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CANADIAN NETWORK FOR DAIRY EXCELLENCE

Development of Methane Efficiency Evaluations for Canadian Holsteins

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Lactanet's Genetic Toolbox

Feed Efficiency
April 2021

Body Maintenance Requirements
April 2023

Methane Efficiency
April 2023

Reduce Feed Costs

Reduce Methane Emissions

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Collected Methane

- Collected from the University of Guelph and University of Alberta under two international projects:

THE Efficient Dairy GENOME PROJECT

THE Resilient Dairy GENOME PROJECT

- Both herds used the GreenFeed system (C-Lock Inc., Rapid City, SD)
- Average CH4 production (g/d) was recorded multiple times per day for at least 5 consecutive days, mainly in first lactation cows
- End result: Weekly average of daily CH4 production

CH_4 Analysis at University of Guelph

A Pivotal Result

- Research led by Flavio Schenkel, Saeed Shadpour and Christine Baes
- Close involvement of Filippo Miglior, Lactanet's Senior Advisor for Genetic Strategic Initiatives
- **A cow's milk MIR data can be used as a good predictor of its methane production**

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Predicting methane emission in Canadian Holstein dairy cattle using milk mid-infrared reflectance spectroscopy and other commonly available predictors via artificial neural networks

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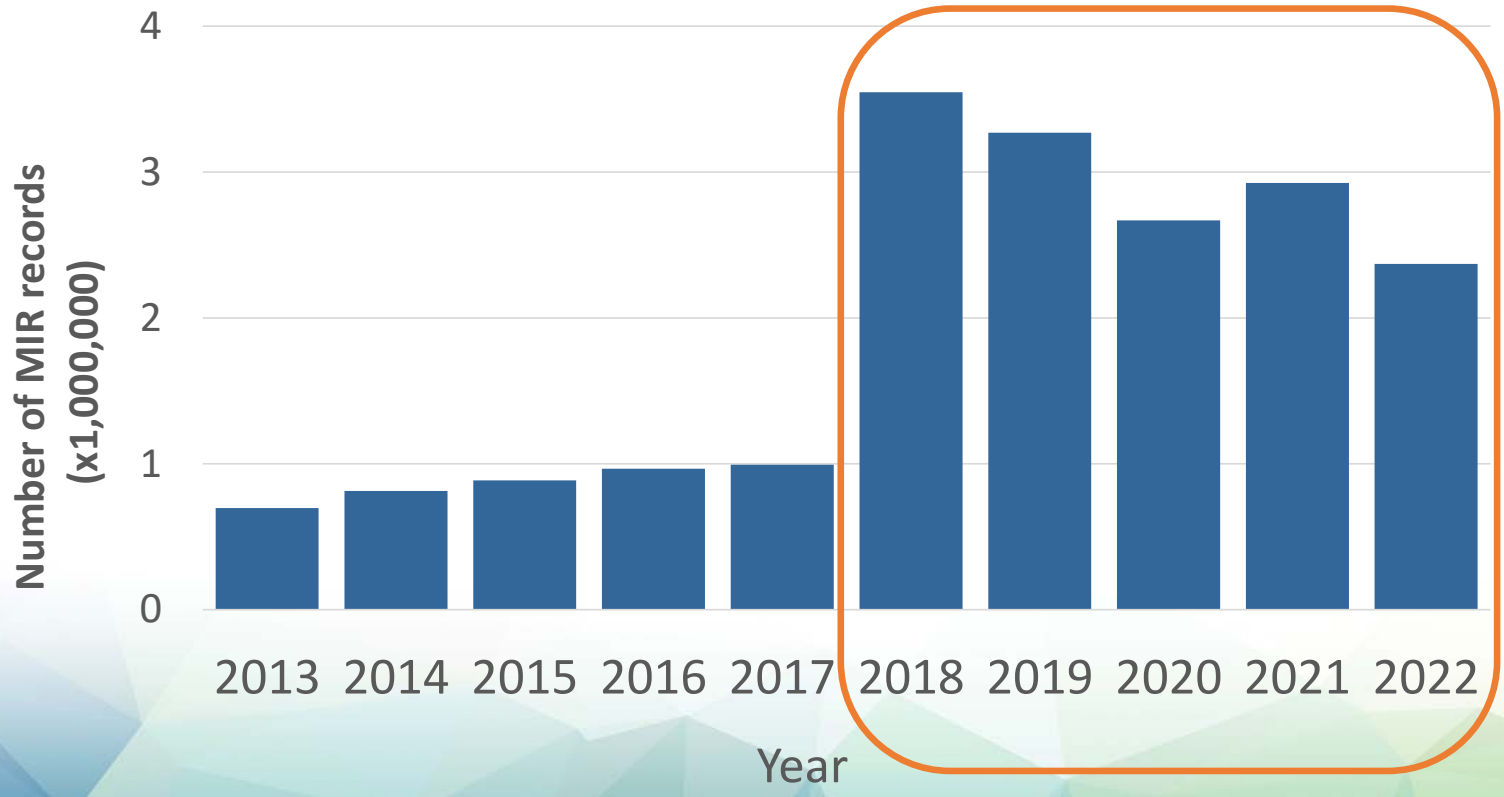
Milk MIR Investment by Lactanet

