gembloux agro bio tech

Université de Liège

Genetic parameters for methane emissions predicted from milk mid-infrared spectra in dairy cows

  

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Introduction

- Methane (CH_4) is the largest contributor to total greenhouse gas emitted by the dairy sector.
- CH_4 is 21 times more potent to CO_2 in greenhouse effect.
- Generally CH_4 is measured by respiration chamber or Sulphur hexafluoride (SF_6) method in animals.
- Phenotype gap for direct CH_4 measurement leads to indirect indicators:
    - Milk fatty acids in milk
    - Direct MIR prediction from milk
    - Other proxies

IPCC (2007), FAO (2010), EU (1998), Johnson (1994), Koch et al. (1963), Chilliard et al. (2009), Dijkstra et al. (2011), Dehareng et al. (2012)

Objectives

- Prediction of CH_4 emission (g/day) and CH_4 intensity (g/kg of FPCM)
- Estimation of heritability for these CH_4 traits
- Genetic correlation estimate of these CH_4 traits with FPCM, fat yield and protein yield
- Estimation of EBV of CH_4 traits

Calibration statistical parameters

	N	SD	SECV	R^2cv
CH_4 g/day	452	126.39	68.68	0.70

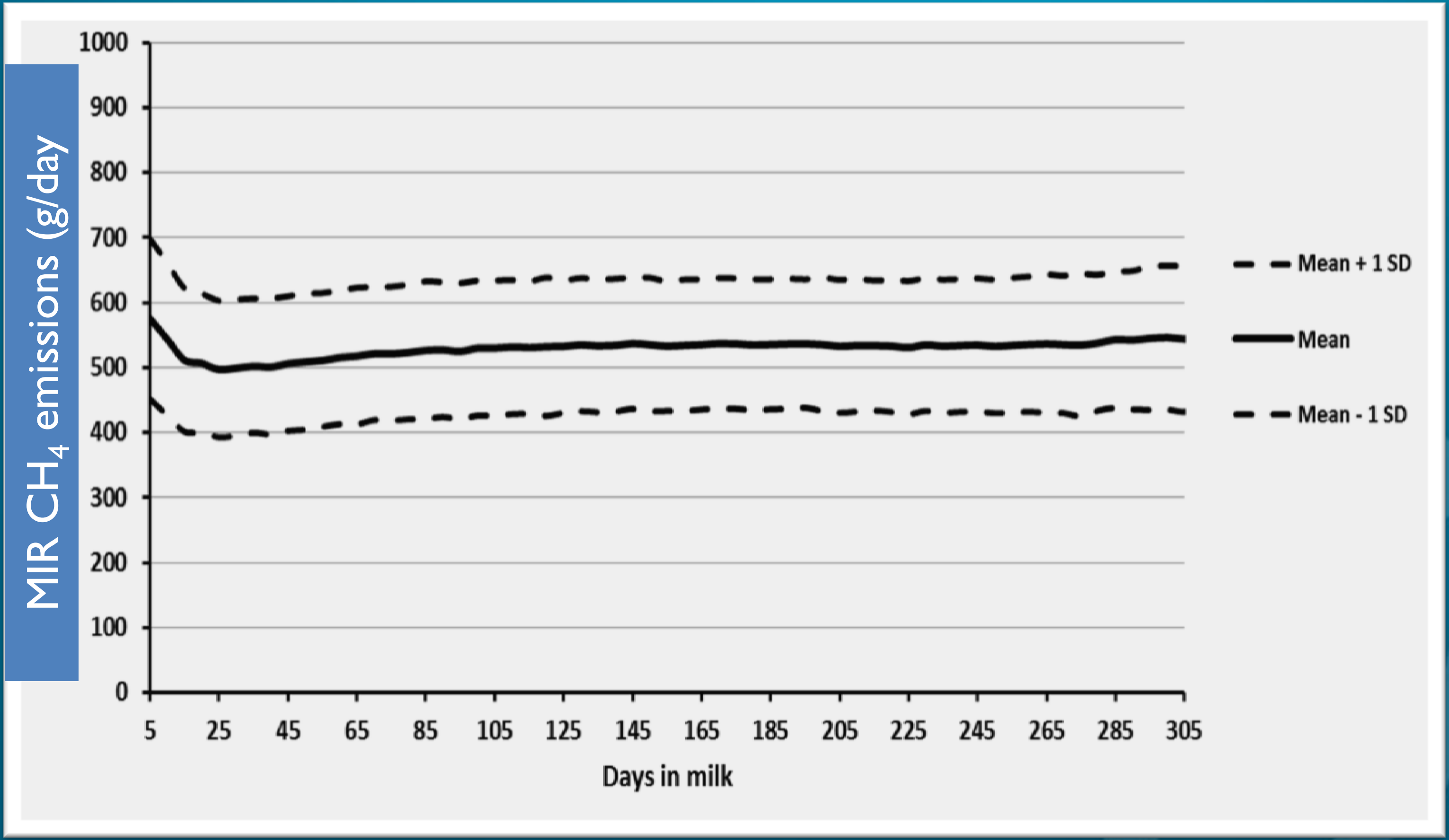
Vanlierde et al. (unpublished)

SECV=standard error of cross validation
R^2cv=cross validation coefficient of determination

