Methane Index Explorer: Optimising a Breeding Value Format for Simultaneous Inclusion of Enteric Methane Emissions in Breeding Schemes and National Inventories

Authors: P. C. Ariyarathne, S. M. Hickey, T. P. Bilton, P. Johnson, N. K. Pickering, S. J. Rowe, and J. C. McEwan

Presented by: **Pavithra Ariyarathne**

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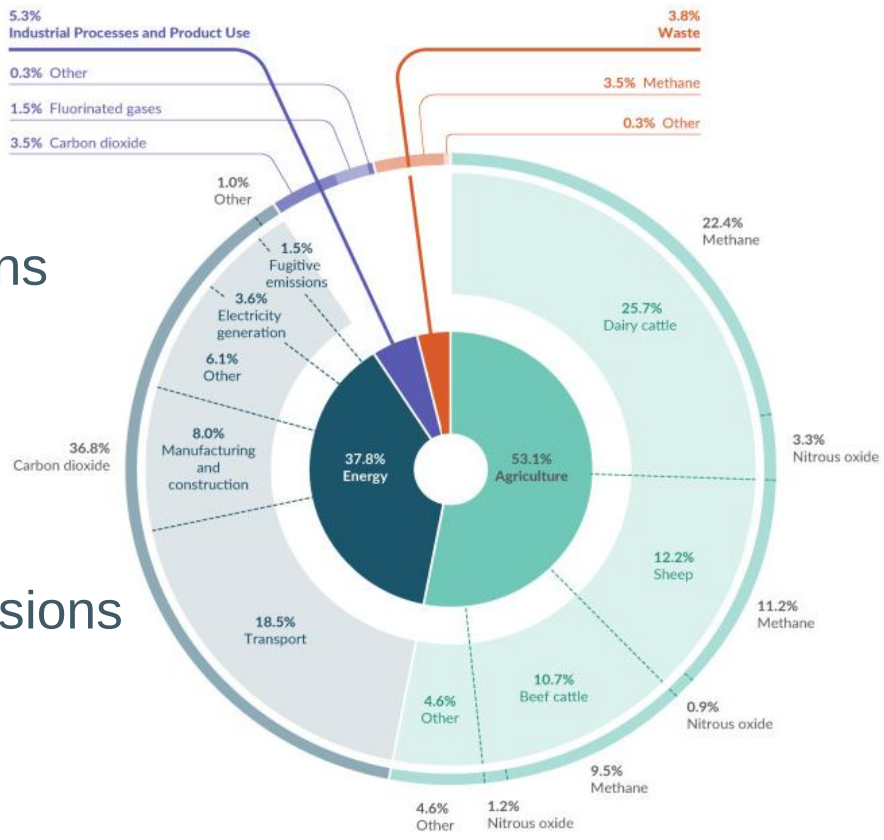
Introduction

- Ruminants are a major source of NZ methane (CH_4) emissions
    - Agriculture (enteric fermentation from livestock) – 53%
    - Fossil fuel extraction and use – 38%
    - Landfills and industrial processes – 9%
- Methane is heritable (0.19 - 0.32) – selection can reduce emissions
- Antagonistic relationships (paper in preparation)
    - CH_4 – liveweight (0.61), feed intake (0.33)
    - Liveweight – weaning weight (0.91), carcass weight (0.85)
- Research problem: Would selection for CH_4 affect progress in the production index?



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Research Objectives

- Develop a selection response evaluation format for reducing CH_4 using portable accumulation chamber breeding values (BVs) – (PACCH4BV)
- Aiming for:
  - Ram selection in breeding programs
  - Governmental inventory reporting
  - Methane Index Explorer (MIE) software integration
  - Allows breeder to explore consequences
    - With his animals
    - With his breeding scheme/recording/genotyping

Methods: Data Collection

- Animals: AgResearch Woodland Genetic Research Flock 2638 (birth year 2021 & 2022)
- BVs and genomic BVs (gBVs) from the SIL database
- Animal evaluation (AE) 6 used more genotypes than AE5

