



Using Bulk Tank Milk Spectra to Predict Enteric Methane Emissions from Lactating Cows in Commercial Dairy Herds

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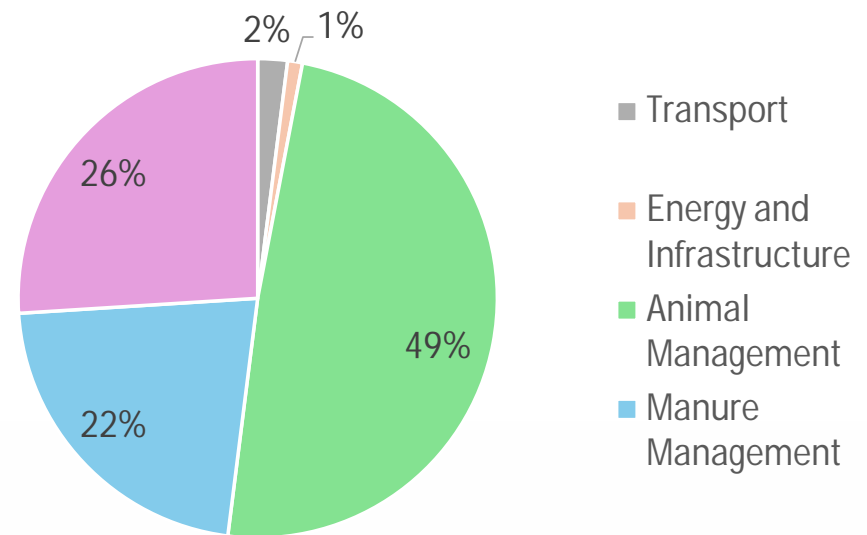




Enteric CH₄ emissions account for approximately 30% of global methane emissions (FAO, 2023)

Background

Contribution of on Farm Activities to the Carbon Footprint of Dairy Farms



Source: Dairy Farmers of Canada, 2025

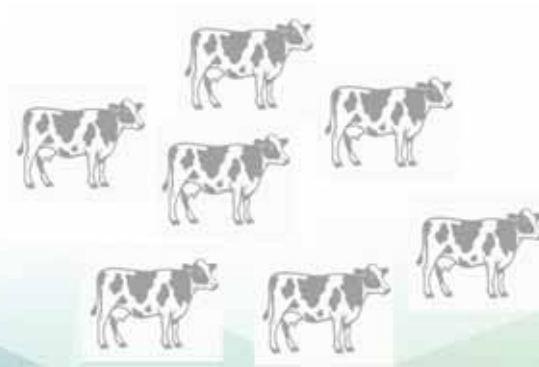




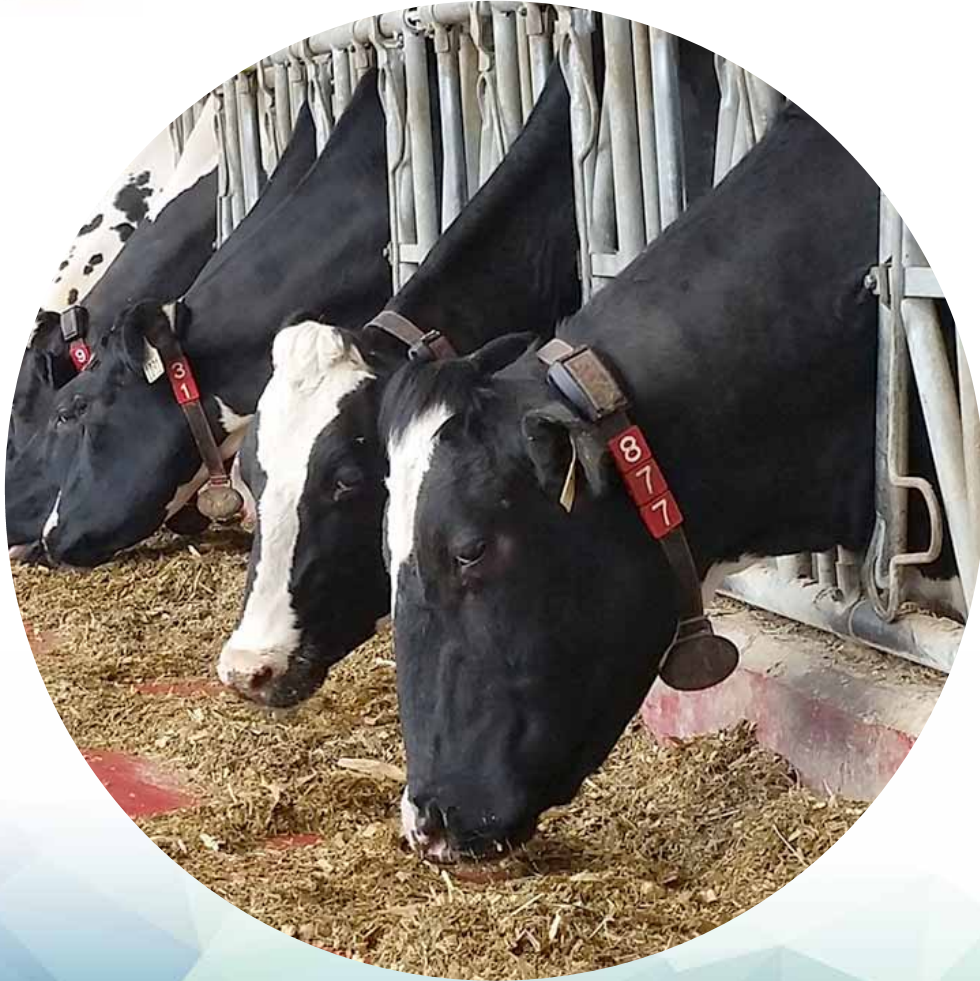
Background

Growing interest in monitoring enteric CH₄ emissions using practical, scalable approaches to assess the situation and evaluate mitigation strategies

No available studies to predict herd-level enteric CH₄ emissions



Objective



Predict herd-level
enteric CH₄
emissions using bulk
tank milk samples

Materials & Methods



14 commercial dairy farms (AMS) -HO, JE, AY
24 sniffers – Moologer, Tecnosens (IT)

~86 400 measurements /day



Deployed since August 2024

Records every second: ppm CH₄ & CO₂, airflow, humidity, and temperature

1.102 billion

records collected by December 31, 2025

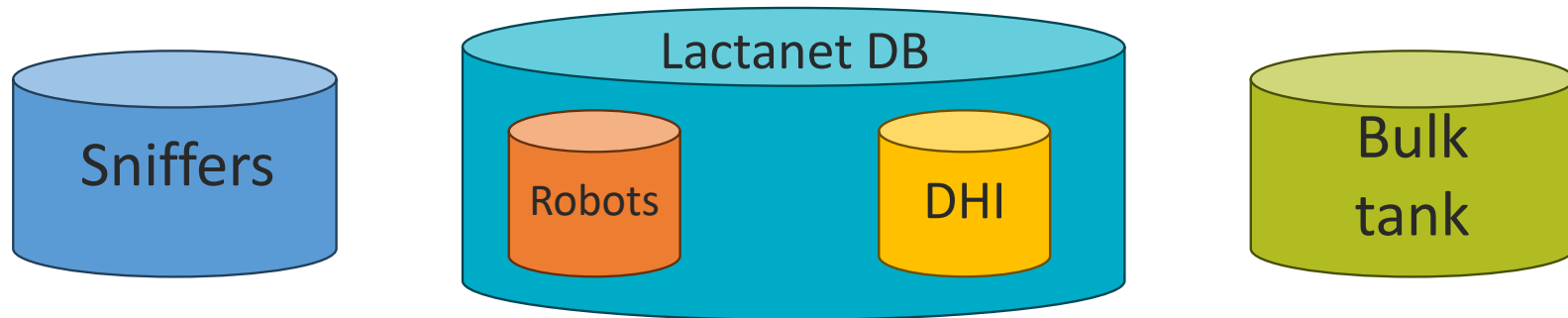


'Nose' in the feeder entrance
(viewed from underneath)