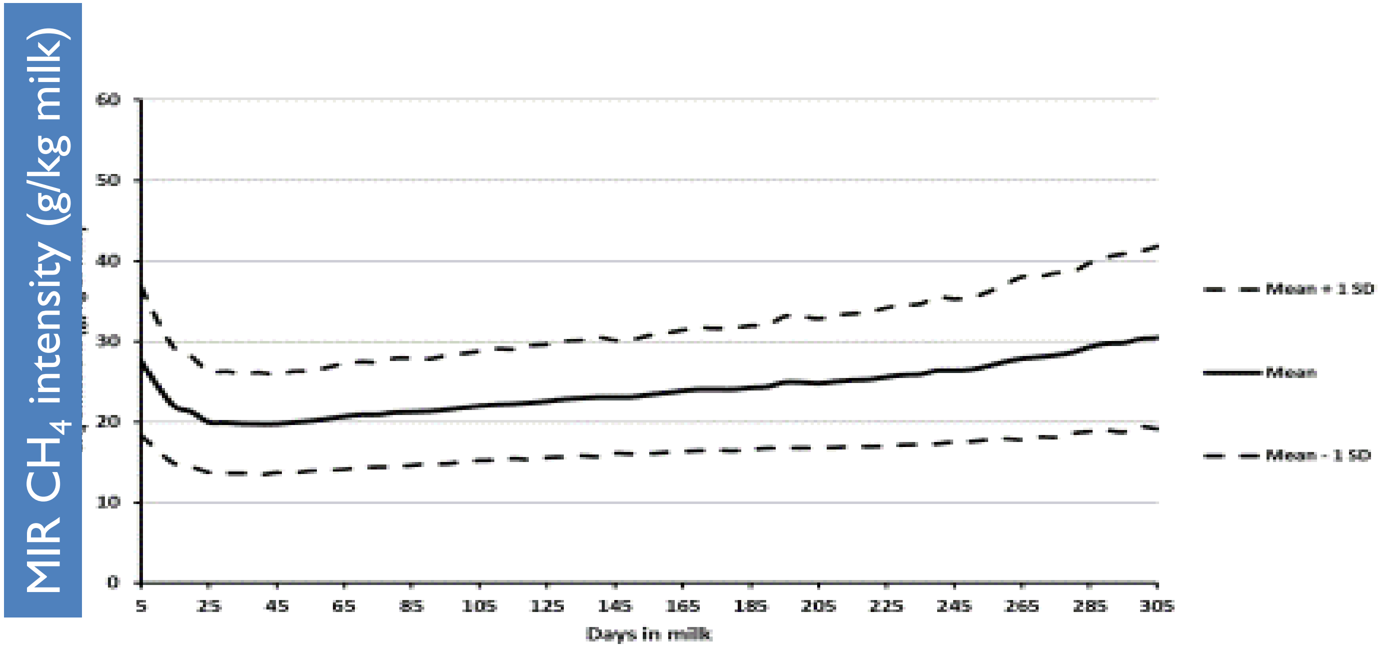
MIR CH_4 predictions and milk production traits

Traits	Parity 1 (N=338,917)	Parity 2 (N=221,420)	Parity 3 (N=119,107)
MIR CH_4 (g/d)	547 ±111	559±112	558±114
CH_4 intensity (g/kg of FPCM)	23.66±8.21	21.51±8.53	20.37±8.56
FPCM (kg/d))	23.98±5.64	27.58±7.50	29.32±8.27
Fat yield (kg/d)	0.93±0.23	1.08±0.31	1.16±0.35
Protein yield (kg/d)	0.79±0.19	0.91±0.24	0.95±0.26

Evolution of the MIR CH_4 emissions (g/day) over the first lactation



Evolution of the MIR CH_4 intensity (g/kg milk) over the first lactation



Multi-trait random regression test day model

$$y=X\beta+Q(Zp+Zu)+e$$

y: MIR CH_4 indicators and milk traits (total 5)

β: herd x test day, 24 classes of days in milk, and 3 classes of age at calving → fixed effects

