Genetic Evaluations for Energy Balance A Real Possibility?

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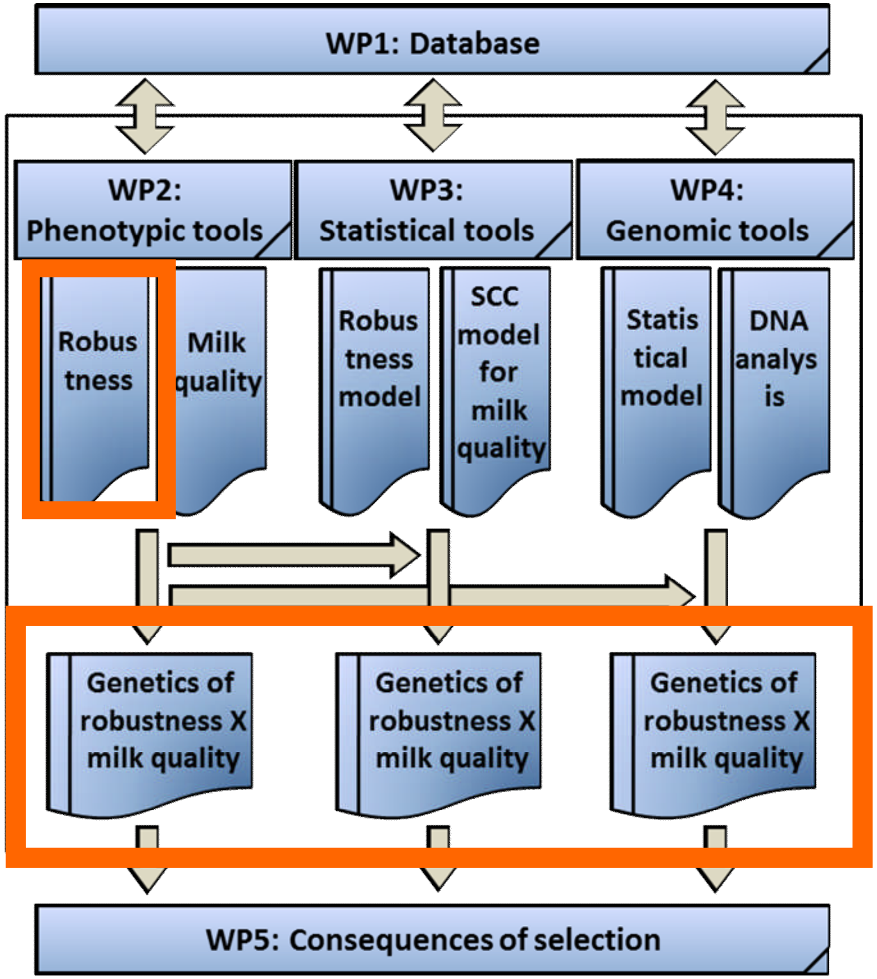
Develop innovative and practical breeding tools for improved dairy products from more robust dairy cows



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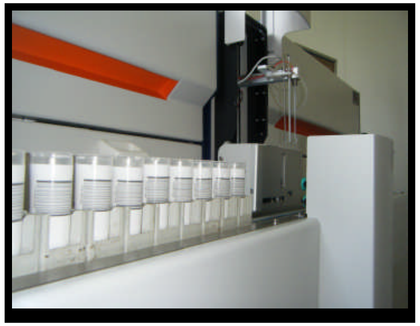
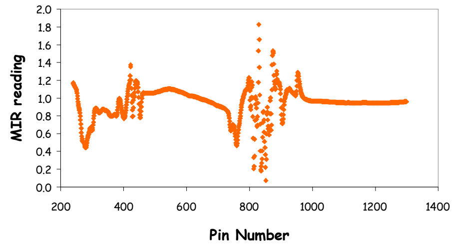
Introduction

