



Prediction of methane emissions based on milk fatty acid profiles shows similar performance to milk MIR spectra

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VERONA ITALY



Background

Reducing methane emissions in dairy cattle



Direct methane measurements are expensive → **One possible solution: Prediction of methane emissions using milk MIR spectra** (Dehareng et al, 2012; Vanlierde et al., 2021)

APPLICATIONS

- DHI Baden-Württemberg (FeMIR report - Dale et al., 2024), DHI Bavaria (since 2025 - <https://www.lkv.bayern.de/methanauswertungen-ab-2025-im-lkv-zwischenbericht/>) for herd management
- Canada: Single step genomic evaluation for MIR predicted methane since April 2023 (Shadpour et al., 2022; Oliveira et al., 2024; Van Doormaal et al., 2023).
- Belgium, France and Ireland will launch genetic evaluation for milk MIR predicted methane by end of 2025 (Zanon et al., 2025)

What is MIR-predicted methane?



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Black box trait

The biological mechanisms linking milk MIR spectra to methane emissions are not understood.

Objectives of this study



1. Develop a prediction model for methane emissions in Austrian dairy cows (Fleckvieh and Brown Swiss) using milk mid-infrared (MIR) spectra.
2. Compare this model with model based on milk composition traits (14 fatty acids (FA), fat%, protein%, lactose%) to better understand the underlying biological signals.

breed4green - Direct and indirect traits for feed efficiency and greenhouse gas emissions for breeding and herd management



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- **Project duration**

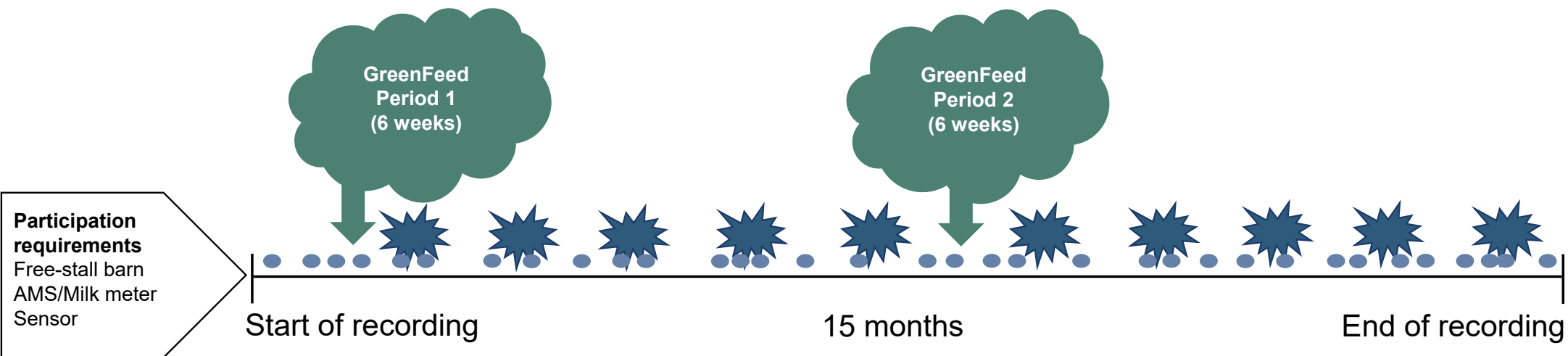
January 1, 2023 - December 31, 2027

- **Measuring methane emissions using GreenFeed**

- **Research farm** Raumberg-Gumpenstein
- **Commercial farms**
25 Fleckvieh & 5 Brown Swiss dairy farms
 - Farms with high automation (AMS or daily milk yield, sensor system) and milk yield with indoor feeding (grass and/or maize silage and concentrate)
 - No feed additives that reduce methane emissions
 - Limitation: no pasture



- **Data from external cooperations**



Kristina Linke: breed4green: First results from a dataset on methane emissions in commercial farms for genetic studies

