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CANADIAN NETWORK FOR DAIRY EXCELLENCE

The long road to select for environmental efficiency traits

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A team effort

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

SEMEX
Genetics for Life

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UNIVERSITY OF ALBERTA

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Focus on Environmental Sustainability

Lactanet has recently focused on environmental efficiency traits, and launched new genomic evaluations:

- **Feed Efficiency** evaluations in April 2021
- **Methane Efficiency** evaluations in April 2023

How did we arrive here?

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Global research initiatives

2008
RobustMilk EU Proj. 2008-12
OptiMIR EU Proj. 2009-15

2010 – 2015
USDA-NIFA grant
Australia New Zealand RFI

2012 - 2014
gDMI – global dry matter initiative

2012-2016
Methagene EU
FUNC - nordic

2015-2020
EDGP

2019-2024
RDGP
CDCB-FFAR

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Building environmental traits capacity over time

2012 - $1.2M

Milk Spectral Data

- Milk MIR pipeline and storage since 2013
  90% of milk recorded cows since 2018

2014 - $10.3M

Efficient Dairy Genome Project

- Feed Efficiency & Methane Emission DB
  4,500 cows with FE and 1,500 with ME

2018 - $12.8M

Resilient Dairy Genome Project

- Additional international partners
  12,000 cows with FE and 3,500 with ME

2022 - $6.2M

New regional initiatives

- Lactanet investing in FE and ME collection
  CH_4 sniffers in Canadian commercial farms

2023- $16.2M

$Dairy_{Zero}$ Genome Project

- New Genome Canada program
  Roadmap for GHG mitigation
  **Pending Formal Approval*

Since 2013, multiple projects ($4.2M) to genotype cows with medium-high density chips -> over 45,000 cows

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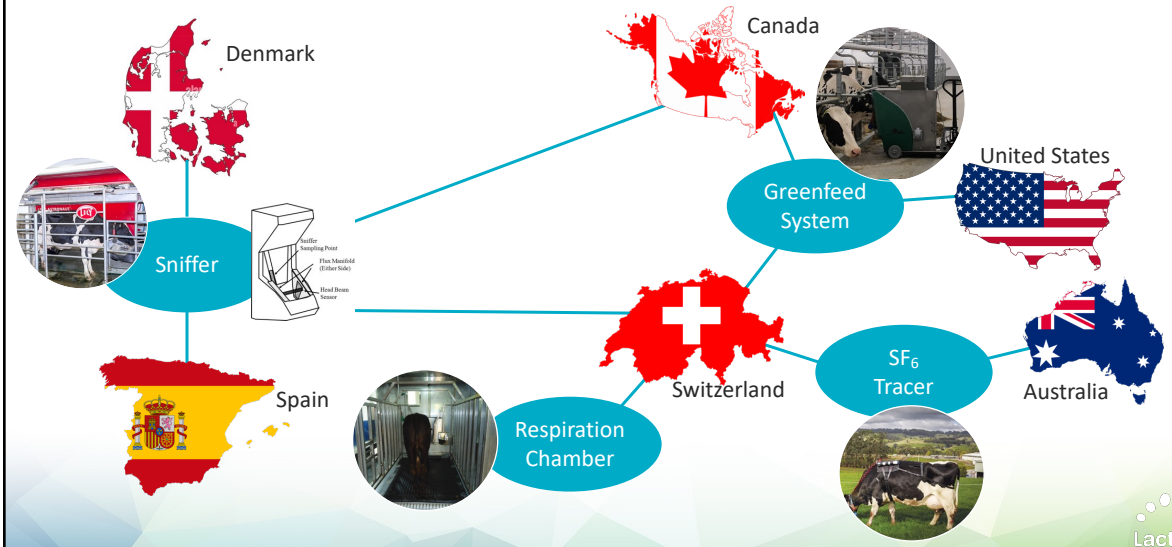
Methane Emissions – different devices



