ESTIMATING GENETIC PARAMETERS FOR PREDICTED ENERGY TRAITS FROM MID-INFRARED SPECTROSCOPY ON MILK

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S Smith[1], S Denholm[1], V Hicks[2], M Coffey[1], S McParland[3], E Wall[1]

[1] SRUC, EH9 3JG United Kingdom

[2] NMR, Fox Talbot House, Chippenham, SN15 1BN

[3] Teagasc, Moorepark, Co. Cork, Ireland

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The data

- 922 Holstein – Friesian dairy cows
- 2003 – 2014
- 5 lactations
- c.520,

Cows subject to long term 2 x 2 factorial exp.

	Genetic	
Diet	S HF	C HF
	S LF	C LF

Phenotypes recorded:

- ✓ Milk yield
- ✓ Fat %, protein %
- ✓ Live weight
- ✓ Body condition score
- ✓ Dry matter intake

Diet components :

- ✓ Organic matter digestibility (% DM)
- ✓ Metabolizable energy (MJ/kg DM)
- ✓ Crude protein (g/kg DM)
- ✓ Organic matter (g/kg DM)

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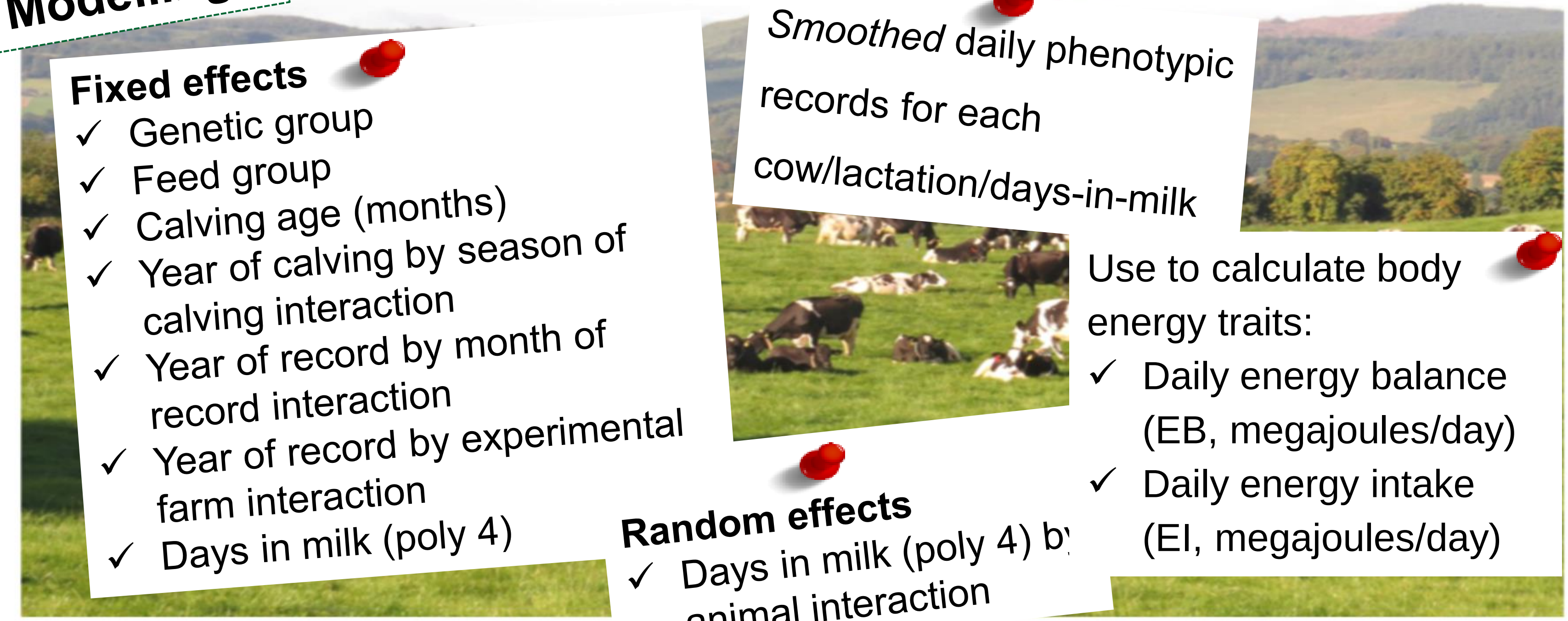
Modelling



Fixed effects

- ✓ Genetic group
- ✓ Feed group
- ✓ Calving age (months)
- ✓ Year of calving by season of calving interaction
- ✓ Year of record by month of record interaction
- ✓ Year of record by experimental farm interaction
- ✓ Days in milk (poly 4)

