

# Within and between animal variation in methane production

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# Summary

- There is some variation between animals in methane production
- Some studies show more variation than others
- Need to consider the best (and most profitable) ways of exploiting this variation

# Progress ....

- Leslie et al. (AJEA, 2008) “Total emissions from the NZ dairy sector have risen by 70% since 1990 as a consequence of changes in the number of animals and the productivity of each animal. *However emissions per unit of product have declined by 17.7%*”
- Sheepmeat – *decrease of 17.5% in emissions per unit of product*
- “preliminary studies suggest that NZ products have a lower emissions intensity than their northern hemisphere counterparts

# Australian sheep data

Expts	CH4 l/day	Estimated Variance Components		
		Animals	Residual	Total
2006	18.4	0	16.5	16.5
2007 adj FI	26.8	11.4	3.2	16.6
2007 ign FI		25.4	3.2	28.6

2006 – 2 sex, 2 diets (high/low protein, sheep all fed same amount), 3 treats (drenched, born defaunated, faunated), significant differences between chambers;

2007 – 23 lambs, 3 treats (ns), 2 measurement periods (ns), variable FI,  $r(\text{CH}_4, \text{FI}) = 0.7$

# More sheep data

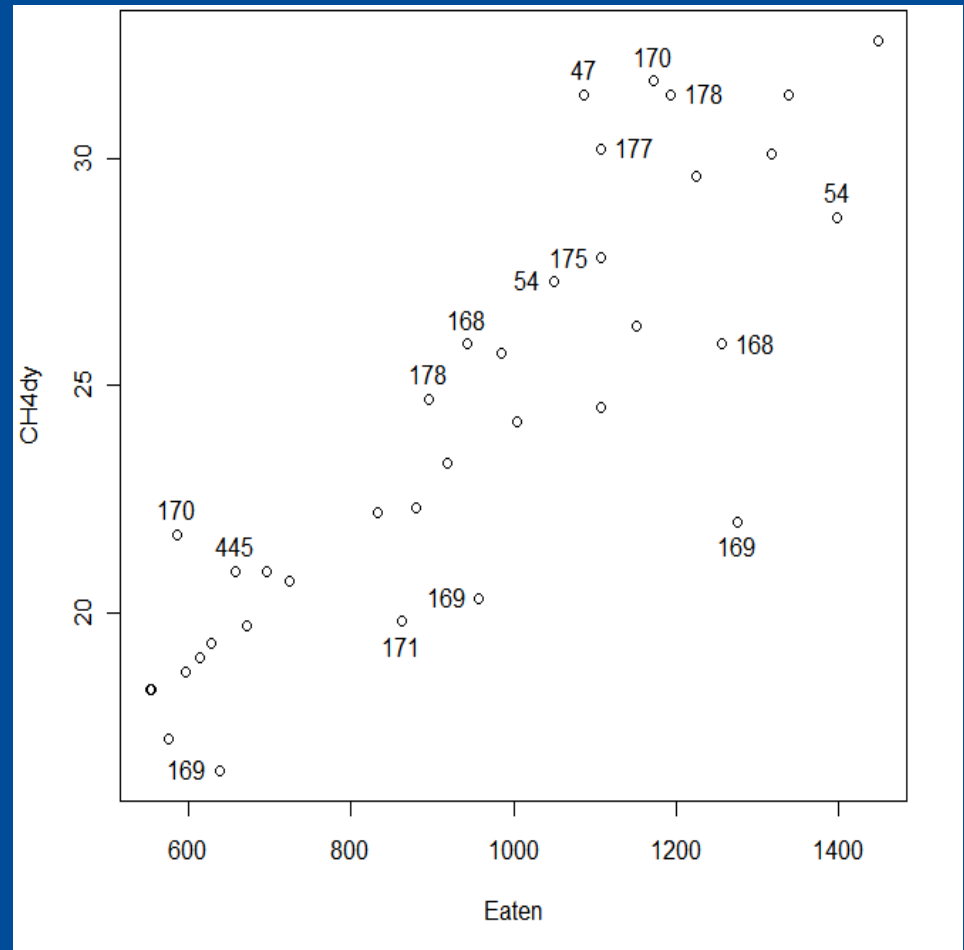
Expts in	CH4 lit/day	Estimated Variance Components		
		Animals	Residual	Total
2008a	23.4	1.8	1.1	2.9
2008b adj FI	26.8	2.1	3.8	5.9

