

TOWARDS SELECTING FOR LOW-EMITTING COWS IN DENMARK



ICAR  **2023**
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*Measure and analyze
individual methane emission
23/05/2023*

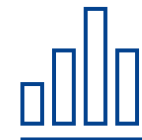
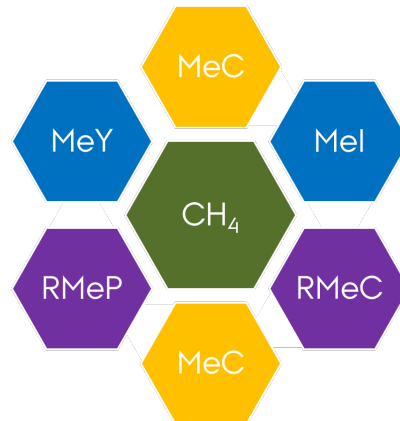
Overview

EDITING
SNIFFER DATA

METHANE
PHENOTYPES

HERITABILITIES
AND
CORRELATIONS

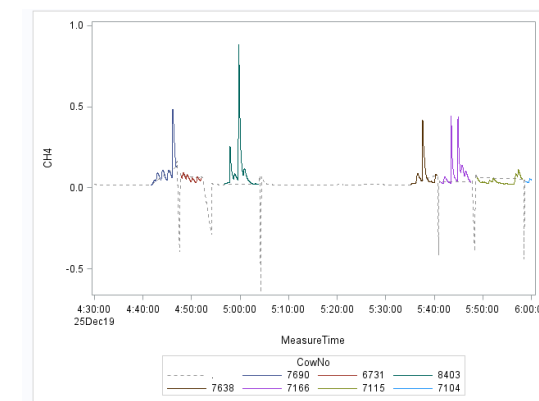
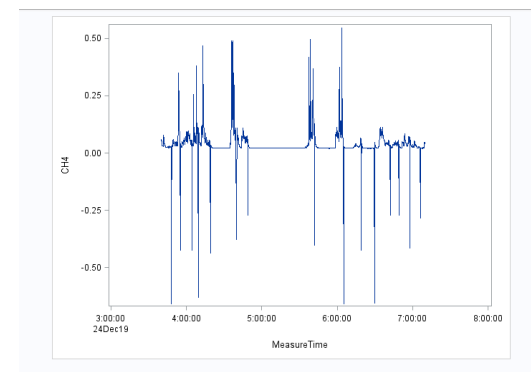
FUTURE
RESEARCH



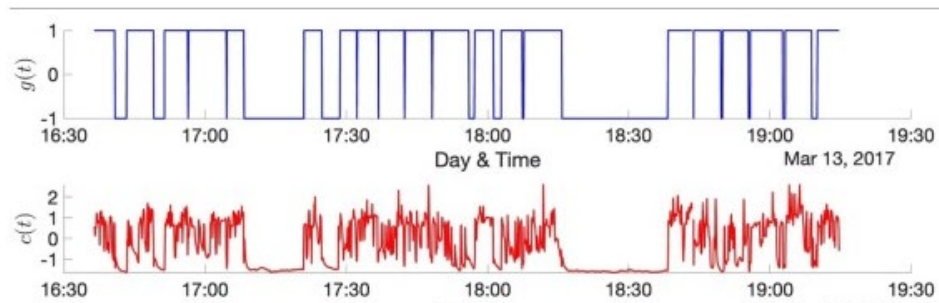
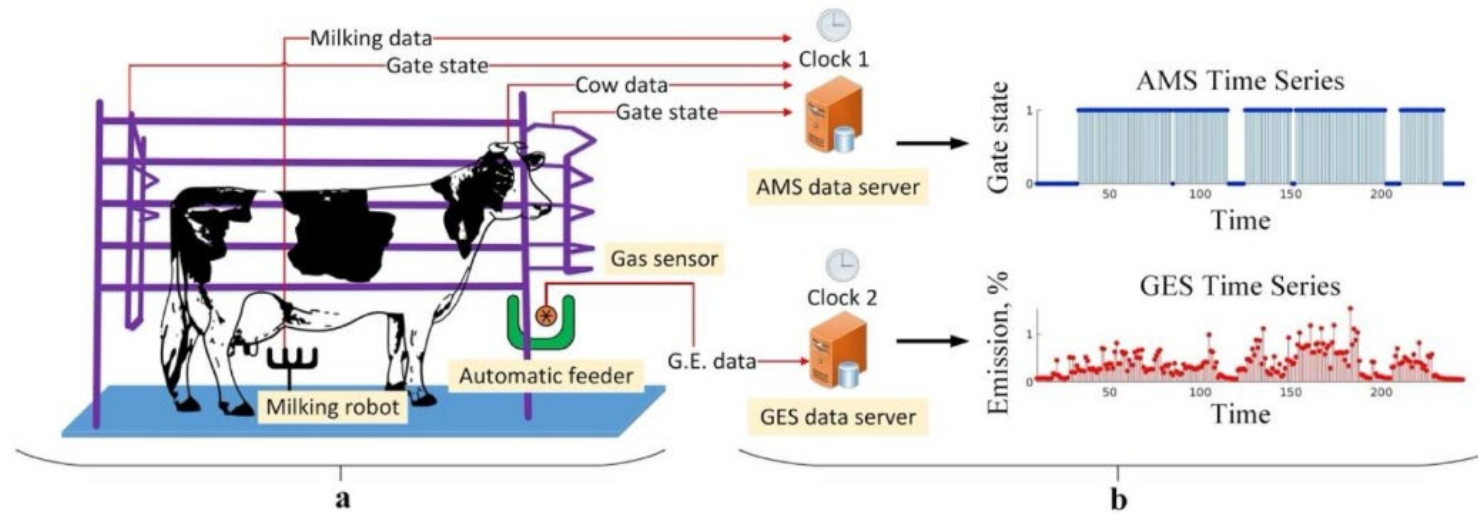
READING/EDITING SNIFFER DATA

