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

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Enteric methane emissions (EME) account for approximately 30% of global methane emissions. As a result, there is growing interest in monitoring EME using practical, scalable approaches to support mitigation strategies. The objective of this study was to predict herd-level EME using bulk tank milk samples.

Twenty-four methane sniffers were installed on 14 commercial dairy farms equipped with automatic milking systems across Quebec, Canada, starting in August 2024. The sniffers recorded CO_2, CH_4, airflow, humidity, and temperature every 1 second (1.102 billion records collected by December 31, 2025). Sniffer measurements were averaged by 10 seconds and matched to individual milkings for each cow and subsequently aggregated at the herd level. Because sniffer outputs were expressed in ppm, a transfer function (Madsen et al., 2010) was applied to convert methane concentrations into daily EME (g/day). To enable comparisons across farms, predicted EME were expressed as grams of CH_4 per kg of FPCM. A support vector machine model was developed using bulk tank milk spectra to predict herd-level EME (R2 0.72 and 0.55 RMSE 1.32 and 1.74 for training and test sets, respectively, RPD 1.6).

The model was applied to all 4,280 dairy herds in Quebec in 2025 (n= 718,184). The average predicted EME was 14.9 g CH_4/kg FPCM, with values ranging from 8.6 to 24.6 g CH_4/kg FPCM. The averages for summer and winter were 14.8 and 15.2, respectively. Hierarchical cluster analysis could discriminate between herds whose EME were predominantly either in the fourth or first quartile relative to the population, demonstrating the model's ability to discriminate between low and high emitting herds.To our knowledge, no previous studies have reported EME at the herd level. Therefore, model outputs were validated indirectly using cow-level estimates, which were consistent with values reported in the literature. The results indicate that the proposed model can effectively rank dairy farms according to their predicted EME. Such rankings may help identify management, nutritional, or environmental factors influencing EME in Canadian dairy herds.