Genetic parameters for daily milk weights in U.S. Holsteins using pen-based contemporary groups

F.L. Guinan, R.H. Fourdraine, F. Peñagaricano & K.A. Weigel

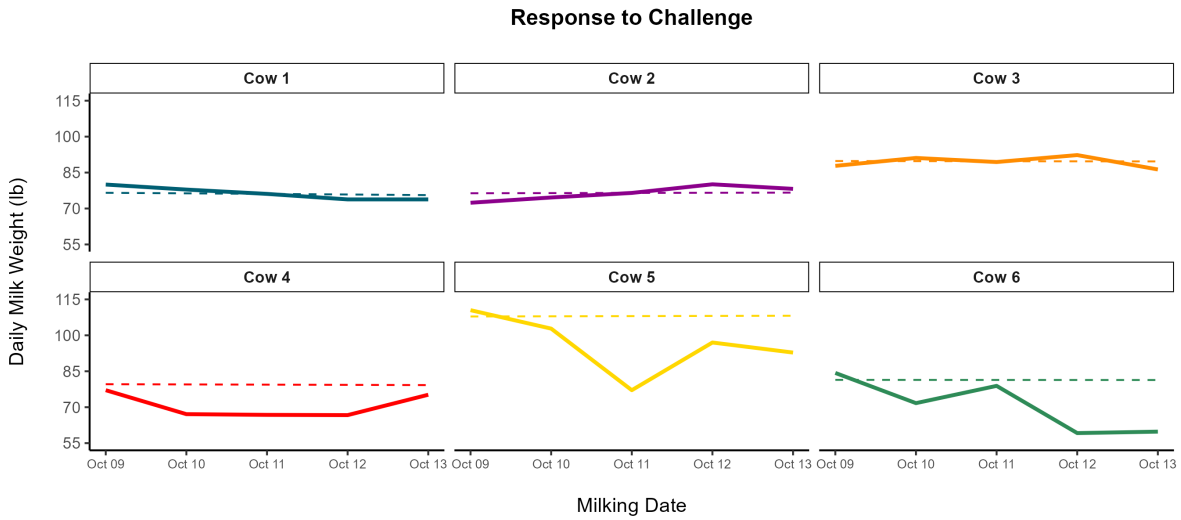
Interbull Annual Meeting 2024
Bled, Slovenia
May 20th, 2024