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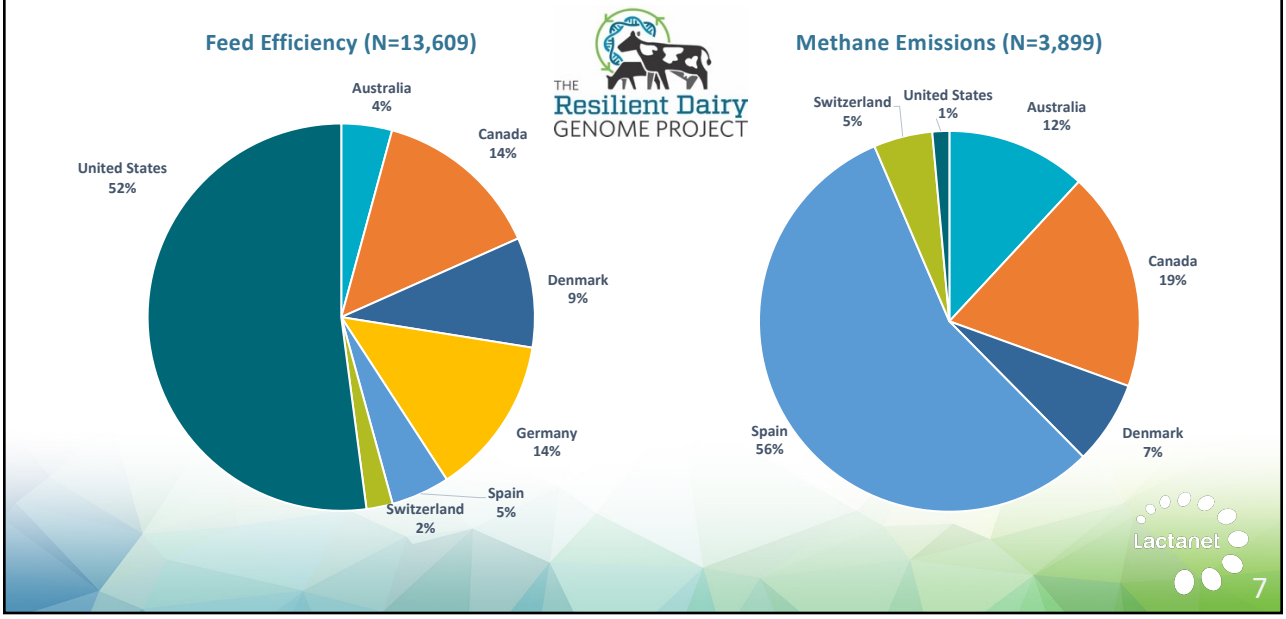
Number of phenotyped cows as of Feb 2023



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Lessons from EDGP and RDGP projects

- **International partnerships** are key for delivering genomic evaluations for **environmental efficiency traits**
- RDGP data base is sizeable and growing
  - Canada, US, Denmark, Switzerland, Germany, Spain, Australia
  - 13,600 cows for Feed Efficiency
  - 3,900 cows for CH_4 emissions

- Genomic evaluations for **Feed Efficiency** using the common database launched in 2021 in several partner countries
- CH_4 emissions predicted with **enough accuracy using milk MIR**
- Evaluations for **Methane Efficiency** launched in April 2023

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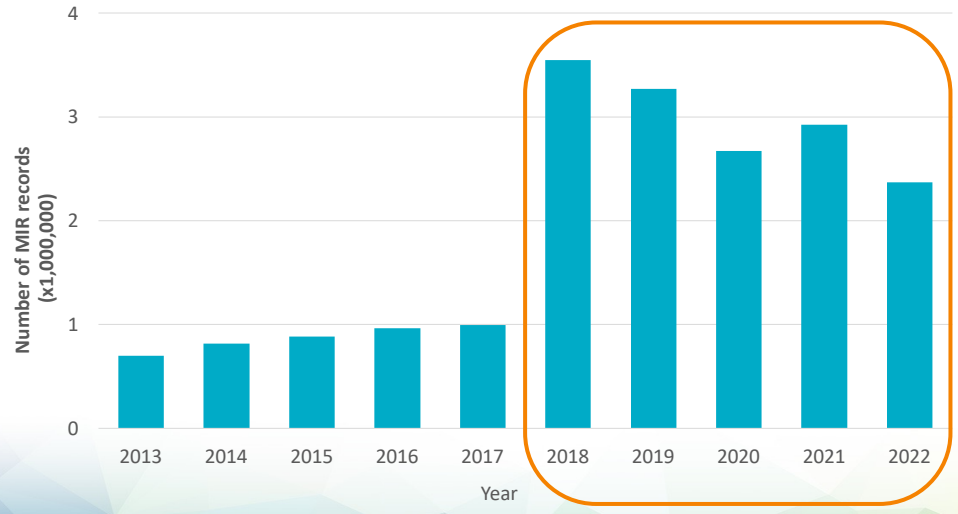
Canadian Milk MIR data for Holstein



Using records since 2018

14.8 M Spectra

1.3 M Cows

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Milk Spectral Data Processing

Individual milk samples processed by FOSS Milkoscan FTIR spectrophotometers

Identification of subsets

Quality control

Standardization

Pre-treatment

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Identification of Subsets

- MIR records split into subsets according to lab
  - From 4 labs, serving 5 provinces
- Keeping only Holstein data