p: random permanent environmental effects

u: additive genetic effects, e: random residual effect

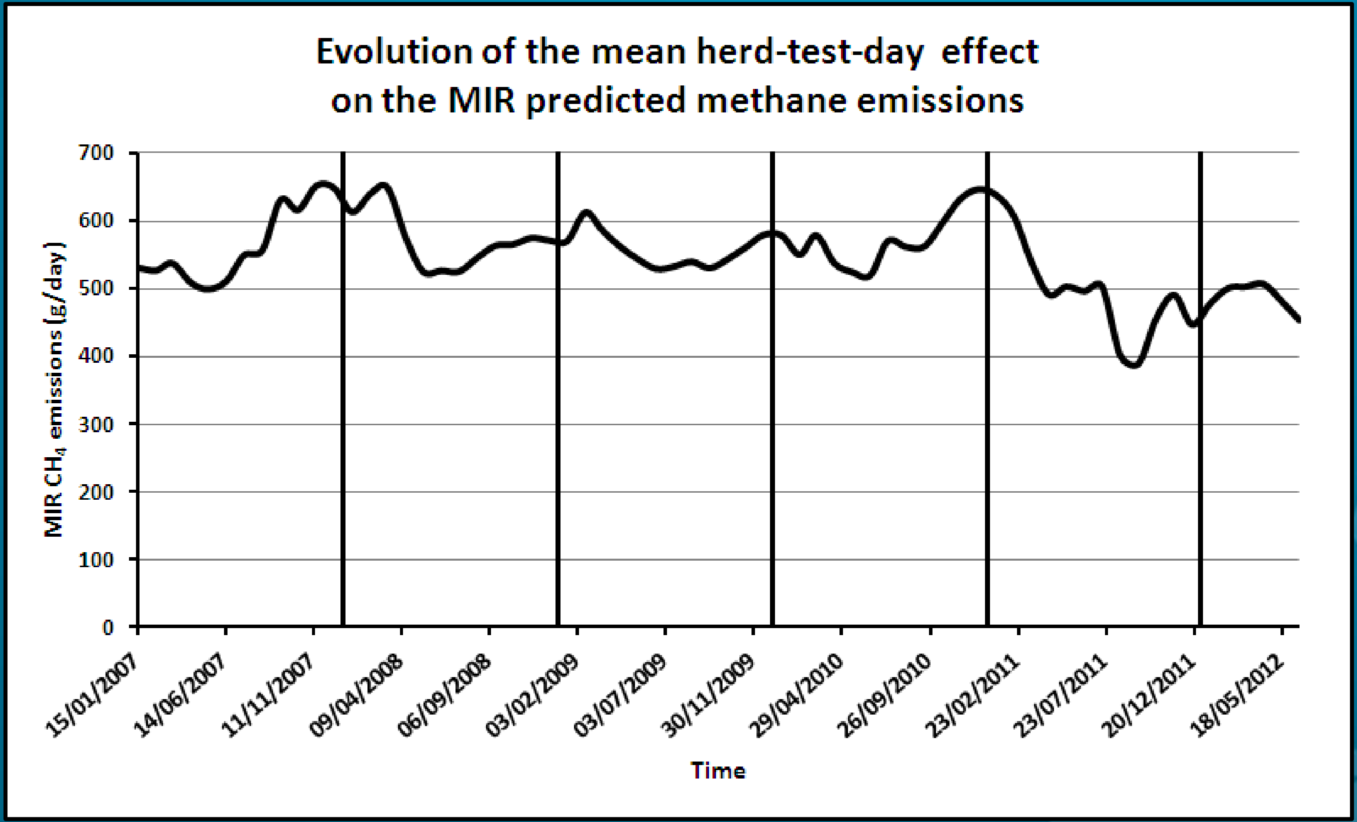
Q: coefficients of 2^{nd} order Legendre polynomials

