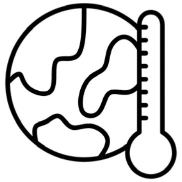
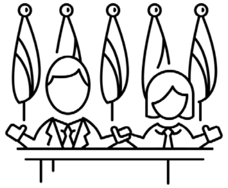
Genetic parameters for methane production, intensity, and yield predicted from milk mid-infrared spectra throughout lactation in Montbéliarde cows

Solène FRESCO, D. Boichard, S. Fritz & P. Martin

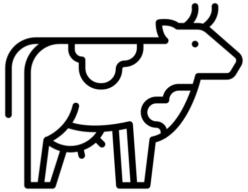
Context



Climate change
& CH_4 emissions



International political
commitments



Ruminants contribution
to CH_4 emissions

Need for tools to reduce CH_4 emissions → Genetic evaluation

Direct measurements are challenging and not adapted for large-scale phenotyping

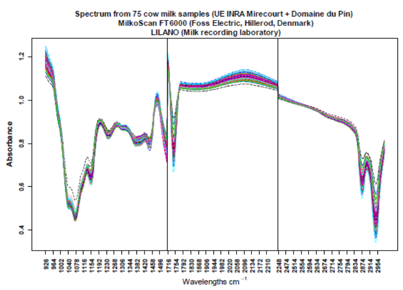
→ Prediction from milk mid infrared (MIR) spectra

The Methabreed project

Led by Eliance and funded by APIS-GENE

1

Develop methane prediction equations from milk MIR spectra and GreenFeed measurements



2

Apply the equations to the national database

3

Develop **genetic** and genomic analyses using the predictions as phenotypes

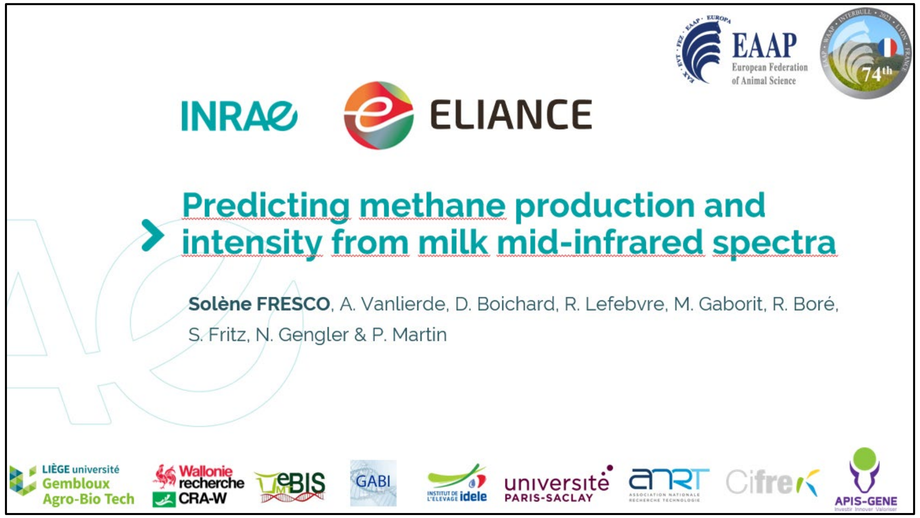
Develop a genomic evaluation

Propose new breeding goals

Development of the prediction equations

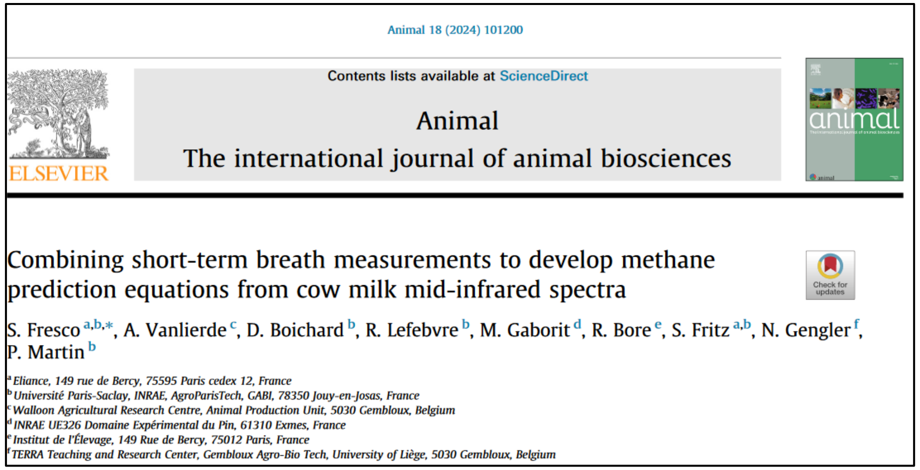
Development of methane prediction equations from milk MIR spectra (1,800) & direct measurements with GreenFeed devices (26,000) using the Partial Least Square method

