

Repeatability and correlations of residual carbon dioxide and feed efficiency in Nordic Red Cattle

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- Feed costs is the main cost of production.
- Improving feed efficiency ----> higher profit and sustainability.
- RFI is mostly used and well-known criterion.
- Feed intake is expensive to record.
- Possibility to records gaseous traits.

Rationale

- **Residual CO₂ production** (RCO₂) can be used as an indicator trait (or criterion) to improve feed efficiency.
- **Hypothesis:** given we can measure CO₂ production accurate enough, then RCO₂ and residual energy intake should be highly correlated.

Objectives

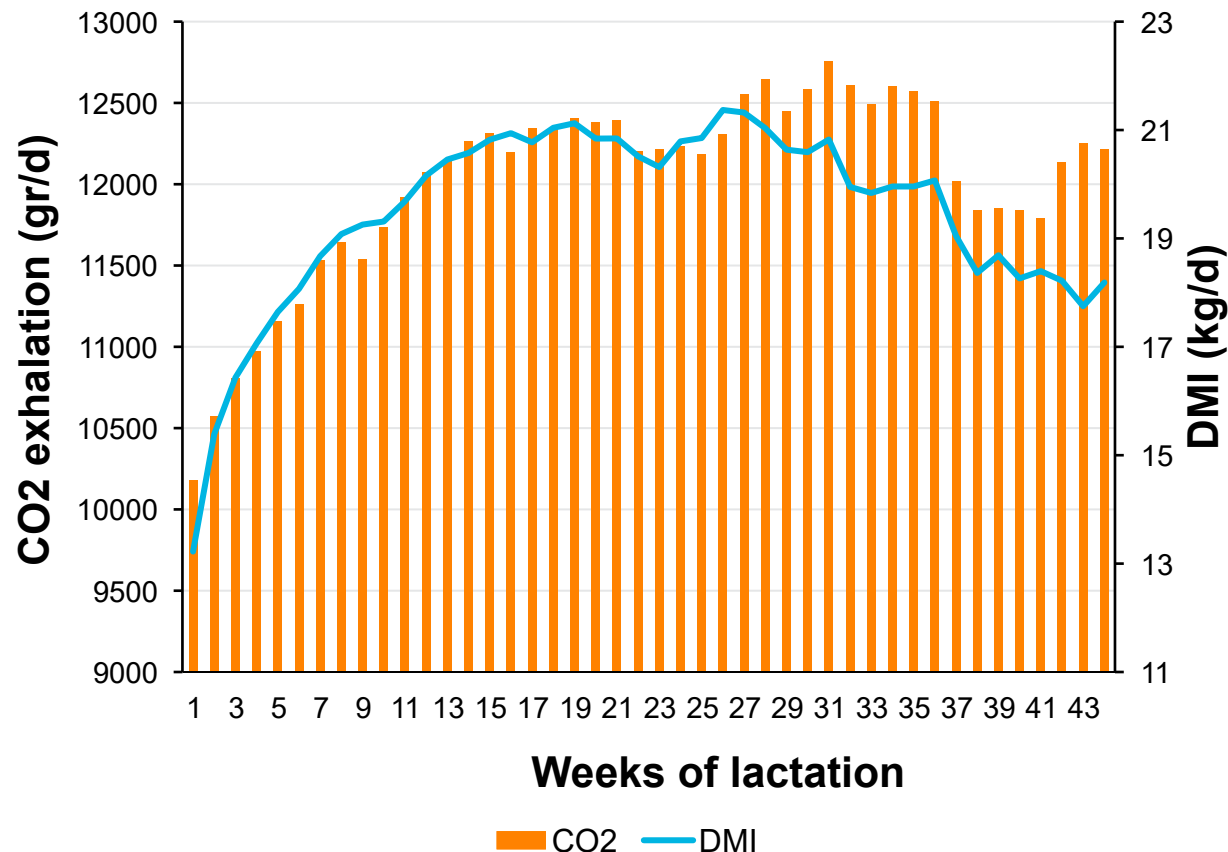
- To model lactation trajectories for CO_2 , DMI, RCO_2 and RFI.
- To estimate repeatabilities for RCO_2 observations at different lactation stages
- To calculate animal correlations between RCO_2 and RFI

Table1. Distribution of records lactation months.

