Predicting Energy Balance Status of Holstein Cows using Mid-Infrared Spectral Data

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Introduction

Energy balance (output-input) is a heritable indicator of health & fertility in dairy cows

Useful for multi-trait breeding programme

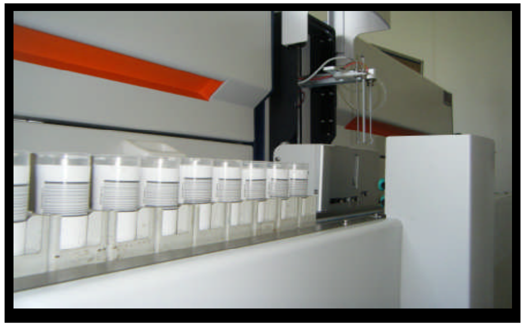
BUT

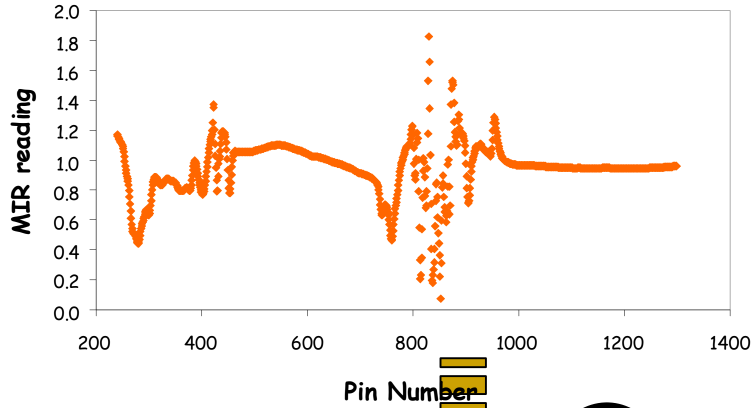
- Expensive to measure (correctly)
- Measurement not feasible on commercial herds
- Little data available

Methods to model energy balance exist

- Require expensive phenotypes
- Rely on phenotypes not always available

Fat to protein ratio





Potential errors

1

2

Milk fat content : Milk protein content

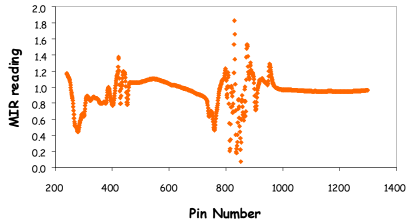
3

Predicted Energy Balance

Objective

•Predict energy balance directly from milk using MIR spectral data

•Can we improve the accuracy of prediction?



Predicted Energy Balance

Materials and Methods

1. Data Collection

- **Langhill experimental herd of Holstein cows** (SAC, Scotland)
  - Two genetically divergent lines
  - Two feeding systems
- **Routinely recorded phenotypic traits**
  - Milk, fat, protein, DMI, live weight & BCS
- **Random regressions fit to get daily solutions**
  - Models fit within parity
  - Data retained between 1990-2010

Materials and Methods

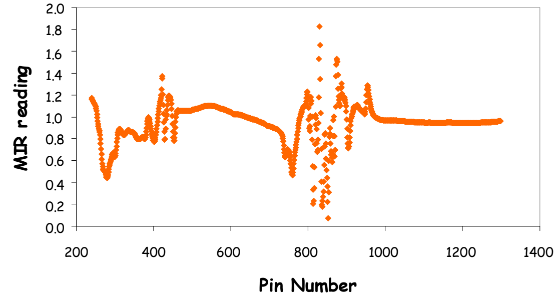
2. Calculation of energy balance

- Two separate measures *(Banos & Coffey, 2010)*
  - Direct_EB = inputs – outputs

    incl. milk production, DMI, weight, BCS & diet
  - Body energy content = predicted protein and lipid weights from BCS and LWT

3. Mid Infrared Spectral (MIR) data

- Monthly samples from all cows sent for MIR analysis
- September 2008 - May 2010