Smoothed daily phenotypic records for each cow/lactation/days-in-milk

Use to calculate body energy traits:

- ✓ Daily energy balance (EB, megajoules/day)
- ✓ Daily energy intake (EI, megajoules/day)

Random effects

- ✓ Days in milk (poly 4) by animal interaction

Equations:

$EB = EEI - (EEP + EEM + EEA)$

Where

EB is Energy Balance
EEI is Effective energy intake
EEP is Effective energy needed for milk production
EEM is Effective energy needed for maintenance
EEA is Effective energy needed for activity

$EC = 4.1868\ (9.4\ BL + 5.7\ BP)$

Where

EC is energy content
BL is Body lipid (kg)=(0.037683 BCS) EBW
BP is Body protein (kg)=(0.20086-0.006672 BCS) EBW
Note: BCS is expressed on a 1 to 9 scale , converted from a 0 to 5 scale)

$EEI = OMI \times EEC$

Where,
OMI = Organic matter intake per day (Omi, kg) = OM × DM = Organic matter × Dry matter intake
EEC = Effective energy content of feed/kg OM (MJ) = (See Banos & Coffey 2010 and Coffey et al 2001)

CEE =
Such that BL1 and BP1 are body lipid and body protein records on the first test day of lactation respectively and EE processed in the changes in BL and BP is defined as (Emmans, 1994)

- $EE_{(BL\_change)} = EE_{(BL\_change)} \times 56.0$ iff $BL\_change>0$
- $EE_{(BL\_change)} = EE_{(BL\_change)} \times 39.6$ iff $BL\_change<0$
- $EE_{(BP\_change)} = EE_{(BP\_change)} \times 50.0$ iff $BP\_change>0$
- $EE_{(BP\_change)} = EE_{(BP\_change)} \times 13.5$ iff $BP\_change>0$

1. Effective energy intake (MJ)

Calculated based on organic matter intake, digestible crude protein, metabolisable content.

Equations developed by Emmans (1994)

EI = Energy in — Energy used to digest

Feed

For example a score of 230 means that a cow has consumed 230 MJ of food, once it has been processed, at the time measured

Also work by Banos and Coffey (2010)

2. Energy balance (MJ/d)

Calculated based on milk yield, fat and protein content, dry matter intake, body weight, body condition score

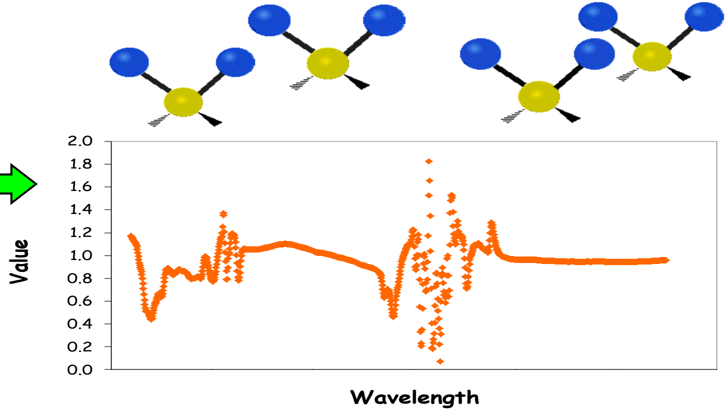
Equations developed by Emmans (1994)

EB = Energy in − Energy out

For example a score of 55 means that the cow is in positive energy balance by an excess of 55MJ, at the time measured

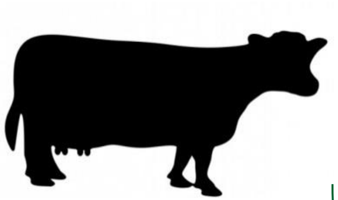
Also work by Banos and Coffey (2010)

Mid-infrared (MIR) technology

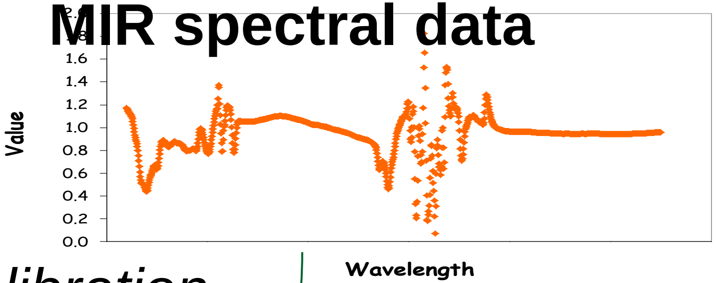


Calibration

Research animal measurements



MIR spectral data



Alignment & calibration

Statistical analysis

Other milk production data

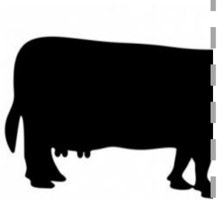
Predicted trait

Internal cross – validation

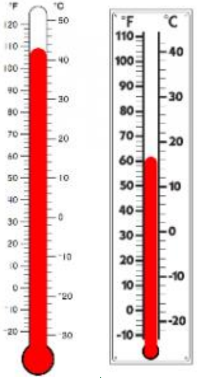
Initially developed by McParland et al. 2011