- Great potential and availability
- Milk MIR data on **90% of milk recorded cows** since 2018



≈13M records from 7,171 herds

≈1.6M cows

≈143,120 genotyped cows

MIR Data Processing

Individual milk samples processed by FOSS Milkoscan FTIR spectrophotometers

Predicting Methane

- MultiLayer Perceptron Artificial Neural Network based on Bayesian regularization model
- 241 MIR spectral datapoints used as input predictors (excluded uninformative and water associated regions)
- Input was weekly average of daily methane production from 496 first lactation cows in two herds

Prediction Accuracy = 0.70

Genetic Correlation = 0.92 (0.22)

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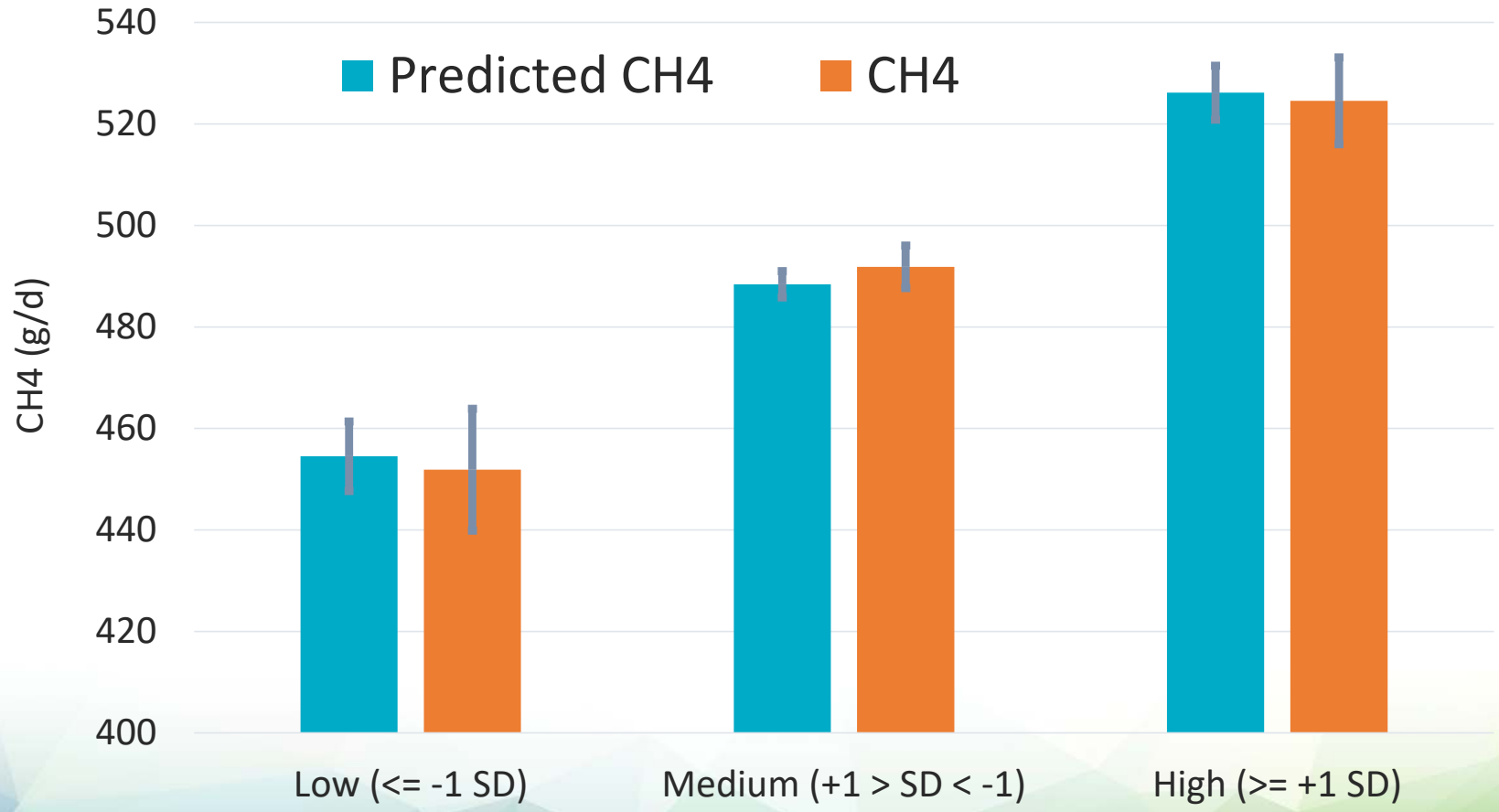
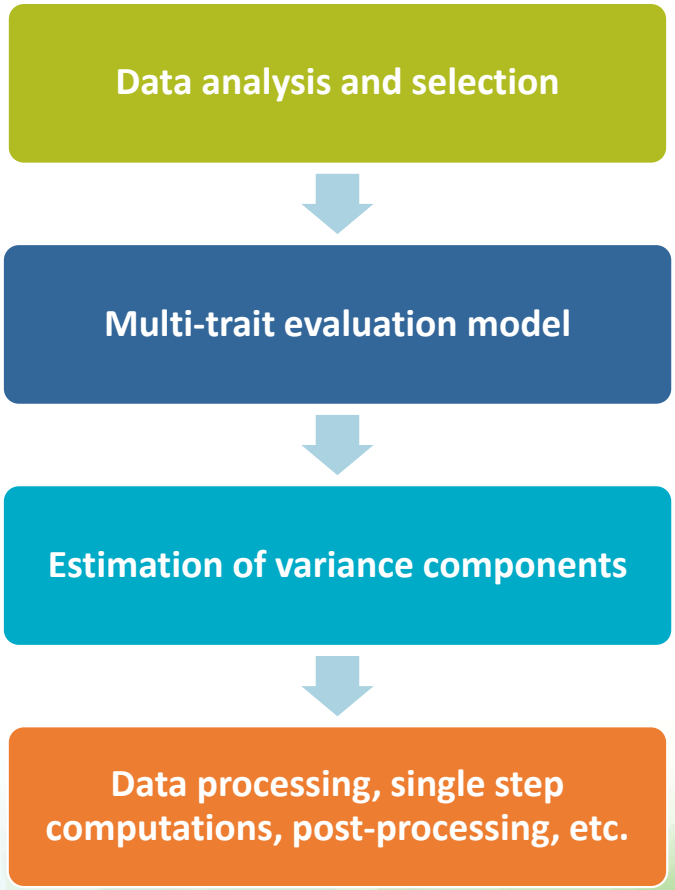
Average Predicted and Collected CH_4 by GEBV Class