2008a – 8 drenched vs 8 control sheep, 4 measurement periods

2008b – 12 sheep, 3 feeding levels (0.7, 1.05, 1.4 x maintenance)

# Summary - sheep

- Meas error 1-3 (litr/day)<sup>2</sup>
- Reasonably repeatable
- Small numbers of animals – sheep variance may depend on sample and conditions
- Ewe 169 had less CH<sub>4</sub> than expected for her FI
- Might want CH<sub>4</sub>/\$ product, rather than FI





# Swiss Dairy Cattle

**Paper: Absence of persistent methane emission differences in three breeds of dairy cows: A. Munger and M. Kreuzer, Aust J Exp Agric, 2008, 48, 77–82**

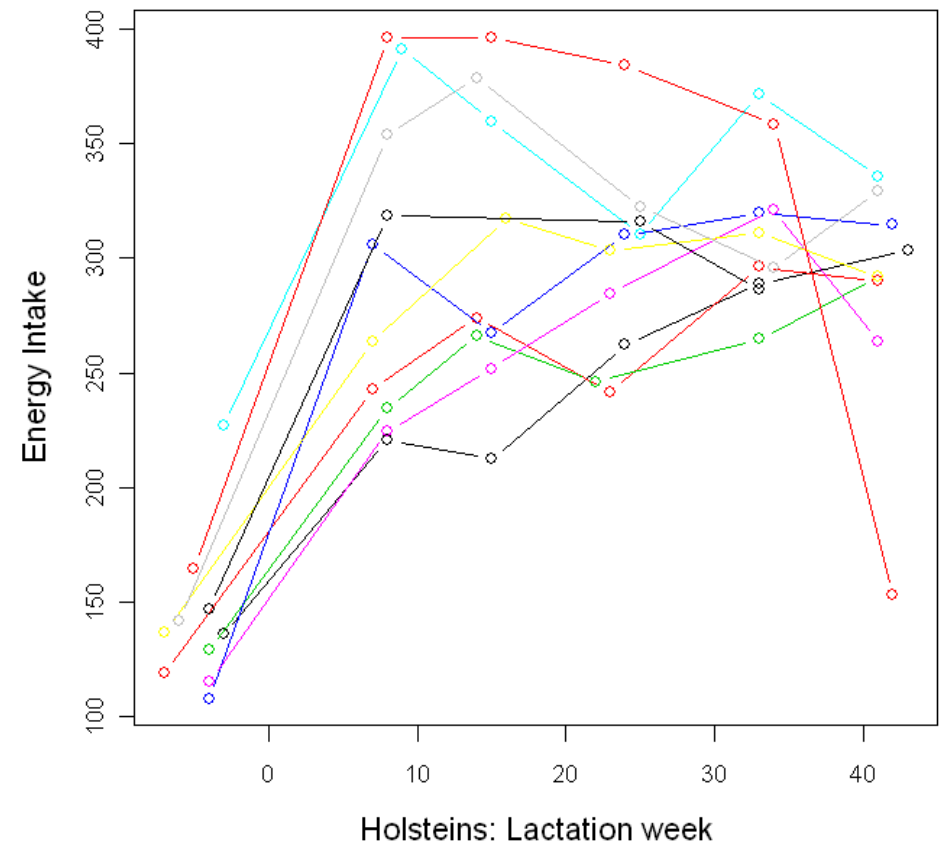
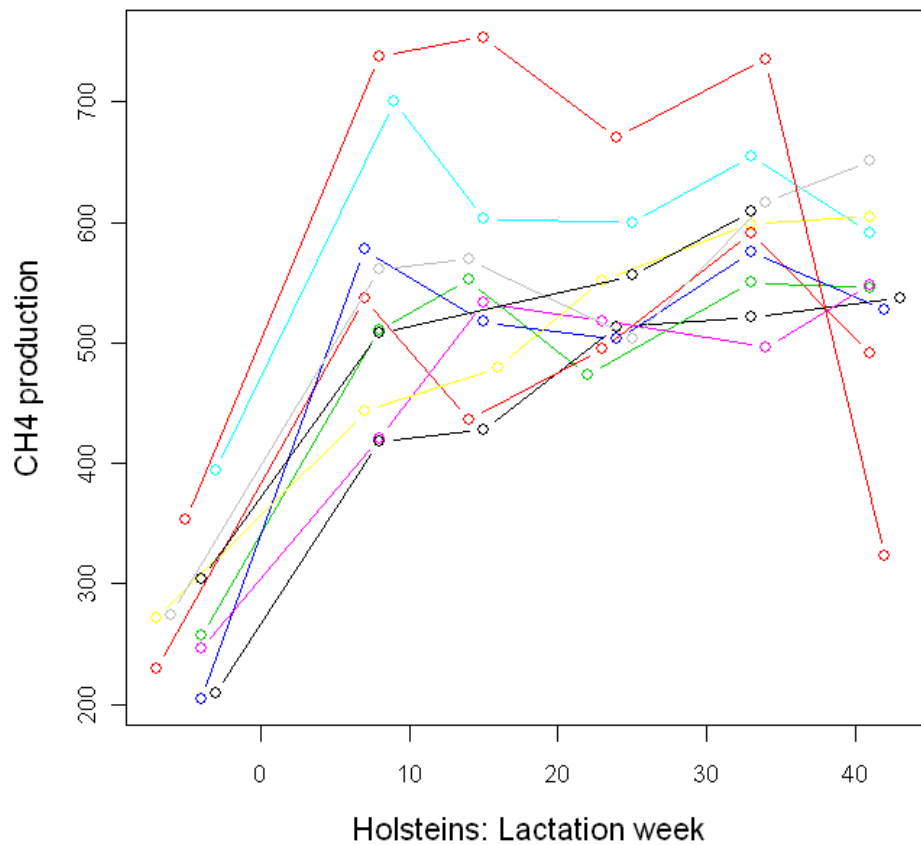
## Correlations with mean CH<sub>4</sub> production

