Implementation of Feed Saved evaluations in the U.S.

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Background

- Improving feed efficiency can impact numerous aspects of dairy production
  - Feed is the largest single expense in dairy production
  - More efficient animals may produce less manure and GHG
  - Reduced feed requirements will also decrease land utilization for crops
- Requires feed intake measured on individual animals
  - In dairy animals, also need to avoid negative impacts on production, fertility, and health

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Initial project

United States Department of Agriculture
National Institute of Food and Agriculture

- NIFA grant – 2010 to 2017
  - *"Genomic Selection and Herd Management for Improved Feed Efficiency of the Dairy Industry"*
- Initiated U.S. feed efficiency database
- Demonstrated that feed efficiency, as measured by **RFI**, is a heritable trait that can be improved through genetic selection
- Low reliabilities due to small reference population

- Cow data collected mid-lactation for at least 28 days; most at least 42 days
- More than 537k daily records of intake and yield
- More than 110k component measurements collected regularly
- Body weight, BCS, health events, diet composition

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FFAR & CDCB project

- Beginning 2019
- Goal to collect feed efficiency phenotypes for 3,600 additional cows
- Collaborating institutions:
  - Michigan State University, Iowa State University, University of Wisconsin, University of Florida, Animal Genomics & Improvement Lab (ARS, USDA)


FFAR Awards MSU Grant to Decrease Feed Costs for Milk Production

May 21, 2019

Advanced Animal Systems

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Data Collected for FFAR project

- Official start **Spring 2019**
  - Cow data collected mid-lactation for at least 28 days; most at least 42 days
  - More than **235k** daily records compiled – dry matter intake, milk yield
  - More than **46k** component measurements collected routinely (fat percent, protein percent, lactose percent, SCC, etc.)
  - More than **63k** body weight measurements
  - BCS, health events collected
  - Diet composition measured regularly

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Data Processing

- Daily data compiled and edited, checks for outliers and missing data by CDCB and contributing institution
- Residual feed intake (RFI) calculated following methodology developed throughout NIFA project
- RFI data combined/confirmed with associated data from CDCB Cooperator database (pedigree, birthdate, calving dates, parity, etc.)

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Calculating RFI

- Energy sink model following Tempelman et al., 2015

RFI

$$DMI = parity \times \sum_{k=0}^{5} DIM + b_1 MilkE + b_2 MBW + b_3 \Delta BW + ration(exp) + testwk + \varepsilon$$

Parity class by 5th order Legendre polynomial of DMI on DIM

Milk Energy

Metabolic body weight ($BW^{0.75}$)

Change in body weight

Random effect of experiment-specific ration

Random effect of test week

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Current RFI Phenotypes

Institution	NIFA 2010	CDCB/FFAR	TOTAL
Miner Agric. Res. Inst. (NY)	58		58
Virginia Tech	96		96
Purina Anim. Nutr. Ctr. (MO)	184		184
U.S. Dairy Forage Res. Ctr. (WI)	624		624
Univ. of Wisconsin	1,054	623	1,677
Michigan State Univ.	315	251	566
Iowa State Univ.	1,006	207	1,213
Animal Genomics & Imprv. Lab	834	370	1,204
Univ. of Florida	582	338	920
TOTAL	4,753	1,789	**6,542**

Beltsville, MD
USDA herd

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RFI evaluations

- RFI used as phenotype for genetic evaluation in **Holsteins**
- Follows typical pipelines as most other CDCB evaluations (2-step methodology)

- Traditional evaluation – animal repeatability model
  - Effects for age parity group, trial date, herd management group, permanent environment, herd-sire interaction
  - Regressions on genomic evaluations for milk net energy and body weight composite

- Genomic evaluation – uses deregressed evaluations from traditional evaluation in a model similar to BayesA to estimate SNP effects
  - Provides estimates for all genotyped Holsteins
  - Standard set of ~79k SNP used as with all other official CDCB evaluations

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Feed Saved – RFI and BWC

- Simple interpretation
- Captures both energy wasted due to biological inefficiency and energy wasted due to excessive body size
- REL higher than just RFI

Body Weight Composite (BWC)

Trait	Relative value (%)
Stature	23
Strength	72
Body depth	8
Dairy form	-47
Rump width	17

Values are weights (expressed as percentages) from composite formula calculated by Holstein Association USA (2017) and, therefore, do not sum to 100.

$$PTA_{FSAV} = -138 \times PTA_{BWC} - 1 \times PTA_{RFI} \text{ pounds/lactation}$$