Materials & Methods

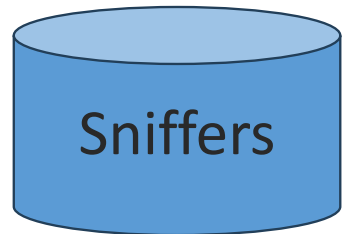
Data sources and processing





Materials & Methods

Data sources



Pump Sniffer data

Extract events (e.g., calibration, nose maintenance, etc.)

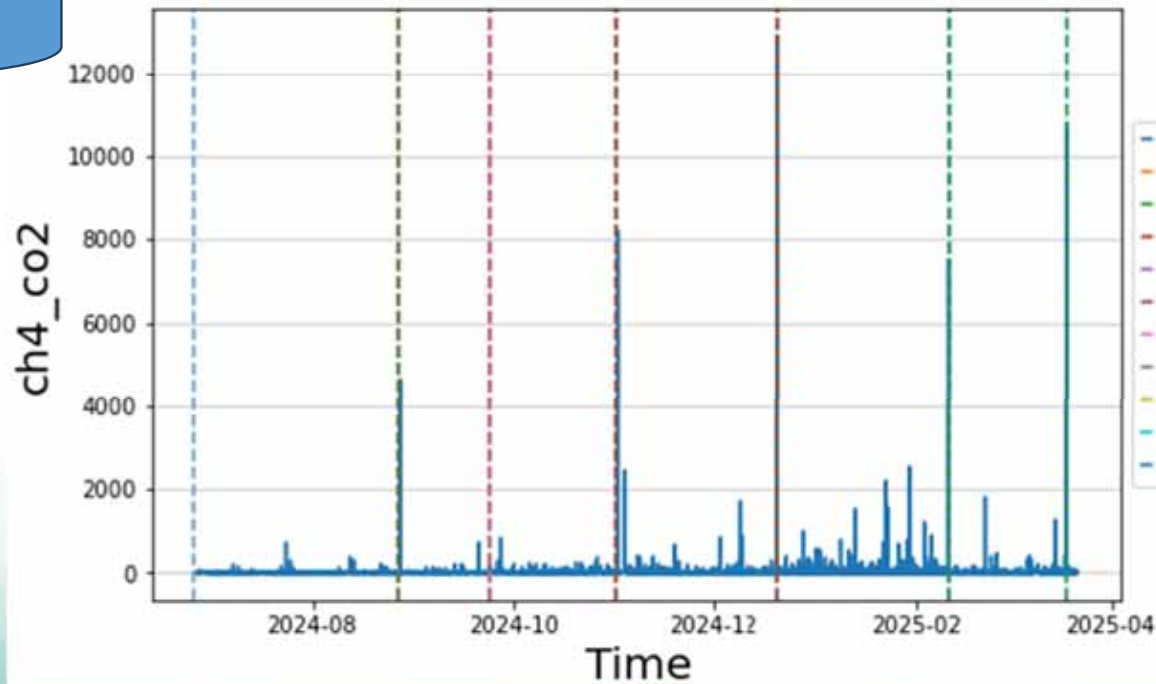
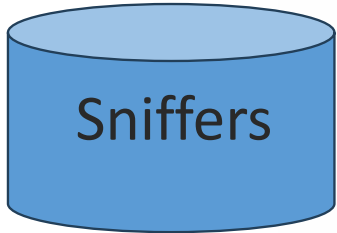
Correct baseline

Aggregate into 10 sec



Materials & Methods

Data sources

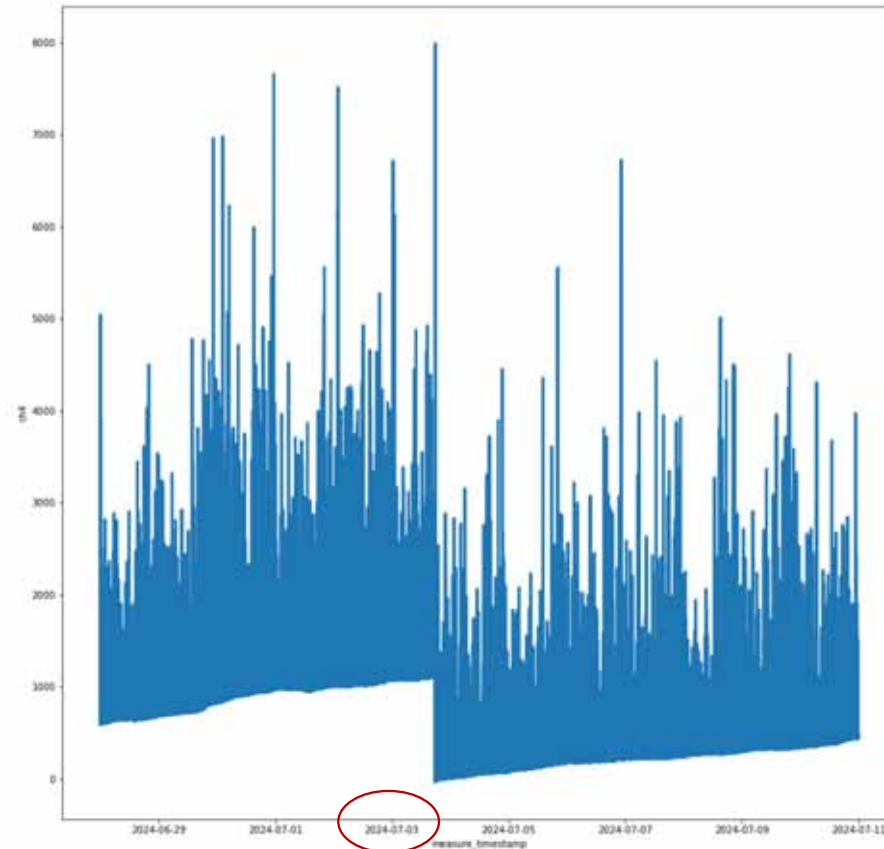
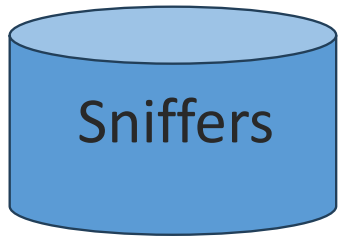