- No. of animals = **46** RDC
- CO₂ measurements made from Oct. 2021- May 2022
- **Two** GreenFeed units
- Total number of Obs.: **23128** (3.43 rec/anim/d)
- CO₂ edition criterion: $\mu \pm 2.5 \text{ S.D.}$)

LM	after editing (n=5995)	
	Avg. CO ₂	S.D.
1	10714	1200
2	11440	1231
3	11948	1255
4	12281	1269
5	12359	1303
6	12229	1555
7	12582	1606
8	12585	1203
9	12146	1293
10	11877	1143
Mean	<u>12003</u>	1407

Trajectories of DMI and CO₂ (weekly averages)



Modelling residual traits

1) Prediction model by fitting a multiple regression model to DMI and CO₂ observations

$$Y = c0 + c1 \times ECM + c2 \times MBW + c3 \times BWL + c4 \times BWG$$

2) Calculation of RFI & RCO₂

$$RFI = \text{Actual_DMI} - \text{Predicted_DMI}$$

$$RCO_2 = \text{Actual_CO}_2 - \text{Predicted_CO}_2$$

Estimating phenotypic co-variances between test days

➤ **Data:** daily observations.

$$Y_{tijl} = YM_i + LM_j + \sum_{k=0}^{nf} \emptyset ltk \beta k + \sum_{m=0}^{nr} \emptyset ltk Ulk + \varepsilon_{tijl}$$

Y_{tijl} : daily observations of RCO₂ or RFI

YM_i : Year-Month of recording

LM_j : Lactation Month

βk : Fixed regression coefficients

Ulk : autoregressive covariance structure

$\emptyset ltk$: the k^{th} Legendre polynomials plus Wilmink for the test day record of cow l on day t

$nf = 4$ and $nr = 1$

Trajectories of RFI and RCO₂ (weekly averages)