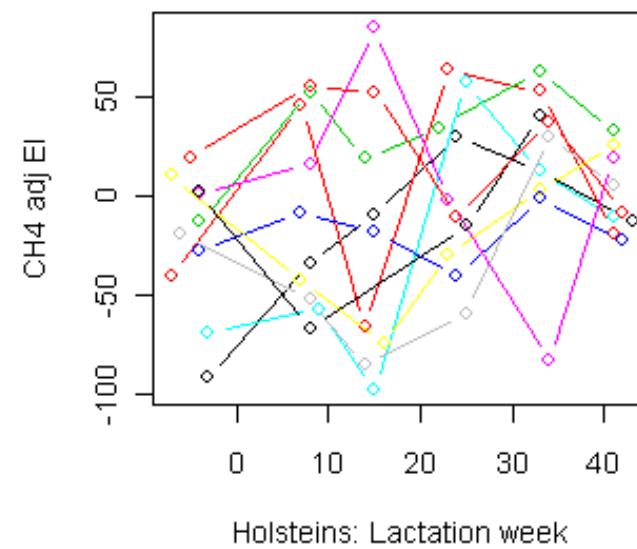
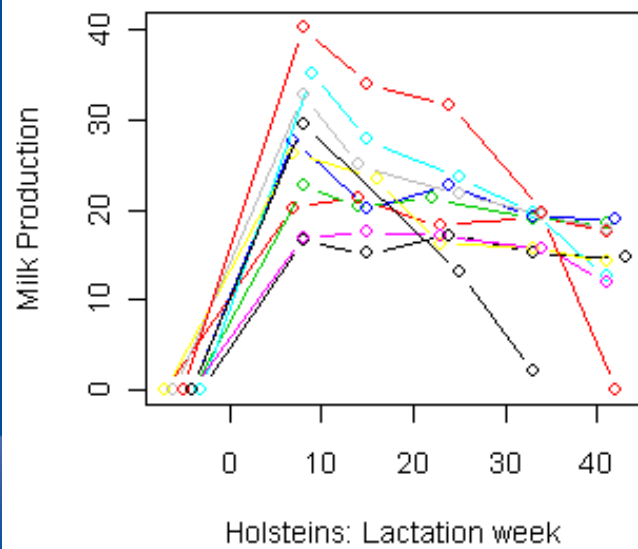
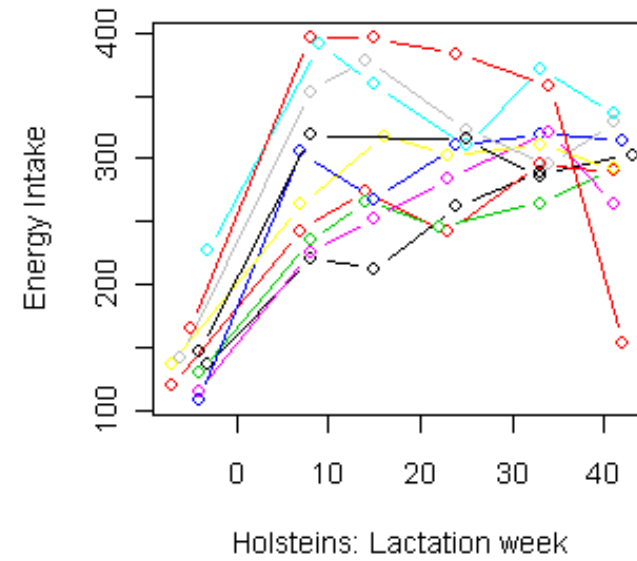
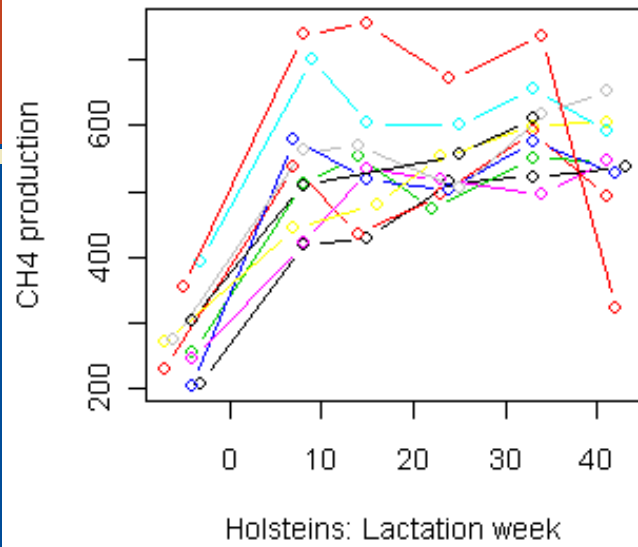
Dry matter intake	0.97
Energy intake	0.97
Milk production	0.83

