How to Breed for more Feed Efficient & Climate Friendly Cows?

19th June 2024, WJCB world conference, Aarhus, Denmark

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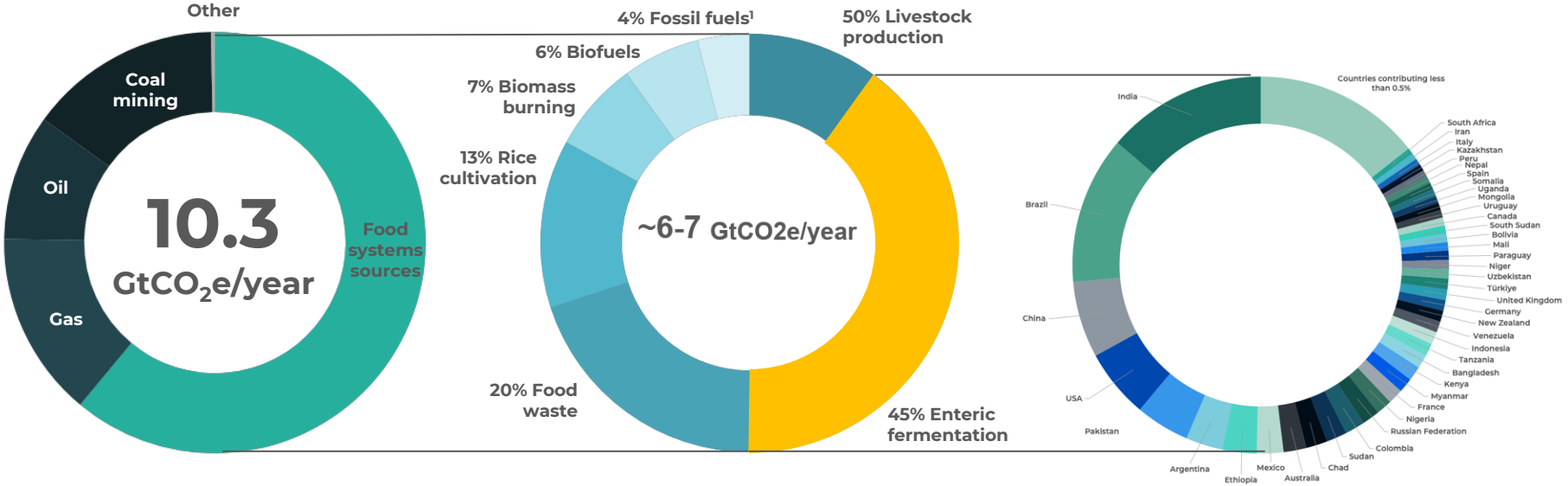
ENTERIC METHANE CONTRIBUTION TO GLOBAL AND FOOD SYSTEM METHANE



Global anthropogenic methane emissions (2017)[1]

Food system methane emissions

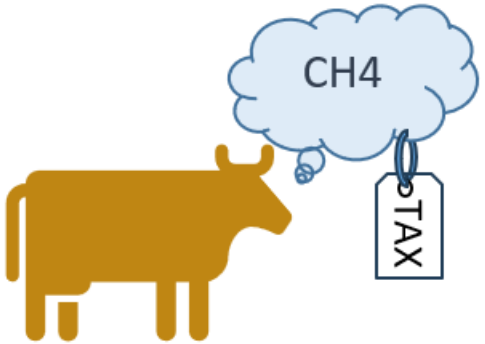
Proportions of enteric methane emissions

[1]*Saunois et. al 2020: Total anthropogenic emissions are based on estimates of a full anthropogenic inventory and not on the sum of the "agriculture and waste", "fossil fuels", and "biofuel and biomass burning" categories due to methodology of adding different inventories. IPCC AR6 WGIII (2022). Available at: https://www.ipcc.ch/report/ar6/*

[2]*Hegarty RS, Cortez Passetti RA, Dittmer KM, Wang Y, Shelton S, Emmet-Booth J, Wollenberg E, McAllister T, Leahy S, Beauchemin K, Gurwick N. 2021. An evaluation of emerging feed additives to reduce methane emissions from livestock. Edition 1. A report coordinated by Climate Change, Agriculture and Food Security (CCAFS) and the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) initiative of the Global Research Alliance (GRA).*