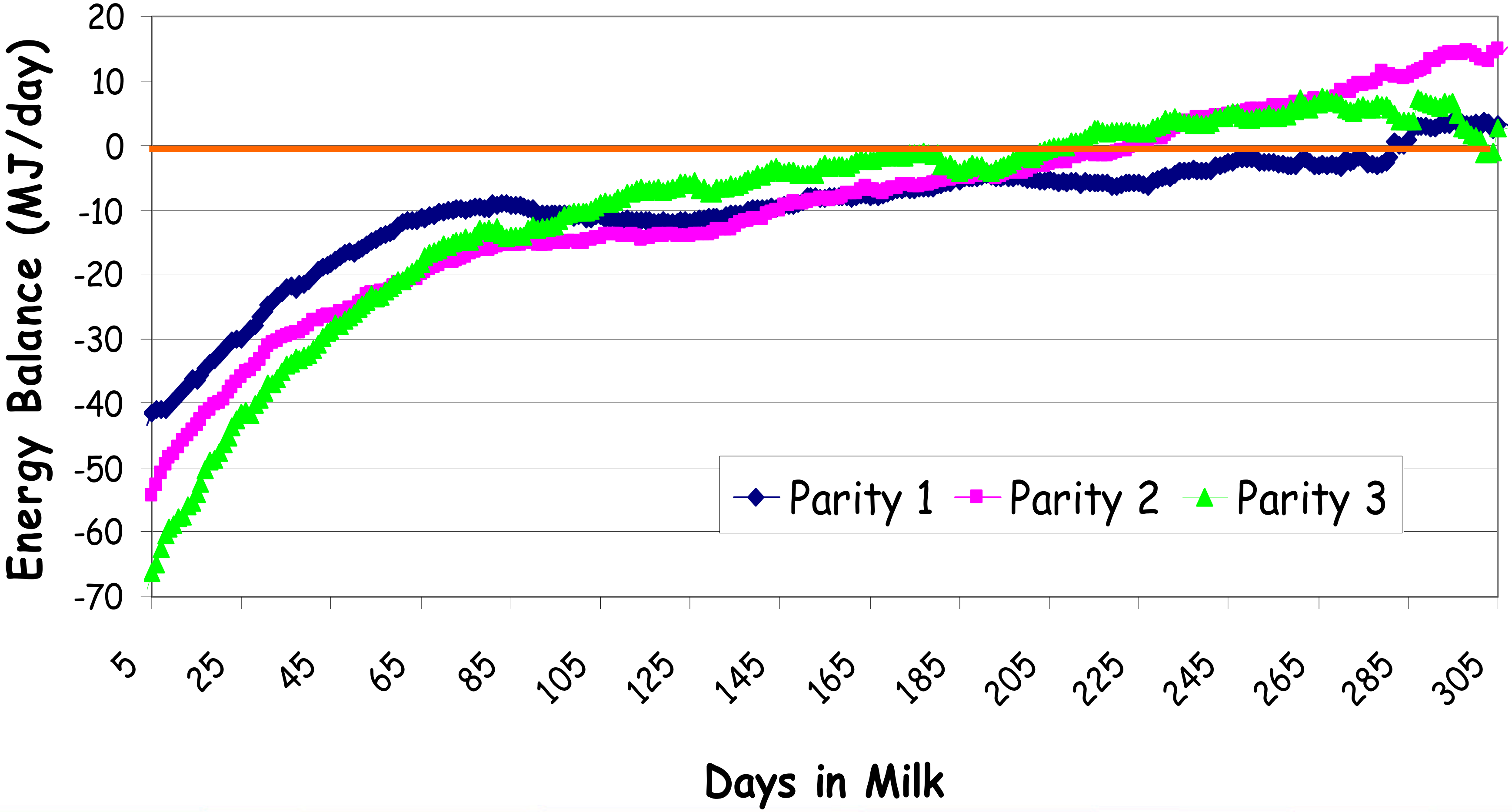
Materials and Methods

4. Prediction equations

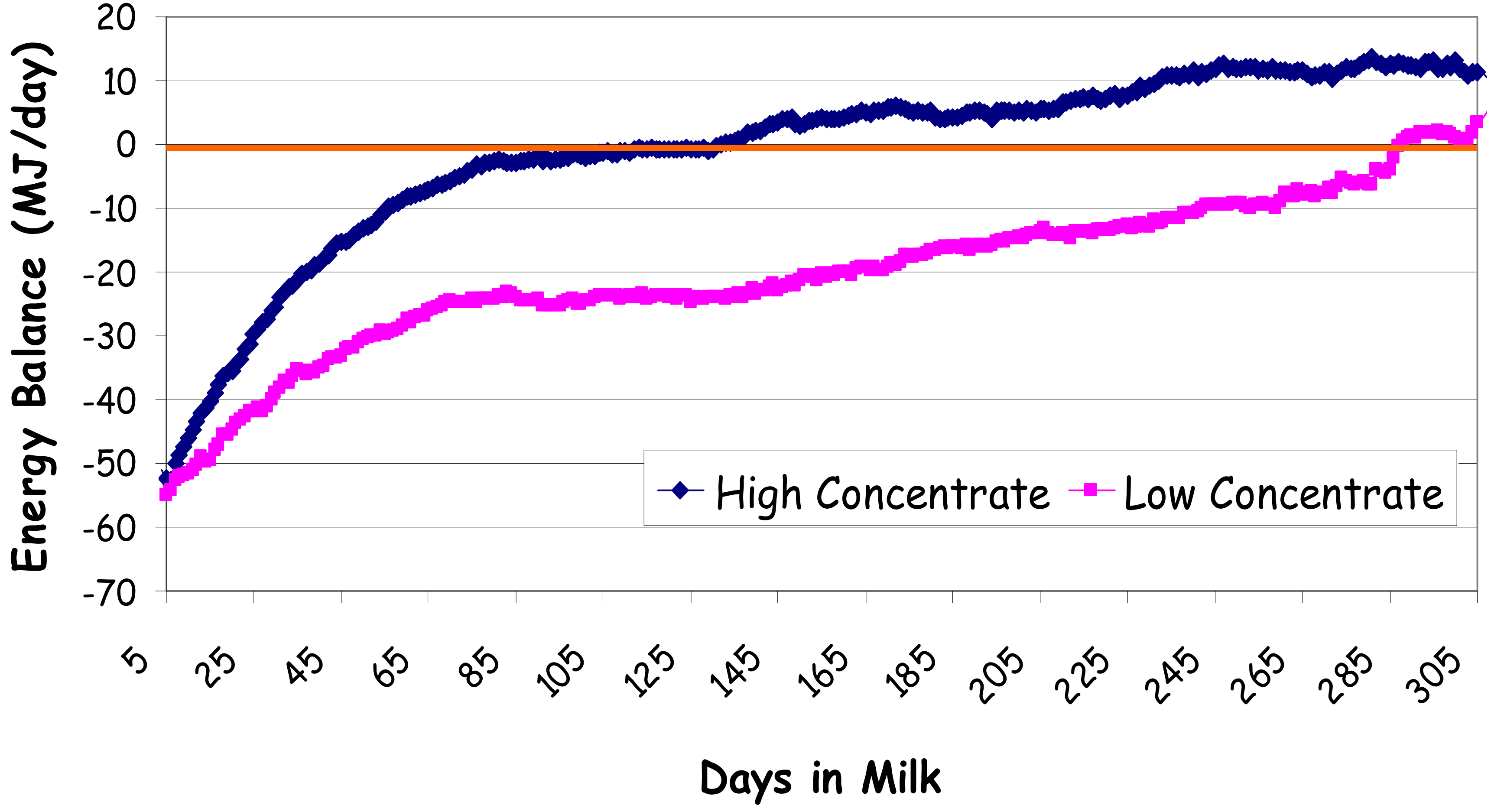
- Partial least squares analysis
- Two models – MIR only
  MIR + milk yield
- AM, MD & PM yields analysed separately
  - 1,883 AM, 1,731 MD and 1,855 PM records
- Cross validation method
- Also external validation
  - 25% of data set independently tested
- Best model - highest r for external validation