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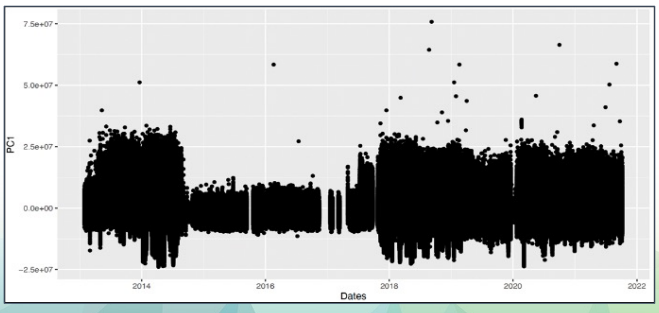
Identification of Subsets and Quality Control

- Remove uninformative and water associated regions
  - Using 241 spectral datapoints
- Within each lab subsets, change in patterns over time using PCA (Bonfatti et al., 2017) and Bayesian Changepoint Detection used to form additional subsets with homogenous signals
  - Only using MIR records since 2018 due to limited prior samples and increased variability
- Removed outliers within each final subset based on Mahalanobis distance



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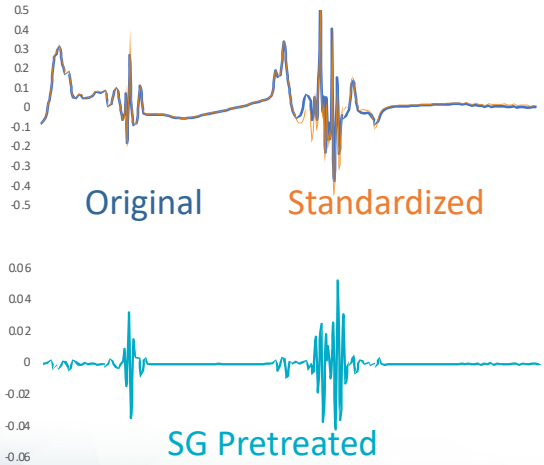
Standardization and Pretreatment



- Standardize the spectra of the secondary spectrometer to match the spectra obtained from the master machine (Bonfatti et al. 2017)
  - Master machine: Valacta Lab, Ste-Anne-de-Bellevue, QC
- Smoothing pretreatment using a third order Savitzky–Golay filter yielded the best results and applied to all spectra
- All spectral datapoints included in standardization and pretreatment steps and then reduced back again to 241

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Collected Methane

- Varying collection protocols in Canada with the GreenFeed system
  - U of Guelph: 1st lactation cows 120-150 DIM 3 or 4 times a day for 5 consecutive days
  - U of Alberta: 1st and multiparous cows 30-250 DIM, 2 times per day for 12 consecutive days or 3 times per day for 5 consecutive days
- Average daily g/d CH_4 production calculated for each animal
- Optimized final training set for prediction models
  - Currently using collected Canadian GreenFeed measurements
  - First lactation animals with collected CH_4 5-305 DIM

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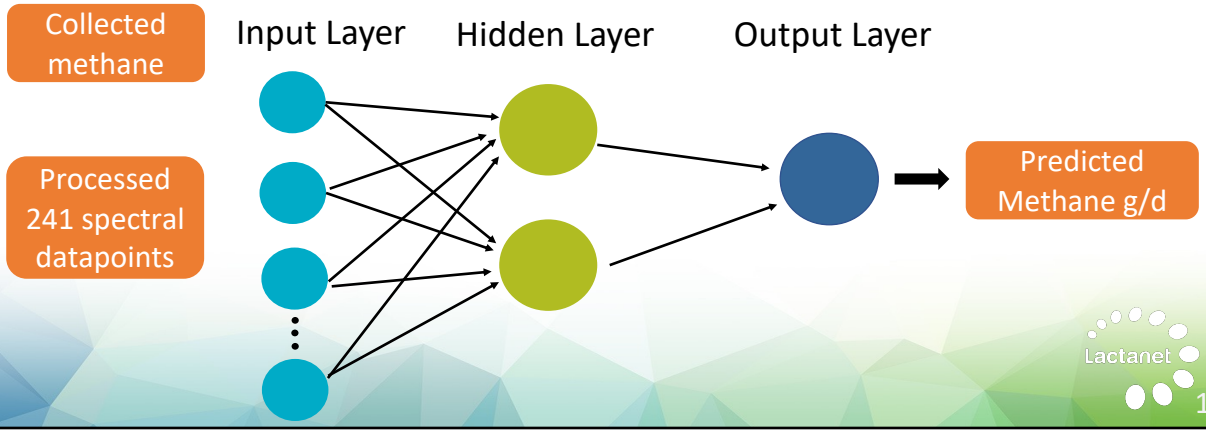
Predicting Methane using Artificial Neural Network

