Progress toward incorporating residual feed intake into the New Zealand national breeding objective for dairy cattle: Genetic parameters in half-sib 6-9 month old Friesian bulls and heifers

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Introduction

Breeding Worth (BW) =

$ net farm income/5 tonne of DM

"animals whose progeny will be the most efficient converters of feed into farmer profit"

Gross Efficiency not Net Efficiency

Introduction

- Residual Feed Intake Economic Value
  - 1 kg DM per day feed saved = $-127/animal
- Expensive (~$1,500 animal) and difficult trait to measure
- Genomic approach or Performance Test?
- Value of predictors?

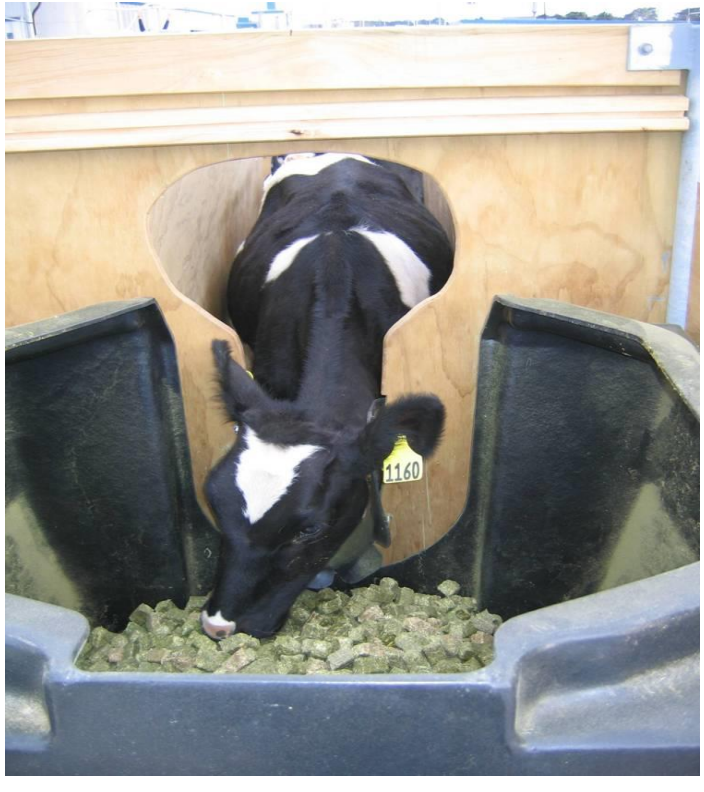
Objectives of this study

- Estimate RFI in young bull calves and their female half sibs
- Estimate heritability of RFI
- Estimate genetic correlation for RFI between young bulls and their female relatives
- Value of predictor: thermal images

Experimental Animals

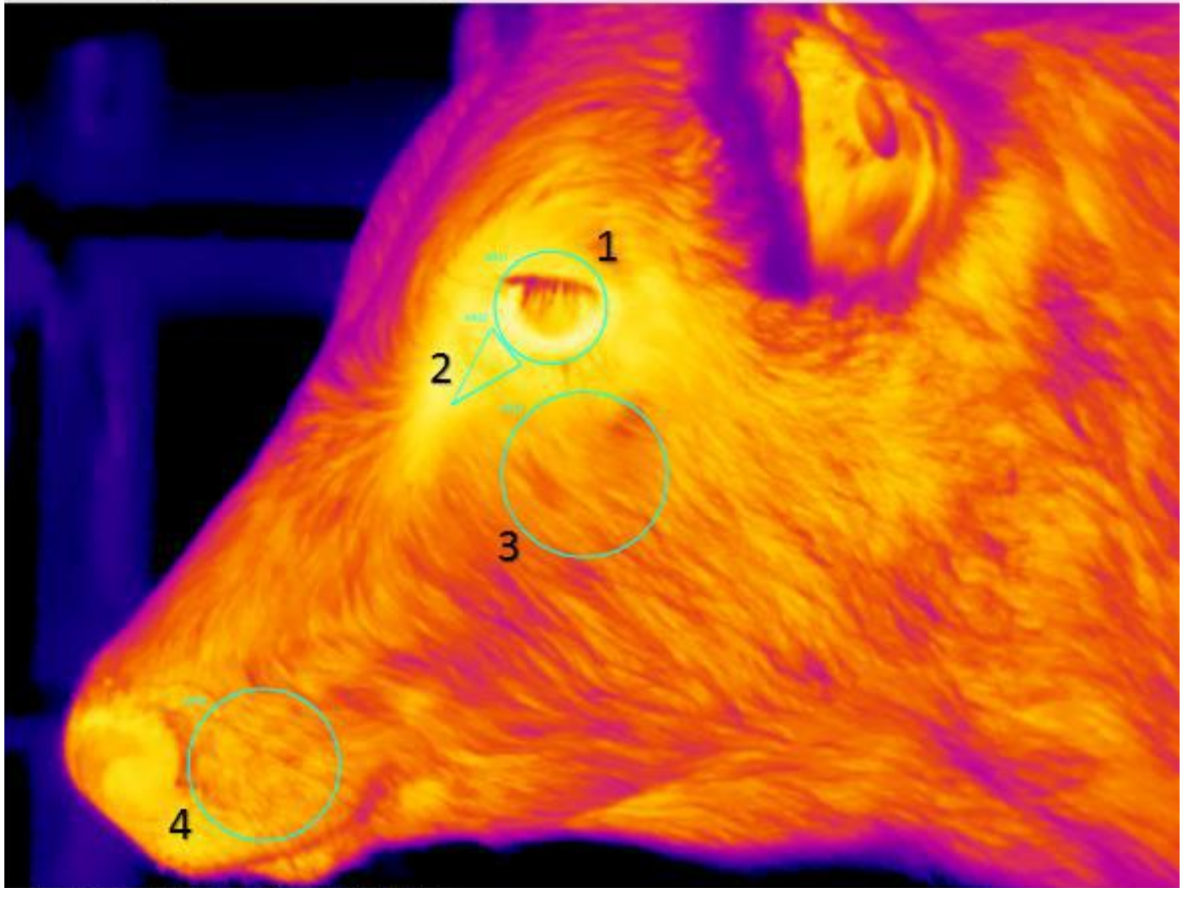
- Male and Female Friesian calves aged 6-9 months – common sires
- 73 young bulls; 246 heifers
- 30 - 40 day feeding trials (2 temporal cohorts)
- 24-hour access to feed & automated intake measurements
- 3x weekly live weight measurements