RESULTS

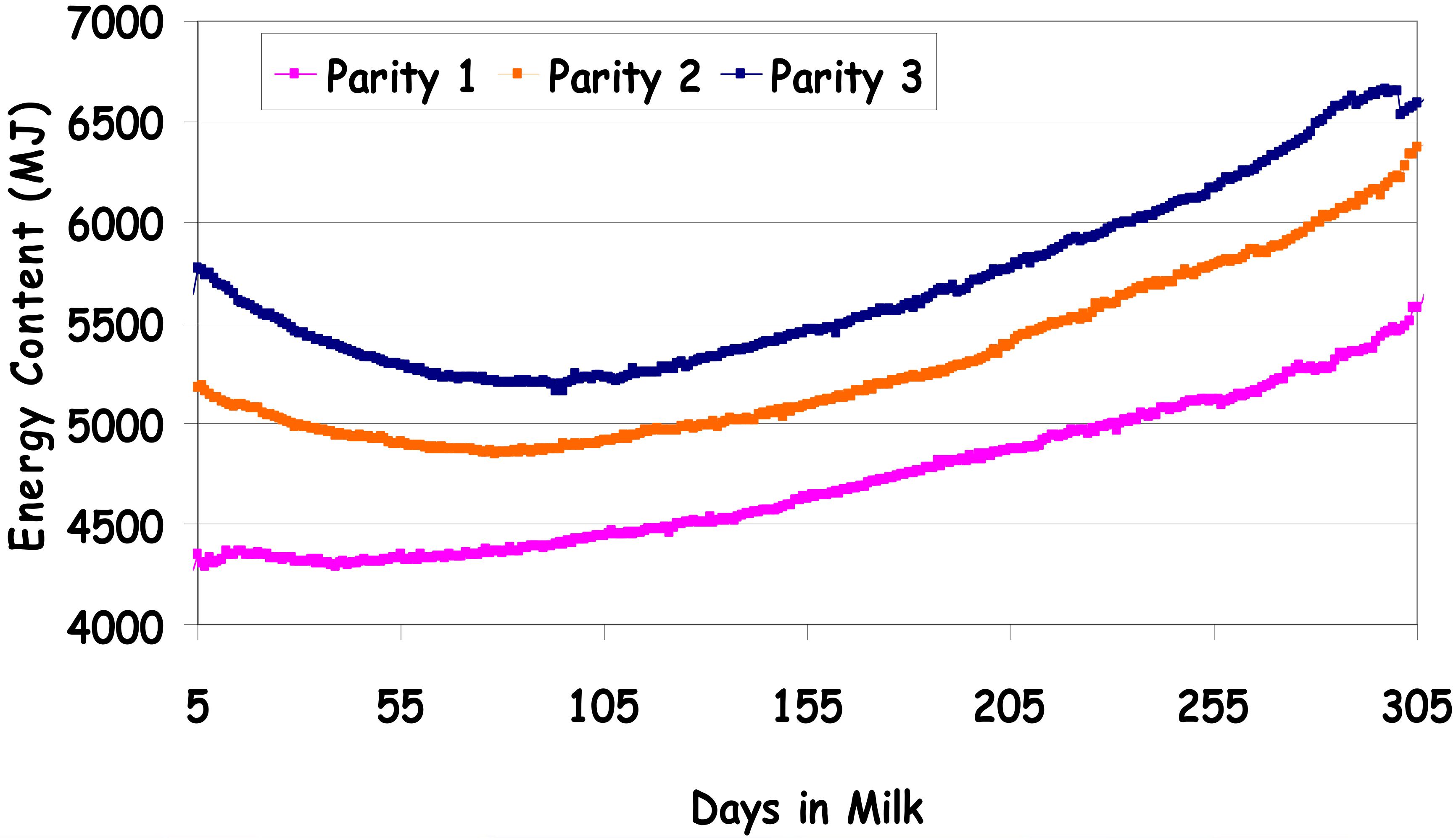
Energy Balance Lactation Curves



Energy Balance - Feed Group



Energy Content Lactation Curves



Cross Validation Results

Correlation

Fat to Protein Ratio & Direct_EB = **-0.28**

(early lactation)

	r
AM	
Direct_EB (MJ/d)	0.72
Energy Content (MJ)	0.56
MD	
Direct_EB (MJ/d)	0.71
Energy Content (MJ)	0.62
PM	
Direct_EB (MJ/d)	0.75
Energy Content (MJ)	0.63

External Validation Results

	External Validation		
	b (se)	RMSE	r
AM			
Direct_EB (MJ/d)	0.93(0.05)	22.18	0.68
Energy Content (MJ)	0.77(0.07)	876.44	0.43
MD			
Direct_EB (MJ/d)	0.94(0.05)	16.72	0.67
Energy Content (MJ)	0.80(0.06)	833.48	0.52
PM			
Direct_EB (MJ/d)	0.95(0.04)	20.32	0.72
Energy Content (MJ)	0.83(0.06)	822.56	0.54

Adding milk to the model

	MIR only		MIR + Milk
	r		r
AM			
Direct_EB (MJ/d)	0.68	<	0.70
Energy Content (MJ)	0.43	<	0.46
MD			
Direct_EB (MJ/d)	0.67	<	0.69
Energy Content (MJ)	0.52	<	0.54
PM			
Direct_EB (MJ/d)	0.72	<	0.75
Energy Content (MJ)	0.54	<	0.55

Conclusion

- Predicting energy balance directly from milk is more accurate than using fat:protein ratio
- Greater predictive ability when milk yield included in the model
- Maximum predictive ability for external validation 75%
  - Still a lot of unexplained variation
  - "Noisy" phenotype as measured here

Implications

- Involvement in another project OptiMIR (http://www.optimir.eu)
  - Roll these equations nationally via milk recording agencies
  - Provide an energy status prediction to farmers
- Bring this on a further step to predict fertility using mid-infrared spectrometry

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www.robustmilk.eu