→ Presented at EAAP 2023 and published in Animal (2024)



<u>4 equations:</u>

- MeP_direct in g/d
- MeI in g/kg of FPCM
- MeY in g/kg of DMI
- MeP_indirect = predicted MeI x observed FPCM in g/d



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Combining short-term breath measurements to develop methane prediction equations from cow milk mid-infrared spectra

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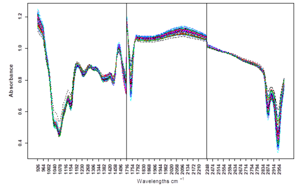
Application of the equations

Milk recording companies



MIR spectra routinely collected from commercial farms

Prediction equations

CH4 predictions

MeP direct (g/d)
MeI (g/kg of FPCM)
MeY (g/kg of DMI
MeP indirect (g/d)

<u>Genetic analyses of CH4 traits:</u>

- **Estimation of genetic parameters**
- Single-Step Genomic evaluation
- Response to selection

608,072 MIR spectra collected between 70 and 200 DIM from 92,500 1st and 2nd parity Montbéliarde cows

Statistical description of CH4 predictions in 1st lactation

CH4 traits	MeP_direct g/d	MeI g/kg FPCM	MeY g/kg DMI	MeP_indirect g/d
Mean (SD)	403 (36)	13.6 (1.6)	17.1 (1.2)	299 (72)
Min - Max	245 - 556	7.6 - 19.2	13.4 - 21.5	81 - 535

Modeling traits throughout lactation

Random regression models to account for repeated measurements (Wombat, Meyer 2007)

$$\mathbf{y} = \mathbf{X\beta} + \mathbf{Za} + \mathbf{Wpe} + \mathbf{e}$$

Herd x test-day
Year x month of calving
Age at calving
DIM (polynomial function)

$$\mathbf{a} \sim \mathbf{N}(\mathbf{0}, \mathbf{A} \otimes \mathbf{G_0})$$

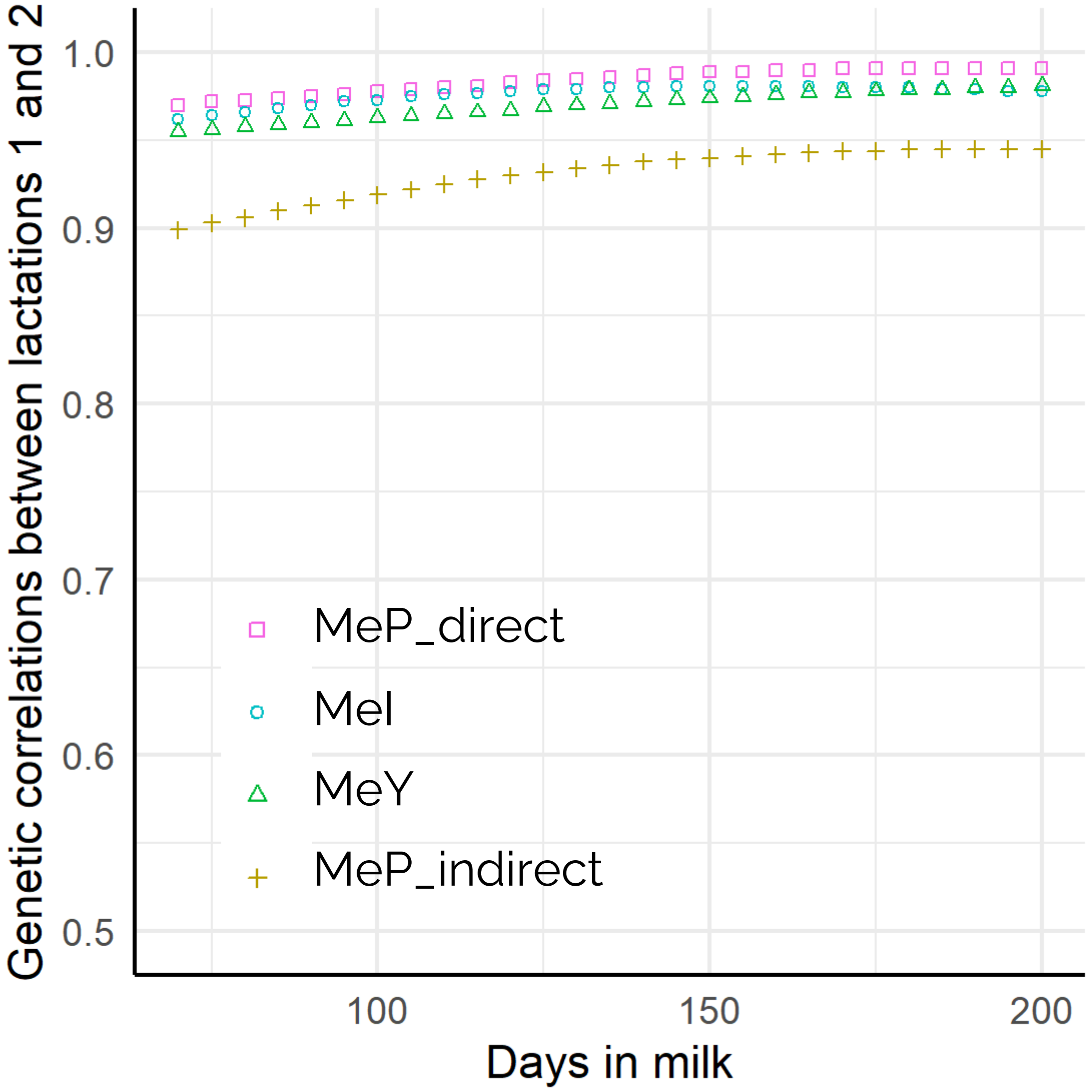
$$\mathbf{pe} \sim \mathbf{N}(\mathbf{0}, \mathbf{I} \otimes \mathbf{P_0})$$

