Genetic selection for lower predicted methane emissions in dairy cattle

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Introduction

- Mitigation of enteric methane (CH_4) emission in ruminants is an important area of research
  - Nutrition
  - Microbes
  - Genetic variation — New!
- Breeding
  - Direct
  - Indirect
    - Feed efficiency
    - Predicted methane emission

Aim of study

To establish whether first lactation cows differed *phenotypically, genetically and genotypically* for their individual predicted enteric CH_4 emission

Potential of genetic selection to reduce CH_4 emissions

Collected data

- Experimental farm: 613 cows
  - Feed intake (daily)
  - Ration composition (twice weekly)
  - Body weight (weekly)
  - Milk production & milk contents (weekly)
- Blood samples: 588 cows
  - Illumina 50k Chip
  - 43,011 SNP

Available data

- After all editing steps:
  - 548 animals
  - 17,759 cow-week records
    - 225 days (100 – 305 days)
- Analysed traits:
  - Dry matter intake (DMI, in kg/d)
  - Residual feed intake (RFI, in MJ/d)
  - Fat and protein corrected milk (FPCM, in kg/d)
  - Predicted methane emission (PME, in gr/d)

Trait definition

- Predicted methane emission (in gram/day):
  (Intergovernmental Panel on Climate Change Tier-2 methodology (IPCC, 2000))

  = feed intake (in kg DM/d)
  x energy content of kg DM (= 18.4 (MJ/kg DM))
  / energy generated by methane (= 0.05565 (MJ/g))
  x percentage methane of gross energy (= 0.06)
  x scaling factor [1 + (2.38 – level of intake (multiples of maintenance level)) x 0.04]

PHENOTYPIC

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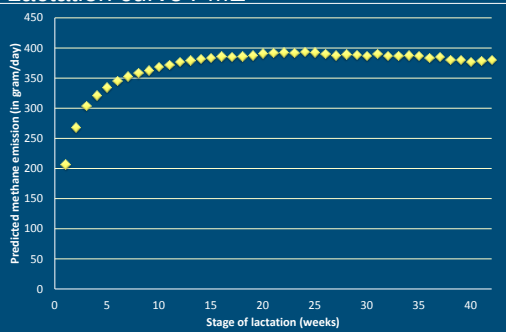
Lactation curve PME



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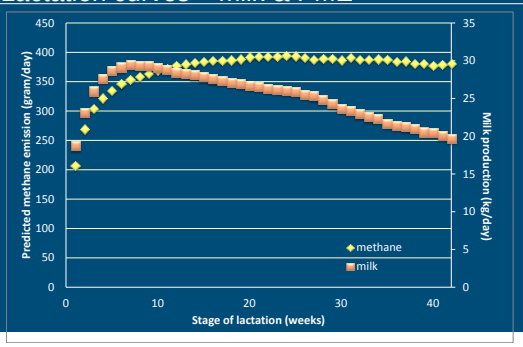
Lactation curves – milk & PME



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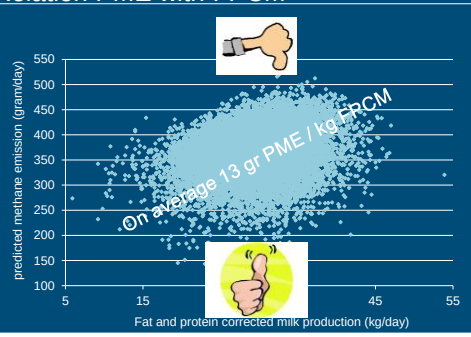
Relation PME with FPCM



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Phenotypic correlations

	PME	FPCM	DMI
FPCM	0.26		
DMI	0.99	0.31	
RFI	0.72	-0.45	0.72

PME = Predicted methane emission (g/d)
FPCM = Fat and protein corrected milk production (kg/d)
DMI = Dry matter intake (kg/d)
RFI = Residual feed intake (MJ/d)

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GENETIC

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Heritabilities

Lactation period (weeks)	PME
0-42	0.35
1-5	0.29
6-10	0.30
11-15	0.36
16-20	0.40
21-25	0.42
26-30	0.35

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Heritabilities

Lactation period (weeks)	PME	PME/FPCM
0-42	0.35	0.58
1-5	0.29	0.66
6-10	0.30	0.65
11-15	0.36	0.46
16-20	0.40	0.39
21-25	0.42	0.44
26-30	0.35	0.55

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Genetic correlations

Lactation period (weeks)	PME - FPCM	PME - RFI
0-42	0.31	0.32
1-5	-0.66	0.84
6-10	-0.18	0.50
11-15	0.42	0.18
16-20	0.67	0.21
21-25	0.70	0.34
26-30	0.60	0.43

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GENOMIC

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Accuracies of predicting PME

	Rgg'
Polygenic	0.21
Polygenic + SNP	0.37

g = true breeding value
g' = predicted breeding value

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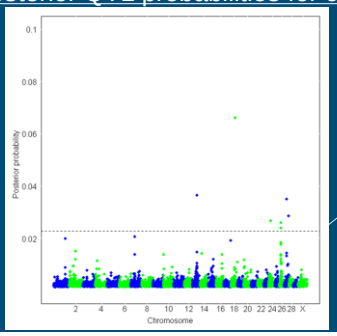
Posterior QTL probabilities for cumulated PME



Bayes Factor of 10.1

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Possible impact on PME

- 0.22 genetic s.d. per year, i.e.
  - Classical breeding programme (progeny testing milk)
  - Genomic selection, with low accuracy and short generation interval (Calus et al., 2011)
- Ten years: 13 to 9 gr PME /kg FPCM
  i.e. **30% reduction**
- Realistic?
  - How much effort will be put on this trait
  - Association with real methane emission

Take home message

Breeding for reduced predicted methane emission is possible and opens up opportunities to breed more environment-friendly cows!

Acknowledgements

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Thank you for listening

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