

Measuring individual carbon dioxide emissions as a proxy for feed efficiency on dairy farms

- Preliminary results

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How to assess feed efficiency?

- Directly measure individual feed intake:
 - Laborious, costly, difficult to manage
- Alternatives:
 - Estimate (e.g. computer vision)
 - Proxies



Residual CO₂ as a proxy for feed efficiency¹

- Concept ~ residual feed intake (RFI)
- $RCO_2 = \text{actual CO}_2 \text{ production} - \text{predicted CO}_2 \text{ production}$

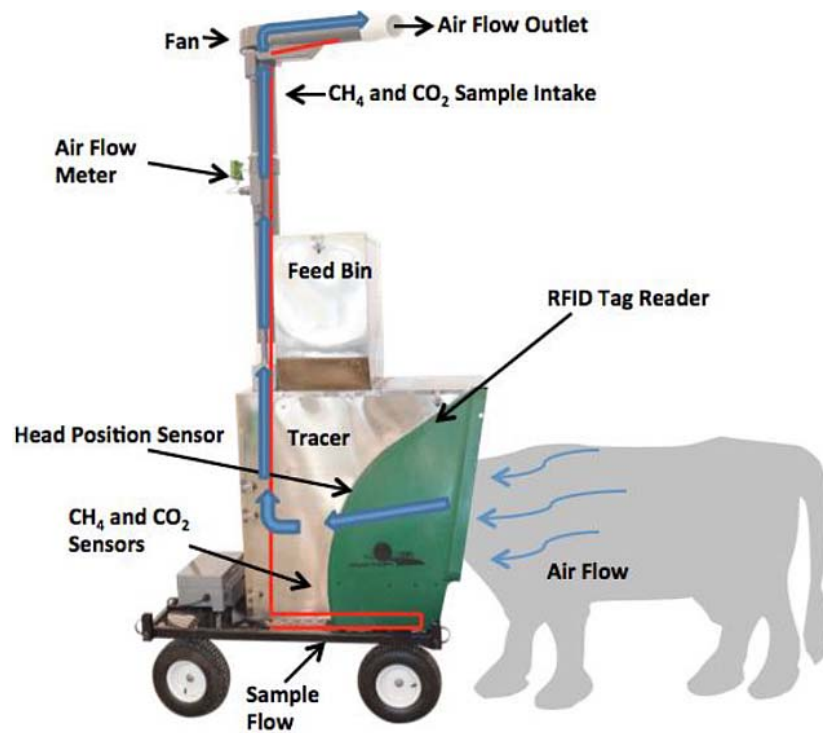
↑
Estimate from
breath measurements

↑
Based on
e.g. energy-corrected milk &
metabolic body weight

- 11 respiration chamber studies
- Conclusions:
 - Potential for ranking cows based on feed efficiency
 - On-farm studies needed

Aim

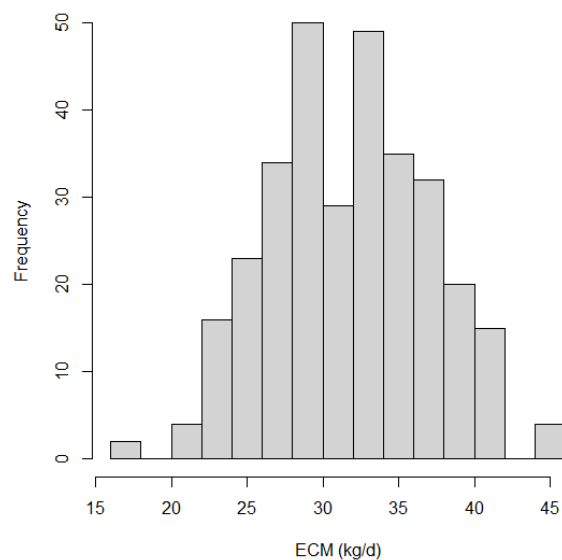
- RFI vs. RCO_2 using GreenFeed data in mid-lactation on a dairy farm



