1.37 %
Total 100 ewe flock CO2 Eqvt tonne/yr	+ 1.1 %	+ 0.4 %	-1.6 %
kg CO2Eqvt per kg lamb produced	-2.6 %	-2.4 %	+0.8 %

Summary

- Reduce animal methane emissions in sheep mainly through improvement of production (and reproduction) efficiency.

- Providing tools to enable selection of low emitting sheep
  - Permanent, cumulative and long lasting change

- Develop reference population, add on to existing projects

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