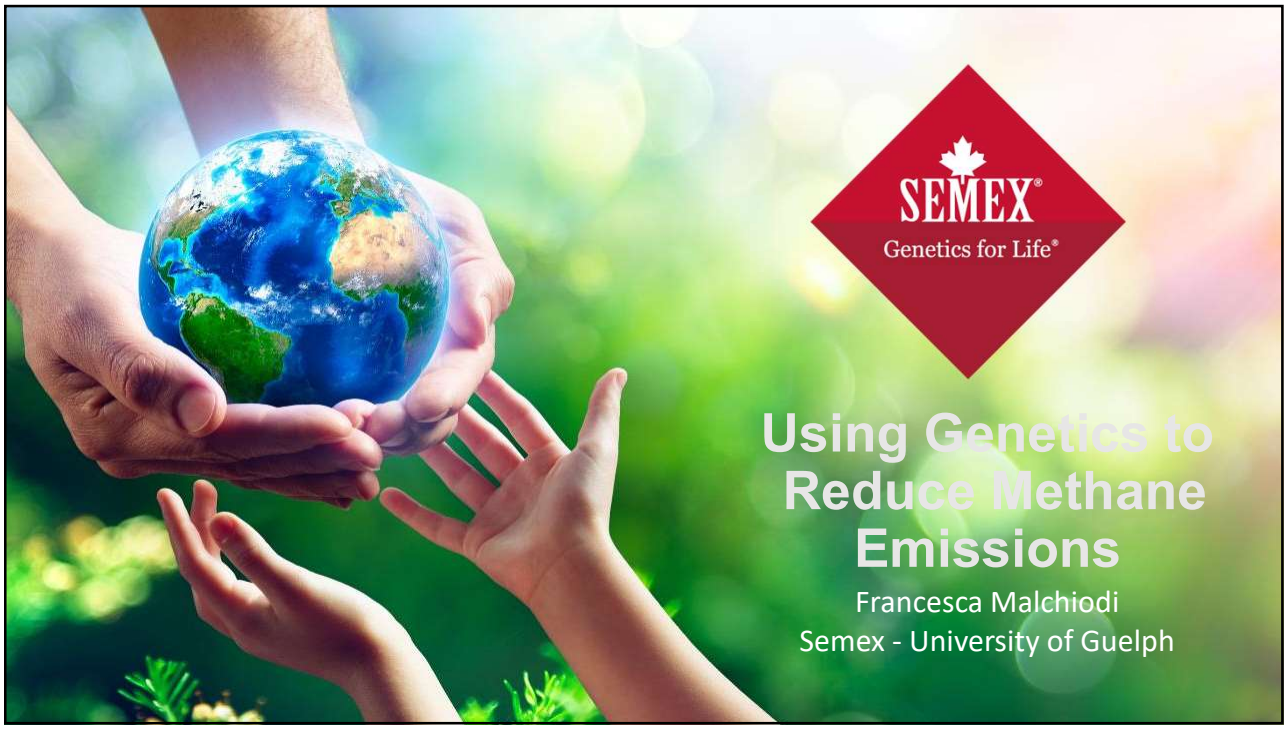


A TEAM EFFORT

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

Lactanet

UNIVERSITY of GUELPH

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

SEMEX Genetics for Life

Francesca Malchiodi
Mike Lohuis
Jay Shannon

UNIVERSITY OF ALBERTA

Dagnachew Hallemariam
Graham Plastow
Paul Stothard

GLOBAL METHANE PLEDGE

149 signatories working collectively reducing global methane emissions across all sectors by at least 30% below 2020 levels by 2030