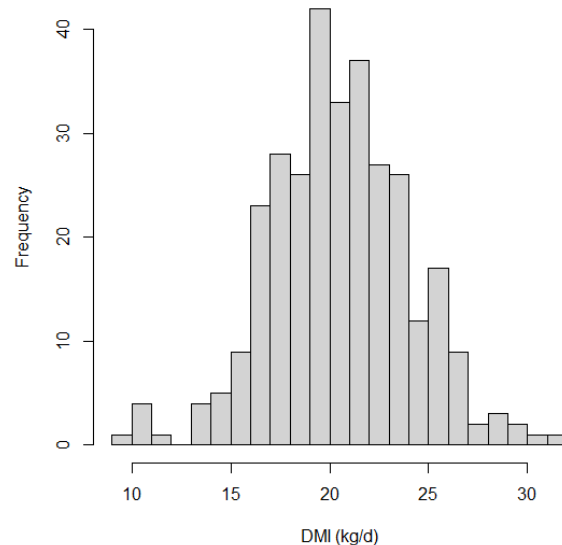
Materials and methods

- 5 GreenFeed experiments on Dairy Campus of WUR (anonymized)
- $n = 313$ cow-treatment observations
- 115-175 DIM
 - Minimize effect of energy balance changes
 - Highly correlated with average RFI over the whole lactation²
- No information: feed composition, CH_4
- RCO_2 & RFI ~ mixed-effects models:
 - Energy-corrected milk & metabolic body weight
 - Treatment and experiment