Prior - variance components- REML

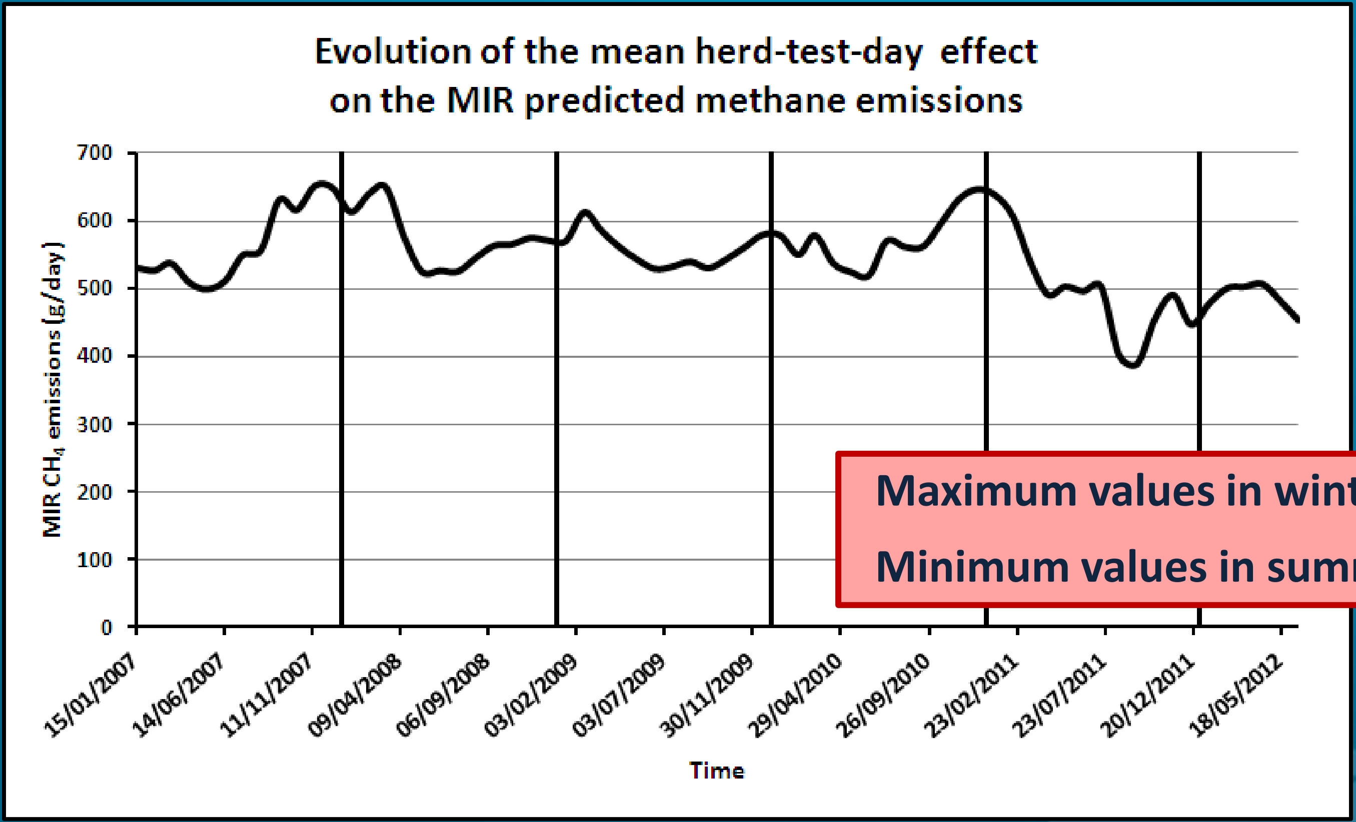
Variance components – Gibbs Sampling

Fixed effect- BLUP

Modelling of CH_4 emissions



Modelling of CH_4 emissions

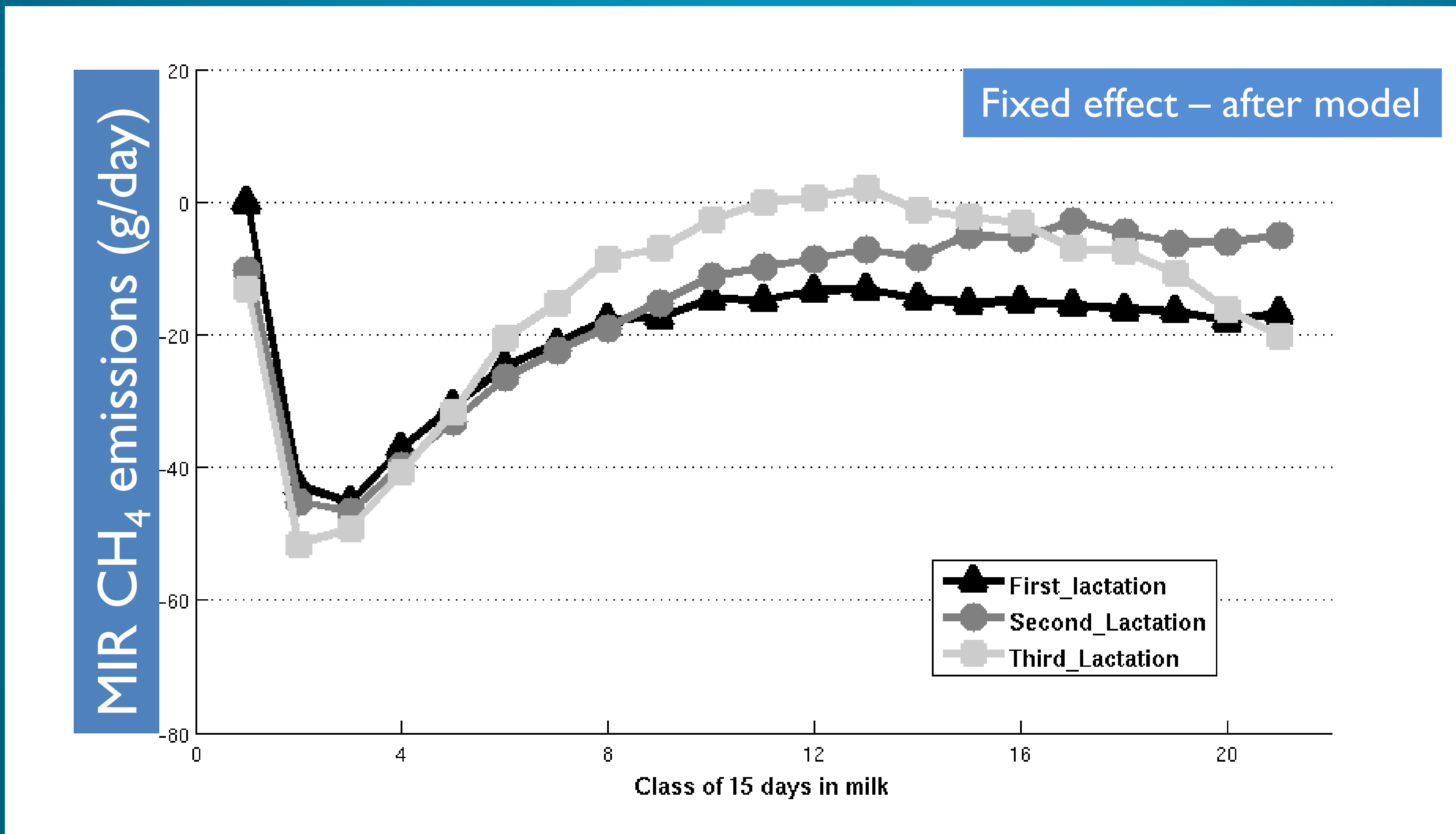


Maximum values in winter