Thursday – 4 June 2026 (12:15-12:30) | Industria Room

Technical Session 8

From Measurement to Genetics: Methane Emission and Feed Efficiency

Data



- Data from 16 commercial farms, for 11 farms already data from period 1 and 2 available (Fleckvieh and Brown Swiss)
- Calculated the mean methane emission for each cow with at least 19 spot samples in the respective period
- The milk recording data selected for analysis was the one corresponding to the week with the highest number of methane measurements
- Milk MIR Spectra (the same as in Vanlierde et al., 2021):
 - First Derivate Transformation
 - Used the following wave points: 10-168, 205-228, 423-528 → 289 relevant wave points
 - Outliers in spectral data removed based on Mahalanobis Distance to ensure a cleaner model
- After edits: 807 records from 604 cows

Model



- **PLS - Predictors**

- Model 1: Milk MIR spectra (LP2)
- Model 2: Milk components (14 FA, LP2)
- Model 3: Milk MIR spectra (LP2) + DIM (1-3, dummy variable) + parity (1-5+, dummy variable) + milk yield (LP3)
- Model 4: Milk components (14 FA, fat%, protein%, lactose%, LP2) + DIM (1-3, dummy variable) + parity (1-5+, dummy variable) + milk yield (LP2)

- **Cross-validation**

- 5 fold cow-independent cross-validation: Ensuring that records from same cow stay together - no mixing of records from same cow in calibration (training) and validation (testing)
- Leave-one-herd-out validation

Validation results



Predictors	5-fold cow independent cross-validation			Leave-one-herd-out validation		
	R	R ²	RMSE	R	R ²	RMSE
MIR	0.52	0.27	59	0.42	0.22	64
FA	0.42	0.18	63	0.41	0.21	67
MIR + DIM + P + MILK	0.61	0.38	55	0.56	0.33	58
FA + Fat% + Protein% + Lactose% + DIM + P + MILK	0.61	0.37	55	0.58	0.35	57

Correlations between predictions



Model	MIR + DIM + P + MILK	FA	FA + Fat% + Protein% + Lactose% + DIM + P + MILK
MIR	0.77	0.66	0.64
MIR + DIM + P + MILK		0.45	0.86
FA			0.63



Trait	Origin	Correlation with methane			
		All (n=807)	5-90 DIM (n=252)	91-180 DIM (n=206)	181-365 DIM (n=349)
Milk yield		0.26	0.40	0.39	0.35
Fat%		0.00	-0.11	0.10	-0.08

Energy Status as a Key Signal in Milk Mid-Infrared Spectra

Signals from fatty acids - reflect the cow's energy status (feed intake vs. mobilization of body reserves)

C18:2 cis-9, cis-12	Preformed	-0.18	-0.25	-0.03	-0.08
C18:3 cis-9, cis-12, cis-15	Preformed	0.03	-0.06	0.14	0.06
C18:2 cis-9, trans-11	Preformed	0.05	-0.06	0.04	0.03

Conclusions



- **Prediction of methane based on milk FA shows similar performance to milk MIR spectra**
- Milk MIR spectral and FA explained a part of the variability in methane emissions: signals related to **energy status (feed intake vs. mobilization of body reserves)**
- If milk MIR spectra is used to predict methane: **favors cows with a negative energy balance (during early lactation)**, as well as those with consistently **lower de novo FA synthesis** → could **compromise animal health and fertility**

Outlook



- **Validation** of developed models
- Modeling methane emissions from dairy cows is complex (MIR+parity+DIM+milk yield → **$R^2 = 33-38\%$**)
- Further development
 - ML models
 - Additional predictor traits: body weight, feeding information, AMS data, sensor data,...

First results see C. Matzhold (ZuchtData) at EAAP 2026



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Duration: 1.5.2023 - 31.10.2027

Project partners



 HBLFA
Raumberg-Gumpenstein
Landwirtschaft



supported by the BMLUK and dafne.at

 Federal Ministry
Agriculture and Forestry, Climate
and Environmental Protection,
Regions and Water Management
Republic of Austria



Cooperation and supporting partners



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