DAIRY FARMERS OF CANADA

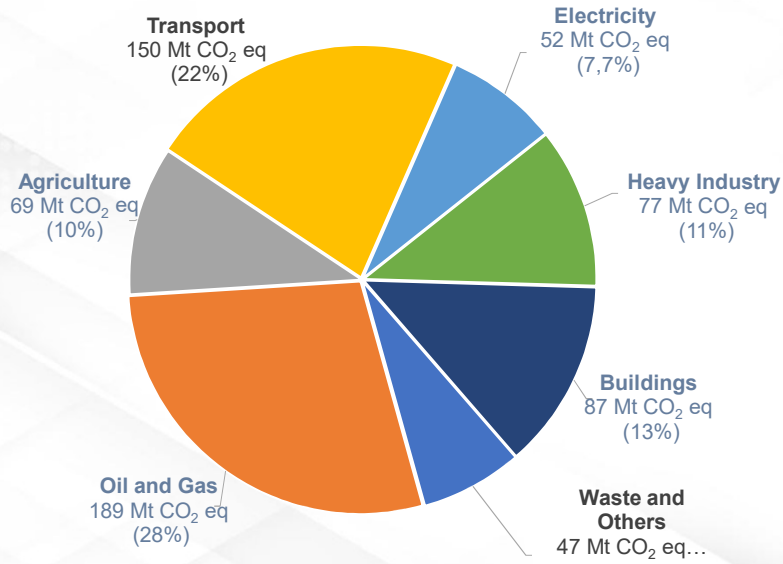
A goal to reach net-zero greenhouse gas (GHG) emissions from farm-level dairy production by the year 2050, with a milestone in 2030

GLOBAL DAIRY PLATFORM

Leading organizations, including some of the largest dairy companies in the world among first to support new global 'Pathways to Dairy Net Zero' climate initiative

Climate Mitigation - The need to compete in the consumer narrative

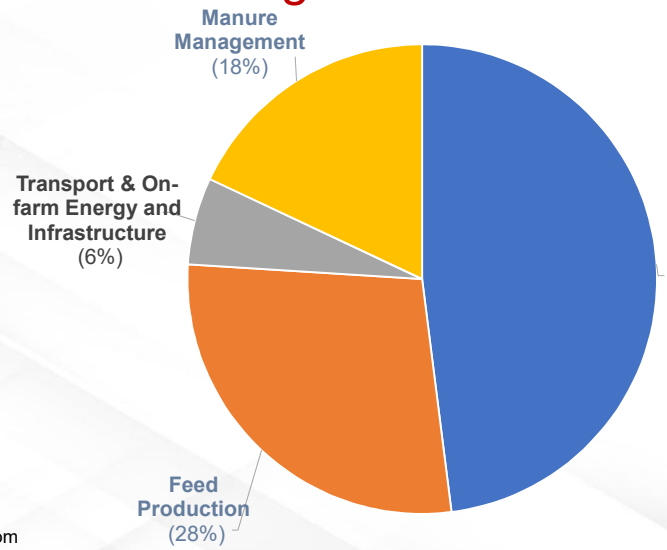
Canada's GHG Emissions by Economic Sector (2021)



Agriculture:	**69 Mt CO_2 eq**
Livestock:	**34 Mt CO_2 eq**
Dairy:	**12 Mt CO_2 eq**

Adapted from https://publications.gc.ca/collections/collection_2022/eccc/En81-4-2020-1-eng.pdf

Environmental Profile of Producing 1 kg of Canadian milk (2016)



Livestock Management (48%) → **Enteric Fermentation (i.e. methane)**

Adapted from https://www.dairyfarmers.ca/content/download/6327/56092/version/2/file/LCA__ExecutiveSummary.pdf.

Why Methane?

14%

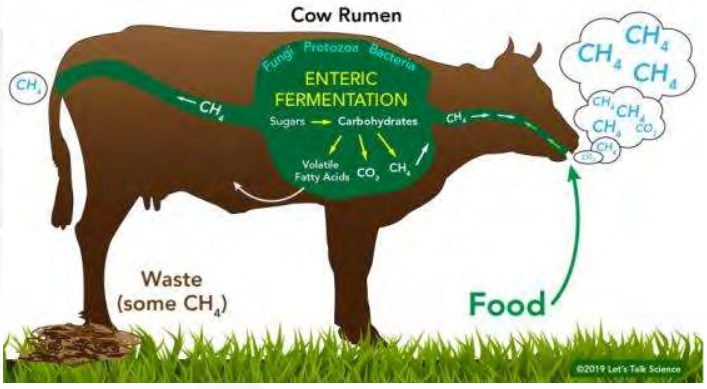
of Canada's GHG emissions in 2021 and remains in the atmosphere for ~12 years

Responsible for ~1/2 the net global temperature change due to human activities in the last decade

Reductions in CH_4 emissions are required to limit future climate change and reach net zero CO_2 emissions