Minimum values in summer

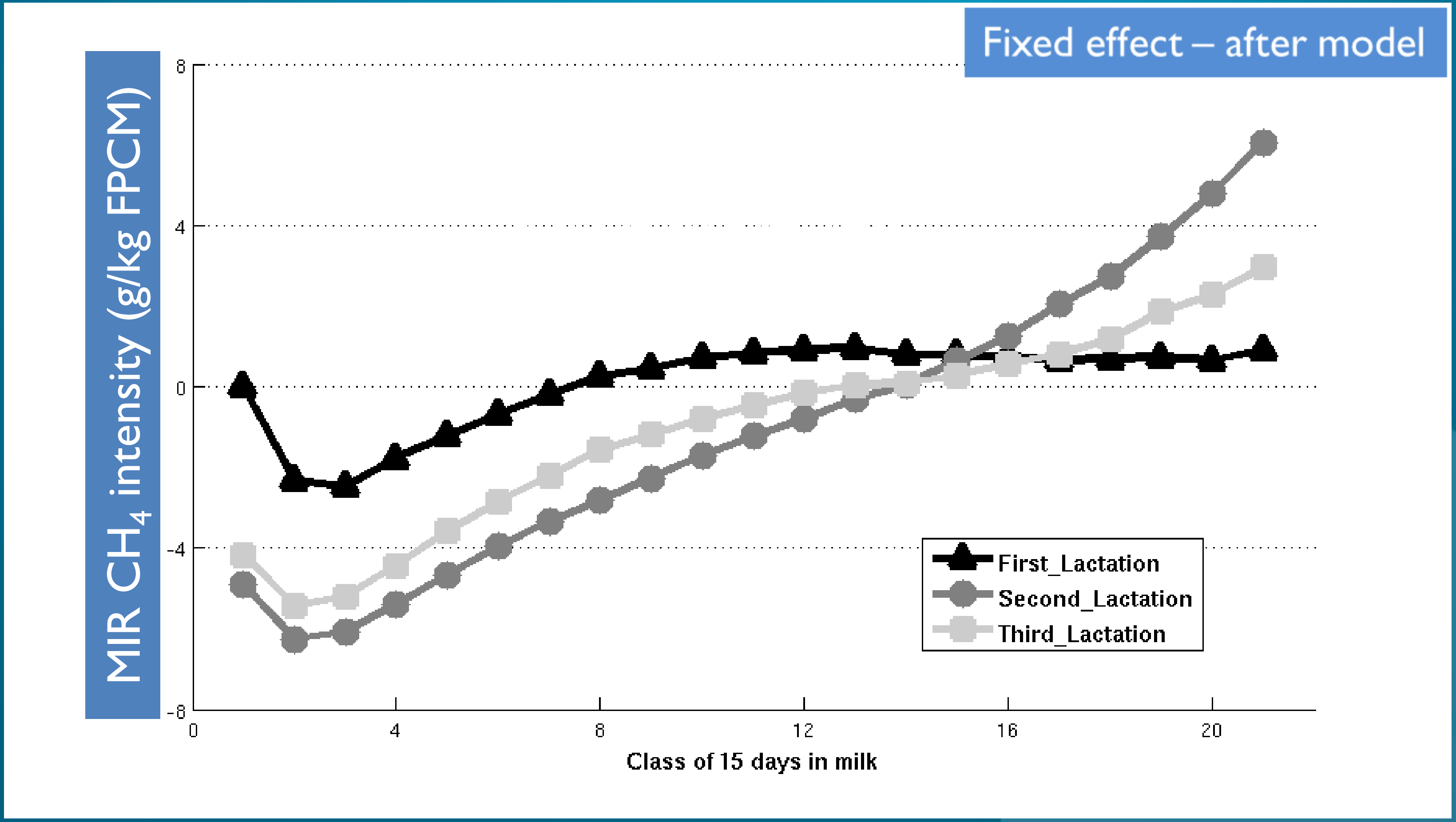
Relative CH_4 emissions across lactation

First lactation first day assumed zero



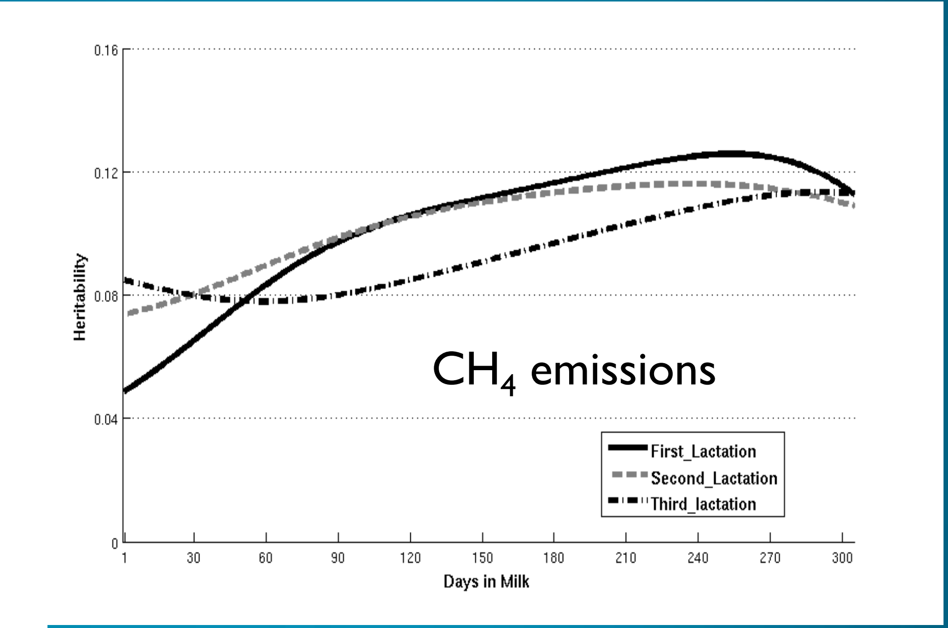
Relative CH_4 intensity(g/kg of FPCM) across lactation