Inspiration

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

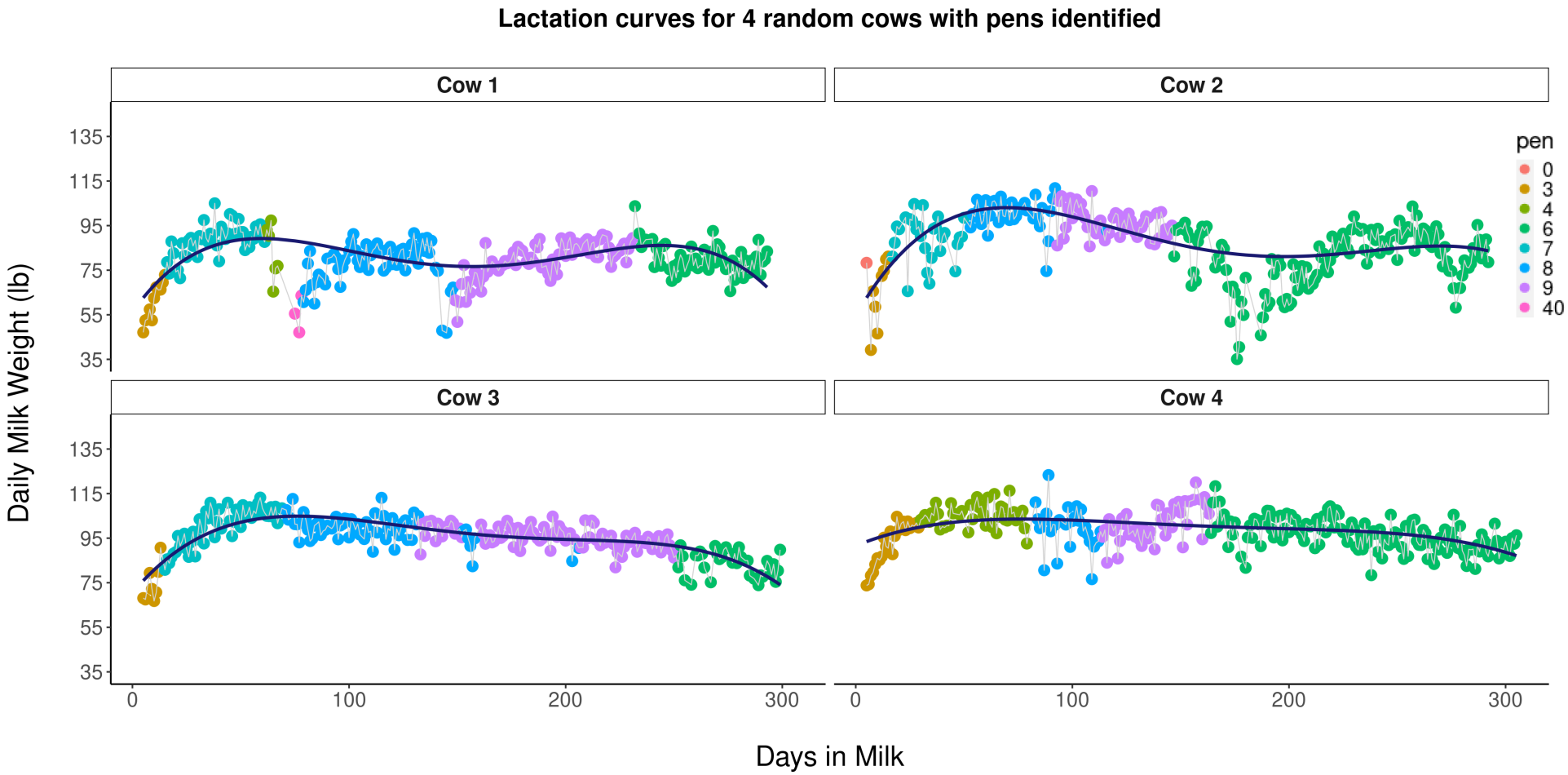
Calculating resilience indicators in US Holstein cows using pen-level data

- How do cows respond to perturbations at the pen level?
- Capturing the "true" environment the cow is experiencing along with contemporaries in pen



What about using pen level data to model contemporary groups for daily milk weights?

Background



Cows are grouped into pens according to parity, lactation stage, reproductive status
→ Management is at the group/pen level

How do we incorporate this into genetic evaluation methodology?

Objective

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

Modeling contemporary groups to estimate genetic parameters for milk

Current Method

Phenotype
305-d Projected milk production

Contemporary Group
Herd-year-season

Each cow has 1 contemporary group

Proposed Method

Phenotype
Daily Milk Weights

Contemporary Group
Herd-pen-milking date

Each cow could have **up to 305** contemporary groups if she changed pen every day of the lactation

Final Dataset

- Lactation 1
- At least 100 obs in lactation period
- At least 25 unique cows per herd-year-season (hys)
- At least 25 unique cows per herd-pen-milking_date (hpm)
- 305D Milk > 0
- Daily Milk Weight > 0
- GIBBSF90+
  - 50,000 rounds
  - 10,000 burn in

Herds (n)	157
Cows (n)	114,243
Obs (n)	21,000,951
Hys (levels)	1,492
Hpm (levels)	285,592

