Milk mid-infrared spectral data as a useful tool to predict feed intake in dairy cows

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Background

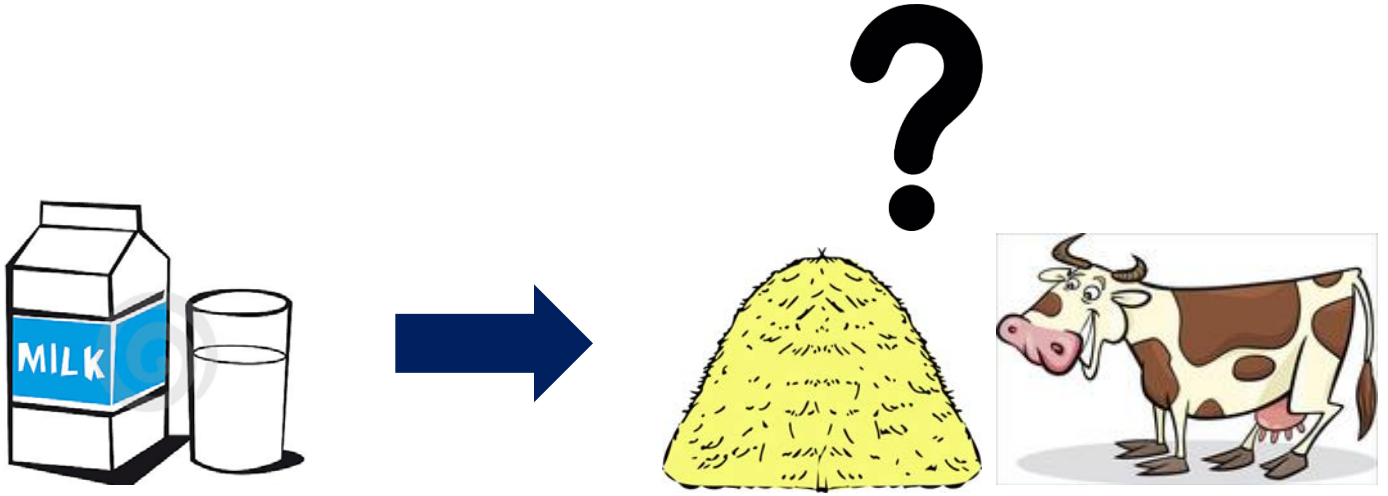
- Collecting feed intake data is difficult and expensive
- → Improvements in feed efficiency mainly indirect and due to the genetic improvement in milk production
- Berry and Crowley, 2013: possible to predict feed intake using milk production, live weight and type traits
- McParland et al., 2014: feed intake could be predicted using mid-infrared (MIR) spectrometry of milk

Background

- Having access to (predicted) feed intake data
  - → direct selection for feed efficiency
  - → herd management decisions

Objective

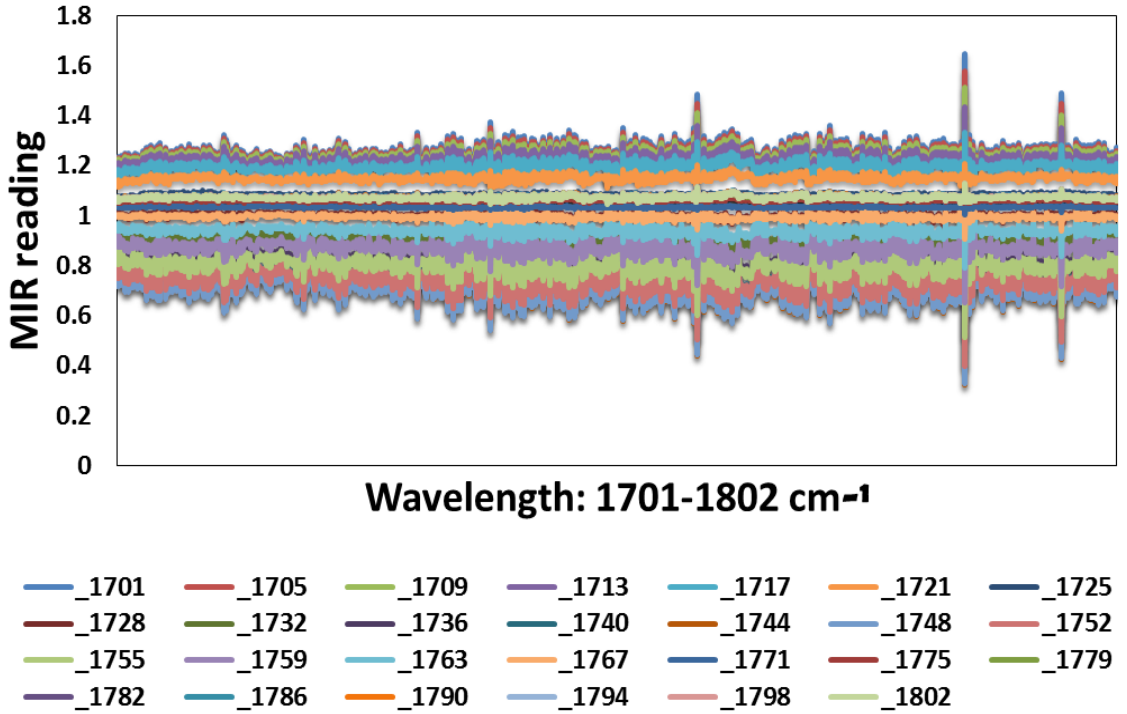
To accurately predict feed intake of lactating cows using milk mid-infrared spectra (MIRS)