	2021		**2022**	
Rams	744		605	
PAC recording	384 (51.6%)		324 (53.6%)	
Animal evaluation	**AE5**	**AE6**	**AE5**	**AE6**
Number genotypes used	1 (0.1%)	739 (99.3%)	304 (50.2%)	603 (99.7%)

Methods: Index Construction (MIE software integration)

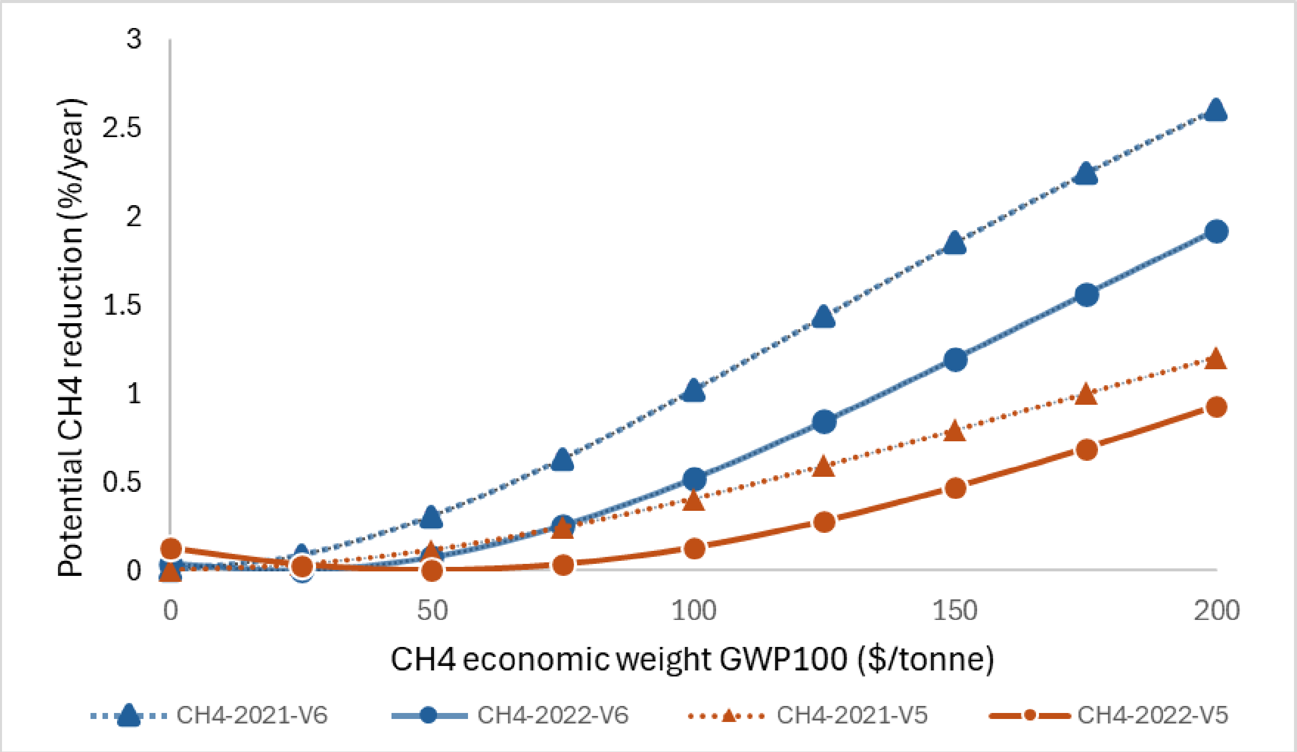
- NZMW-plus Index = NZMW + FEC + DAGS + MEAT
- Dual-Purpose CH_4 index ($DPCH_4$)
  - PACCH4gBVs converted to PACCH4BV% : (g/day ÷ scaled mean PAC emissions (7.5)) × 100
  - DPCH4 : PACCH4BV% × -0.51 = $100 tonne CO2e GWP100
- PACCH4 assessed across 9 economic weights: $0–$200/t (GWP100)
  - 9 DPCH4 indices were calculated
- Economic weights of other traits are as per SIL Technical notes (2022)