Genomic Evaluation for Methane Efficiency

Lactanet and Semex collaborated on the development of a new, single step genomic evaluation system



Data Used for Genetic Evaluation *(April 2023)*

- First lactation Holsteins from 6,128 herds
- Between 120 and 185 DIM

Records	773,743	**Genotyped Animals**	134,963
Cows	541,565	**Genotyped Cows**	68,138
Sires	10,765	**Genotyped Sires**	7,921

Genomic Evaluation for Methane Efficiency

- **Single-step four-trait Animal Model (using MiX99)**
  - Predicted Methane (CH_4, g/d), Milk (kg/d), Fat (kg/d), Protein (kg/d)
  - Fixed: Age at calving, DIM, Year-Season of calving
  - Random: Herd-Test-Date, Permanent Environment, Animal

	Predicted CH_4	Milk Yield	Fat Yield	Protein Yield
Predicted CH_4	**0.23**	-0.13	0.38	-0.11
Milk Yield	-0.06	**0.38**	0.48	0.83
Fat Yield	-0.18	0.66	**0.27**	0.71
Protein Yield	0.01	0.90	0.74	**0.28**

Heritabilities on diagonal, Genetic correlations above diagonal, Phenotypic correlations below diagonal
*all approximated SE are <0.033

Genomic Evaluation for Methane Efficiency

- **Methane Efficiency (ME):**
  - Calculated via linear regression (recursive re-parameterization) using GEBV for Predicted CH_4 and each of Milk, Fat and Protein yields

	Milk Yield	Fat Yield	Protein Yield
Predicted CH_4	-0.13	0.38	-0.11
Methane Efficiency	0.00	0.00	0.00

Methane Efficiency helps to reduce the methane production of the cow and herd without impacting production levels