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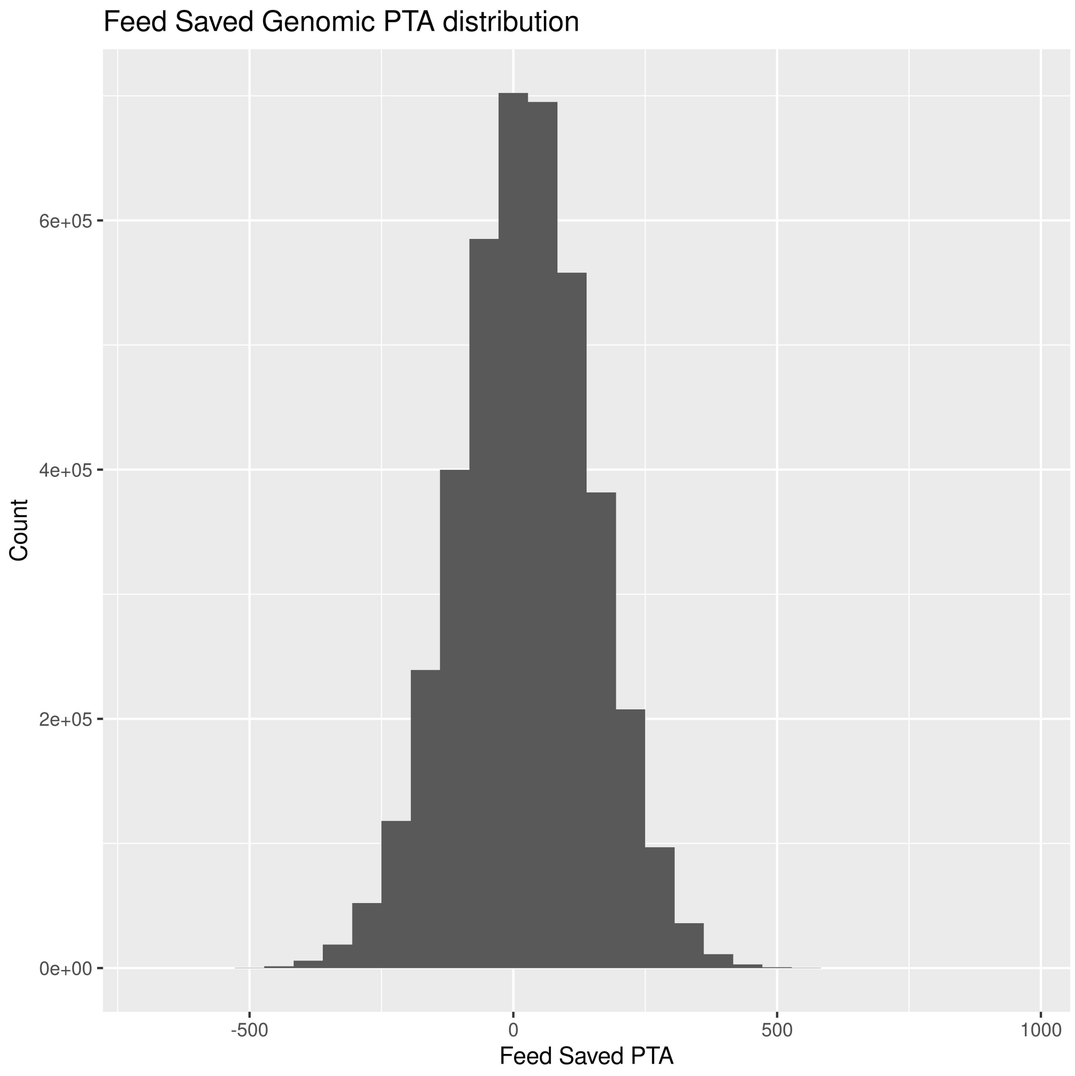
Inclusion of International data (CAN)

- RFI phenotype exchange between CDCB and Lactanet
  - For the purposes of genetic evaluation
  - CAN genotypes for these cows available at CDCB
- Data added for April 2021 evaluation
  - 660 RFI records from 568 cows from 3 Canadian herds
  - Genomic reliability gained 1 to 2 percentage points
- CDCB/ FFAR Feed Efficiency team are also participants in the Canadian Resilient Dairy Genome Project

Genomic Evaluations



	Mean	SD	Min	Max
Feed Saved PTA (lb/lactation)	21.4	128.0	-689	922
Feed Saved Reliability (%)	38.4	3.6	10	95

Economic Impact

- Inclusion of Feed Saved should improve US profitability by **$8 million per year**
- Feed Saved evaluations are currently available to the industry as a stand-alone trait
- Plans to incorporate the trait into an economic selection index in the near future

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Additional economic revisions

- Based on the same data collected for the Feed Saved evaluations, additional research has led to the following updates:
  - Estimated maintenance requirements have been found to be ~50% greater than those suggested by the NRC (2001) and greater than twice those previously used in NM$
    - Added maintenance cost applied to BWC in NM$ update
  - Feed costs required for milk, fat, and protein production will be adjusted
    - Feed required for milk will be reduced (0.225 lb. DMI reduced to 0.12 lb. DMI) in NM$ update
    - Reductions also in feed required for fat (5.42 lb. DMI reduced to 5.0 lb. DMI) and for protein (7.50 lb. DMI reduced to 6.0 lb. DMI)

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“Challenges & Benefits related to implementation”

- Challenges
  - Utilizing new data source from research farms
  - New stream of data requires careful quality control
  - Incorporation of data collected from numerous environments and different experimental designs
  - Limited data availability → low reliabilities
  - Identify consistent, representative sources of phenotypes

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“Challenges & Benefits related to implementation”

- Benefits
  - Provide producers and the dairy industry with a new tool to increase profitability
  - Provide a tool that can improve the dairy industry’s environmental impact
  - Encourage further data collection
  - Update previous estimates that only used theoretical values
  - Foster international collaboration in order to have meaningful impact on the global industry

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Acknowledgments

CDCB & AGIL colleagues

FFAR/ CDCB Feed Efficiency team

Data providers

Dairy producers

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Thank You!

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