- Energy balance (output-input) is an indicator of health & fertility in dairy cows
- Useful for multi-trait breeding programme
- BUT
  - Measurement not feasible on commercial herds
  - Little data available
- Milk mid-infrared spectrum accurate predictor of energy balance

Example of Energy Balance Prediction





Milk fat content

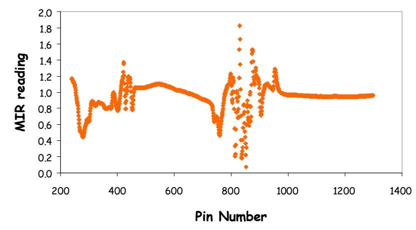
Milk protein content

Predicted Energy Balance

Objective

- Validate prediction equations on independent data

- Determine genetic parameters of predicted energy balance



Predicted Energy Balance

Materials and Methods

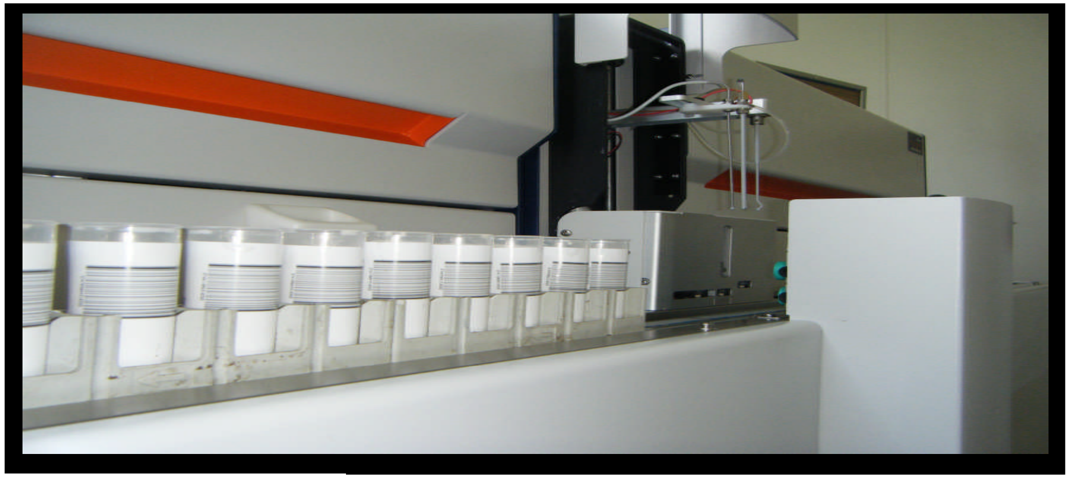
1. 2 Data Sets

- Langhill experimental herd (SAC, Scotland)
  - 2 genetically divergent lines * 2 feeding systems
- Teagasc Moorepark (Ireland)
  - Different strains of Holstein-Friesian
- Routinely recorded phenotypic traits
  - Milk, fat, protein, live weight, BCS & (DMI)
- Random regressions fit to data separately
  - Models fit within parity
  - Data retained between 1990-2011
- Energy balance (MJ/d) =inputs - outputs
  - Incl. milk, fat, protein, LWT, BCS, DMI

Materials and Methods

2. Mid Infrared Spectral (MIR) data

- MPK samples (AM & PM) analysed weekly
- SAC samples (AM, MD & PM) analysed monthly
  - June / September 2008 – January 2011
  - Light shone through each milk sample
  - 1,060 wavelength readings for each sample