- Calibration
- Pump replacement
- Nose maintenance
- Filter cleaning
- Calibration zero
- Flowmeter replacement
- Water filter installation
- Gas analyser replacement
- Error detected-see logbook
- Nose replacement
- Water filter replacement

- Maintenance
- Calibration
- Calibration zero
- Error detected-see logbook
- Filter cleaning
- Flowmeter replacement
- Gas analyser replacement
- Leak fixed
- Nose maintenance
- Nose replacement
- Pump replacement
- Water filter installation
- Water filter replacement
- Data pipeline
- Data collection started
- Data collection stopped
- Software version
- TeamViewer ID
- Miscellaneous
- General comment
- Robot re-assignment

Materials & Methods

Data sources

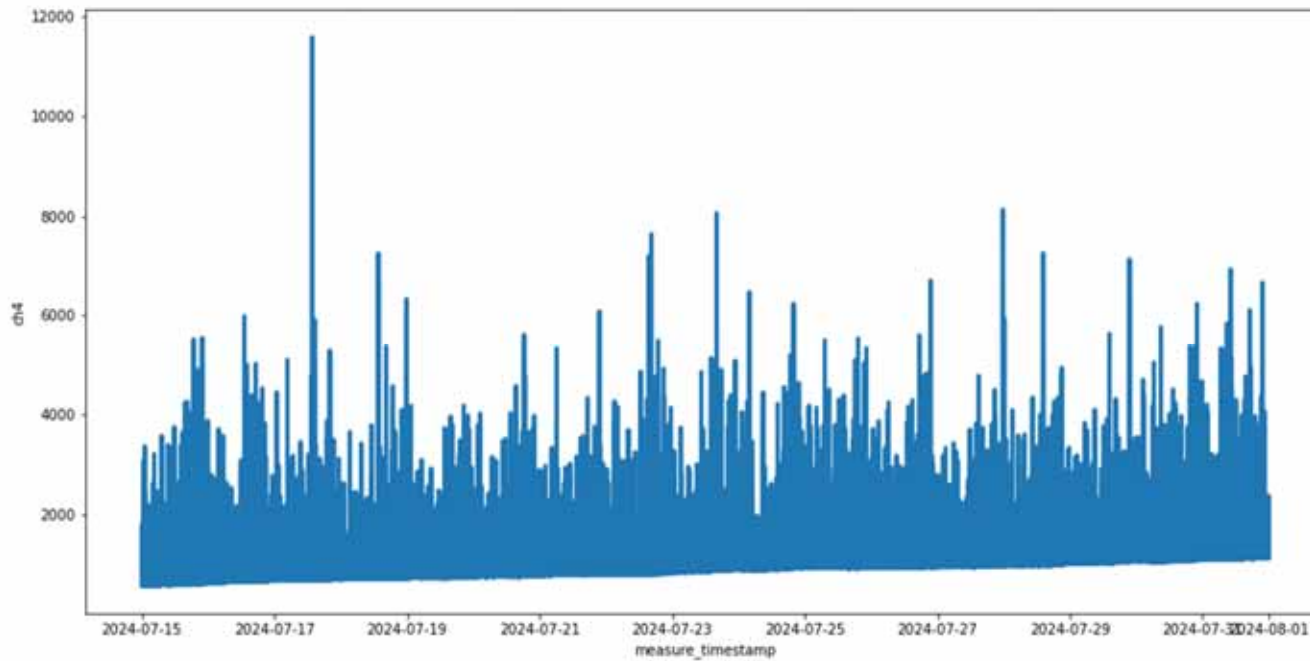
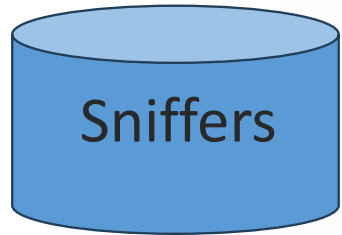


Calibration date



Materials & Methods

Data sources



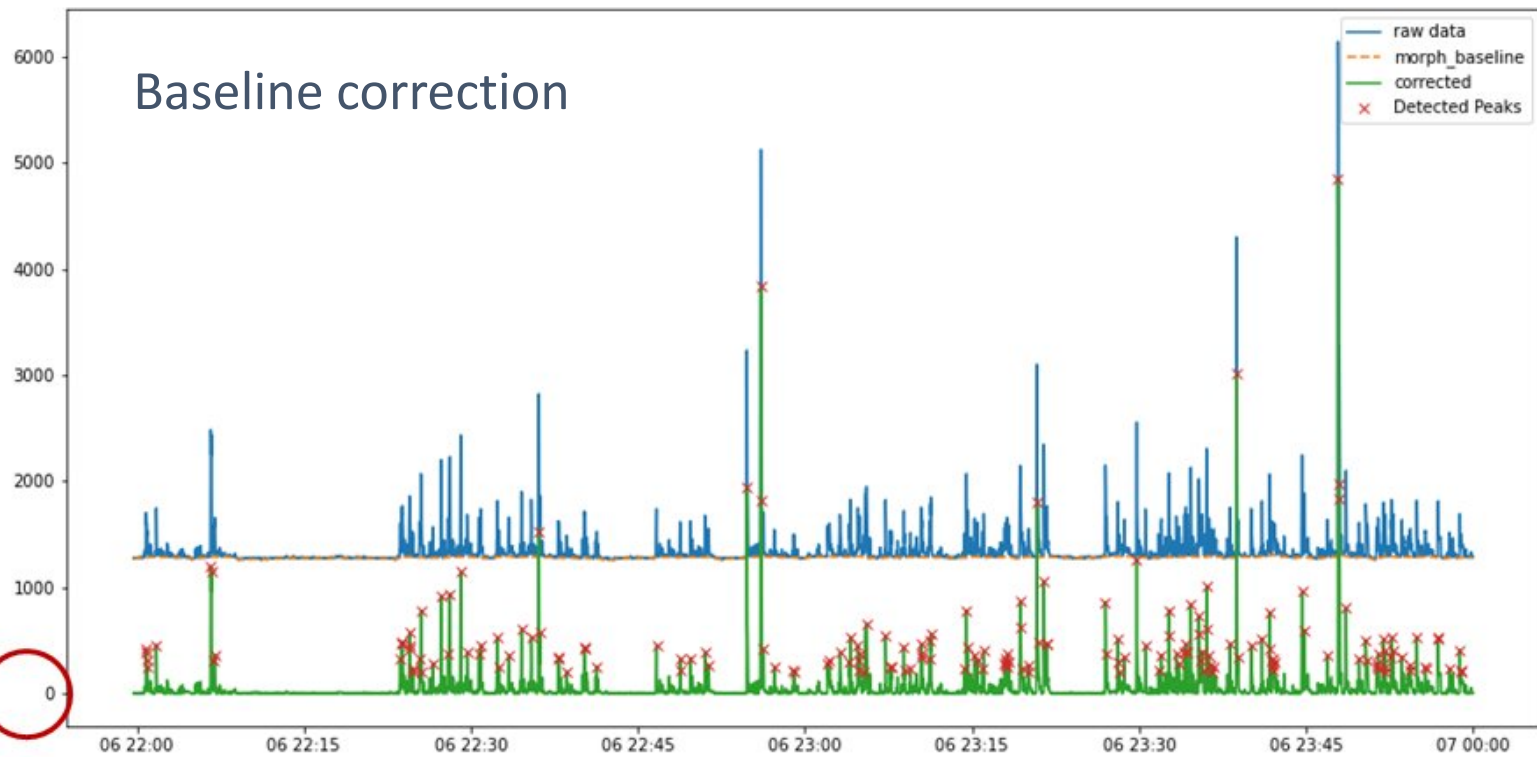
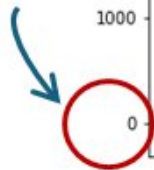
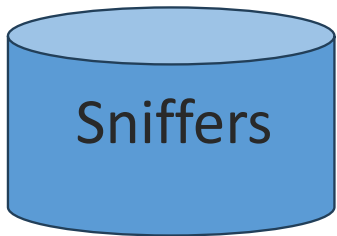
Baseline drifting