Expression of Methane Efficiency

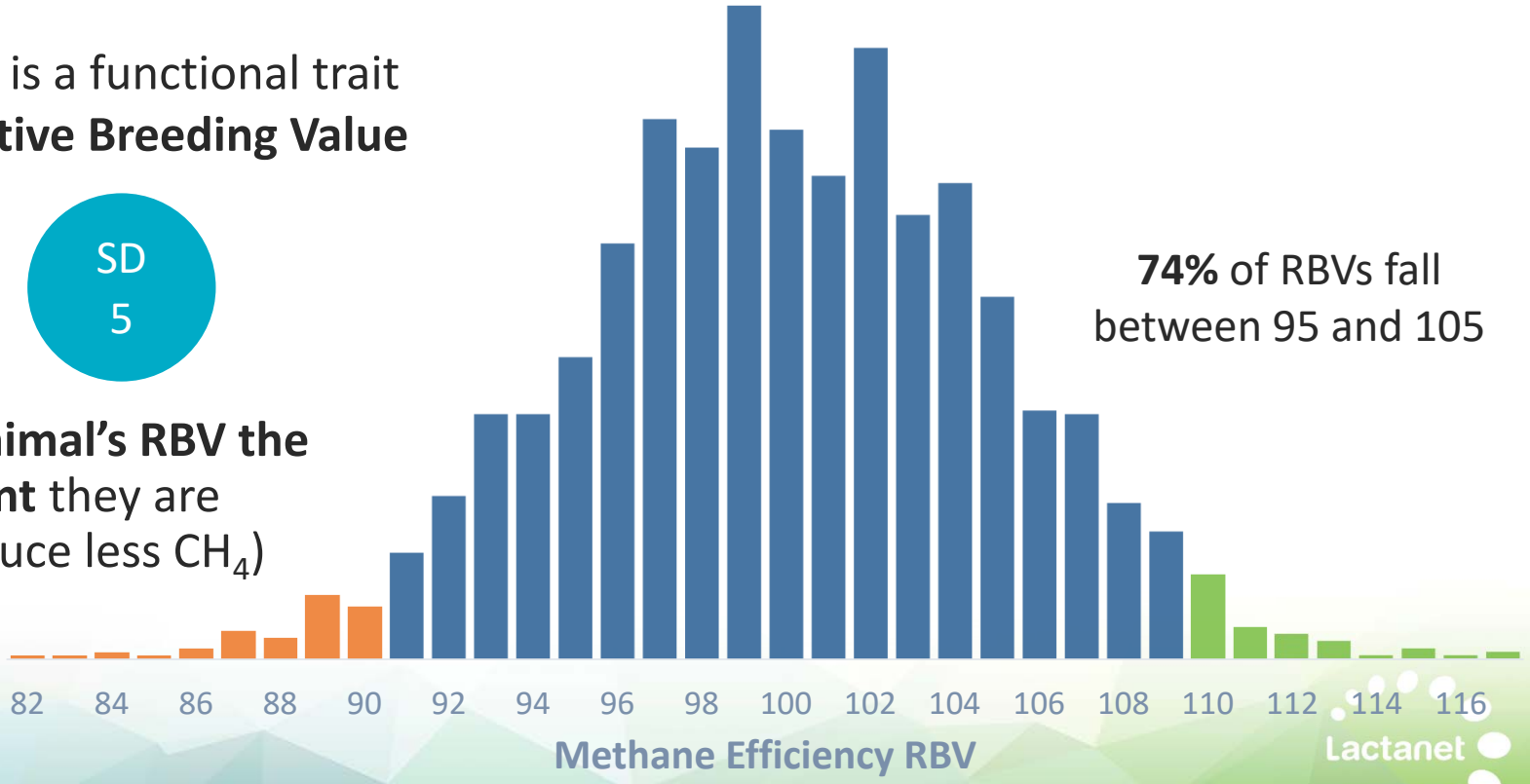
(Official Sires)

Methane Efficiency is a functional trait expressed as a **Relative Breeding Value**

Average 100

SD 5

The higher an animal's RBV the more efficient they are (i.e.: they produce less CH_4)