Reading methane records

- **Baseline:** morning cleaning
- **Door sensor** -1 CH₄
- **Sneezers** also cause alarms
- **Smoother function** to predict cow entrance and align time
 - Holt Winters Double exponential smoother
- **Average of CH₄** concentration per day



Time Synchronisation –GES and AMS




Computers and Electronics in Agriculture

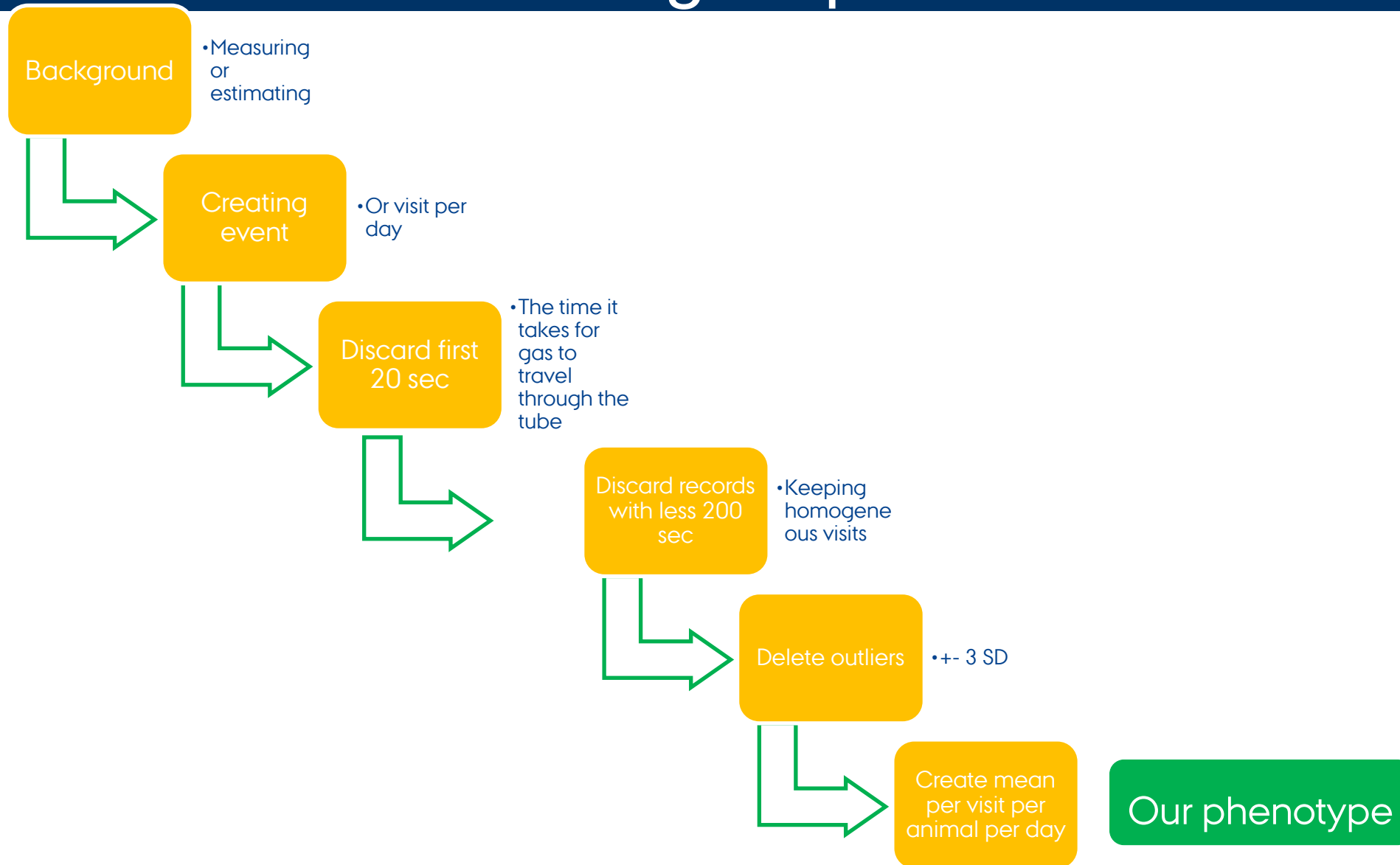
Volume 201, October 2022, 107299



Data synchronization for gas emission measurements from dairy cattle: A matched filter approach

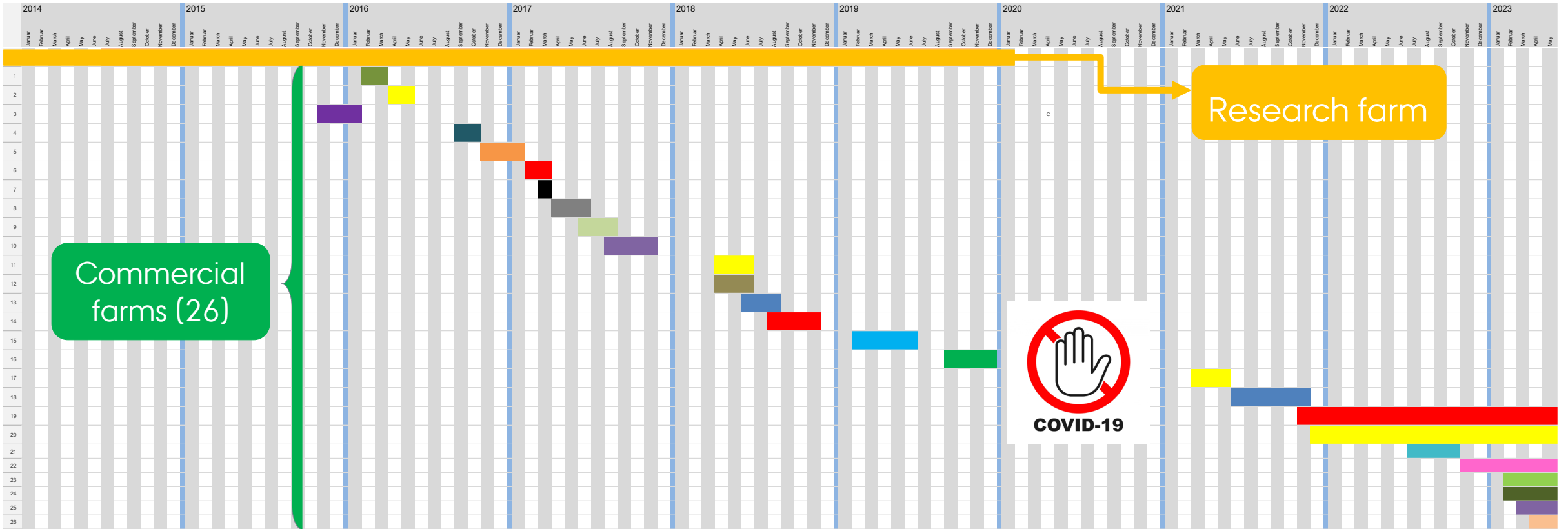
Viktor Milkevych , Trine Michelle Villumsen , Peter Løvendahl , Goutam Sahana 