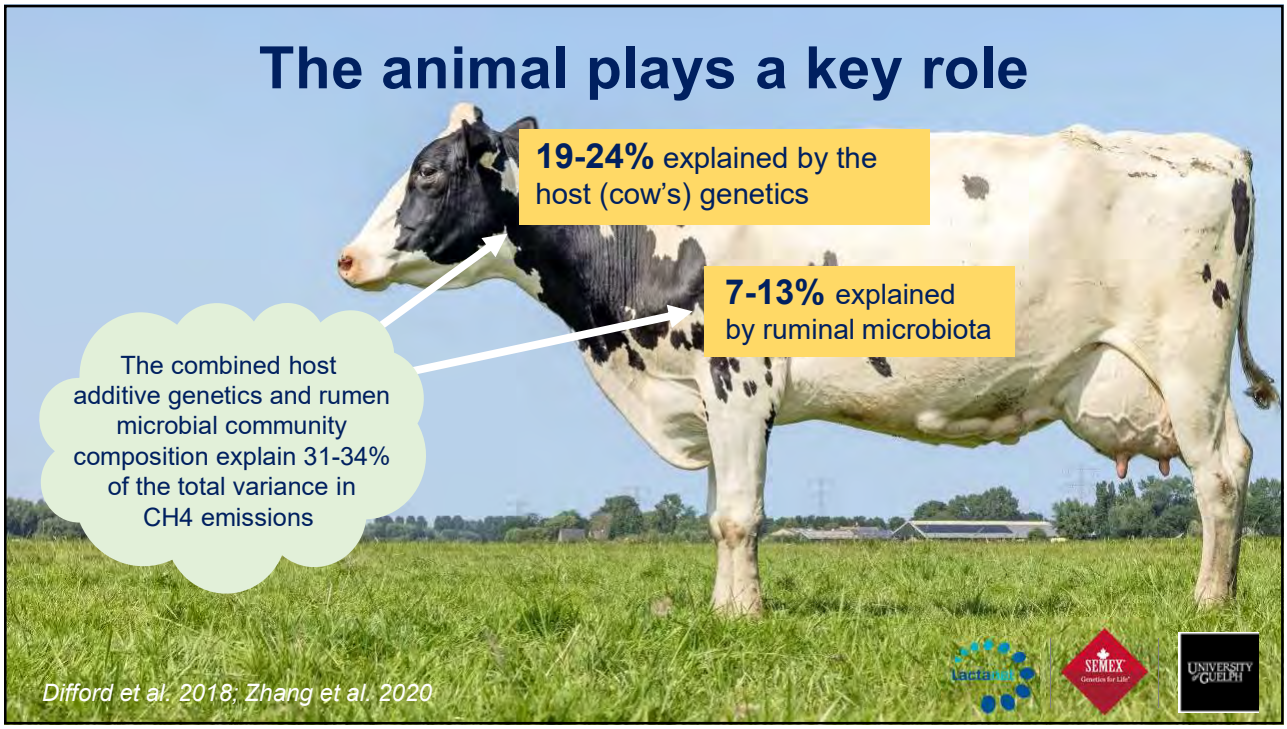
An Opportunity

Where does CH4 come from?



- Most CH4 is produced by fermentation during rumination process
- More than 90% is excreted through the breath by eructation (burping)

The animal plays a key role



Lactanet Genetic Toolbox

Feed Efficiency
April 2021

Body Maintenance Requirements
April 2023

Methane Efficiency
April 2023

Reduce feed costs

Reduce methane emissions

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

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

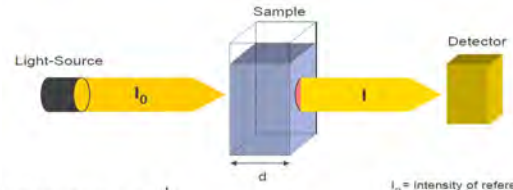
- Varying collection protocols with the GreenFeed system (C-Lock Inc., Rapid City, SD)
- Over 500 cows' individual methane emissions measured with Greenfeed system

Milk sample collected on farm

Milk sample analyzed in lab

MIR spectroscopy is already used to determine milk components such as fat and protein percentages as well as BHB in milk samples