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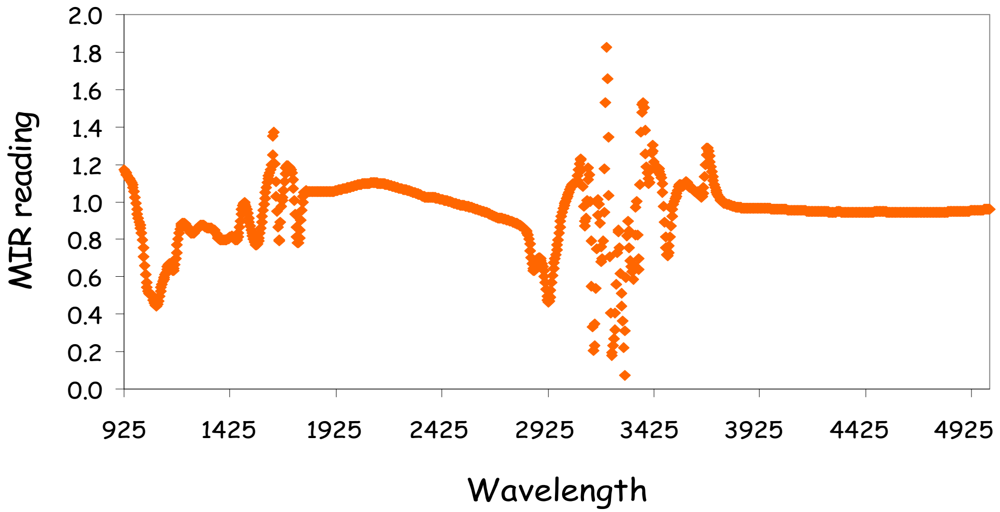

Materials and Methods

3. Prediction equations

- Partial least squares analysis (PROC PLS, SAS)
- Predictors – MIR spectrum + milk yield
- AM, PM & (MD) samples handled separately
- SAC samples (n ≤ 2,989)
- MPK samples (n ≤ 844)
- 3 sets of analyses
  - Calibration – develop equations
  - Validation - independent test of equations

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Calibration & Validation Data

Calibration		Validation	
1. Within Research data set			
SAC	→	SAC	(4 iterations)
MPK	→	MPK	(4 iterations)
2. Across Research data set			
SAC	→	MPK	
3. Pooled data sets			
SAC & MPK	→	SAC & MPK	

RESULTS

Within Research Data Set

Data Sets		Cross Val		External Validation		
Cal	Val	RMSE	R	Bias (se)	RMSE	R
SAC						
PM	PM	24	0.70	2.18(0.85)	25	0.65
AM	AM	24	0.70	1.57(0.90)	25	0.67
MD	MD	24	0.72	-2.35(0.90)	25	0.69
MPK						
PM	PM	19	0.74	3.63(1.70)	21	0.66
AM	AM	19	0.74	-1.99(1.23)	21	0.67

Across Research Data Set

Data Sets		Cross Val		External Validation		
Cal	Val	RMSE	R	b (se)	RMSE	R
SAC	MPK					
PM	PM	24	0.70	0.11(0.04)	28	0.09
AM	PM	25	0.69	0.08(0.03)	28	0.09
MD	PM	24	0.71	0.14(0.03)	28	0.15
PM	AM	24	0.70	-0.05(0.05)	28	0.03
AM	AM	25	0.69	0.00(0.04)	28	0.00
MD	AM	24	0.71	0.08(0.04)	28	0.07