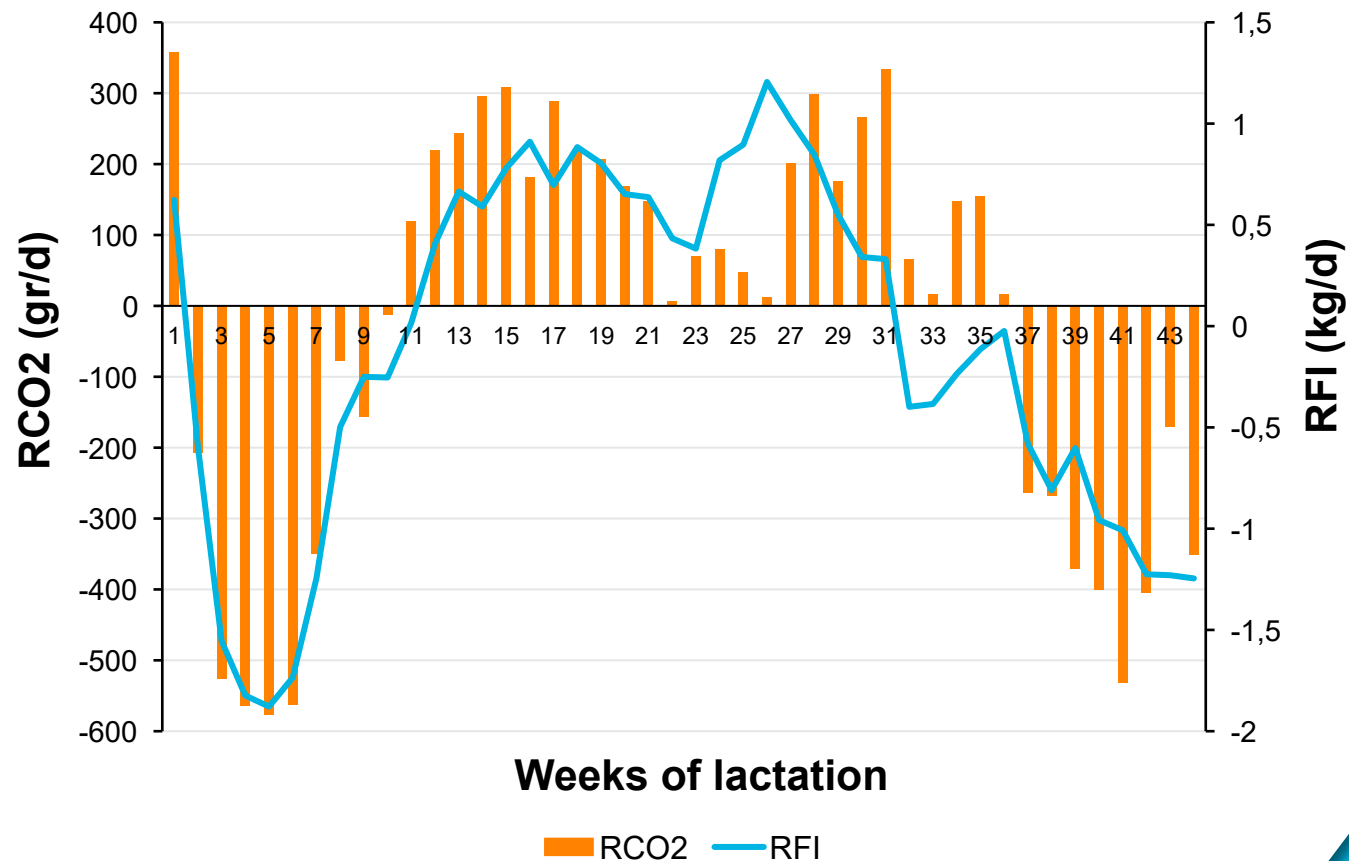


Table 2. **Animal correlations** (above diagonal) and **phenotypic correlations** (below diagonal) between **RCO₂** in selected days of lactation.

DIM	6	36	66	96	126	156	186	216	246	276	305
6		0.59	0.22	0.15	0.15	0.16	0.17	0.17	0.18	0.18	0.17
36	0.27		0.91	0.84	0.78	0.70	0.62	0.53	0.45	0.38	0.32
66	0.10	0.26		0.98	0.93	0.86	0.76	0.67	0.58	0.50	0.43
96	0.07	0.24	0.27		0.98	0.93	0.86	0.78	0.71	0.64	0.58
126	0.07	0.23	0.27	0.28		0.98	0.94	0.89	0.83	0.77	0.72
156	0.08	0.21	0.25	0.27	0.30		0.99	0.96	0.91	0.87	0.83
186	0.08	0.19	0.23	0.25	0.30	0.31		0.99	0.97	0.94	0.91
216	0.09	0.18	0.22	0.25	0.31	0.33	0.35		0.99	0.98	0.96
246	0.10	0.16	0.20	0.24	0.30	0.33	0.36	0.41		0.99	0.99
276	0.10	0.14	0.18	0.23	0.29	0.33	0.37	0.42	0.45		0.99
305	0.09	0.10	0.14	0.18	0.24	0.28	0.31	0.36	0.39	0.41	
σ_{II}^1	1.281	0.534	0.514	0.514	0.523	0.549	0.590	0.645	0.710	0.783	0.859
σ_{ϵ}^2	0.792	0.840	0.820	0.845	0.791	0.829	0.855	0.807	0.808	0.820	1.141
σ_p^3	1.506	0.995	0.967	0.989	0.949	0.994	1.039	1.033	1.076	1.134	1.429
Repeat	0.72	0.29	0.28	0.27	0.30	0.30	0.32	0.39	0.44	0.48	0.36

¹ σ_{II} : animal SD ($\sqrt{\text{diag}(\mathbf{I} \times \mathbf{K}_p - \mathbf{I})}$); ² σ_{ϵ} : residual SD ($\sqrt{1 - \sigma_{II}^2}$); ³ σ_p : phenotypic SD ($\sqrt{\text{diag}(\mathbf{I} \times \mathbf{K}_p - \mathbf{I}) + \mathbf{I} \times \sigma_{\epsilon}^2}$)).