CH<sub>4</sub>adjEI ~ Breed + Lactation stage  
small effect of breed (S 16 litres/day more than expected) & poss

Lactation week	<0	8	15	23	33	41
	0	9	16	9	23*	16

# CH4 and Energy Intake over time

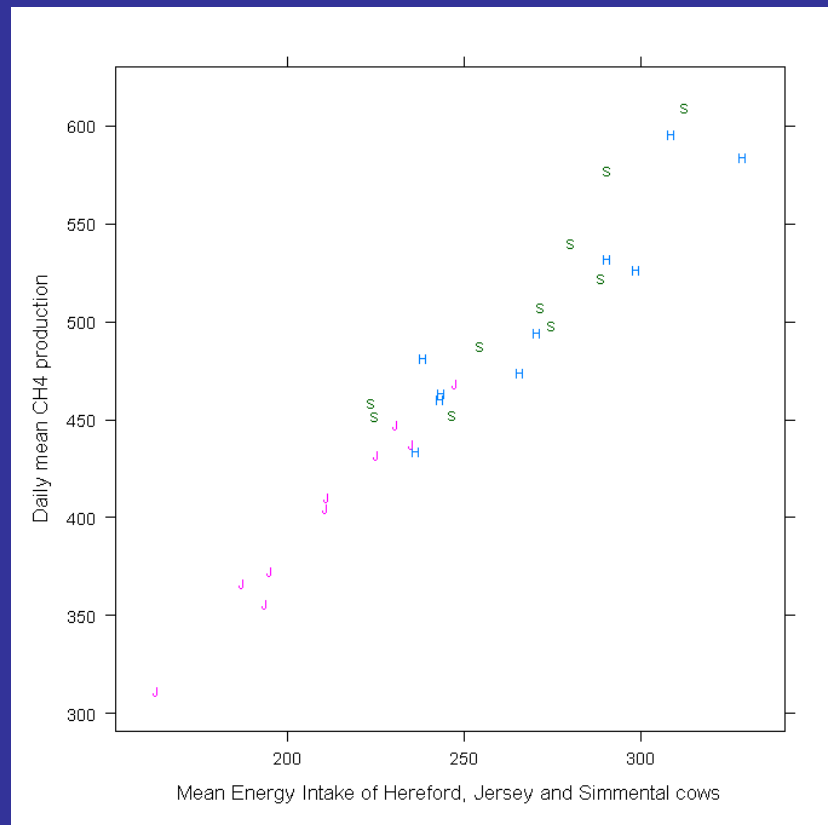




- Some small effects: Model:  $CH4_{adjEI} = \text{breed} + \text{Lactation stage}$
  - Breed significant – S about 16 litres more  $CH4$  than expected