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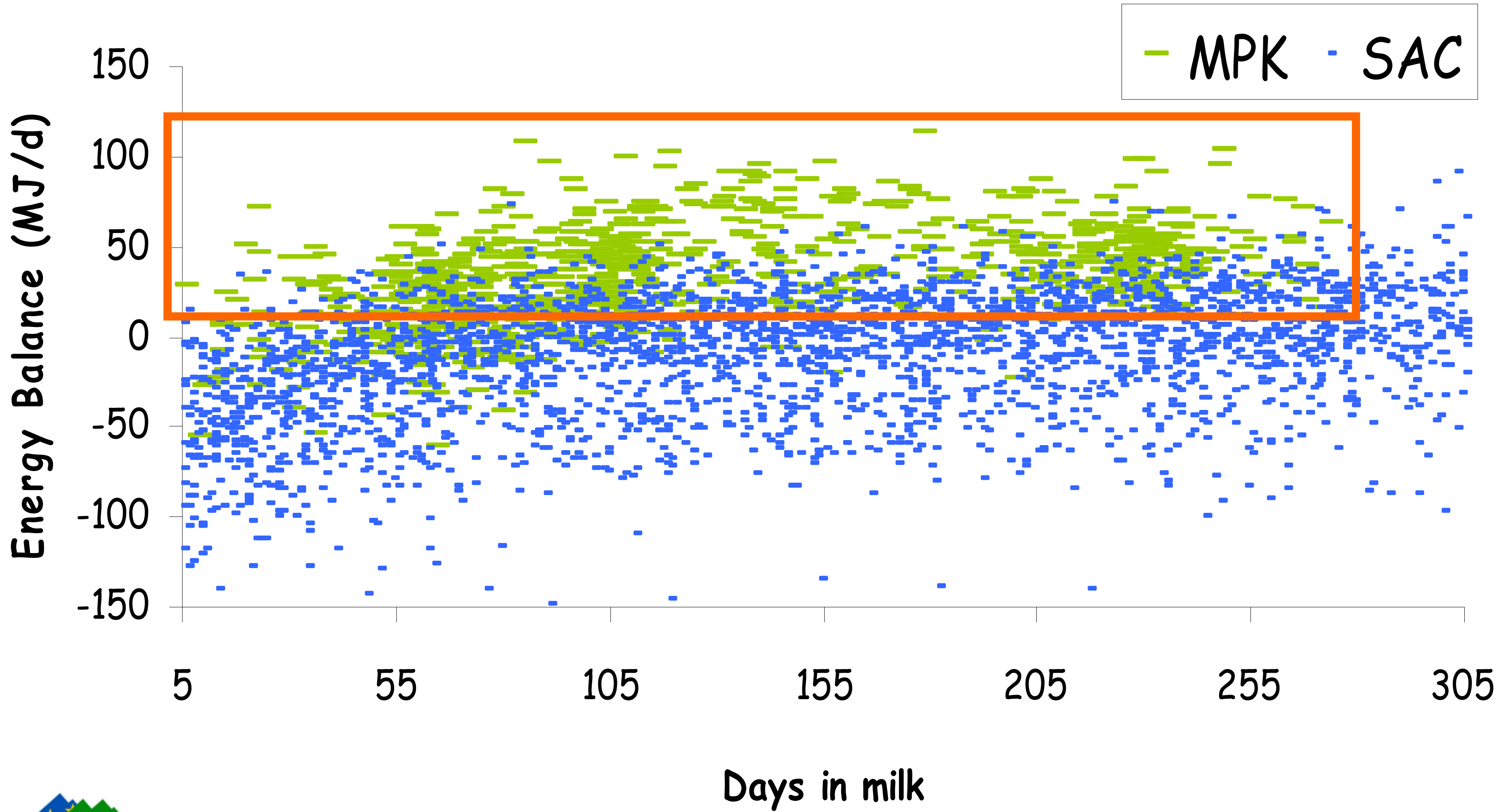
Energy Balance – SAC & MPK