Calibration

Research an



Barometer: relationship between weight of air and weight of mercury



Sonar clicks and returning echoes

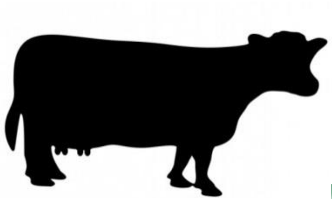
Thermometer: expansion/ contraction of mercury

ially developed McParland et al. 2011

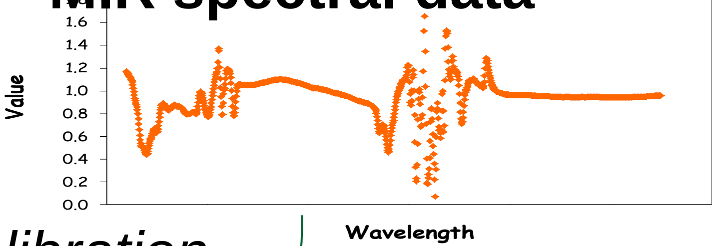
Internal cross – validation

Calibration

Research animal measurements



MIR spectral data



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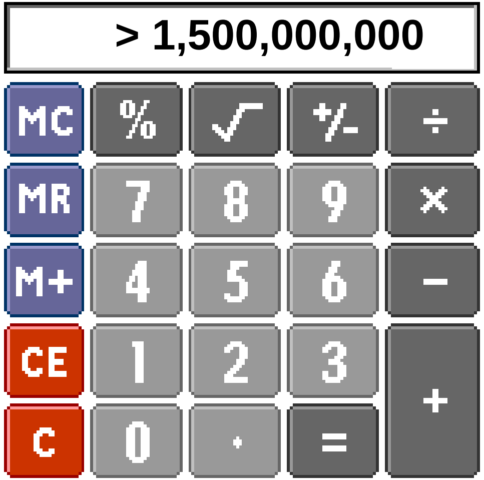
National spectral data

- Standardised spectral data
- Data from March 2013 – July 2015
- 361 herds
- > 135,000 animals
- Almost 1.5 million testdates



Materials & Methods

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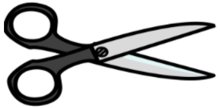
Edits:



Reference dataset

- Energy traits within +/- 3 standard deviations of mean retained in reference dataset
- Standardised spectra only used (according to collaboration with OptiMIR project.
- QA based on calculated Mahalanobis distance of spectral data

Predicted dataset

- At least 5 records per animal within lactation 1 to 3 (scaled)
- WIM in milk between 0 and 50
- Age 1st calving between 16 and 48 months
- At least 10 records per herd-year-season of calving and of record

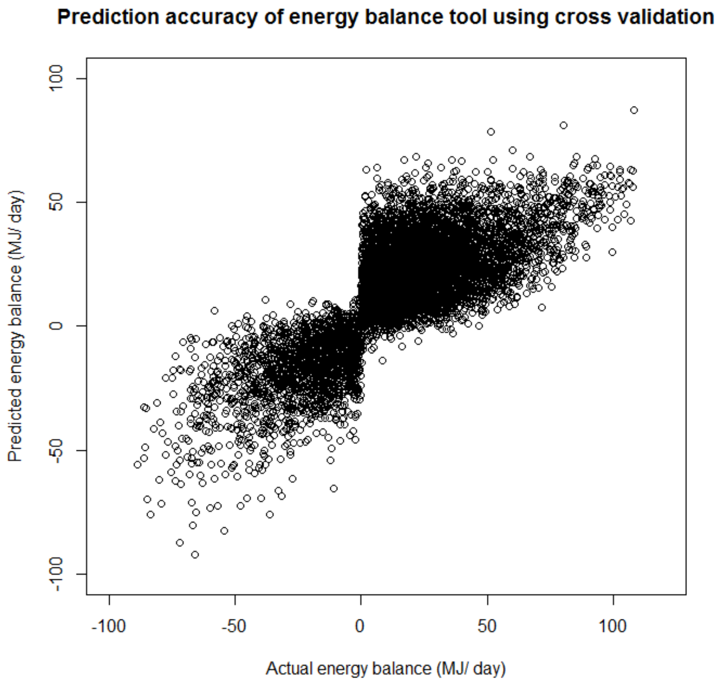
Prediction accuracy (R):