Editing steps

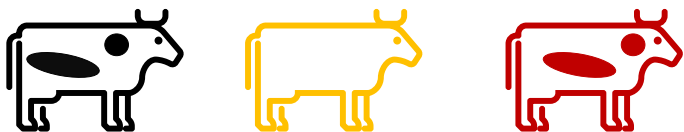


MEASUREMENTS IN FARMS

Farms with methane measures

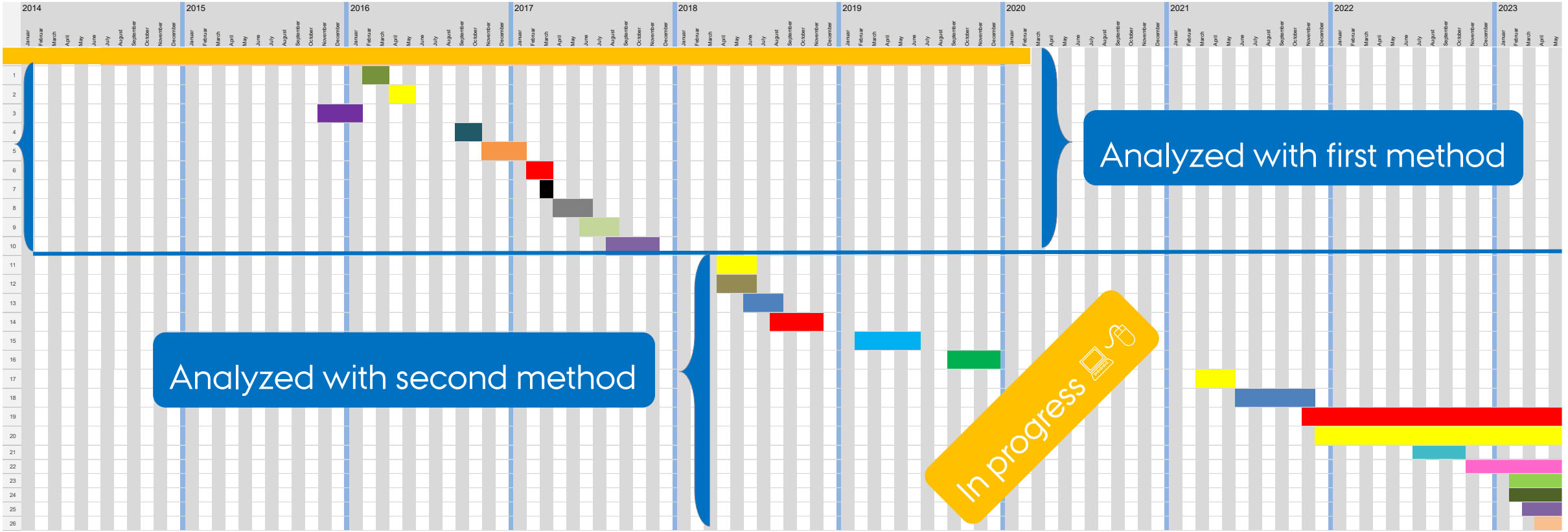


Records from about 7.5K cows



Currently: 14 sniffers with multiplex

Farms with methane measures



PHENOTYPES

FROM METHANE PPM TO G/D



- Based on ratio **CH₄/CO₂**
- **Madsen et al. 2010:** CO₂ (L) = HPU / 21.75 kJ per L CO₂ produced
- **Pedersen et al. 2008:** CO₂ (L/d) = 180 L CO₂/h/HPU * 24 hours
- Where HPU (heat producing unit) = is HP/1000 watt
- **CIGR, 2002:** HPU = 5.6 x kg BW^{0.75} + 22 x kg ECM + 1.6*10⁻⁵ x number of days in pregnancy³

Other methane phenotypes

RESIDUAL

RMeP

RMeC

1. Regression on MBW and DMI and fixed effects
2. Regression on MBW and ECM and fixed effects
3. Regression on MBW, DMI and ECM and fixed effects

RATIO

Methane intensity (MeI)

g CH₄ / kg ECM

Methane yield (MeY)

g CH₄ / kg DMI

PUBLISHED RESULTS

Data description

- **Research farms (Danish Cattle Research Center; DCRC-DKC)**
 - 650 Holstein cows with ~26K weekly records
 - 170 Jersey cows with ~8K weekly records
- **10 commercial farms**
 - ~2,300 Danish Holstein cows
 - ~14,000 CH₄ records
- **1,962 cows with genotypes (50k)**



Exploring phenotypes



Journal of Dairy Science
Volume 104, Issue 8, August 2021, Pages 8983-9001



Research

Breeding for reduced methane emission and feed-efficient Holstein cows: An international response

C.I.V. Manzanilla-Pech¹, P. Løvendahl¹, D. Mansan Gordo¹, G.F. Difford¹, J.E. Pryce^{2,3}, F. Schenkel⁴, S. Wegmann⁵, F. Miglior⁴, T.C. Chud⁴, P.J. Moate^{6,7}, S.R.O. Williams⁷, C.M. Richardson^{2,3}, P. Stothard⁸, J. Lassen⁹



Front Genet. 2022; 13: 885932.