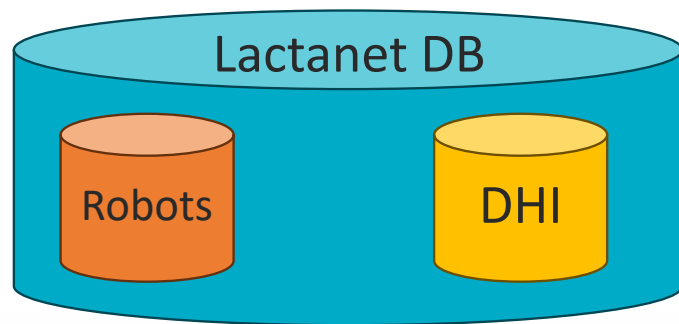
Materials & Methods

Data sources



Materials & Methods

Data sources



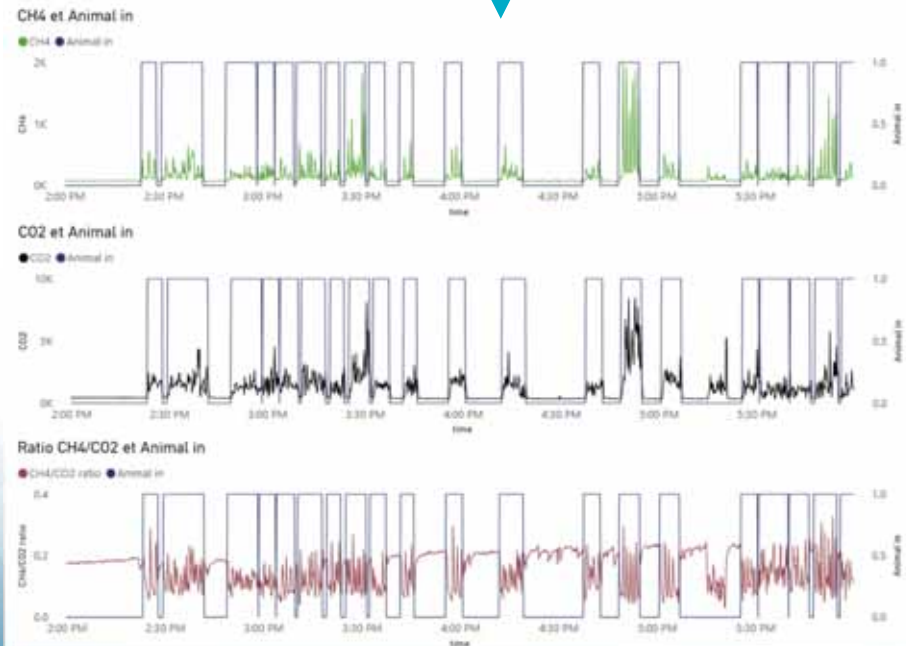
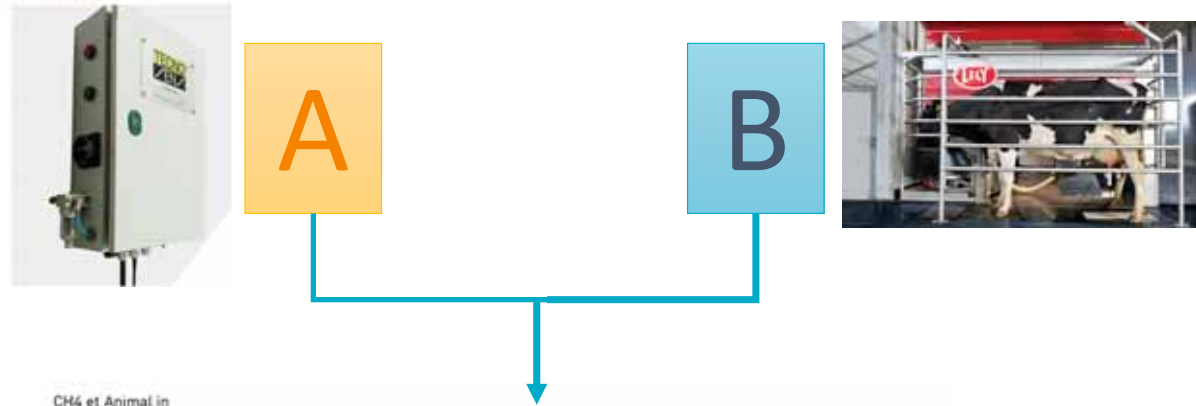
Animal id

Milking related data (robot no, milking time, DIM etc.)