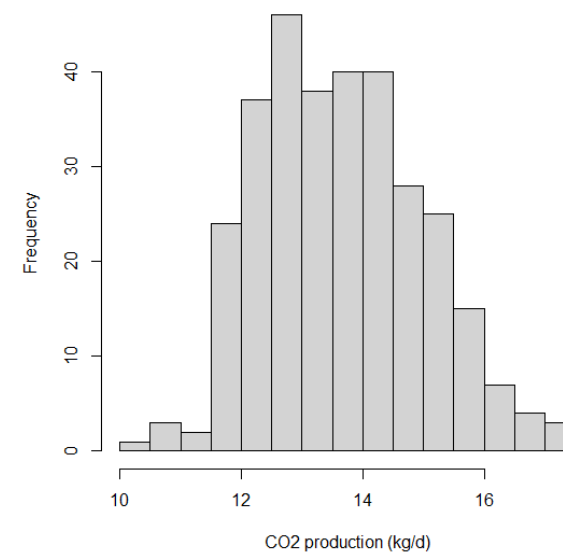
Input and output levels



Energy-corrected milk
 31.7 ± 5.3 kg/d

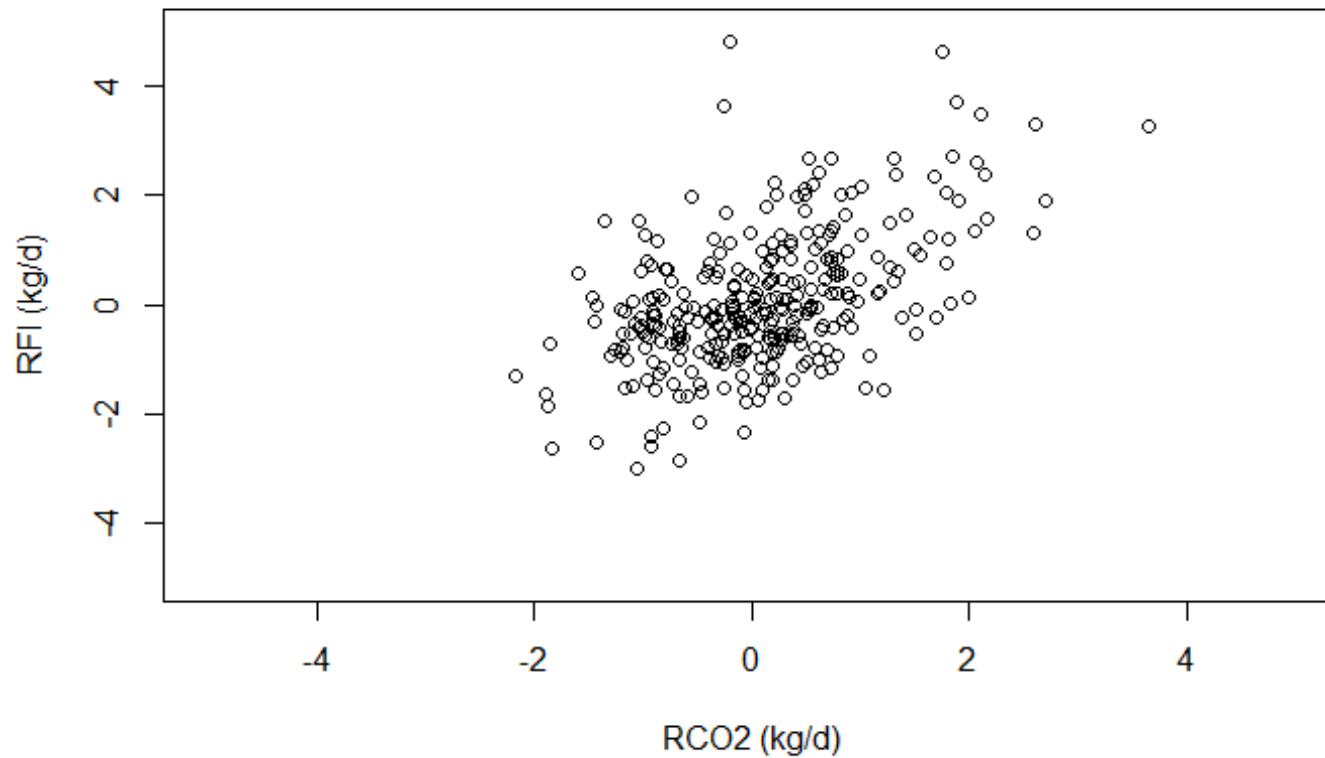


Dry matter intake
 20.5 ± 3.5 kg/d



CO₂ production
 13.7 ± 1.3 kg/d

RFI vs. RCO₂

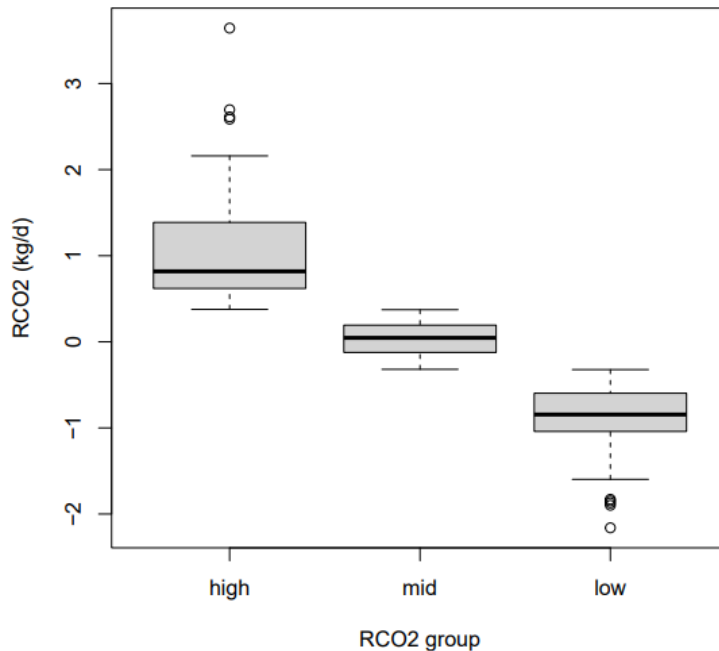


$$r = 0.52$$

Differences in RCO₂ (kg/d) by RCO₂ group

3 equal-sized (n = 104-105) groups created: **high**/mid/**low** residual CO₂

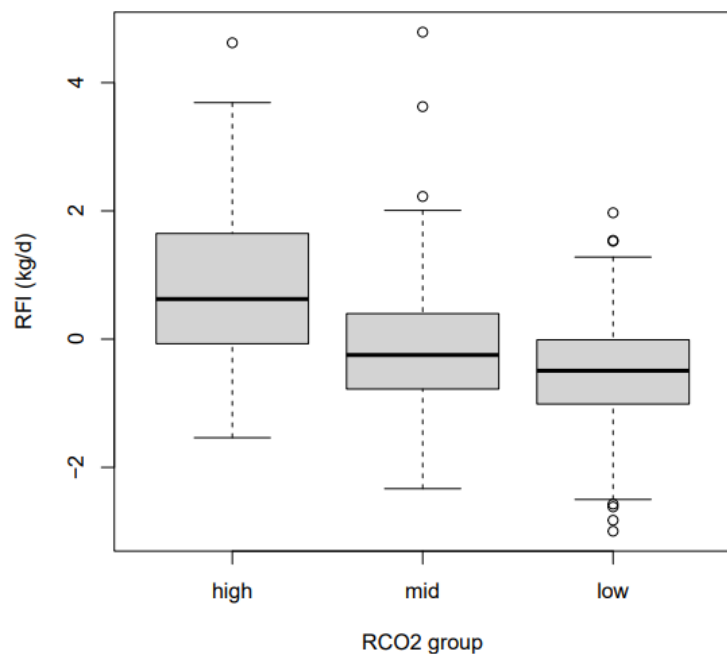
Value of RCO₂ by RCO₂ group



Comparison	Difference (kg/d)	95% CI	P-value
Low vs. High	-1.92	-2.06; -1.78	<0.0001
Mid vs. High	-1.02	-1.16; -0.88	<0.0001
Low vs. Mid	-0.90	-1.04; -0.76	<0.0001

Differences in RFI (kg/d) by RCO₂ group

Value of RFI by RCO₂ group



Comparison	Difference (kg/d)	95% CI	P-value
Low vs. High	-1.31	-1.67; -0.95	<0.0001
Mid vs. High	-0.89	-1.25; -0.53	<0.0001
Low vs. Mid	-0.42	-0.78; -0.06	0.0168

