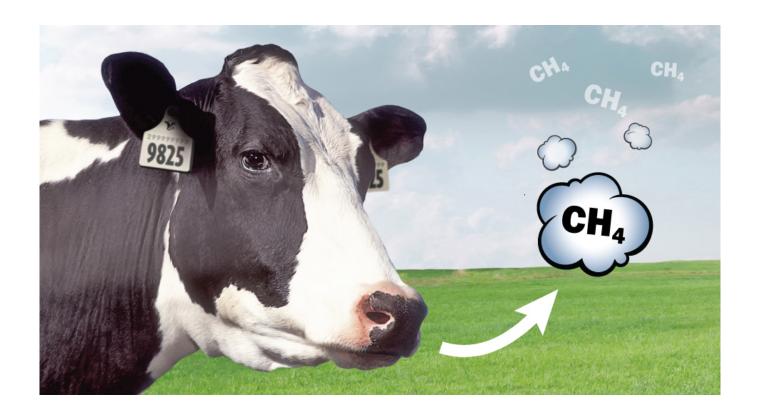


# Genetic Selection for Reduced Methane (CH<sub>4</sub>)

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Climate change, caused by the rise of greenhouse gases (GHG) in the atmosphere, has become a global concern. One GHG in particular has received more attention compared to others: methane (CH<sub>4</sub>). Why is there such a large interest in CH<sub>4</sub> emissions and what genetic strategies can be used to offset or reduce such emissions?



Methane (CH<sub>4</sub>), a potent greenhouse gas (GHG), is under the spotlight for two main reasons. First, it is responsible for nearly half the net global temperature change due to human activities in the last decade<sup>1</sup>. Second, "for limiting future climate change, together with reaching net zero carbon dioxide emissions, strong, rapid and sustained reductions in  $CH_4$  emissions

is required", some experts say<sup>2</sup>. Even though the agriculture industry is not the sole source of increasing global  $CH_4$  emissions, it has the potential to mitigate this increase and contribute to climate cooling by reducing its rate of  $CH_4$  emissions<sup>1</sup>, a key asset for limiting global warming to 1.5°C by  $2050^{3.4}$ .

As discussed in our previous article, <u>Environmental Footprint of the Dairy</u> <u>Industry</u>, CH₄ made up 14% of Canada's GHG emissions in 2020, of which

30% arose from the agriculture sector<sup>5</sup>. When accounting for all on-farm and off-farm GHGs involved in the production of 1 kg of milk on Canadian dairy farms, CH₄ appears as the largest contributor to the milk footprint at close to 50%. It mostly comes from digestion (enteric fermentation) and to

a lesser extent from manure management.

Enteric fermentation is part of a cow's digestion process where microbes and bacteria break down food generating nutrients for the animal and CH<sub>4</sub> as a by-product. This CH<sub>4</sub> is emitted into the atmosphere when the cow belches, contributing to the dairy sector's carbon footprint and representing a loss of 4% to 7% gross energy intake for the animal<sup>6</sup>. In Canada, the average CH<sub>4</sub> produced per cow is approximately 150 kg per lactation. Can genetic selection be used to reduce these emissions, combat global warming, and improve dairy cattle efficiency?

## Using Genetics to Reduce Methane Emissions

Using genetics to select for cows with reduced  $CH_4$  emissions is a permanent and cumulative solution to reducing GHG emissions. However,  $CH_4$  is expensive and difficult to measure resulting in few animals with  $CH_4$  data. This prompted researchers at the University of Guelph to look at alternative methods to predict  $CH_4$  emissions. Let's take a closer look at the data:

### Collected Data

Under the Efficient Dairy Genome Project (EDGP) and the Resilient Dairy Genome Project (RDGP, see <a href="http://www.resilientdairy.ca/">http://www.resilientdairy.ca/</a>), researchers have been collecting CH<sub>4</sub> production data to be used as a potential reference population for the estimation of genomic evaluations. This data collection has mainly been conducted using a GreenFeed system, which measures gas fluxes including CH<sub>4</sub> from individual animals each time they visit the feed trough component of the machine (Figure 1). However, this method is labor intensive, costly, and not feasible for commercial dairy farms, resulting in relatively few animals with measured CH<sub>4</sub> emission

phenotypes. As such, researchers from the University of Guelph identified an alternative method, using artificial intelligence and machine learning approaches, that can be used to predict CH<sub>4</sub> emissions on a larger scale while the collection of emission data continues.