PMCID: PMC9178123

Published online 2022 May 26. doi: 10.3389/fgene.2022.885932

PMID: 35692829

Selecting for Feed Efficient Cows Will Help to Reduce Methane Gas Emissions

Coralia Ines Valentina Manzanilla-Pech^{1,*}, Rasmus Bak Stephansen¹, Gareth Frank Difford², Peter Løvendahl¹ and Jan Lassen^{1,3}

	Trait	MeP	MeC	MeI	MeY	RMeP	RMeC
r_g	RFI1	0.65 (0.13)	0.34 (0.18) ^a	0.28 (0.19) ^a	0.16 (0.19) ^a	0.48 (0.15)	0.33 (0.15)
	RFI2	0.76 (0.09)	0.32 (0.17) ^a	0.05 (0.20) ^a	0.35 (0.16) ^a	0.47 (0.15)	0.36 (0.17)

Trait ¹	h^2
MeP	0.21 (0.04)
GSMet	0.15 (0.03)
MeY	0.30 (0.04)
MeI	0.38 (0.04)
RMet1	0.14 (0.03)
RMet2	0.13 (0.04)
RMet3	0.16 (0.04)

Trait ¹	MeP	Trait ¹	MeP
MeY	0.46 (0.12)	RMet1	0.70 (0.08)
MeI	0.41 (0.10)	RMet2	0.74 (0.07)
		RMet3	0.75 (0.08)

Trait	h^2
MeP	0.21 (0.05)
MeC	0.20 (0.05)
MeI	0.18 (0.04)
MeY	0.22 (0.05)
RMeP	0.16 (0.04)
RMeC	0.23 (0.06)

Trait	MeP	r_g
MeP	—	
MeC	0.71 (0.12)	
MeI	0.48 (0.16)	
MeY	0.77 (0.07)	
RMeP	0.82 (0.07)	
RMeC	0.77 (0.08)	

Random regression in research data



Journal of Dairy Science

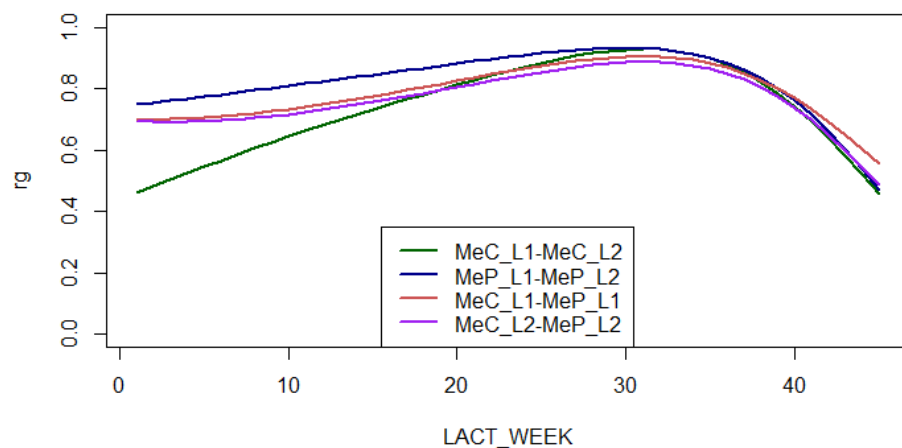
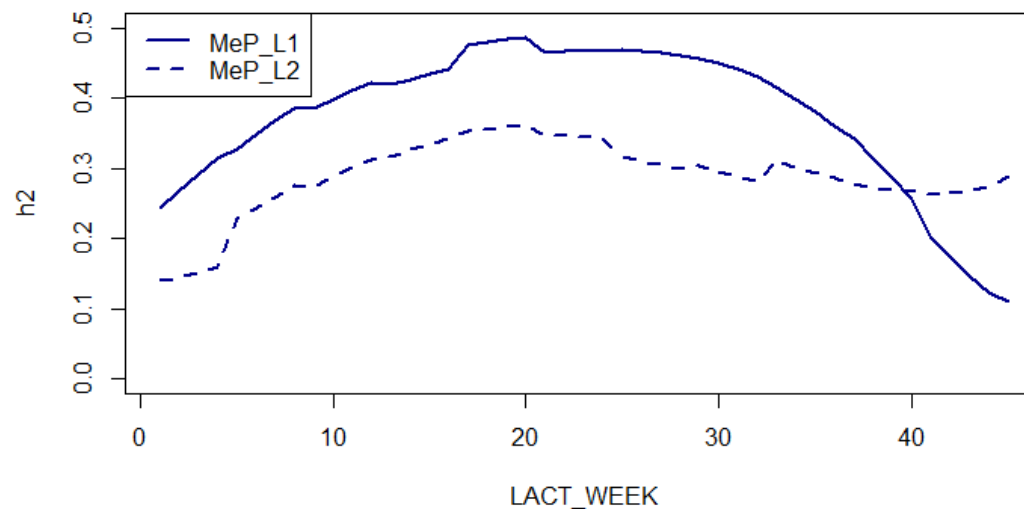
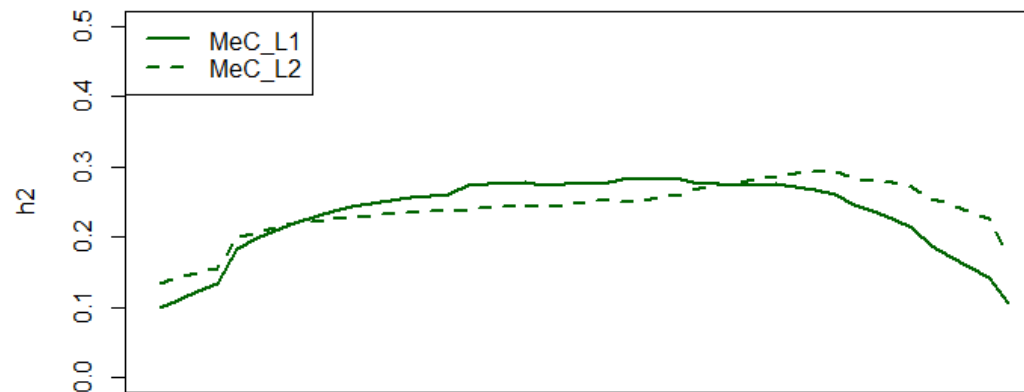
Available online 12 October 2022