74% of RBVs fall between 95 and 105

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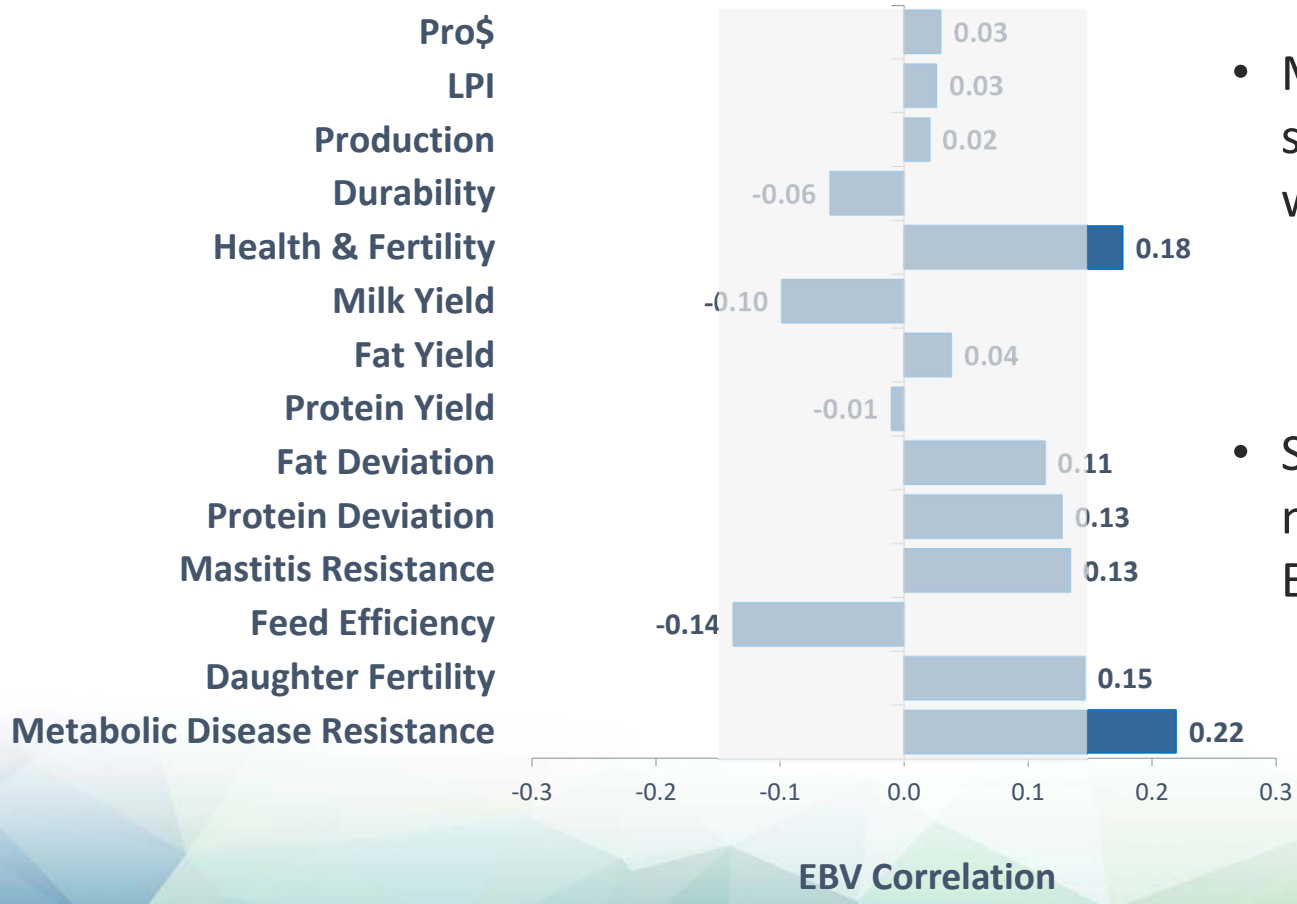
Methane Efficiency is Truly a New Trait



- Methane Efficiency does not have a significant unfavorable correlation with any other evaluated trait

- Selection for Feed Efficiency does not also improve Methane Efficiency
  - Both traits are independent of production yields

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Interpretation

Reduce CH_4 production by selecting for higher Methane Efficiency without impacting production traits

5-point ↑ in a sire's RBV for ME, daughters are expected to produce 3 kg less CH_4 per year

↓

1.5% decrease in CH_4 emissions per cow per year

↓

Herd owners selecting for ME can achieve 20-30% reduction in CH_4 emissions from their herd by 2050

Summary

- Lactanet has a portfolio of traits to genetically select for improved environmental sustainability
- Predicting CH_4 using milk MIR data has proven to be a key and rapid alternative to using collected CH_4
- Methane Efficiency allows selection for reduced CH_4 emissions without impacting production levels
- Lactanet is investing and (co)leading several research projects to help achieve the “Dairy Net Zero” goal

A Team Effort

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Saranya Narayana
Filippo Miglior
Allison Fleming
Janusz Jamrozik
Gerrit Kistemaker
Hannah Sweett
Brian Van Doormaal

Christine Baes
Flavio Schenkel
Saeed Shadpour

And all grad students and post-docs that every day, three times a day have been collecting CH4 data since 2016

Francesca Malchiodi
Mike Lohuis
Jay Shannon

Thank You!

Dagnachew Hallemariam
Graham Plastow
Paul Stothard