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

Model 1

$$305\text{-d Milk (kg)} = \text{AFC} + \mathbf{HYS} + \text{cow} + \text{e}$$

HYS	Herds (n)	Cows (n)	HYS (levels)	σ^2_{hys}	σ^2_g	σ^2_e	Heritability
Fixed	157	114,243	1,492	__	837,300 (27,385)	1,442,700 (20,438)	0.367 (0.011)
Random	157	114,243	1,492	878,960 (33,617)	842,500 (25,093)	1,439,200 (19,145)	0.267 (0.008)

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

Model 2

Daily Milk Weight (kg) = AFC + **DIM** + **HYS** + cow + pe + e

HYS	Herds (n)	Cows (n)	Obs (n)	HYS (levels)	σ^2_{hys}	σ^2_g	σ^2_{pe}	σ^2_e	Heritability	Repeatability
Fixed	157	114,243	21,000,951	1,492	__	10.756 (0.491)	15.083 (0.352)	14.597 (0.005)	0.266 (0.011)	0.64 (0.002)
Random	157	114,243	21,000,951	1,492	10.340 (0.397)	10.854 (0.469)	15.009 (0.329)	14.598 (0.005)	0.214 (0.009)	0.509 (0.004)

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

Model 3

Daily Milk Weight (kg) = AFC + DIM + **HPM** + cow + pe + e

HPM	Herds (n)	Cows (n)	Obs (n)	HPM (levels)	σ^2_{hpm}	σ^2_g	σ^2_{pe}	σ^2_e	Heritability	Repeatability
Fixed	157	114,243	21,000,951	285,592	—	11.958 (0.398)	16.937 (0.297)	11.814 (0.005)	0.294 (0.009)	0.710 (0.001)
Random	157	114,243	21,000,951	285,592	4.905 (0.016)	24.123 (0.661)	10.646 (0.444)	11.859 (0.004)	0.468 (0.011)	0.675 (0.002)

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

Model 4

Daily Milk Weight (kg) = AFC + DIM + **HYS** +**HPM** + cow + pe + e

Herds (n)	Cows (n)	Obs (n)	HPM (levels)	HYS (levels)	σ^2_{hpm}	σ^2_{g}	σ^2_{pe}	σ^2_{e}	Heritability	Repeatability
157	114,243	21,000,951	285,592	1,492	4.955 (0.016)	10.477 (0.603)	14.231 (0.428)	11.852 (0.005)	0.252 (0.013)	0.596 (0.002)

All Models Results

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

	h^2 of 305-d yield		h^2 of daily milk yield				
	Model 1 Fixed	**Model 1 Random**	**Model 2 Fixed**	**Model 2 Random**	**Model 3 Fixed**	**Model 3 Random**	**Model 4 (Fixed & Random)**
σ^2_{cg}		878,960		10.340		4.905	4.955
σ^2_{g}	837,300	842,500	10.756	10.854	11.958	24.123	10.477
σ^2_{pe}			15.083	15.009	16.937	10.646	14.231
σ^2_{e}	1,442,700	1,493,200	14.597	14.598	11.814	11.859	11.852
h^2	0.367	0.262	0.266	0.214	0.294	0.468	0.252
h^{2*}	0.367	0.361	0.266	0.268	0.294	0.517	0.287

h^{2*} represents heritability calculated where cg is random without σ^2_{cg} in the denominator

Reliabilities from all 4 models

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

	Model	Mean Sire PTA Reliability (Random)	Mean Sire PTA Reliability (Fixed)
1	305d Milk Yield Herd-Year-Season	0.79	0.79
2	Daily Milk Weight Herd-Year-Season	0.81	0.81
3	Daily Milk Weight Herd-Pen-Milking Date	0.89	0.81
4	Daily Milk Weight Herd-Year-Season Herd-Pen-Milking Date	0.81	

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

Take home messages

- Utilizing high frequency data may require new definitions for contemporary groups
- We can increase sire PTA reliabilities utilizing daily milk weights
- Are there other modeling techniques to account for the high correlations among residuals with high frequency datasets?

Thank you!

fguinan@wisc.edu