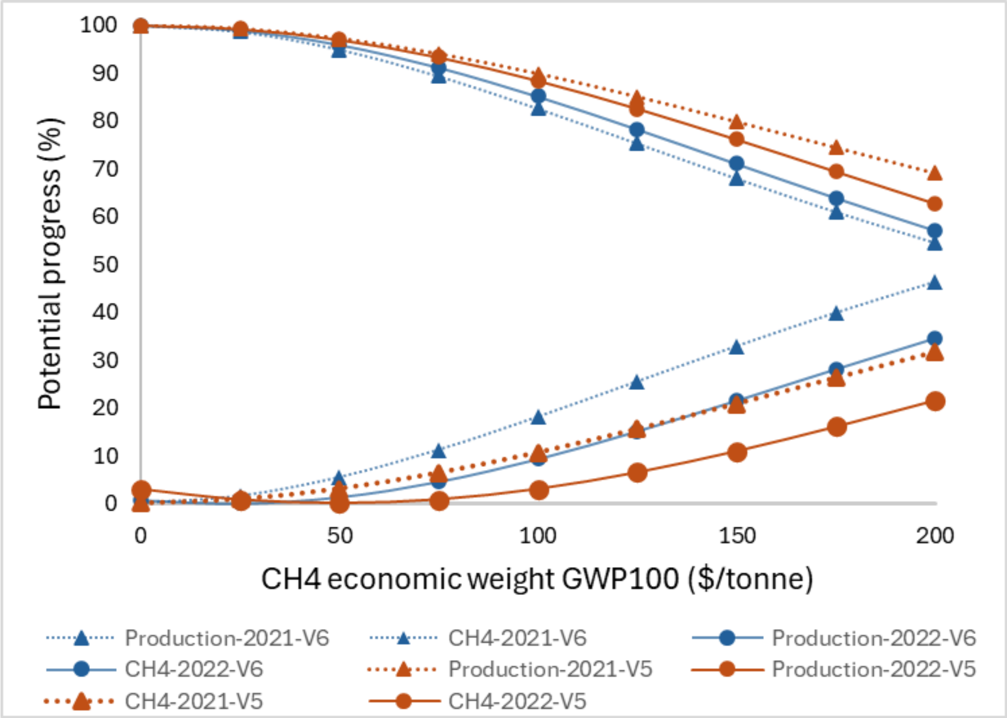
Methods: Evaluating Genetic Progress (MIE software integration)

- Progress: r^2 between indices for each economic weight
  - Production index progress: r^2(NZMW-plus Index & NZMW-plus+DPCH_4 index) × 100
  - CH4 index progress: r^2(NZMW-plus+DPCH4 index & DPCH4 index) × 100
  - but presented here as a % of potential maximum
- PACCH4BV% reduction/year = CH_4 index progress × SD(PACCH_4BV%) × i/L
  - i = selection intensity (2% rams, 30% ewes), L = generation interval (3.5 years)

Key Results

- AE6 (high genotyping) outperformed AE5
- Greater CH_4 reductions with \$50–\$100/t weighting
- Up to 2.6%/yr CH_4 BV reduction in AE6 @ \$200/t
- Low weight on PACCH4 did not increase emissions
- Increased relative potential progress as well





Where does MIE fit?

MIE Software
- Run models
- Predicts selection response

Inputs
- SIL BVs
- Economic weights
- Index parameters

Results for breeders
- Per-animal CH_4 reductions
- Trait trade-offs

Data feedback
- Flock data sent back to SIL
- Update BVs and parameters
- MIE re-runs with updated inputs

Breeder action
- Use results to guide selection
- Apply index in real flocks
- Record flock performance

Conclusions & Implications

- Breeding reduces CH_4 emissions per animal, while increasing per head productivity
- "sweet spot" ~$50-$100/tonne
  - CO2e GWP100 >80% production gains
  - while reducing CH4 by ~0.5%/year
- Genomic data is essential for accurate BVs
- PACCH4BV% is interpretable and effective
- Recommended for breeders and inventories

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