Other animal information such as breed

B

Materials & Methods

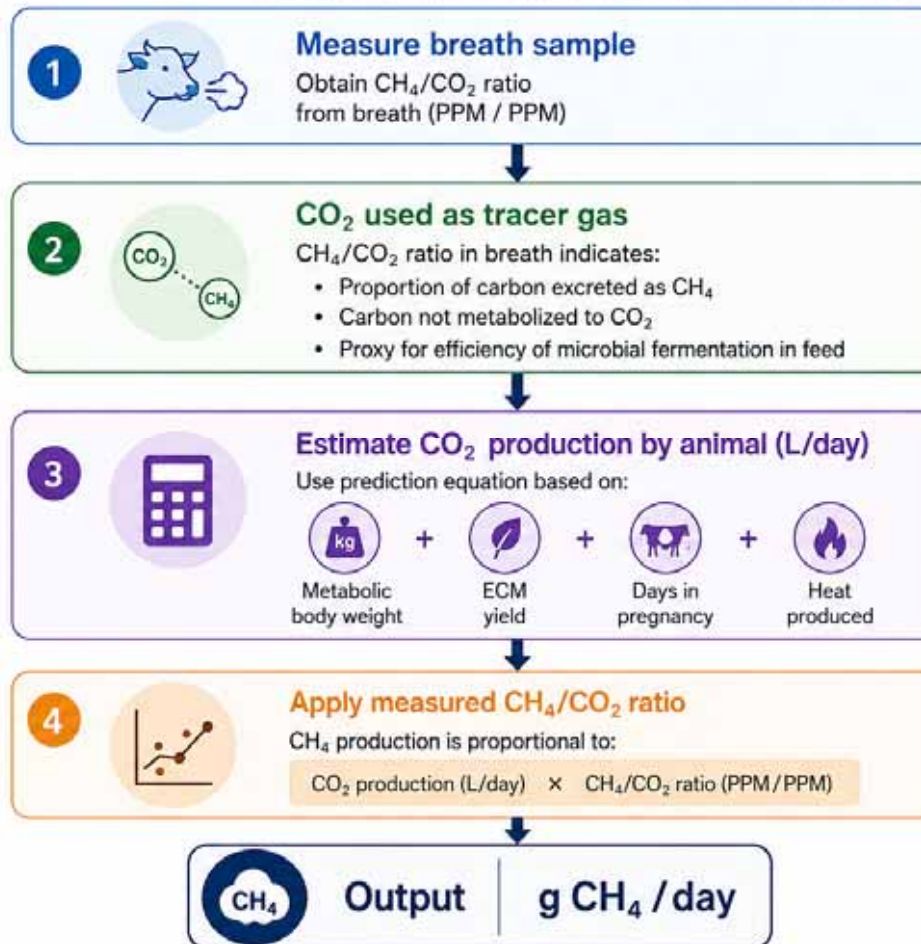


Apply a transfer function (Madsen et al., 2010) to convert ppm into enteric CH₄ emissions g/d and calculate the indicator by cow and herd

Materials & Methods

Transfer Function: Convert PPM to g CH₄/day

Based on the principle that CO₂ can be used as a tracer gas



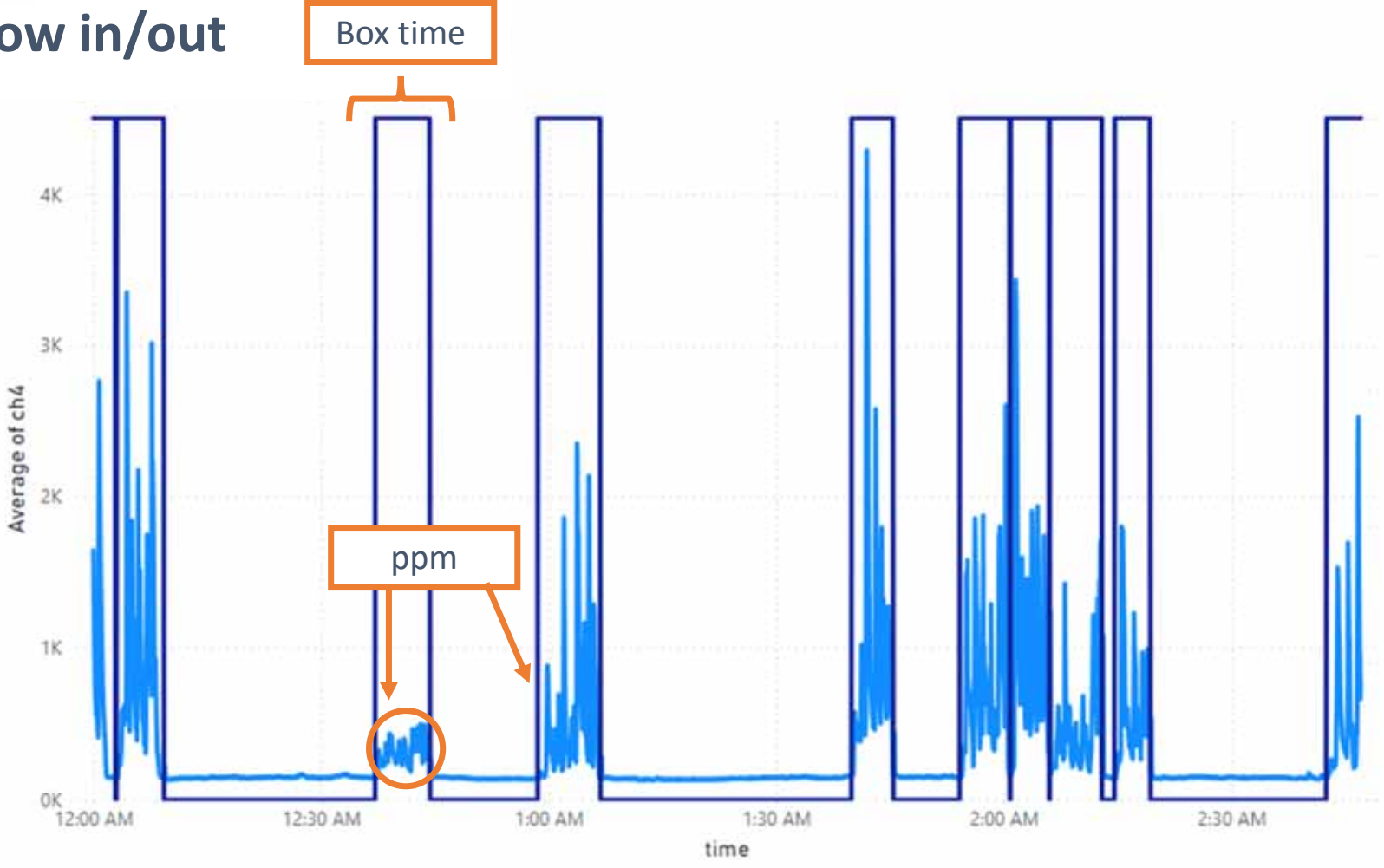
PPM = parts per million (mol/mol) | ECM = energy corrected milk

(Madsen et al., 2010)

