A novel, comprehensive genetic and management initiative to reduce the environmental impact of New Zealand dairy cattle.

Mark Camara, Jeremy Bryant, Peter Amer, Dorian Garrick, Talia Grala, Stewart Ledgard, David Chapman, Eric Kolver, David Burger, Mark Shepherd, Kate Sargeant, Bruce Thorrold
Ministry of Business Innovation & Employment wants impact

This programme will deliver transformational options for dairy and beef farmers to meet environmental targets by:

1. *Developing genetically low nitrogen excreting animals*
2. *Implementing genetic and management strategies to reduce nitrogen leaching*
3. Ultimately, this research partnership will reduce sector-wide nitrate leaching by 20%
Industry growth and water quality

Intense public pressure

Cows and seep

Dairy farming is polluting New Zealand’s water

Government data suggests that 60% of rivers and lakes are unswimmable
Central Government Response
Freshwater National Policy Statement (2014)

• Informs local governments about their responsibilities under Resource Management Act
• Directs regional councils to set objectives for the state of fresh water bodies and set limits to meet them
• Emphasizes catchment-level targets rather than specific on-farm practices
• Full implementation by 31 December 2025
Regionally variable nitrogen limits

- **Auckland**: N input limits: 150kg N/ha/yr on sandy soils, 200kg N/ha/yr other soils
- **Bay of Plenty**: Limits on N and P that can leave a farm property based on a 3 year “benchmark” period (mid-2001 to mid-2004).
- **Horizons**: N limits based on farm’s land use capability (LUC) classification
Variation within regions: Canterbury


**Red** - from 2017 need consent and must be at baseline (if over 20kg N/ha/yr).

**Orange** - Baseline + 5kg N - consent required 2016 (if over 20kg N/ha/yr).

**Blue** and **Green** – Consent required if increase greater than 5kg N/ha/yr.
Enforcement largely model-based

- Overseers required in Otago, Canterbury, Hawkes Bay and Manawatu; under consideration in Waikato and Southland

- Models use "average animal" & don't handle farm-specific genetics.

- Data limitations → simulated farms used for catchment-level planning decisions
Cow urine important for nitrogen leaching

Urine patches can have 1200 kg N per hectare, and plants can’t process it all. (Haynes and Williams, 1993)

Advantages of genetic solutions

- Cumulative and permanent
- Universally applicable (assuming low GxE)
- Infinitely scalable
- No changes to infrastructure or farming practices
- Low cost to farmers once implemented
- Can be “stacked” with management solutions (e.g. alternative pasture plants)
Can milk urea nitrogen (MUN) predict urinary nitrogen (UN)?

1. Ammonia in rumen → blood plasma → passive diffusion to milk and urine (Roseler et al., 1993).
2. MUN routinely measured using spectrography.
3. MUN and UN are phenotypically correlated in response to dietary [N].
4. MUN is heritable (Beatson, unpublished).

Key technology: automated urine sensors

Developed by AgResearch

Continuously-recorded individual-level data for UN, urine volume, and urination frequency in feed stalls or while grazing

Research Aims

1. Genetics, genomics, physiology, and omics to enable selective breeding
   - Quantitative genetic and genomic analyses in representative “Development Herds”
   - Physiological and -omic comparisons of phenotypically divergent animals
   - Develop new animal evaluation models

2. Validation, demonstration, and adoption to achieve national water quality outcomes
   - Develop practical breeding strategies & economic values
   - Validate mitigation strategies at the whole-farm and catchment levels
   - Develop enhanced models for sensible regulation

‘Knowing is not enough; we must apply. Willing is not enough; we must do.’

- Johann Wolfgang von Goethe
7-year Programme

David Chapman (DairyNZ)

Peter Amer (AbacusBio)

Develop practical breeding strategies; economic values, and selection indices for UN

2x2 factorial feeding stall experiments w/ genetically high and low nitrogen excreting cows fed high and low [N] diets
Questions?

Mark.Camara@dairynz.co.nz