- $CH4_{adjEI}$  possible effect of lactation week

Lactation week	<0	8	15	23	33	41
	0	9	16	9	23*	16

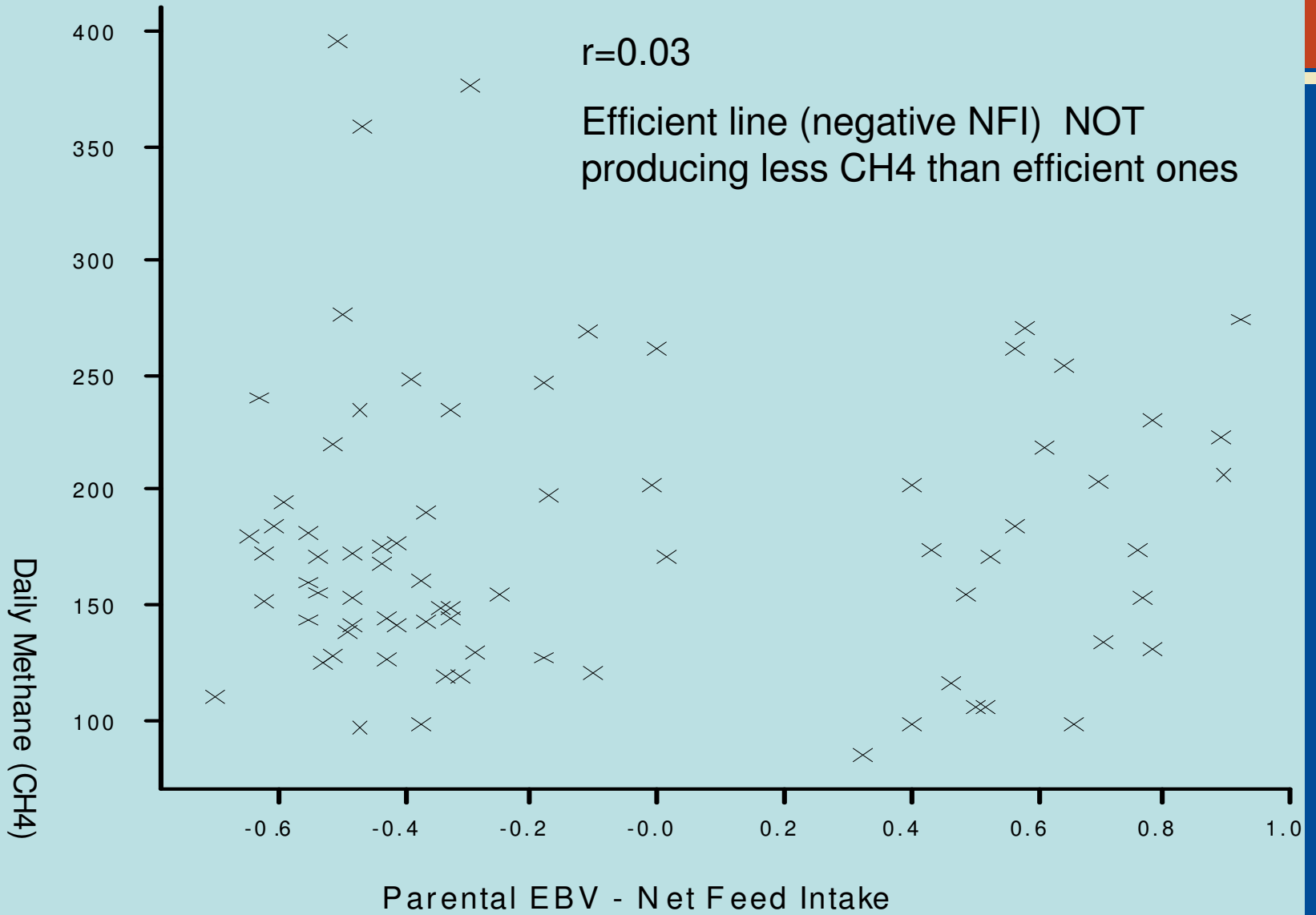
$CH4$  more strongly related to EI ( $r=0.97$ ) than milk production ( $r=0.83$ ) so best strategy to improve  $CH4$  per unit *product* or unit *profit* than unit EI - need good statistical models to ensure stable selection function