Table 3. **Animal correlations** (above diagonal) and **phenotypic correlations** (below diagonal) between **RFI** in selected days of lactation.

DIM	6	36	66	96	126	156	186	216	246	276	305
6		0.44	-0.02	-0.07	-0.02	0.06	0.14	0.19	0.23	0.25	0.27
36	0.28		0.88	0.81	0.74	0.63	0.48	0.34	0.22	0.13	0.06
66	-0.01	0.37		0.98	0.91	0.77	0.59	0.41	0.27	0.15	0.06
96	-0.04	0.35	0.38		0.97	0.87	0.72	0.57	0.43	0.32	0.24
126	-0.01	0.35	0.39	0.42		0.96	0.87	0.75	0.64	0.54	0.47
156	0.04	0.26	0.29	0.34	0.41		0.97	0.90	0.82	0.75	0.68
186	0.09	0.23	0.26	0.33	0.43	0.42		0.98	0.94	0.89	0.84
216	0.13	0.18	0.19	0.27	0.39	0.42	0.53		0.99	0.96	0.93
246	0.17	0.12	0.13	0.22	0.35	0.40	0.53	0.59		0.99	0.98
276	0.19	0.07	0.07	0.16	0.30	0.36	0.50	0.58	0.62		0.99
305	0.22	0.03	0.03	0.13	0.29	0.37	0.54	0.63	0.69	0.70	
σ_U^1	3.457	1.233	1.225	1.166	1.114	1.127	1.221	1.371	1.572	1.797	2.037
σ_ε^2	1.425	1.338	1.565	1.421	1.170	1.473	1.192	1.179	1.208	1.393	1.044
σ_p^3	3.739	1.819	1.987	1.838	1.616	1.855	1.703	1.808	1.982	2.274	2.289
Repeat.	0.86	0.46	0.38	0.40	0.48	0.37	0.51	0.58	0.63	0.63	0.79

Table 4. **Animal correlations** between **RCO₂** and **RFI** in selected days of lactation.

RCO ₂	RFI												
	DIM	6	36	66	96	126	156	186	216	246	276	305	Avg.
	6	0.88	0.57	0.14	0.05	0.02	0.02	0.01	0.01	0.00	0.00	0	0.15
	36	0.45	0.61	0.40	0.31	0.24	0.15	0.06	-0.01	-0.07	-0.11	-0.14	0.17
	66	0.13	0.44	0.41	0.37	0.31	0.23	0.15	0.07	0.01	-0.04	-0.08	0.18
	96	0.09	0.38	0.39	0.37	0.35	0.30	0.24	0.17	0.12	0.08	0.05	0.23
	126	0.11	0.35	0.35	0.37	0.37	0.36	0.33	0.28	0.24	0.20	0.18	0.29
	156	0.15	0.32	0.31	0.35	0.39	0.41	0.40	0.37	0.35	0.32	0.29	0.33
	186	0.18	0.28	0.27	0.32	0.39	0.43	0.45	0.45	0.43	0.41	0.39	0.36
	216	0.20	0.24	0.22	0.29	0.38	0.45	0.49	0.50	0.49	0.48	0.47	0.38
	246	0.22	0.20	0.18	0.26	0.36	0.46	0.51	0.54	0.54	0.53	0.52	0.39
	276	0.23	0.17	0.15	0.23	0.35	0.46	0.53	0.56	0.57	0.57	0.56	0.40
	305	0.24	0.15	0.12	0.21	0.34	0.45	0.53	0.58	0.59	0.59	0.59	0.40
	Avg.	0.26	0.34	0.27	0.28	0.32	0.34	0.34	0.32	0.30	0.28	0.26	0.30

Thank You

**Any
Question?**