Heterogeneous
(7-day classes)

Stability of the CH_4 traits between and within lactations

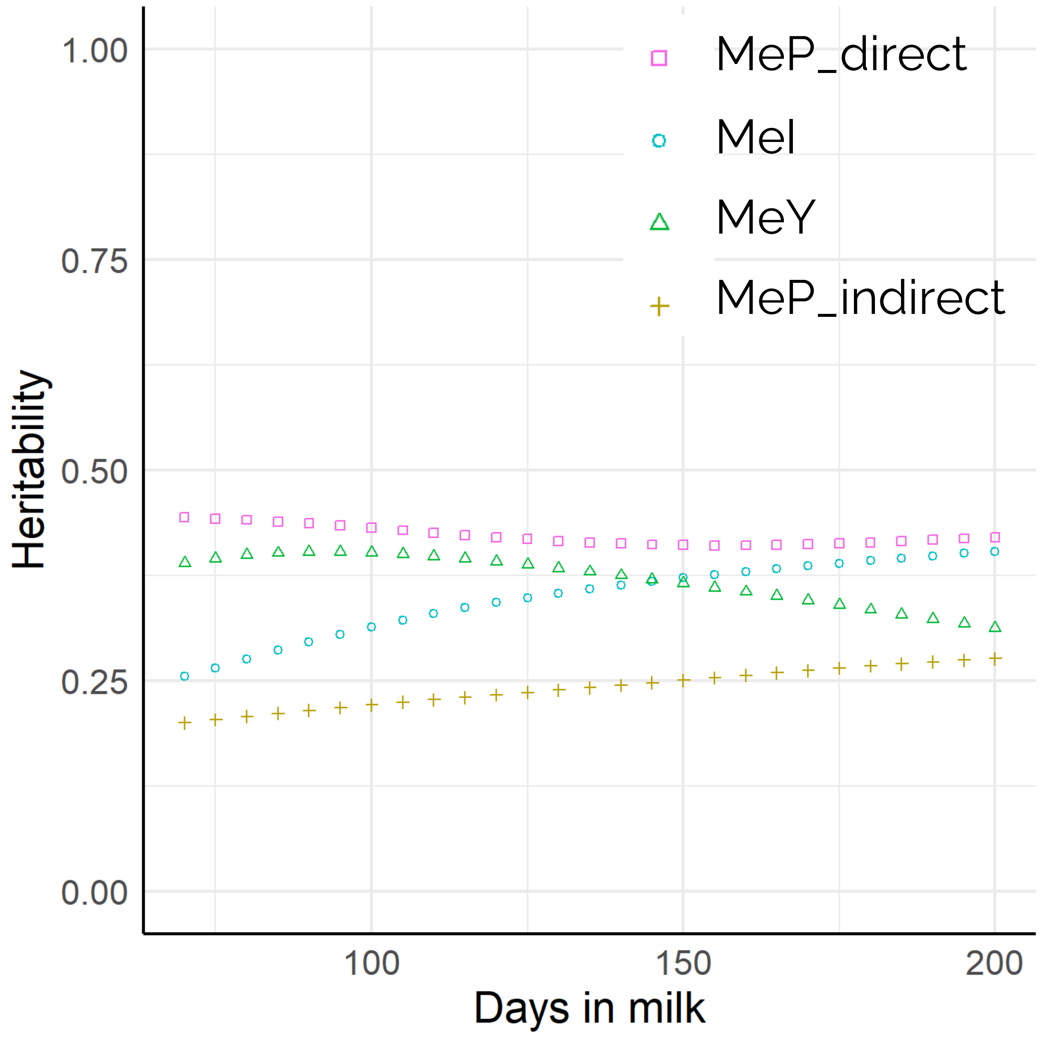
CH4 traits stable between lactations
(average genetic correlations > 0,93)
→ Results in 1st lactation can be extrapolated to 2nd lactation