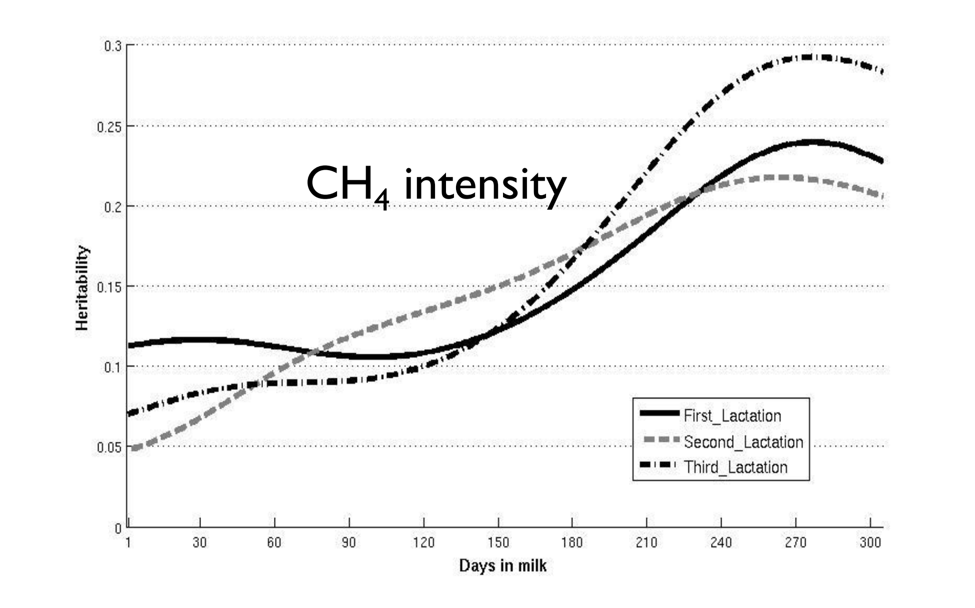
First lactation first day assumed zero



Heritability

	CH_4 (g/d)
Lactation 1	0.10±0.01
Lactation 2	0.10±0.01
Lactation 3	0.09±0.01



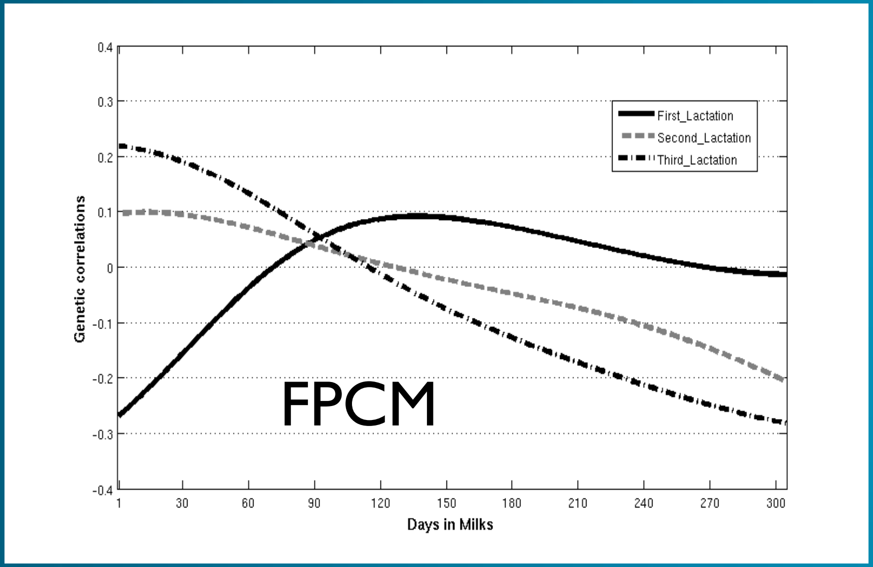


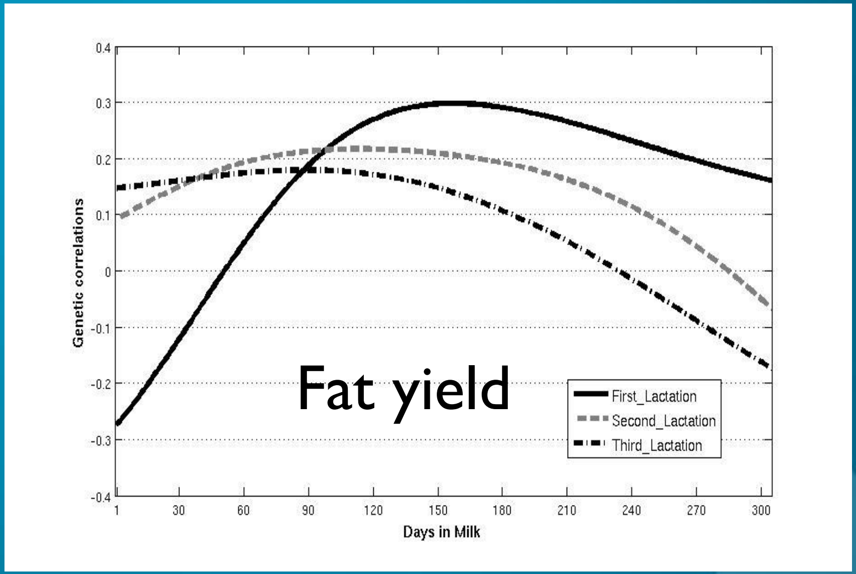
	CH_4 intensity (g/kg FPCM)
Lactation 1	0.15±0.01
Lactation 2	0.15±0.01
Lactation 3	0.16±0.02