Energy balance, 0.77

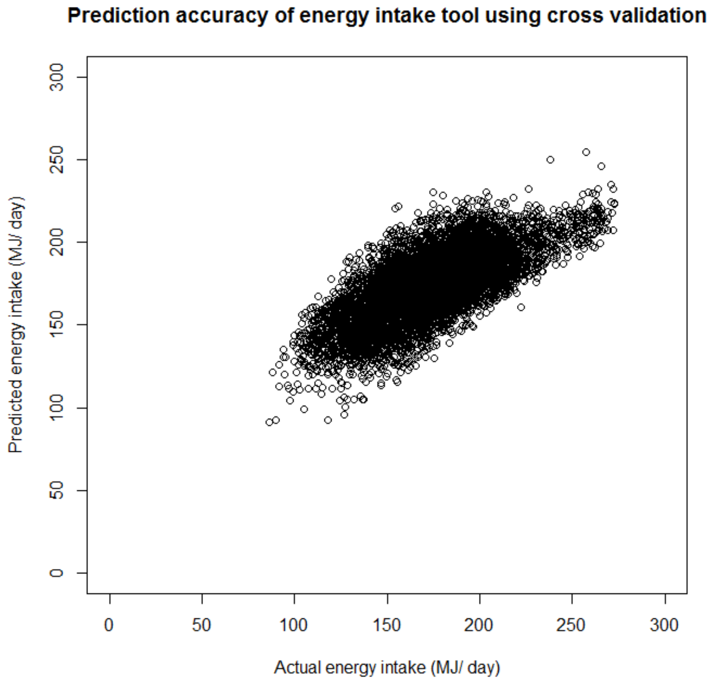
Energy intake, 0.69

R = the sqrt of the coefficient of determination

Materials & Methods



R = 0.78



R = 0.70

Materials and Methods

Univariate

$$y_{ijklmnop} = \mu + W_i + M_j + Y_k + L_m + H_o + a_p + e_{ijklmnop}$$

Response: Energy Trait (MJ/d) — $y_{ijklmnop}$

Fixed effects: WIM — W_i; Record month — M_j; Year record — Y_k; Lact No — L_m; Herd — H_o

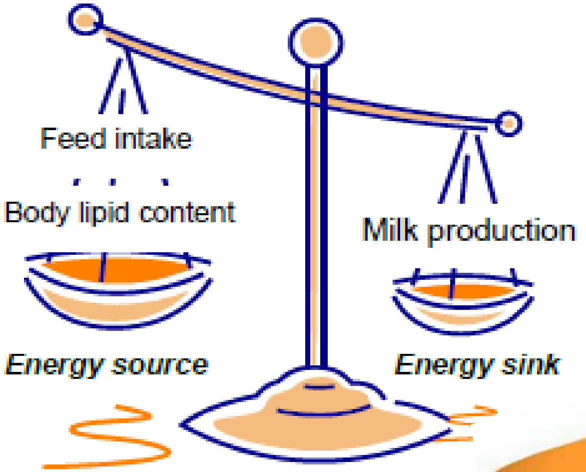
Random effects: Additive genetic effect — a_p

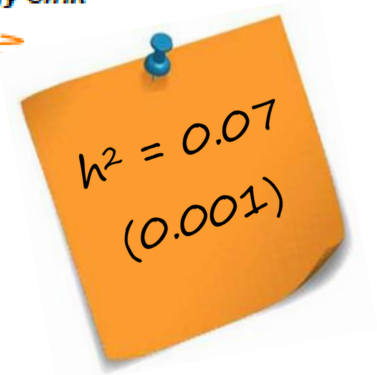
Residual variance: Error — $e_{ijklmnop}$