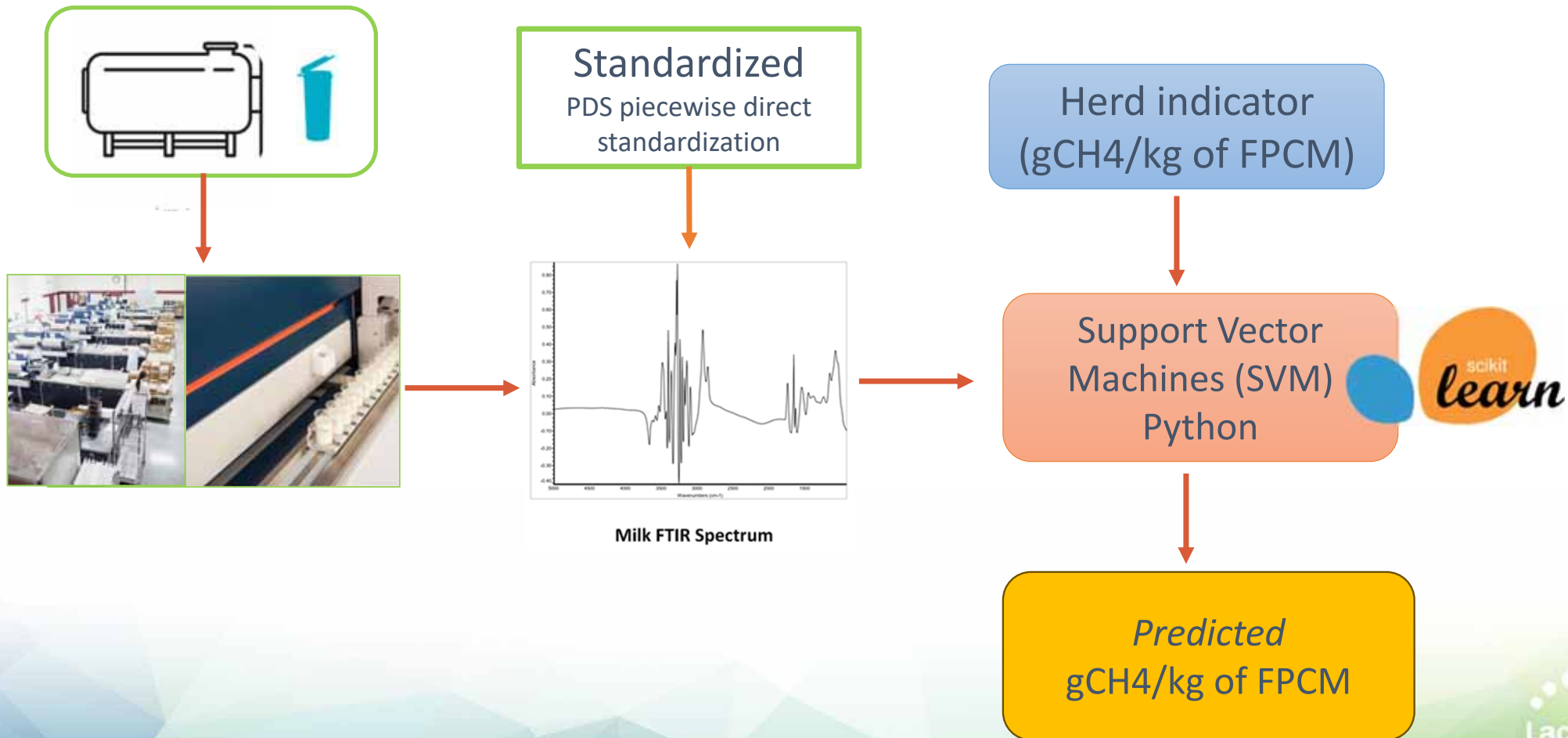


Materials & Methods

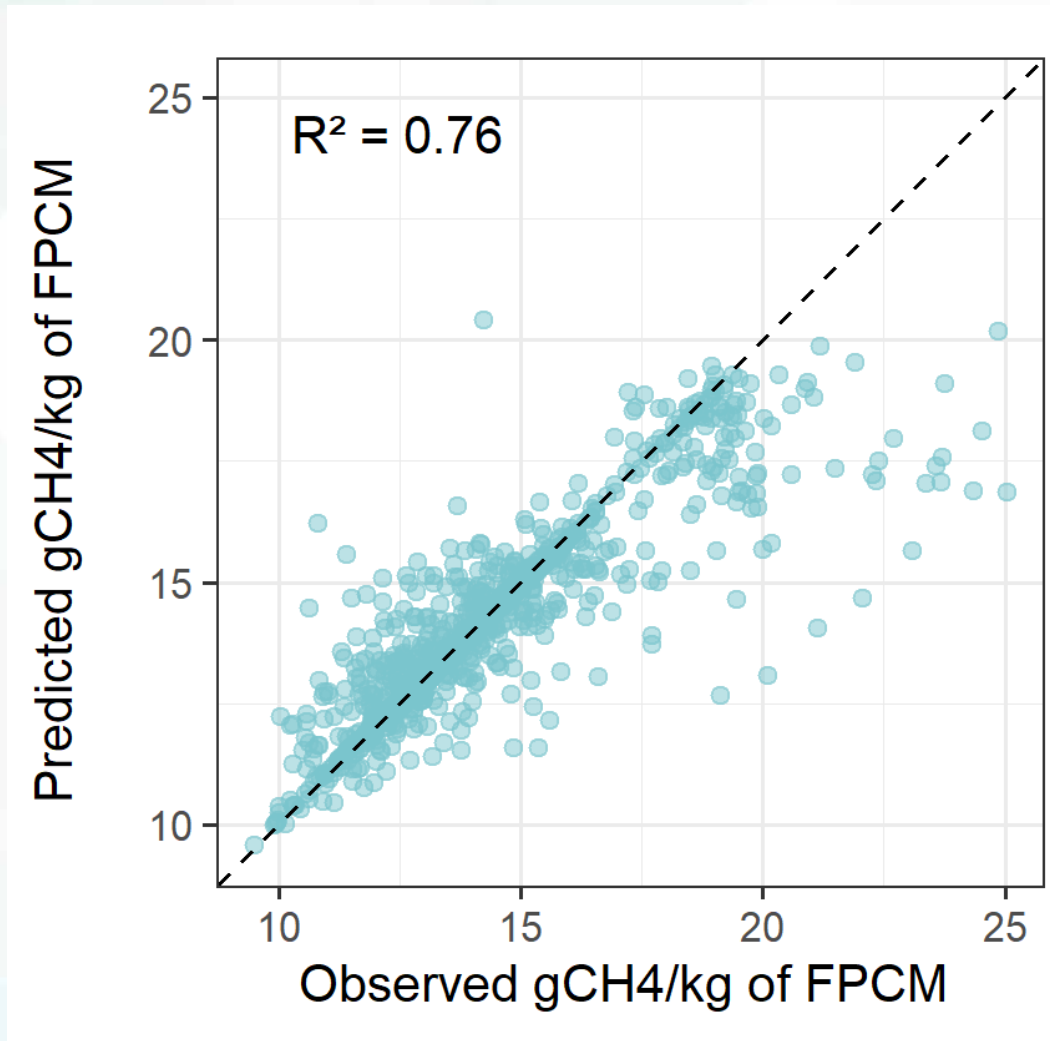
Cow in/out



Materials & Methods



Results



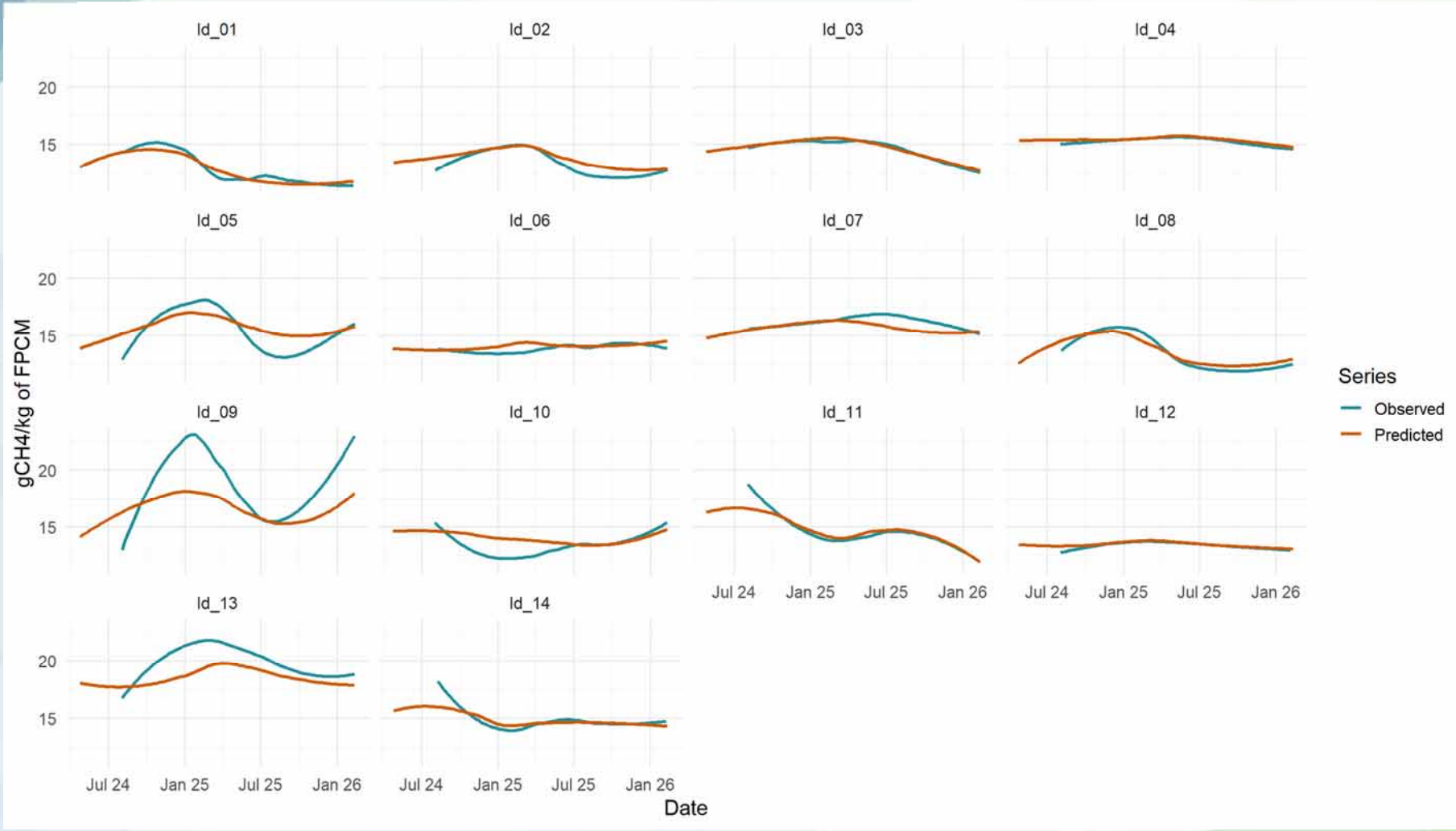
