Prediction of residual energy intake in Fleckvieh cows using mid-infrared spectroscopy

S.-J. Burn[1†], S. Gruber[1†], B. Fuerst-Waltl[1], C. Egger-Danner[2], G. Terler[3], A. Steinwidder[3], J. Sölkner[1], W. Zollitsch[1]

[1]BOKU University, Department of Sustainable Agricultural Systems, Institute of Livestock Sciences, Gregor-Mendel-Str. 33, 1180 Vienna, Austria
[2]ZuchtData EDV-Dienstleistungen GmbH, Dresdner Str. 89, 1200 Vienna, Austria
[3]Agricultural Research and Education Centre Raumberg-Gumpenstein, Raumberg 38, 8952 Irdning-Donnersbachtal, Austria

[†]*These authors contributed equally to this work.*

Contact: sarah.burn@boku.ac.at

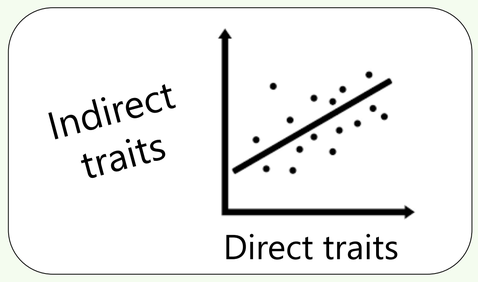
breed4green

Background

feed efficiency → • feed costs • environmental impact

BUT direct efficiency traits → expensive & labor-intensive

Possible Solution



Aim

- comparison of different models for residual energy intake (REI) to indicate feed efficiency
- developing mid-infrared (MIR) prediction equations for REI

Materials and Methods

- 19 Fleckvieh cows (68 lactations)
- research farm Raumberg-Gumpenstein
- 16 325 observations with daily MIR spectra and performance data (2014-2021)
  - energy intake, milk yield, milk solids, body weight, body condition score
- multiple linear regression model for REI in MJ NEL

MIR prediction models

- partial least squares regression
- 212 selected 1st derivative MIR spectra + test-day variables
- 10-fold random external validation by observations

Table 1. Linear regression models for REI with different predictor variables

Model	MilkE	FY	PY	MBW	ΔBW	BCS	ΔBCS	DIM_{l+q}	DIM_{L-5}	Par
REI-1	x			x		x		x		x
REI-2	x			x	x	x	x	x		x
REI-3		x	x	x		x		x		x
REI-4	x			x	x	x	x		x	x

MilkE = milk energy; FY = milk fat yield; PY = milk protein yield; MBW = metabolic body weight; ΔBW = daily body weight change; BCS = body condition score; ΔBCS = daily body condition score change; DIM_{l+q} = days in milk (linear + quadratic); DIM_{L-5} = days in milk (fifth order Legendre polynomials); Par = parity

Results

Table 2. Performance of different REI prediction models in validation with different predictor variables

	MIR			MIR + MY + DIM + Par		
Model	**R**	**R^2**	**RMSE**	**R**	**R^2**	**RMSE**
REI-1	0.56	0.32	10.82	0.59	0.35	10.59
REI-2	0.53	0.28	10.57	0.54	0.29	10.46
REI-3	0.48	0.23	10.85	0.50	0.25	10.72
REI-4	0.44	0.20	9.85	0.44	0.20	9.92

R = correlation between predicted and observed REI; R^2 = coefficient of determination; RMSE = root mean square error; MY = milk yield; DIM = days in milk; Par = parity

Table 3. Accuracies of REI prediction models (REI-1) in validation based on MIR and test-day variables fitted across different lactation stages

Lactation stage	R	R^2	RMSE
Early (<60 DIM)	0.75	0.56	10.27
Mid (60-150 DIM)	0.59	0.35	10.11
Late (>150 DIM)	0.60	0.36	9.91