PREDICTING CH4 USING MIR DATA



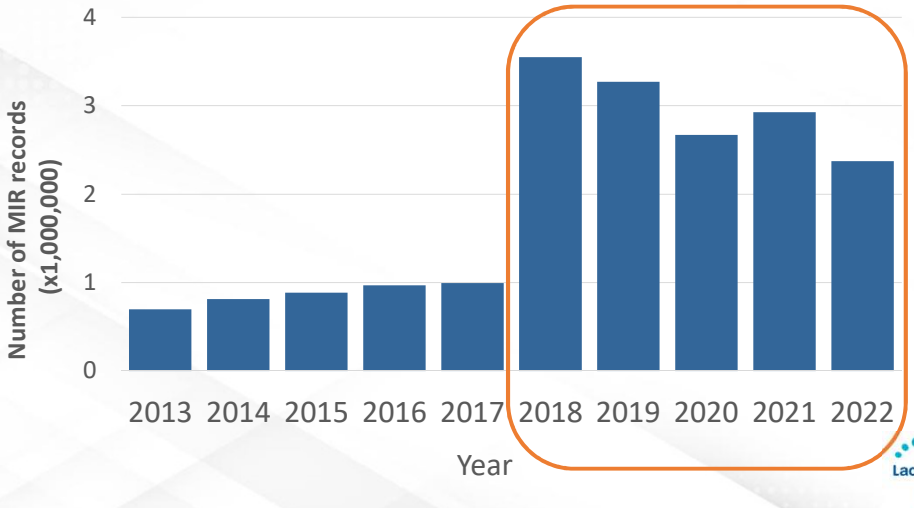
$$\text{Transmission } T = \frac{I}{I_0}$$

$$\text{Absorption} = A = \log \frac{1}{T} = \varepsilon \cdot c \cdot d$$

I_0 = intensity of reference beam
I = intensity of sample beam
d = sample thickness
c = concentration
ε = molar absorption coefficient

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

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**

J. Dairy Sci. 105:8272–8285
https://doi.org/10.3168/jds.2021-21176

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

Saeed Shadpour,[1] Tatiane C. S. Chud,[1] Dagnachew Hailemariam,[2] Graham Plastow,[2] Hinayah R. Oliveira,[1] Paul Stothard,[2] Jan Lassen,[3] Filippo Miglior,[1,4] Christine F. Baes,[1] Dan Tulpan,[1] and Flavio S. Schenkel[1]*
[1]Centre for Genetic Improvement of Livestock, Department of Animal Biosciences, University of Guelph, Guelph, Ontario, N1G 2W1, Canada
[2]Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta, T6G 2P5, Canada
[3]Center for Quantitative Genetics and Genomics, Aarhus University, Tjele, 8830, Denmark
[4]Lactanet Canada, Guelph, Ontario, N1K 1E5, Canada

Predicting CH4 using MIR data

- MultiLayer Perceptron Artificial Neural Network based on Bayesian regularization model
- 241 MIR spectral datapoints used as input predictors
- Collected average daily methane from 496 cows from two herds between 5-305 DIM

Prediction Accuracy: 0.70

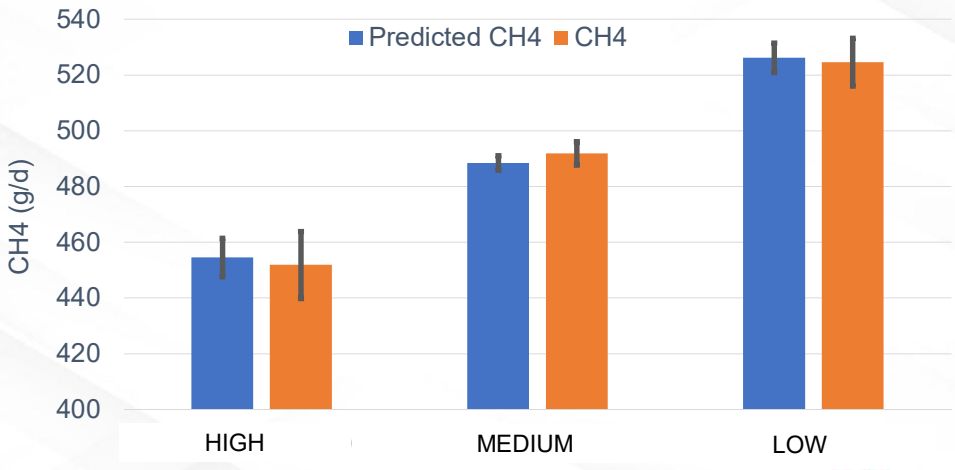
Predicting CH4 for Genetic Selection

23%
Heritability (mid-high)