CH4 traits stable within lactation
(average cross-correlations > 0,93)

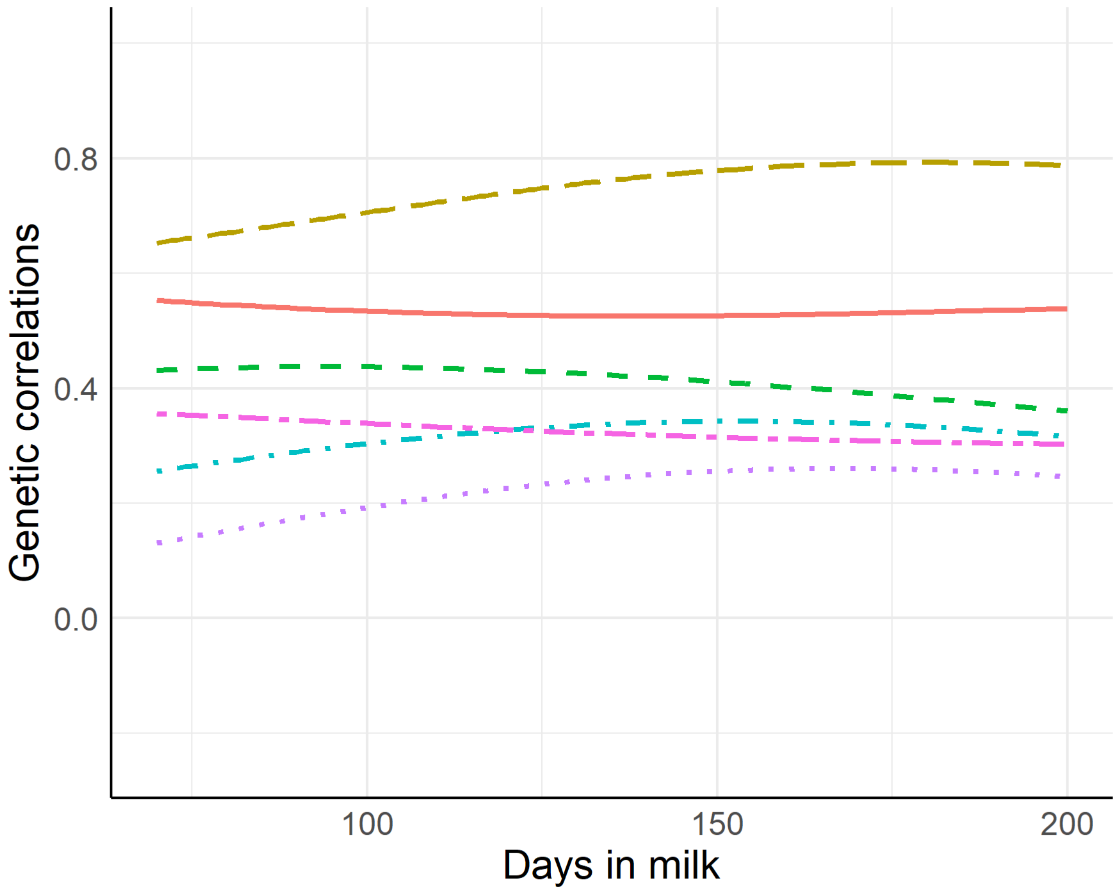


CH_4 traits moderately heritable

Moderate heritability estimates with averages ranging from 0.27 to 0.44 for the four CH4 traits



Genetically different CH_4 traits



CH4 traits **genetically distinct** despite a common basis
→ average genetic correlations of 0.74 for MeP_direct/MeY & 0.53 for MeI/MeP_indirect (<0.40 for the other)

Expected because different units and different methodologies (MeP_direct & MeP_indirect)

Which trait(s) to select for ?