Relevant differences in feed efficiency between RCO₂ groups

Classification accuracy

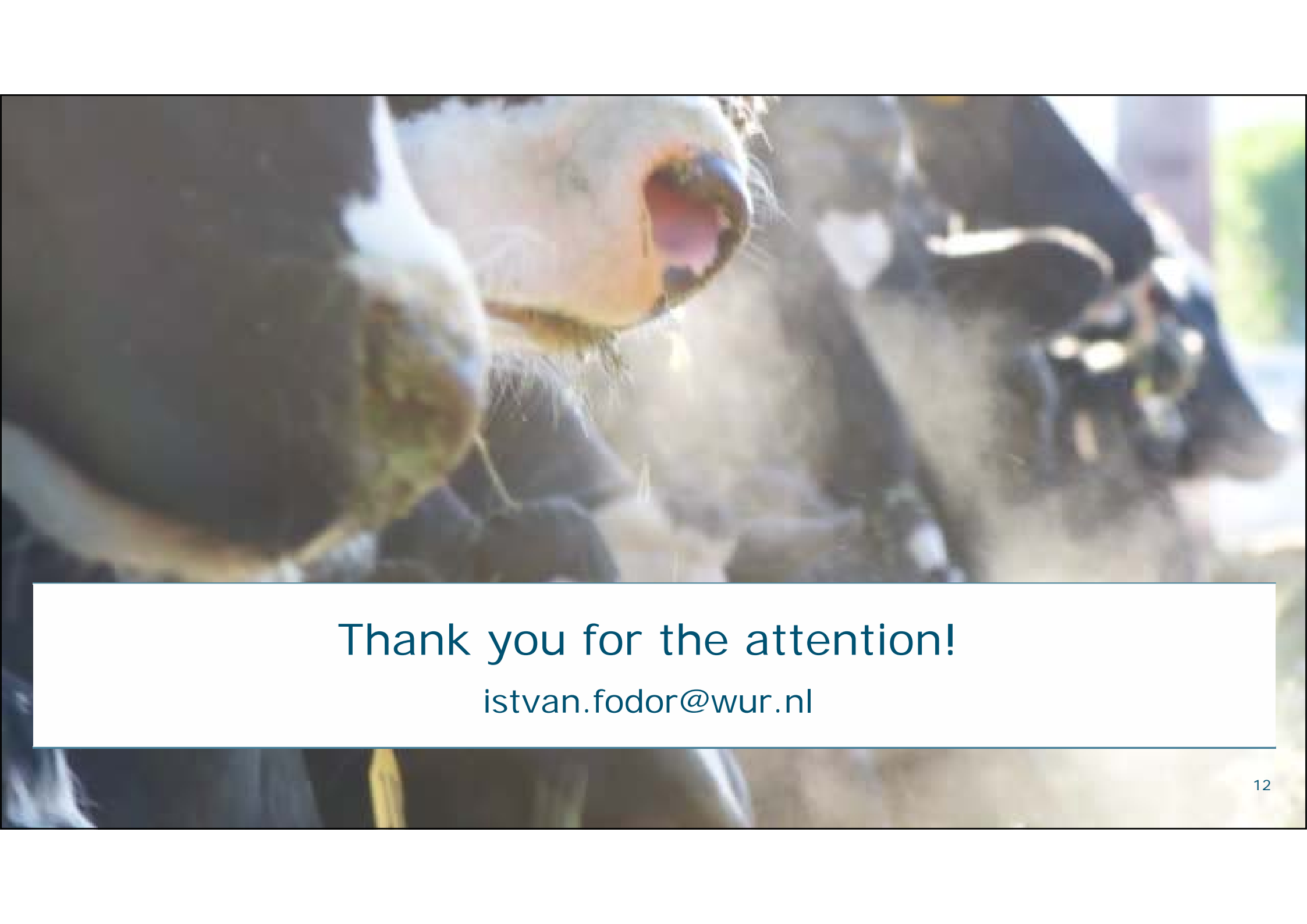
RFI group	RCO ₂ group		
	High	Mid	Low
High	59.0	24.8	16.2
Mid	26.9	37.5	35.6
Low	14.4	37.5	48.1

Overall: 48.2%

Inefficient ↔ efficient misclassification rare

Conclusions & Implications

- RCO_2 is a promising proxy for feed efficiency
 - Highly repeatable CO_2 measurements required
 - Same diet & lactation stage
- Effect of energy balance:
 - Mid-lactation
 - Estimate energy balance



Thank you for the attention!

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