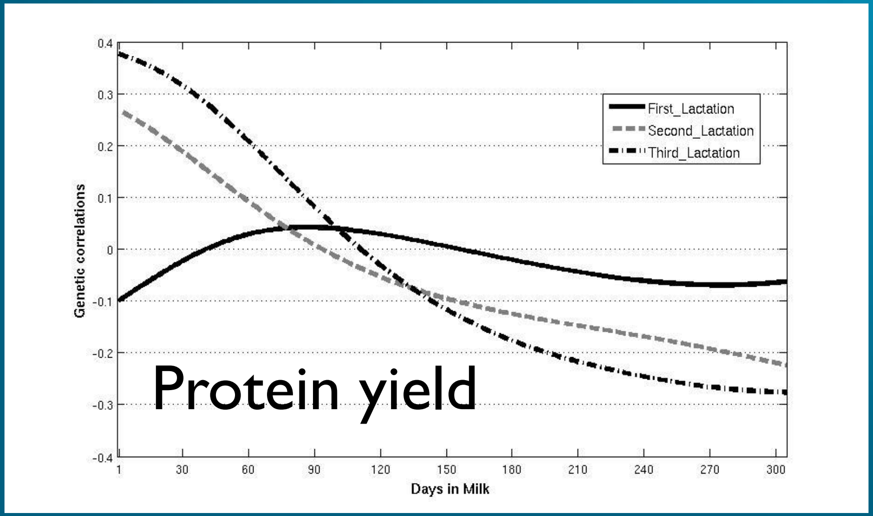
Phenotypic (below diagonal) and genetic (above diagonal) correlations

Traits	MIR CH_4 (g/d)	MIR CH_4 intensity	FPCM	Fat yield	Protein yield
MIR CH_4 (g/d)		0.52	-0.01	0.16	-0.02
CH_4 intensity (g/kg of FPCM)	0.21		-0.84	-0.68	-0.78
FPCM	-0.02	-0.65		0.91	0.91
Fat yield	0.01	-0.58	0.76		0.67
Protein yield	-0.01	-0.60	0.77	0.68	