In Press, Corrected Proof



Genetic (co-)variation of methane emissions, efficiency, and production traits in Danish Holstein cattle along and across lactations

C.I.V. Manzanilla-Pech¹, G.F. Difford², P. Løvendahl¹, R.B. Stephansen¹, J. Lassen^{1,3}



GWAS in methane



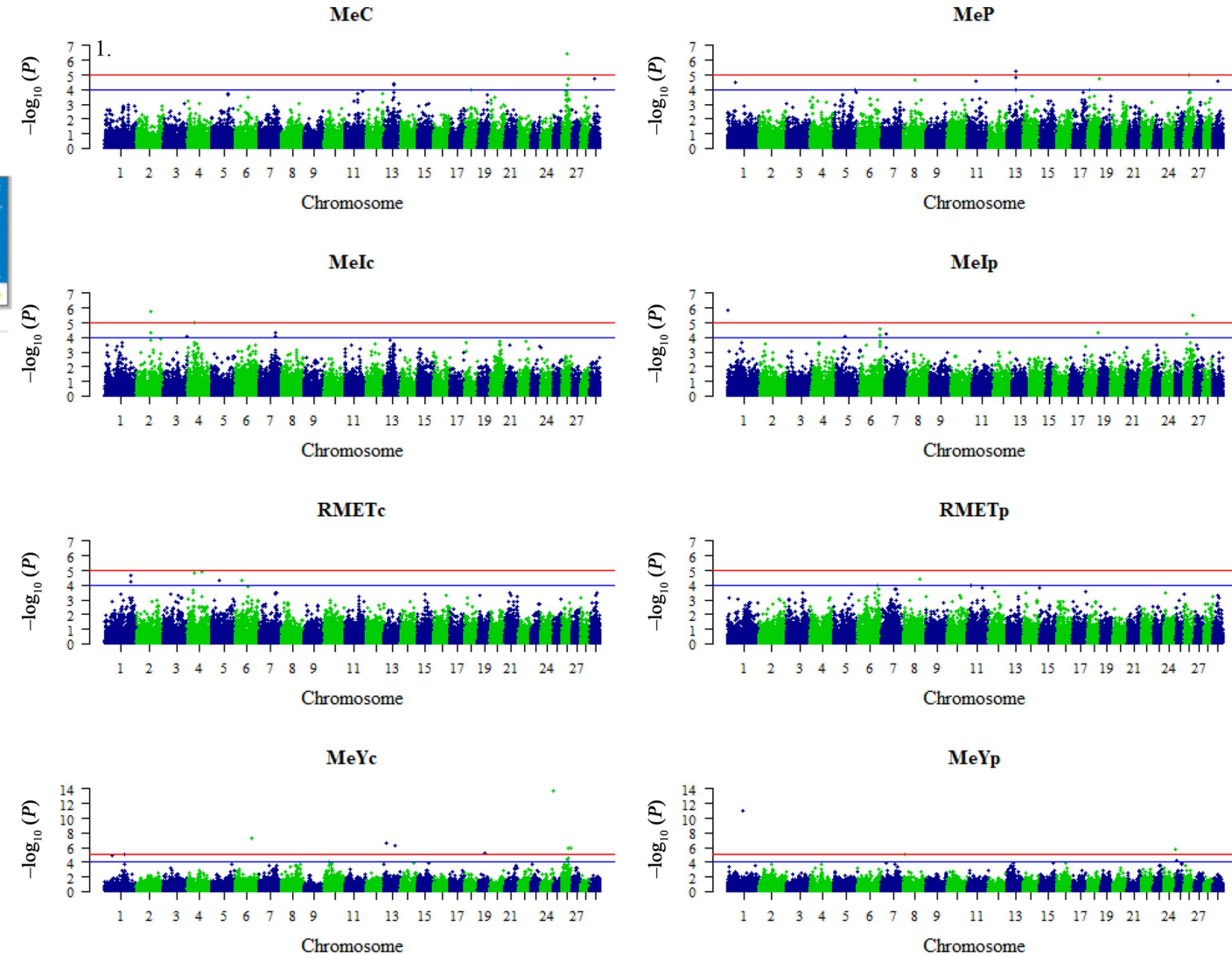
Journal of Dairy Science
Volume 105, Issue 2, February 2022, Pages 1357-1368