Experimental set-up



Thermal Imaging

- Measuring RFI is costly (~ $1,600/ head)
- Heat loss = wasted energy = metabolic inefficiency
- Thermal imaging is a rapid, low-cost, high-throughput way to measure heat loss
- Can thermal imaging replace or supplement RFI measurements?



1 eye
2 corner of eye
3 cheek
4 muzzle

Derived variables

- **Average Daily Growth** (ADG)
  - Regression coefficient for Body Weight vs. Day of Trial
- **Dry Matter Intake** (DMI)
  - Mean daily intake during trial period
- **Body weight** @ Mid-trial (MBW)
  - Prediction from ADG regression @ trial midpoint
- **Metabolic weight** = $MBW^{0.75}$
- **RFI** = residual from regression

$$DMI = \mu + \beta_{MBW}^{0.75} + \beta_{ADG} + \varepsilon$$

Mixed models (ASReml v.4)

- **3 x Univariate animal models (♂,♀,♂+♀)**
  - Response = RFI
  - Fixed effects: Farm Of Origin, Sex, Pen, Age (days), Cohort
  - Random effect: Animal
- **1x Bivariate animal model**
  - Response vector = RFI_{bulls}, $RFI_{heifers}$
  - Fixed effects: Farm Of Origin, Pen, Age, Cohort
  - Random effect: Animal

Key data

Traits	Cohort 1				Cohort 2			
	Heifers		Bulls		Heifers		Bulls	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age at start (days)	206	15	194	15	264	14	270	22
Body weight at start (kg)	195	25	194	25	209	26	227	32
Average daily gain, ADG (kg/day)	1.22	0.21	1.42	0.20	1.12	0.25	1.39	0.30
Dry matter intake, DMI (kg/day)	9.31	1.45	9.33	1.42	9.11	1.37	10.05	1.41
Residual feed intake (kg DM/day)	0.00	1.13	0.00	0.73	0.00	0.87	0.00	0.65

Results: Phenotypic Variation

Results: Genetic Parameters

Univariate Models

Calf data	σ_A^2	σ_R^2	σ_p^2	h^2(se)
Heifers only	0.05	0.37	0.42	0.13 ± 0.14
Bulls only	0.09	0.39	0.47	0.18 ± 0.57
Combined	0.05	0.35	0.39	0.12 ± 0.14

Bivariate Model

Calf Sex	Heifer	Bull
Heifer	0.14 ± 0.01	0.93 ± 1.46
Bull	0.15 ± 0.23	0.19 ± 0.04

Heritability (diagonals), genetic correlation (above diagonal) and phenotypic correlation (below diagonal)

Animal Solutions: Bivariate Model

	Heifers		Bulls	
Sire	Solution	Stderr	Solution	Stderr
1	-0.23	0.19	-0.26	0.25
2	-0.10	0.18	-0.09	0.23
3	0.00	0.17	0.00	0.23
4	0.01	0.21	0.01	0.26
5	0.02	0.21	0.01	0.27
6	0.03	0.19	0.00	0.24
7	0.08	0.18	0.12	0.23
8	0.10	0.19	0.09	0.25
9	0.24	0.19	0.30	0.24

Conclusions

- Genetic parameter estimates, despite large SE's, are promising
  - Heritability ~ 0.15 – 0.20
  - Cross-sex genetic correlation very high
- Selection for improved RFI in young bulls = genetic response in daughters
- Thermal imaging showing considerable promise

Next steps

- Trial comparing RFI in NZ's two main breed: Friesians & Jerseys
- Investigation of relationship between RFI and methane
- Develop appropriate genetic evaluation strategy & models for RFI/DMI
- Further investigation of predictors
  - Thermal imaging
  - Blood mid-infrared spectrometry

Acknowledgements

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