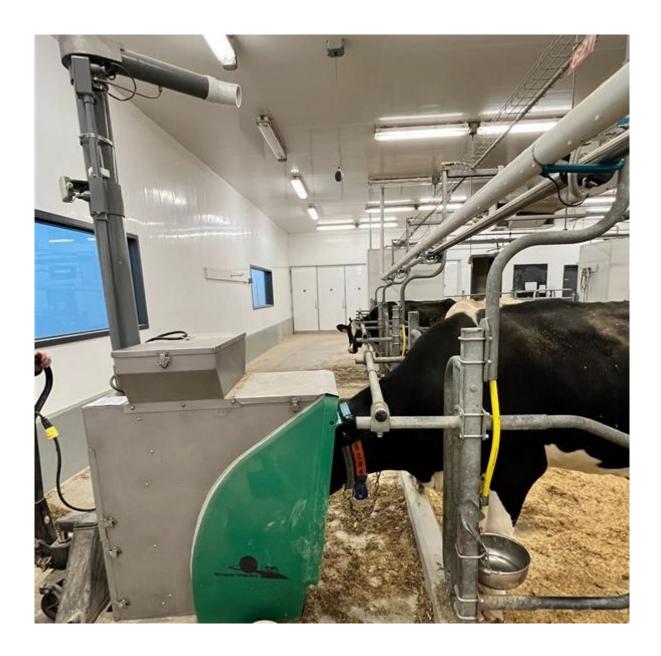


Figure 1. GreenFeed system used to measure gas fluxes including methane from individual animals.

#### Predicted Data

Research has shown a link between a cow's milk composition, especially milk fatty acids, and its CH<sub>4</sub> emissions due to their relationship with enteric fermentation. As such, milk composition data can be used to predict a cow's CH<sub>4</sub> emissions. A technique called mid-infrared (MIR) spectroscopy can determine a milk sample's chemical composition by measuring the absorption of light through the milk. This technology is already used to determine milk components such as fat and protein percentages as well as BHB in milk samples. The Lactanet database contains millions of MIR spectral data collected via our milk recording services and laboratory milk sample analysis. Therefore, predicting CH₄ emissions using milk MIR spectral data has great potential and availability, with each MIR analysis of a single milk sample producing over 1000 data points. Lactanet developed CH<sub>4</sub> predictions via a machine learning algorithm using milk spectral data and CH<sub>4</sub> data collected from research herds in Canada. Using only first lactation data between 120 and 185 days in milk, predicted CH₄ was found to have a genetic correlation with collected CH<sub>4</sub> data of 85% and a relatively high heritability of 23%.

## Methane Efficiency Evaluations

With the use of milk spectral data, Lactanet can accurately predict  $CH_4$  emissions for many cows at a low cost, making genetic evaluations for  $CH_4$  emissions possible!

In support of Dairy Farmers of Canada's goal to reach net-zero GHG emissions from farm-level dairy production by 2050, Lactanet will be launching the first ever national genetic evaluation aimed at reducing  $CH_4$  emissions from dairy cattle.

Effective April 2023, the single-step genomic evaluation of predicted CH<sub>4</sub>

will result in Relative Breeding Values (RBV) for Methane Efficiency in the Holstein breed, allowing producers to select for reduced CH₄ emissions without sacrificing production traits. Given the large reference population available, the average reliability of Methane Efficiency for genotyped young bulls and heifers will exceed the 70% level.

Keep an eye out for more information on these evaluations as we get closer to implementation in April!

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