70%
Reliability

92% genetic correlation between collected and MIR predicted methane

Average Predicted and Collected CH4 by GEBV



Predicting CH4 for Genetic Selection

23% Heritability (mid-high)	**70%** Reliability
92% genetic correlation between collected and MIR predicted methane	Unfavorable genetic correlation with fat yield

Genomic Evaluation for **Methane Efficiency**

Predicted CH_4 production genetically independent of Milk, Fat and Protein yields via linear regression

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

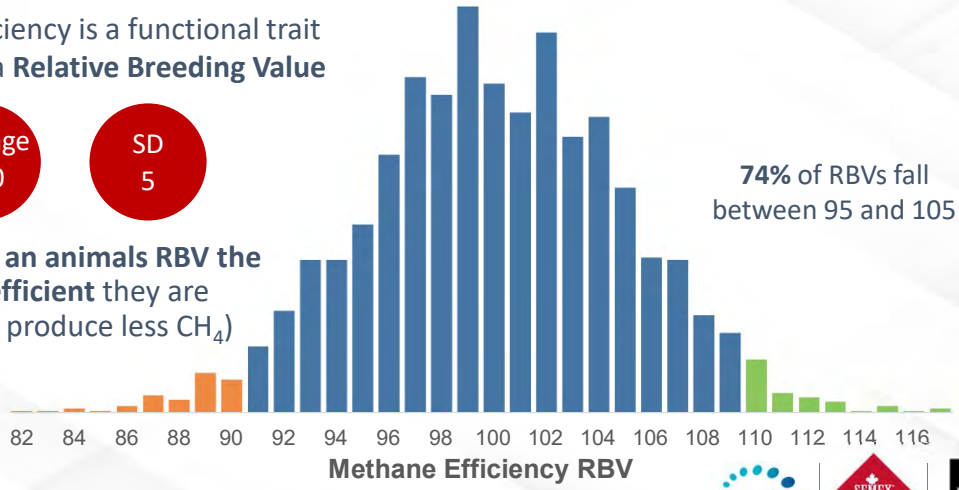
Expression of Methane Efficiency
(Official Sires)

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

Average 100

SD 5

The higher an animals RBV the more efficient they are (i.e. they produce less CH_4)



74% of RBVs fall between 95 and 105

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 3kg less CH_4 per year

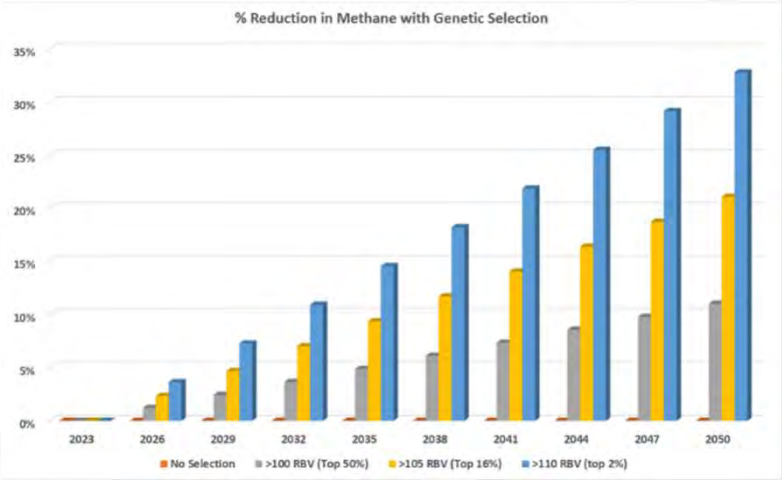
↓

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

REDUCE METHANE 20-30% BY 2050



IMPACT OF GENETIC SELECTION

Monitor Your Herd

Providing genetic methane efficiency evidence shows herd progress

Cow and heifer genomic results allow selection and benchmarking of cows

Innovation Climate Action Award
IDF Word Dairy Summit

Future Strategy

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

Goals:

- Enhance milk MIR prediction
  - Increase # CH_4 records with GreenFeed (BC, QC and AB)
  - Install CH_4 sniffers (MooLogger) in 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 enhanced milk MIR prediction + collected CH_4 from GreenFeed and sniffers

Summary

- The Canadian dairy industry 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 collected CH_4
- Methane Efficiency allows selection for reduced CH_4 emissions without impacting production levels
- The Canadian industry is investing and (co)leading several research projects to achieve the “Dairy Net Zero” goal

Acknowledgements