Mid-infrared spectroscopy (MIRS)

- Based on the interaction between matter and electromagnetic waves in the 900 to 5,000 cm^{-1} region (De Marchi et al., 2014)
- Used for determining fat, protein and lactose concentration in milk
- Milk samples are taken routinely in dairy production

→ Using those samples for predicting FI would be cost-effective



Data

- From six different feeding experiments from a single dairy research herd (NRF) between the years 2007 and 2015
- Records were available on energy intake (EI), milk yield, and milk concentration of fat, protein and lactose

Spline interpolation of missing recs

- Splines were used to interpolate dairy records where the MIR spectra were also available but only where phenotypes were available within 10 days of the MIR observation

- The number of records with both a phenotypic value and MIR varied between 800 and 900 (90-184 cows) for most of the traits

Energy intake variables

- NEL (Net energy lactation):
  - Standard feed value for NEL at 20 kg DMI
  - Calculated using fixed values for body weight, DMI, proportion of concentrate, passage rates etc. (NorFor)
- Elphen is calculated based on real phenotypic records: DMI, weight, milk yield, milk concentration and feed quality

Phenotypes at days with MIR

Trait	No. of records	No. of cow_lact.	Mean	s.d.
NEL (MJ/kg dry matter)	913	226	120.4	32.11
Elphen (MJ/d)	254	115	136.4	21.65
Milk yield (kg/d)	933	231	24.9	6.23
Fat %	864	226	4.4	0.61
Protein %	864	226	3.4	0.30
Lactose %	864	226	4.7	0.18

Partial Least Squares (PLS) regression analysis

- To relate the milk MIR to the milk concentration of fat, protein and lactose as well as for energy intake
  - ➡ Energy intake: milk yield was also considered as a predictor trait
- One-at-a-time cross validation
- External validation (masking entire individuals)
- The number of fitted factors varied between 2 and 25
  - Optimised by the PLS model

Accuracies for milk yield and milk concentration

		One-at-a-time cross validation		External validation	
Trait	n	Fac	R	Fac	R
Fat %	873	23	0.94	19	0.93
Protein %	873	20	0.98	19	0.97
Lactose %	873	25	0.97	24	0.95
Milk yield	942	7	0.73	14	0.67

Accuracy for energy intake

		One-at-a-time cross validation		External validation	
Trait	**n**	**Fac**	**R**	**Fac**	**R**
NEL (milk + milk concent.)	863	2	0.50	2	0.47
NEL (spectra)	922	18	0.81	18	0.73
NEL (milk + spectra)	922	19	0.84	19	0.79
Elphen (milk + milk concent.)	227	2	0.75	2	0.73
Elphen (spectra)	254	9	0.73	9	0.65
Elphen (milk + spectra)	245	7	0.80	8	0.75

Conclusions

- The accuracy of predicting **energy intake using only MIR ~0.70**
- When **milk yield was also included** in the model **~0.77**
- Energy intake **predicted by milk yield and milk concentration** combined **~0.60**

- **Indicating that additional information in the MIR is being exploited in predicting energy intake**
- **In future: investigate the implementation of these predictions to predict GEBV for energy intake in NRF cattle**

Thank you for your attention!