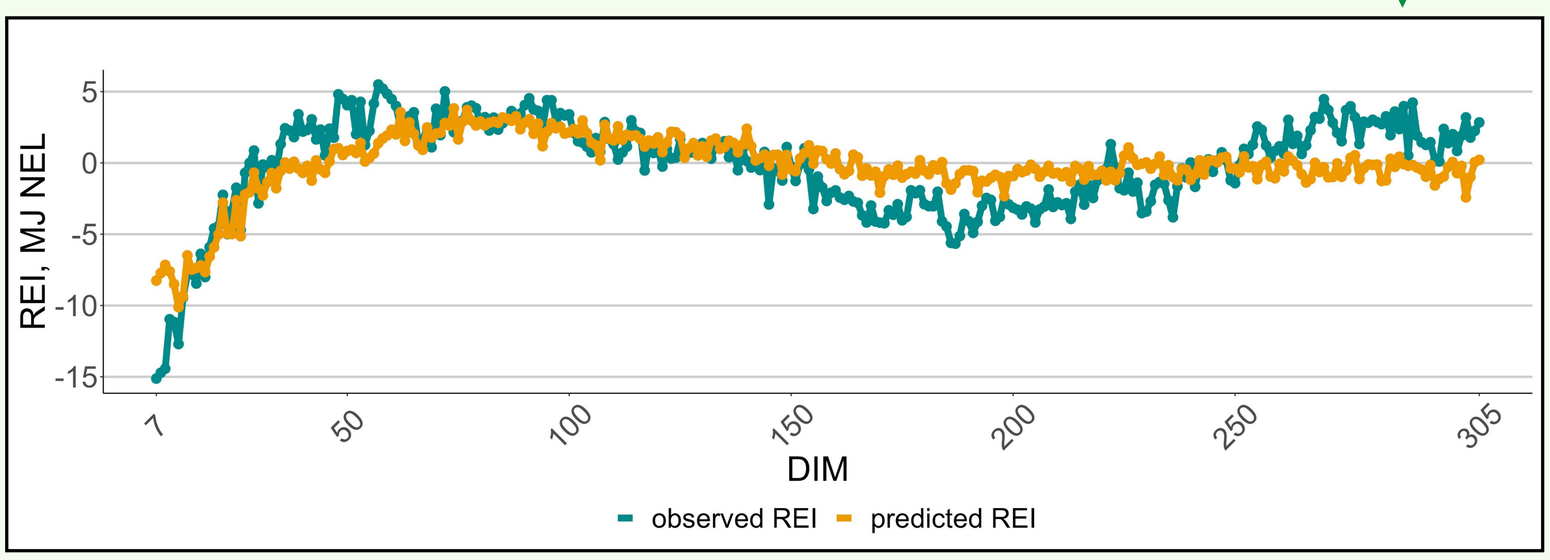


Figure 1. Average observed and predicted REI per day in milk for model REI-1

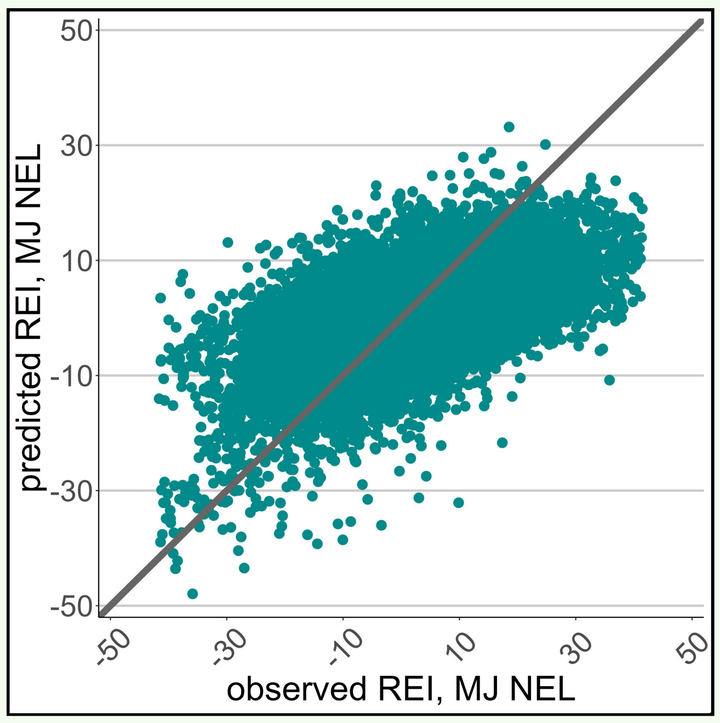


Figure 2. Relationship between observed and predicted REI values obtained in validation for model REI-1 from MIR and test-day variables

Conclusion

- **moderate predictive ability of developed spectrometric prediction equations for REI**
- **model performance depends on REI model and lactation stage**
- **including test-day variables can improve predictive performance**
  - ↳ **potential to use MIR-predicted REI as indirect efficiency trait**

<u>NEXT STEPS</u>: external validation

BOKU Institute of Livestock Sciences
ZUCHT DATA
HBLFA Raumberg-Gumpenstein Landwirtschaft

With support of the federal agency (BML) and dafne.at
Bundesministerium Land- und Forstwirtschaft, Regionen und Wasserwirtschaft
DaFNE