Training:

- $R^2 = 0.79$
- RMSEC = 1.19

Test:

- $R^2 = 0.54$
- RMSEP = 1.76

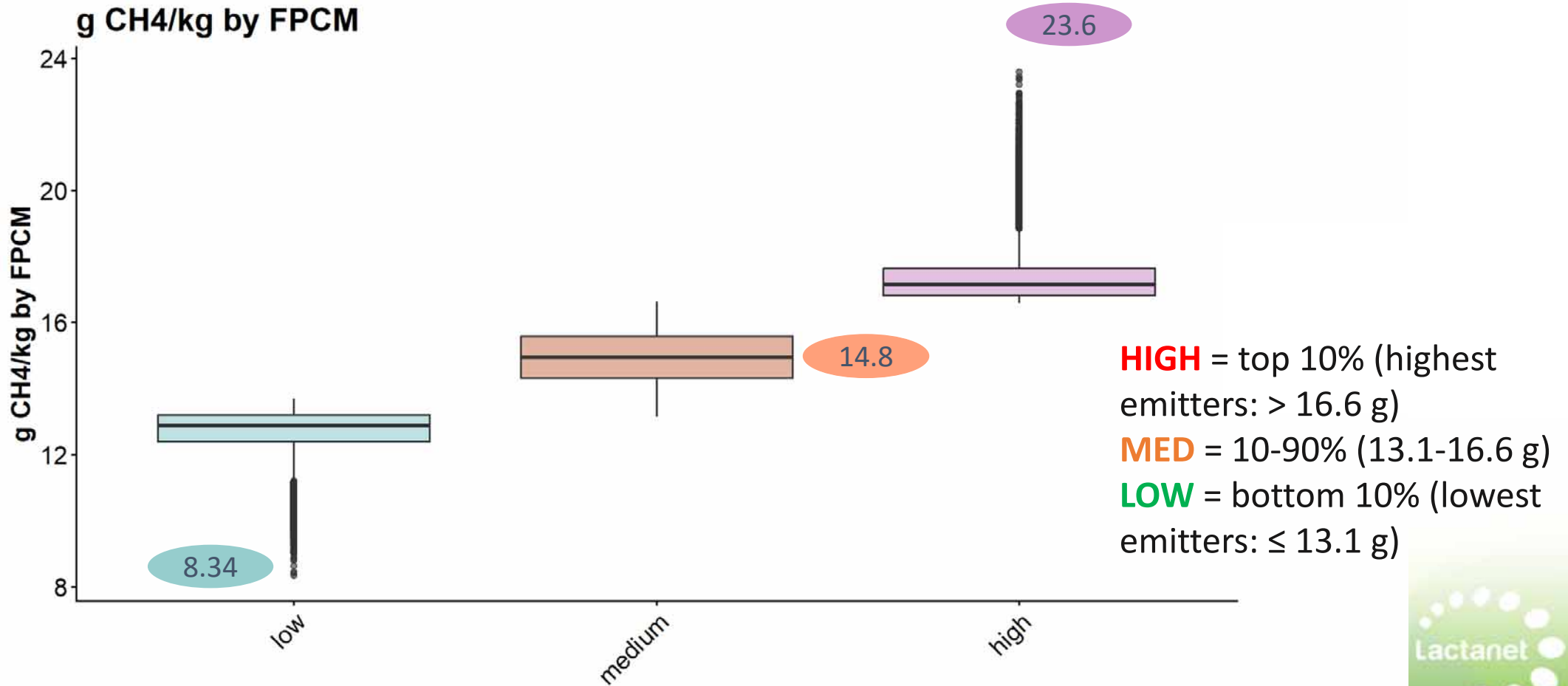
Results





Predicted enteric CH₄ emissions for all the herds in QC (n=4,280)