# Beef Cattle: Univ Alberta - Net Feed Intake

- Relationships of feedlot feed efficiency, performance, and feeding behavior with metabolic rate, methane production, and energy partitioning in beef cattle  
J. D. Nkrumah et al., JAS, 2006
- Steers fed at 2.5 times maintenance
- No difference in FI between high & low NFI groups
- Residual feed intake was correlated with daily methane production and energy lost as methane ( $r = 0.44$ ;  $P < 0.05$ ).

### Methane vs Parents NFI Breeding Value



CH4 v parebvni

Within & between animal variation in CH4 production --- Dorothy Robinson, NSW DPI Beef Industry Centre, Armidale.

# Problem with Net Feed Intake (NFI)

**NFI = feed eaten compared to that required for the animal's growth and maintenance (Big animals eat more than little ones!)**

**Energy Intake =  
maintenance energy + growth energy + error**  
 $\alpha * (\text{body wt})^{0.73} + \beta * (\text{weight gain}) + \text{RFI}$

*High accuracy*



*Low accuracy*



- Regression coefficients biased when x or independent variable subject to measurement error
- 2-variable regression  
inaccurate coefficient (wt gain) biased downward  
accurate coefficient (body wt) biased upwards
- Using regression to calculate RFI based on from periods (e.g. 10 days) – wt gain too inaccurate, so coefficient  $\rightarrow 0$ , i.e. RFI is feed intake adjusted for liveweight
- Tried this when CH<sub>4</sub> measurement reduced FI (and so CH<sub>4</sub> production)

# CH4 from Hi vs Low NFI steers

4 subgroups with CH4 measurements over 10 days

Group	1	2	3	4	Ave SED
Weight	549	561	590	605	
Feed Intake	11.9	11.5	11.4	10.8	0.56
15-day NFI	0.69	0.55	-0.27	-0.98	0.44

Results appeared to show that 15-day NFI correlated with CH4, but in reality 15-day NFI = FI adjusted liveweight, so animals in later periods whose FI most affected by the methane collection process (so ate the least & produced less CH4) considered most efficient.

# Summary

- US data shows relationship of CH<sub>4</sub> and NFI – more experiments needed to verify this for Aus
- There is some variation between animals in methane production
- Some studies show more variation than others
- Need to consider the best (and most profitable) ways of exploiting this variation – not easy!!!