Genetic correlations CH_4 emissions





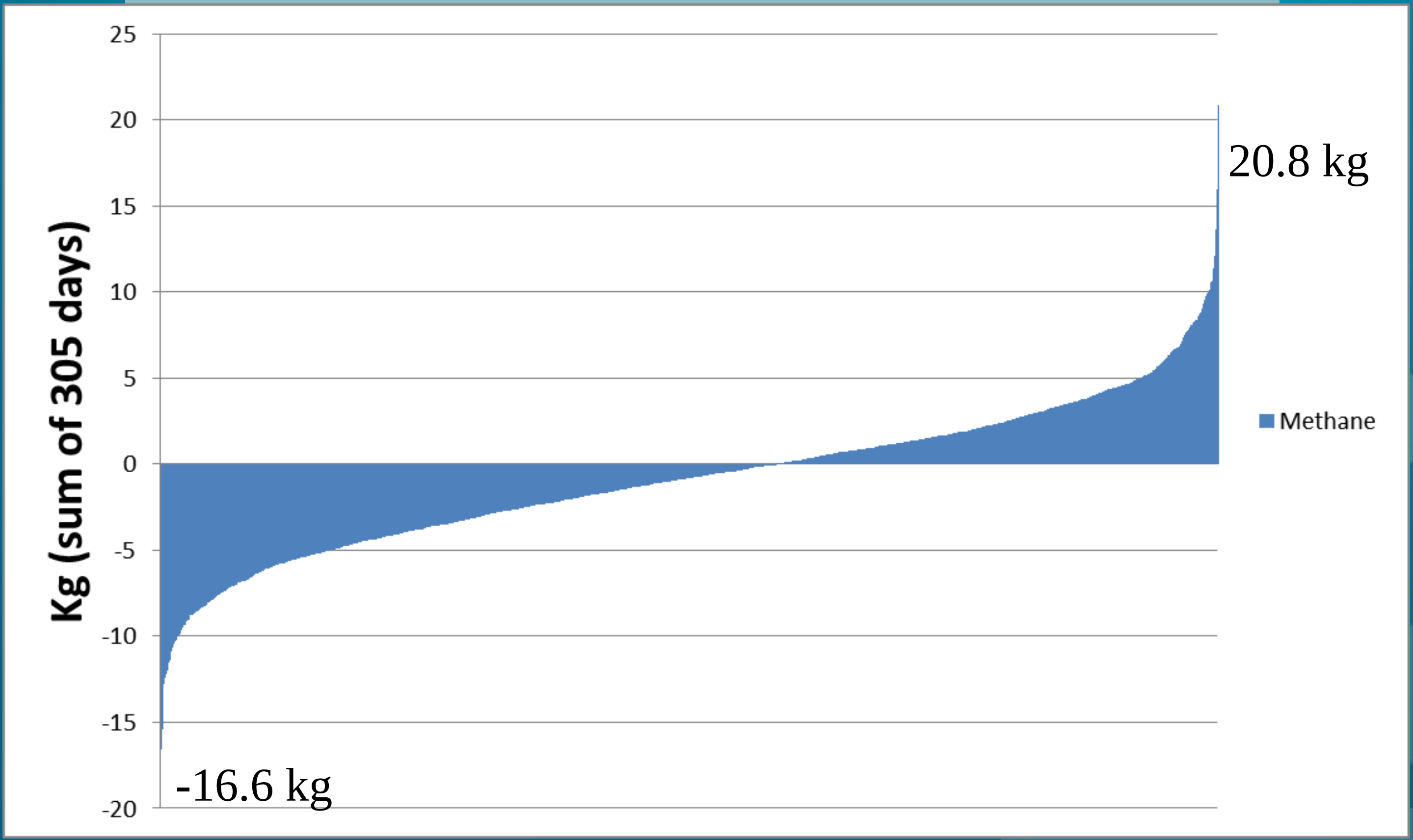


First lactation is different

Second and third lactations similar

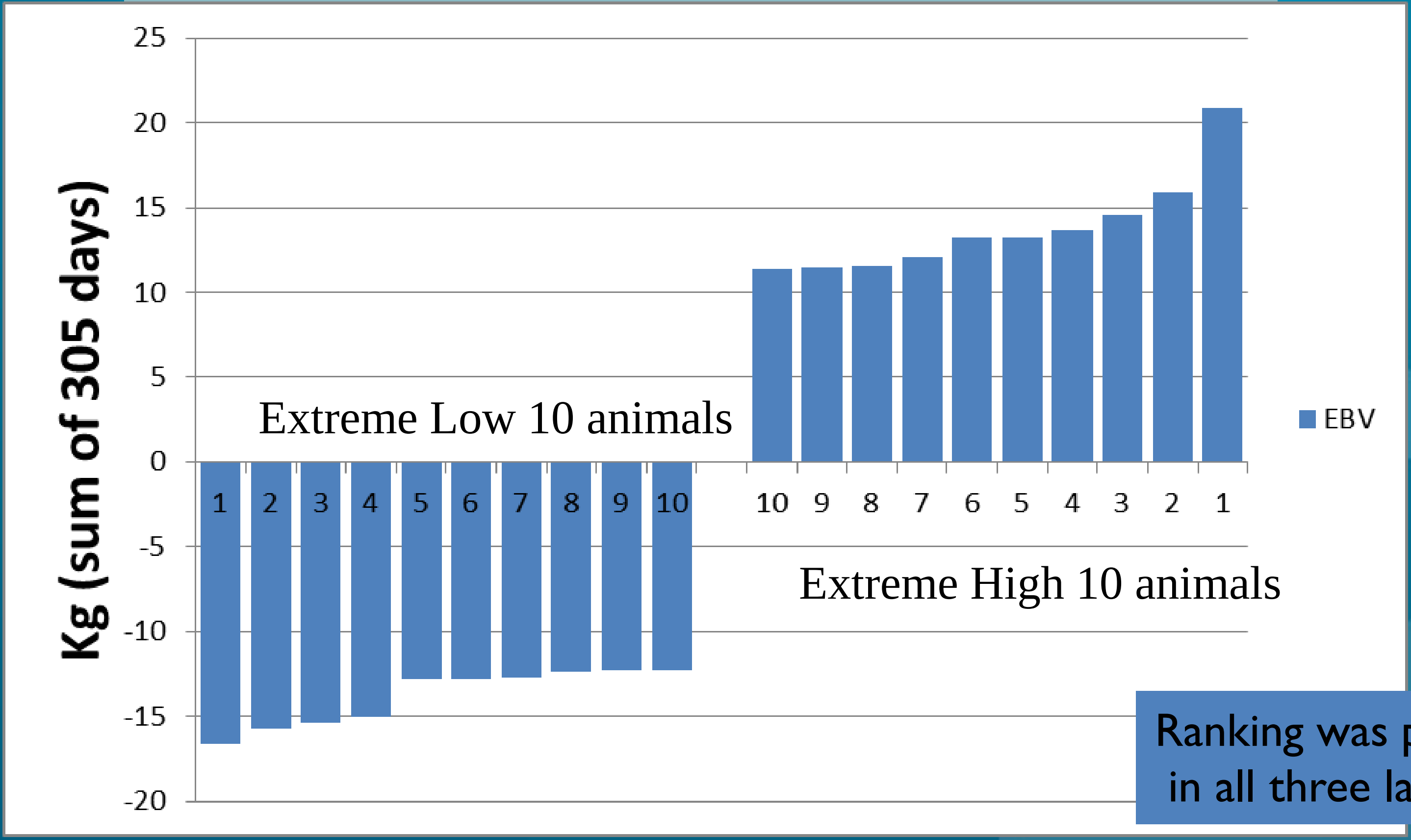
Estimated Breeding Values

Sires (N=2,262) which have daughters with MIR CH_4 records



Estimated Breeding Values

Sires which have daughters with MIR CH_4 records



Ranking was preserved(?) in all three lactations

Conclusions

- Production on less CH_4 (g/day) during peak milk production
- First lactations and second lactation different genetically and within lactations
- Heritability- selection for these traits possible
- Genetic variability seems exist

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Acknowledgements

Supervisors/Collaborators

- Hélène Soyeurt
- Nicolas Gengler
- Marie-Laure Vanrobays
- Amélie Vanlierde
- Fréderic Dehareng
- Eric Froidmont
- Pierre Dardenne
- Eva Lewis
- Frank Buckley
- Mathew Deighton
- Sinead McParland
- Donagh Berry

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