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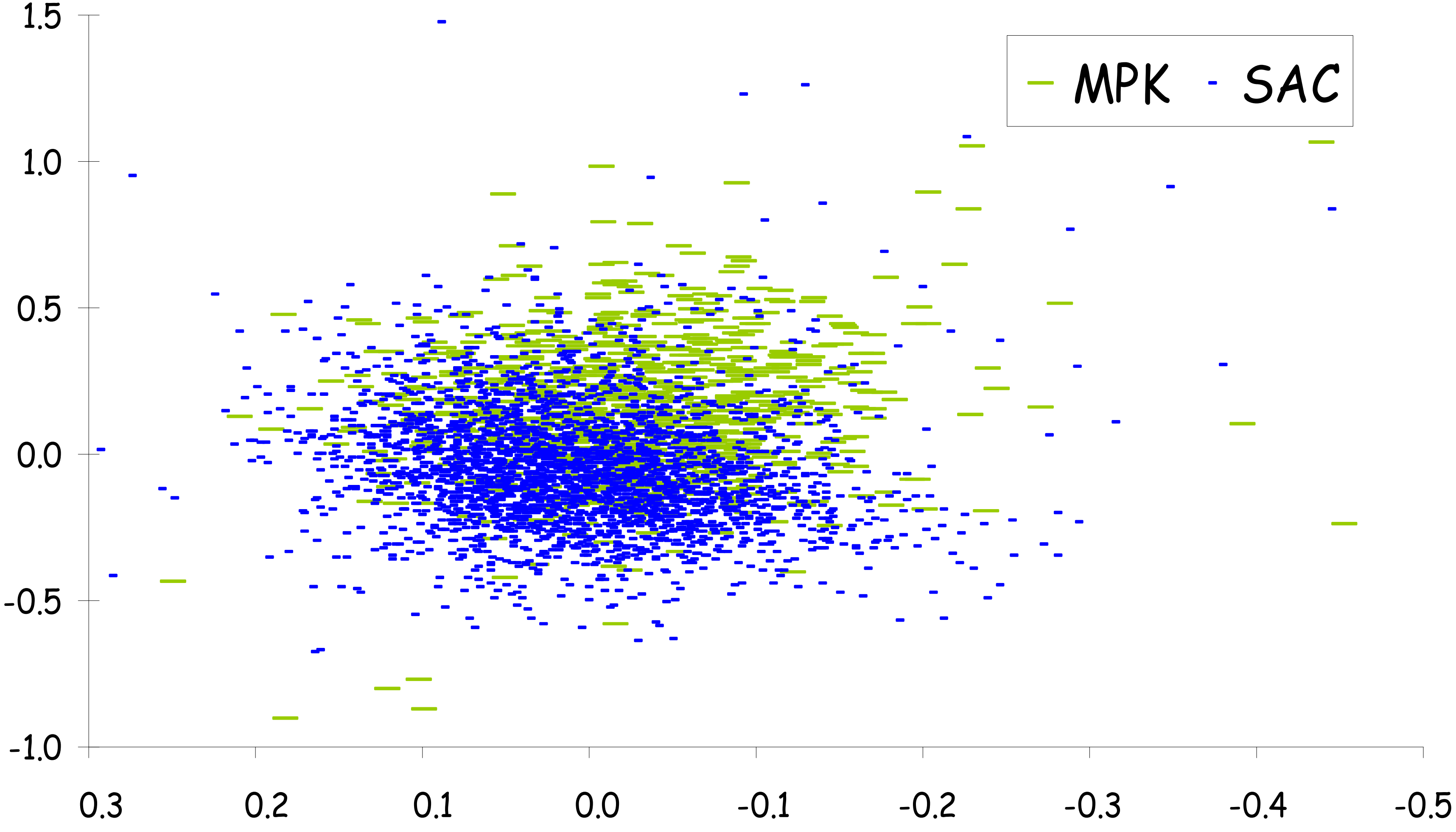
PCA of spectra - SAC & MPK



Pooled Research Data Sets

SAC (MD) and MPK (PM)

- Cross Validation
  - RMSE = 27 MJ
  - R = 0.69

- External Validation
  - Slope = 0.98 (0.03)
  - Bias = 1.12 (0.88)
  - R = 0.69

Genetic parameters

Heritability of energy balance

- True 0.07 (se =0.05)
- Predicted 0.28 (se =0.08)

Repeatability of energy balance

- True 0.29 (se =0.03)
- Predicted 0.43 (se =0.03)

Correlations - true and predicted energy balance

- Genetic = 0.05 (0.42)

Conclusion

- The mid-infrared spectrum is useful as a predictor of energy balance
- Not useful to predict energy balance across systems
- Pooled data across systems gives a robust equation

- Low heritability and low genetic correlation between true and predicted energy balance reported
  - Small data set

- MIR spectrometry is a useful method to routinely collect large volumes of data on energy balance

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