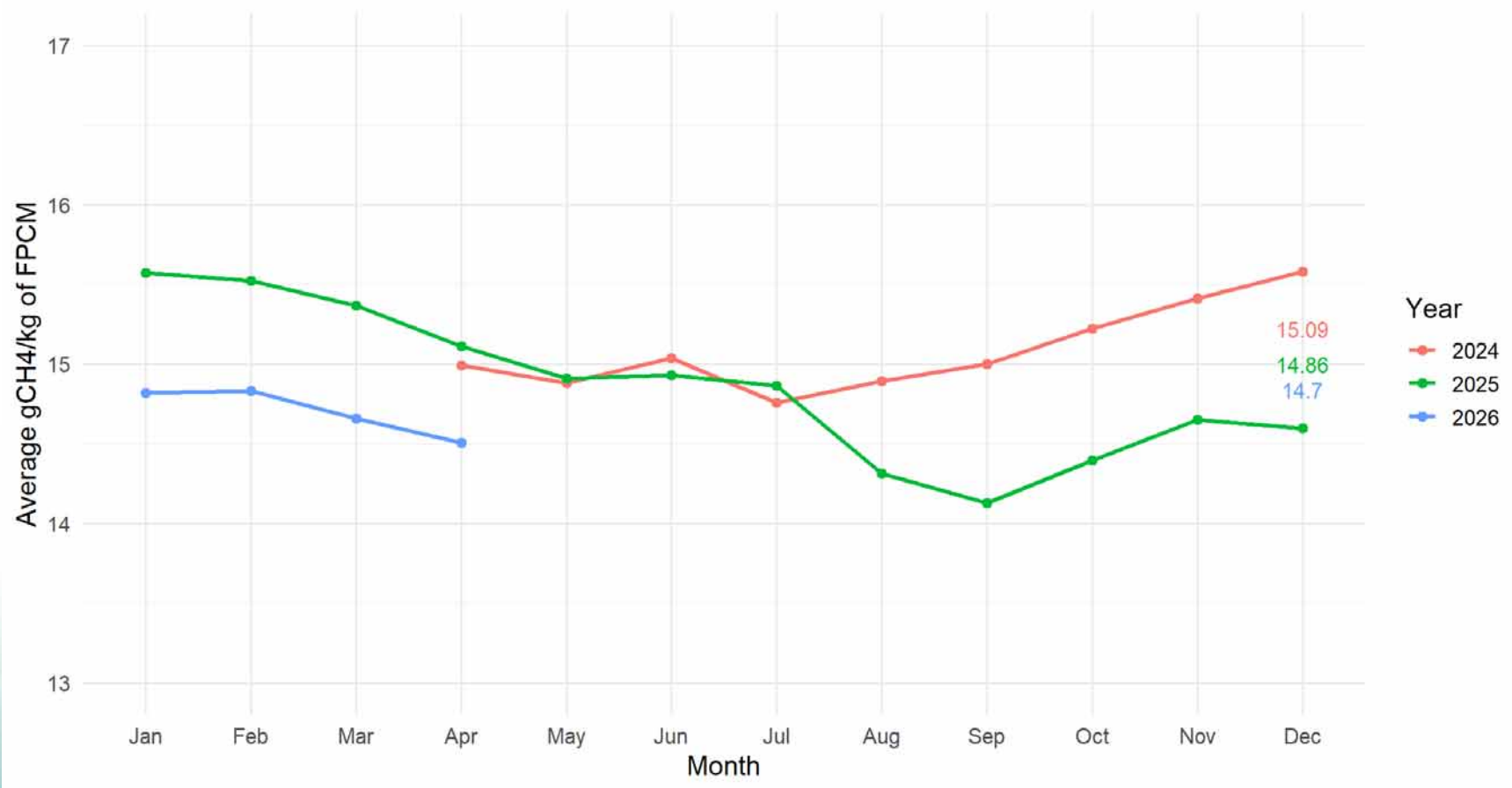
Results





Results

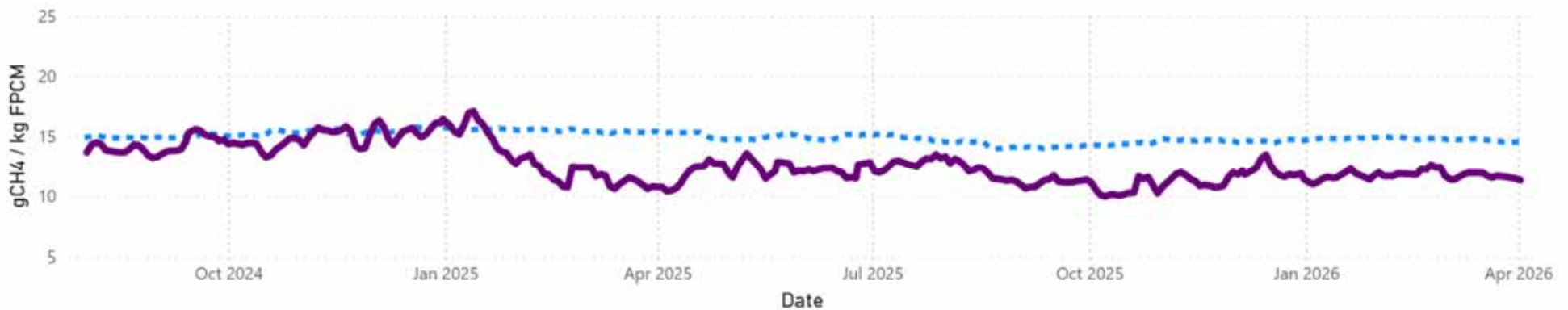
Predict enteric CH₄ emissions for all the herds in QC
(n=4,280)





Results

Predicted enteric CH₄ emissions for all the herds in QC
(n=4,280)



- Provincial average
- Farm enteric CH₄ emissions





Results

Model validation

Model outputs were validated indirectly using cow-level estimates

Results were consistent with values reported in the literature (studies done in Canada CH₄ g/cow/day)

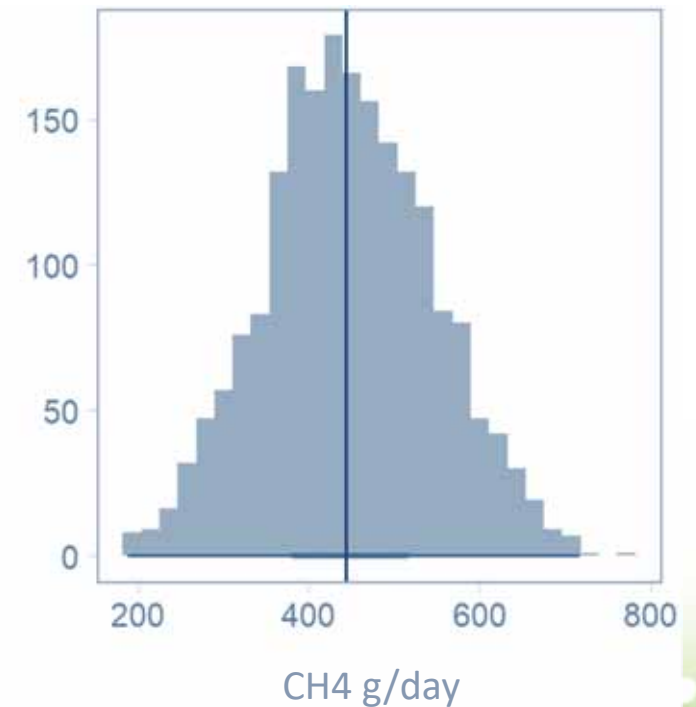
Oliveira et al. 2024 → 490 ± 81

Shadpour et al. 2022 → 462 ± 100

Environment and Climate Change Canada — National Inventory Report 2023 → 476

Velarde-Guillen et al. 2019 → 476 ± 72

457 ± 159 g CH₄/day
164–753 (5–95% range)



Wrap-Up & Next Steps

- Results indicate that the proposed model can effectively classify dairy farms according to their predicted enteric CH₄ emissions.
- May help identify management, nutritional, or environmental factors influencing enteric CH₄ emissions in Canadian dairy herds.
- Testing an Artificial Neural Network model
- Evaluating cow contribution model to the bulk tank



Acknowledgments



Les
Producteurs
de lait
du Québec

Plan pour une
économie
verte



Québec

This project is carried out with the financial support of the Government of Quebec as part of the 2030 Plan for a Green Economy.

<https://www.quebec.ca/gouvernement/eric-CH4-emissionsnt/politiques-orientations/plan-economie-verte>

14 participating farmers





Thank You