MIR-predicted energy traits

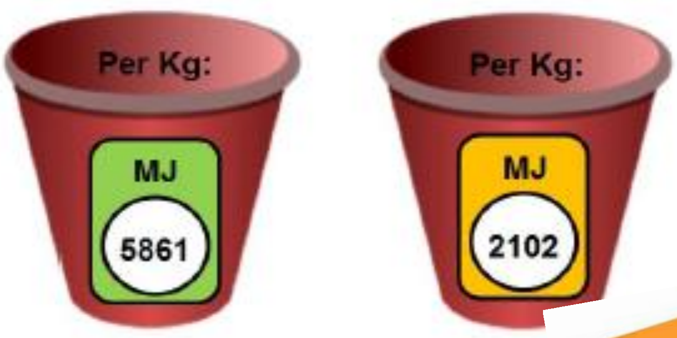
Genetic analysis: heritabilities

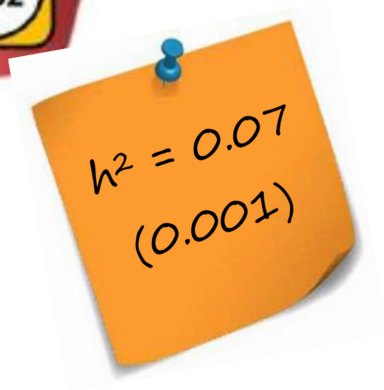
Energy 'balance'



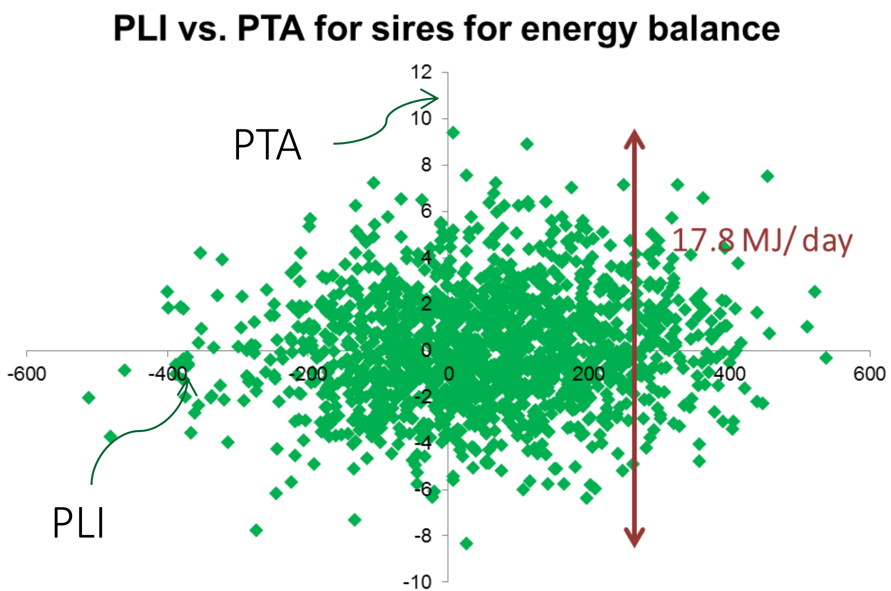


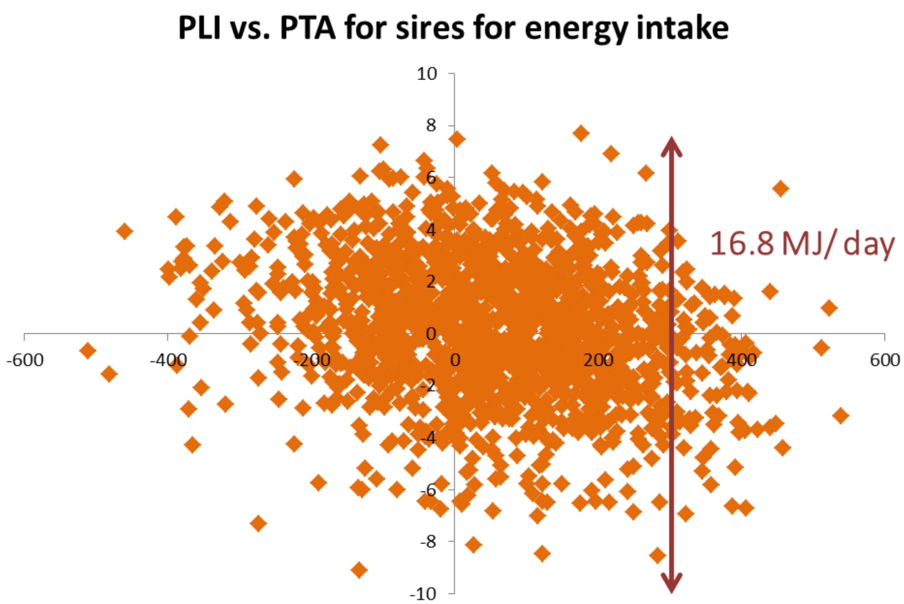
Energy intake





Predicted Transmitting Ability (PTA)





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