Genetic correlations between CH_4 and milk traits

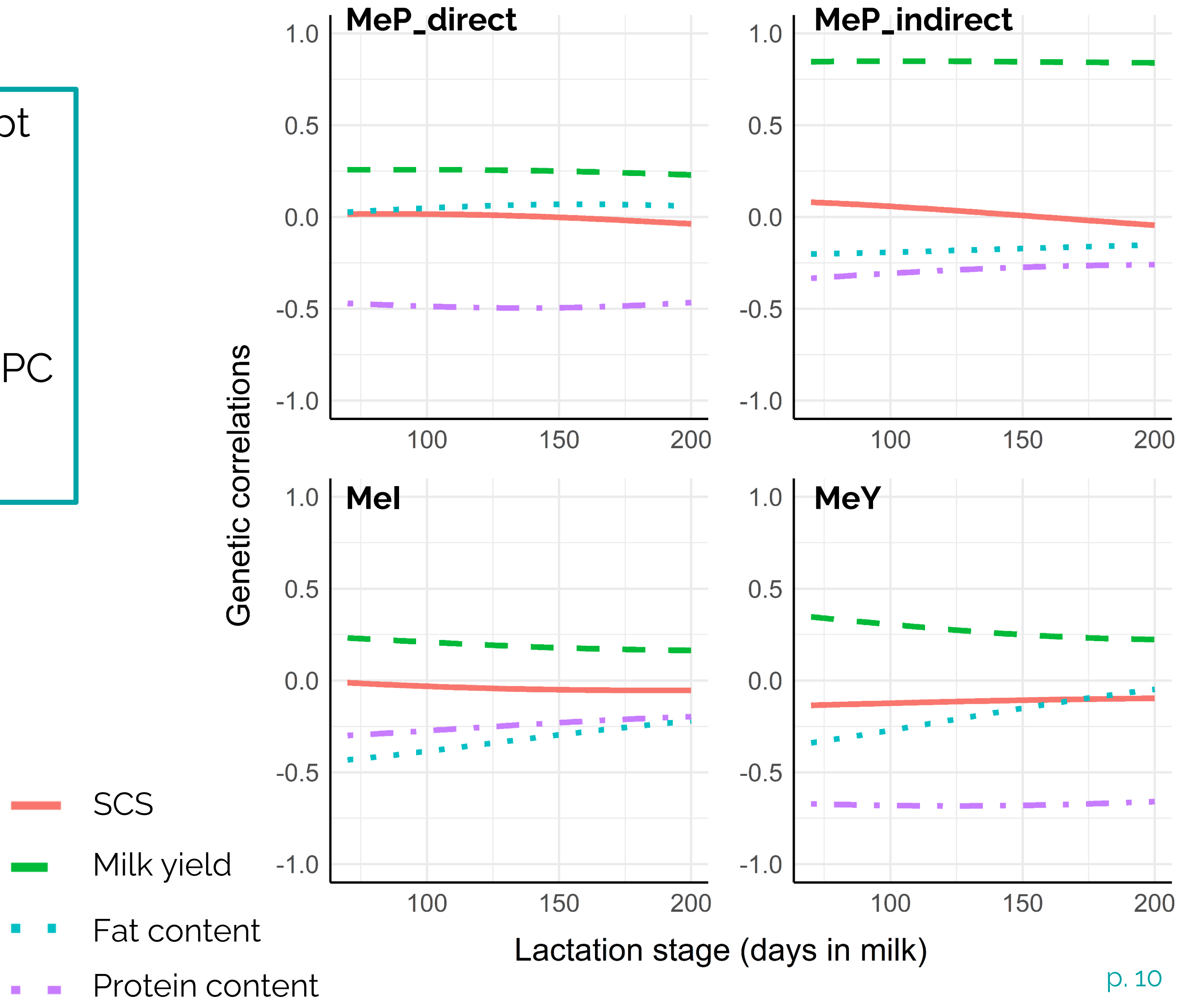
Weak unfavorable correlations with MY except for MeP_indirect

Weak correlations with SCS

Weak to moderate favorable correlations with PC

Weak favorable or null correlations with FC

Compatible with inclusion of CH4 traits into breeding goals



Take home messages

- Environmental impact of dairy cows due to CH4 production when digesting fibers

- Predict CH4 emissions from milk MIR spectra → obtain sufficient quantity of data to develop robust genetic analyses

- Technically possible to select to reduce CH4 emissions (heritability, genetic correlations…)

- Which CH4 trait(s) to select for ?

- It remains to quantify the impact of such a selection, and to determine the acceptability of its implementation (consequences of CH4 selection on other traits of interest).

Thank you for your attention !

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