- Building off knowledge and proof of concept from U of Guelph (Shadpour et al., 2022)
  - MultiLayer Perceptron ANN based on Bayesian regularization
  - ANN better models the complex non-linear relationships
- Only MIR spectra used as input predictors



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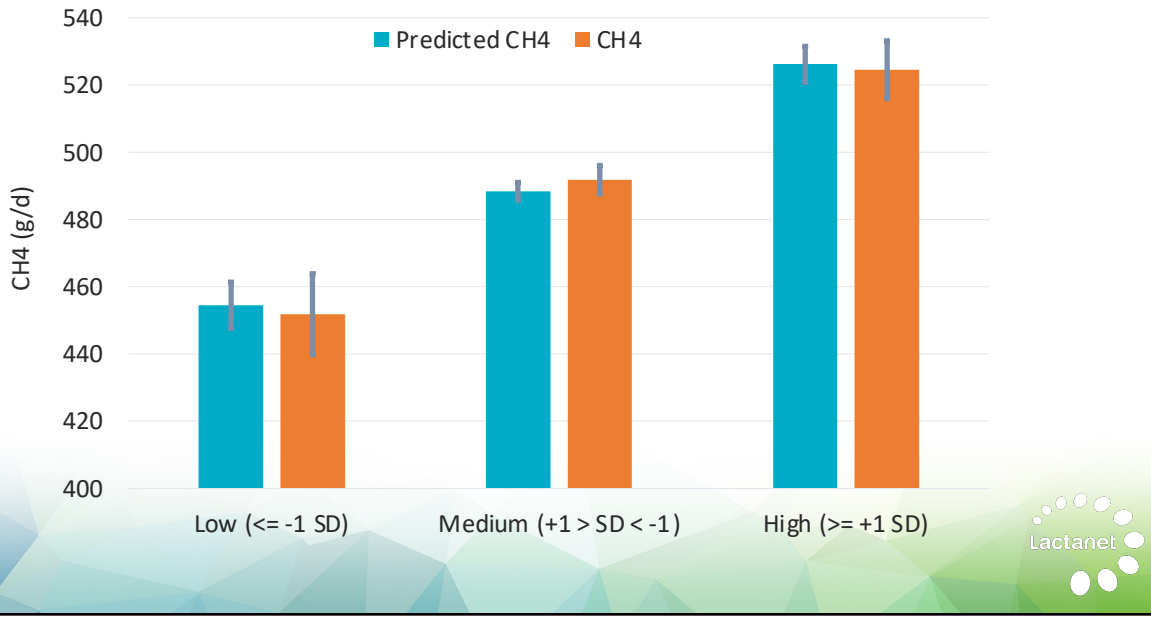

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New provincial and national initiatives

THE Efficient Dairy GENOME PROJECT → THE Resilient Dairy GENOME PROJECT →

International database for Feed Efficiency & Methane emissions	Genomic Evaluations for Feed Efficiency April 2021	Genomic Evaluations for Methane Efficiency April 2023	Resiliency Index (novel fertility, health, efficiency traits) expected 2024-25

FUNDED

Alberta RDAR project $2M
- Sunalta Feed Bins & Sniffer prototypes at Elora

AFC Alberta Milk project $900K
- Alberta Sniffers, KTT, Sunalta weigh scale
- **MAPAQ & Dairy Farmers of Quebec** project $3.2M
- Quebec Sniffers Nutrition R&D & trainees
- Bulk milk test strategy

Genome Canada project $16.3M
- Roadmap for GHG mitigation strategy
- **Pending Formal Approval*

UNDER REVIEW

AAFC Dairy Cluster 4 project $1M

BC Dairy/WEF project $100K

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Future strategy

The current MIR prediction is for 1st parity Holsteins, 120-185 DIM

Our Goals:

- Enhance milk MIR prediction
  - Triple number of cows CH_4 recorded with GreenFeed (BC, QC and AT)
  - Install ~70 CH_4 sniffers (MooLogger) in up to 35 robotic farms across Canada
    - ✓ Including Jersey and Ayrshire, in addition to Holstein
    - ✓ Multiple parities
    - ✓ Full lactation
    - ✓ Different feeding and management systems
- Enhanced genomic evaluation
  - Using new milk MIR prediction
  - Using new milk MIR prediction + collected CH_4 from GreenFeed and sniffers

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Acknowledgments

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