Genomic prediction for feed intake in UK Holstein dairy cattle

Bingjie Li[1], Raphael Mrode[1], Marco Winters[2], Mike Coffey[1]

[1]Scotland's Rural College (SRUC), Roslin Institute Building, Easter Bush, Midlothian, UK

[2]Agriculture and Horticulture Development Board (AHDB), Stoneleigh Park, Kenilworth, Warwickshire, UK

Outline

- Feed efficiency (FE) as a new trait
- Dairy feed intake data in UK
- Genomic prediction for dry matter intake (DMI) in Holstein dairy cattle
- Publication of dairy feed efficiency evaluations
- Summary

Feed efficiency (FE) as a new trait

- Feed cost is the largest part of operating costs in dairy production
- Global interest in including FE into dairy breeding goal
- Including FE into the UK dairy evaluation will result in additional profit and reduced environmental footprint of dairy industry

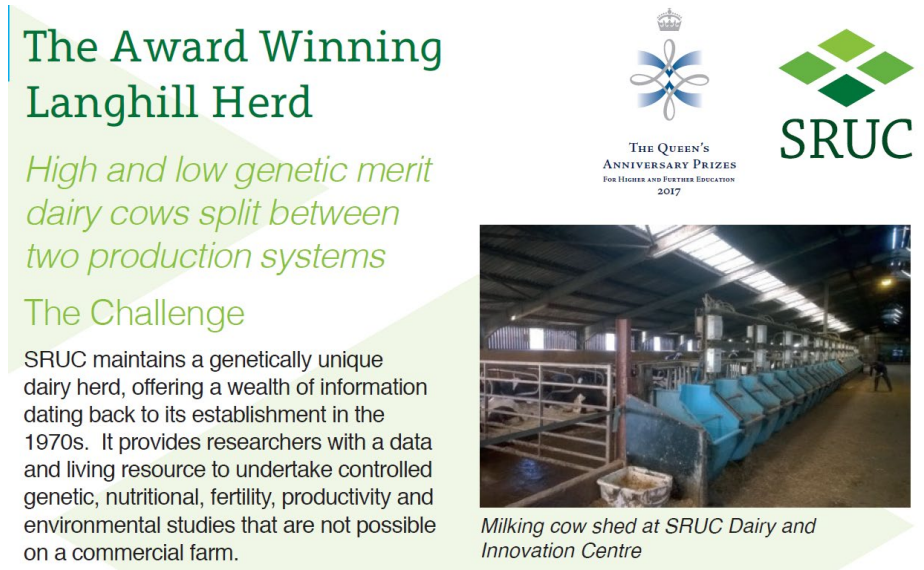


Feed intake data in UK

- Dry matter intake (DMI) have been recorded for individual cows in Langhill research herd over 30 years

- DMI records for 4,328 lactations of 1,763 Holstein cows (Lactation 1-4)
  - A total of 155,026 daily DMI records averaged on a weekly basis

- 80k imputed genotypes available
  - 1,213 genotyped and phenotyped animals
  - 396 genotyped sires/grandsires in pedigree



Milking cow shed at SRUC Dairy and Innovation Centre

Genomic prediction for dry matter intake

- Single-step GBLUP method

- Animal repeatability model

$$DMI = Parity + Lact\_month[Parity] + Age\_calv + Feeding\_grp + YM\_Rec + a + pe + e$$

- Phenotype: Daily DMI (kg/d) averaged by month (in period of ~305 DIM)
- a for additive genetic effect
- pe for permanent environmental effect
- Heterogeneous residual variances by 4 stages over lactation

Estimation of prediction reliability

- Theoretical reliability of GEBV for each individual was calculated by inverting the coefficient matrix of the MME

  - $REL_i = 1 - (PEV_i/G_i)$

- Validation

- Cows were divided into training and testing dataset in 3 scenarios
- Corrected phenotype (yc) was used, and prediction accuracy = cor(GEBV, yc) in the testing dataset

Scenarios	Training dataset	Testing dataset
Old to predict young	Cows born before 2015	Cows born >= 2015
Prediction between two genetic lines[1]	Cows in selection or control line	Cows in the other genetic line
Prediction between two feeding groups[1]	Cows in one feeding group	Cows in the other feeding group

[1]Cows in Langhill research herd are under 2 genetic lines (selection and control line) and 2 feeding groups for over 30 years

Genetic parameters for dry matter intake

- Genetic correlations (DMI_1 and DMI_2+) > 0.9
- Genetic parameters estimated from pedigree and genomics agree with each other taking account of standard errors

	DMI_1	**DMI_2+**
DMI_1	0.16 (0.03)	0.94 (0.05)
DMI_2+		0.19 (0.03)

Table. Genetic parameters for DMI in first lactation (DMI_1) and in other lactations (DMI_2+) from pedigree analyses.

Prediction accuracy from validation

Scenarios	Accuracy = cor(GEBV, y_c)	Bias
Old to predict young	0.62	0.94
Prediction between genetic lines	0.34	1.04
Prediction between two feeding groups	0.68	1.09

- y_c = corrected phenotypes (i.e., DMI correcting for fixed effects and pe effect)
- Bias was estimated as the regression coefficient of y_c on GEBV to approximate regression of TBV on GEBV

GEBV reliability by animal groups

Animal group	Mean GEBV Reliability[1] (%)
1,763 phenotyped animals	37
396 genotyped bulls (sires, grandsires and so on) in 5-gen pedigree	22
Top 10 genotyped sires with most phenotyped daughters[2]	60
1,689 currently active bulls in UK	9

[1]Theoretical reliability of GEBV was calculated by inverting the coefficient matrix of MME, REL = 1- (PEV/G)
[2]The top 10 genotyped sires have >= 20 phenotyped daughters

Publication of feed efficiency evaluations

- GEBV of "**Wasted feed (WF)**" as a basis (Meyer et al., 2017, Interbull Bulletin)

WF = DMI - MilkEnergy * k_DMI_MilkEnergy – Maintenance * k_DMI_LW

- DMI, MilkEnergy, Maintenance are on GEBV level for DMI, milk energy, and live weight
- k_DMI_MilkEnergy and k_DMI_LW reflect correlations between DMI and MilkEnergy/LW

- **Publication of GEBV for feed efficiency**

- Based on WF, and possibly reverse for positive value
- Using predictor traits (e.g., milk, LW) to improve GEBV prediction for DMI
- Similar way as "FeedSaved" is also an alternative

Summary

- Feed intake data has been recorded in UK research herd for over 30 years and will continue being recorded
- It's feasible to include feed intake as the basis of improving FE in the UK national dairy index
- Incorporating predictor traits (e.g., milk, LW) has potential to improve prediction for DMI
- Feed intake data from daughters of active bulls and from more herds or international collaboration will further improve prediction reliability

Thank you ☺