Research

Genome-wide association study for methane emission traits in Danish Holstein cattle

C.I.V. Manzanilla-Pech ¹✉, G.F. Difford ², G. Sahana ¹, H. Romé ¹, P. Løvendahl ¹, J. Lassen ³



Genomic prediction



Journal of Dairy Science
Volume 103, Issue 10, October 2020, Pages 9195-9206

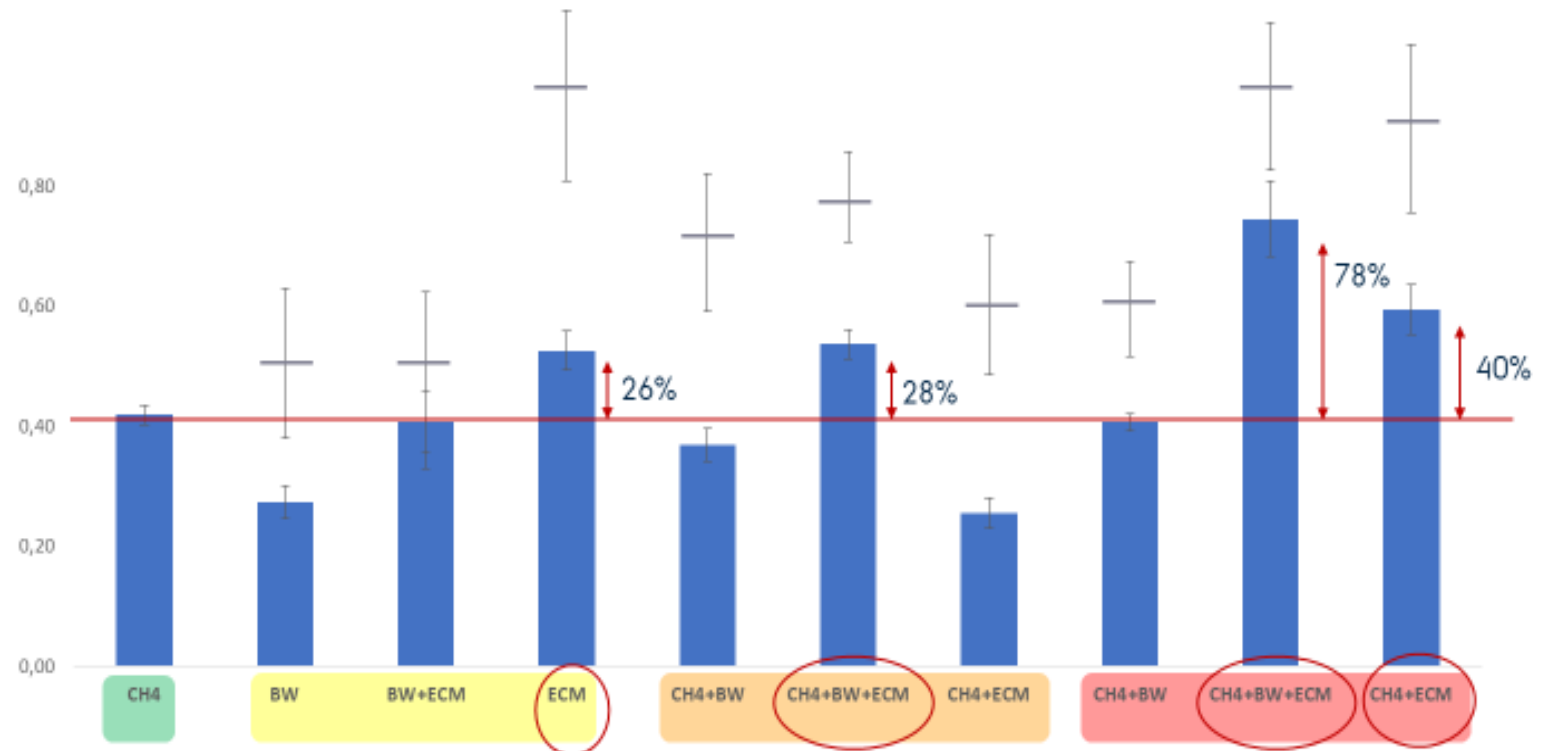


Accuracies

Research

Multitrait genomic prediction of methane emissions in Danish Holstein cattle

C.I.V. Manzanilla-Pech¹, D. Gordo¹, G.F. Difford^{1,2}, P. Løvendahl¹, J. Lassen³



FUTURE GOALS AND RESEARCH

Enlarging the database: keep collecting data

- **Records from ~10.000 extra cows (30 sniffers)**

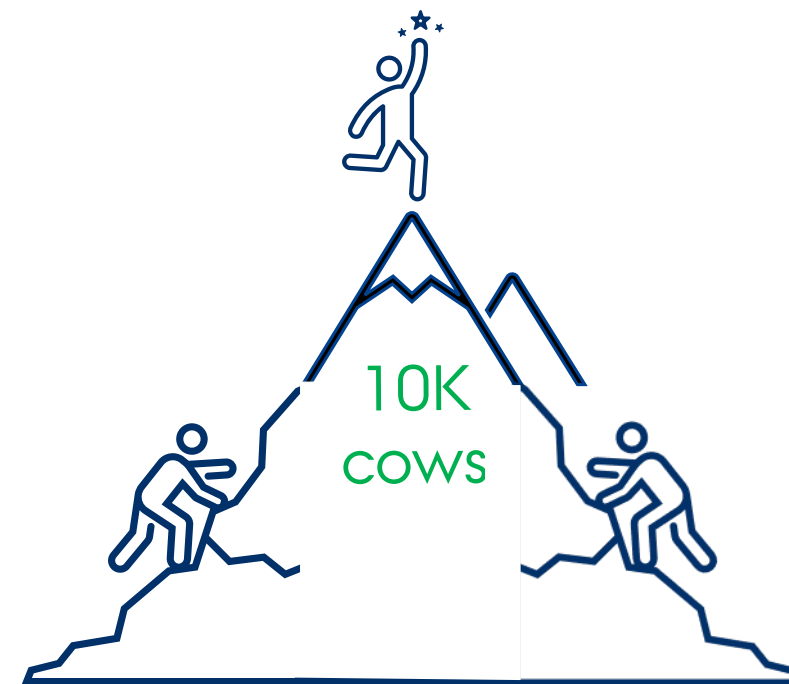
- Prioritize farms with genotypes
- Include farms with CFIT measurements

- **Include all collected data for analyses**

- Genetic parameters for Jersey and RDC breeds
- Routine genetic evaluation for Holstein and Jersey
- Exploratory work: Crossbred animals



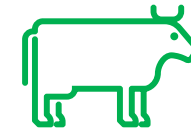
Picture source: VikingGenetics



Current and future work

- Improve **data quality**

- Background, length of milking, head movement

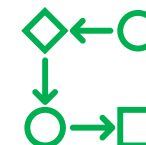


- **Update formulas** to calculate methane production from concentration



- Investigate **different** approaches to calculate **phenotypes**

- **Automatized pipeline** from raw data to phenotype



THANK YOU FOR YOUR ATTENTION



Trine Villumsen



Rasmus B. Stephansen



Jan Lassen



Peter Løvendahl



Viktor Milkevych



Goutam Sahana