Carbon Tax in Denmark

- **Legally** binding **2030** climate gas reduction targets

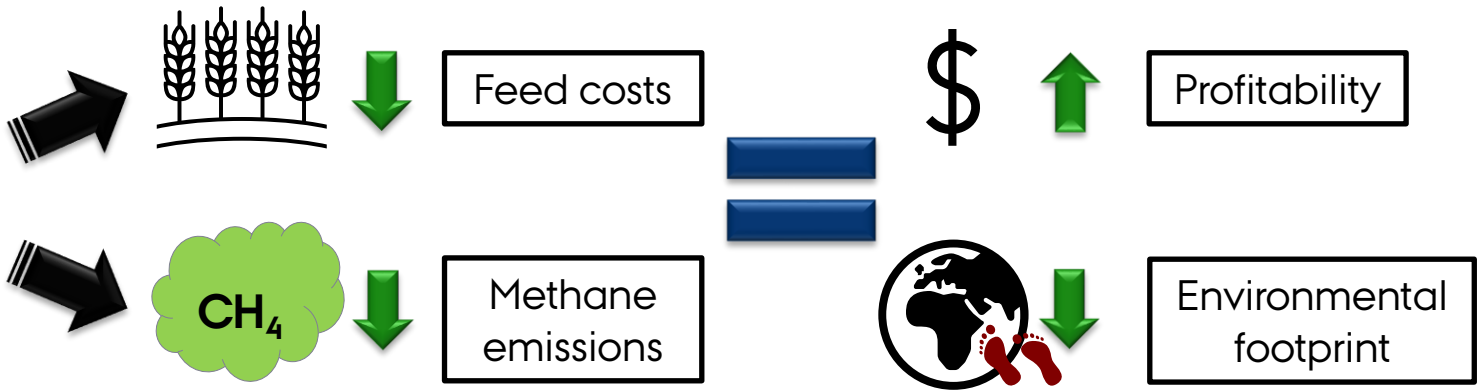


- Suggested **tax** scenarios:
  - Carbon emission tax: 17, 34 or 100 €/**ton CO_{2eq}**

Why Breed for Feed Efficiency?

- **~80%** of the **variable** farm **costs** are related to **feed**
- **Methane** (CH_4) is well **correlated** to **feed intake**
- **Feed production** contributes with greenhouse gas emissions

Motivation: Improve genetic **progress** for feed efficiency

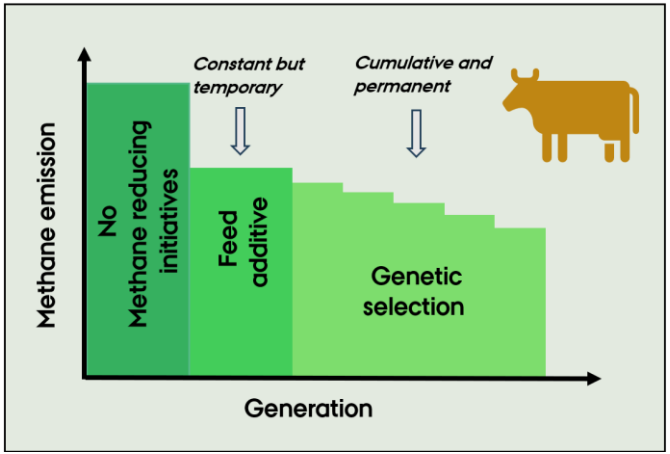


Why Breed for Less Methane?

- **Methane** is a potent climate gas
- In **future**, **methane** emission will have an **economic** value

Motivation: Reduce methane by **direct** selection

Indirect selection is **less** efficient



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Agenda

Options to Breed for Feed Efficiency in Jersey

Options to Breed for Less Methane in Jersey

The Potential for WJCB in the Global Methane Hub?

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Intro to Breeding for Feed Efficiency

How do we define Feed Efficiency?

Historic genetic progress for feed efficiency

- **Feed efficiency** has historically been improved through increasing **milk yield**
  - **Diluting** maintenance requirements
- Higher **milk** yield had **adverse** effects on important **life** functions (health, fertility, metabolic disorders, etc.)

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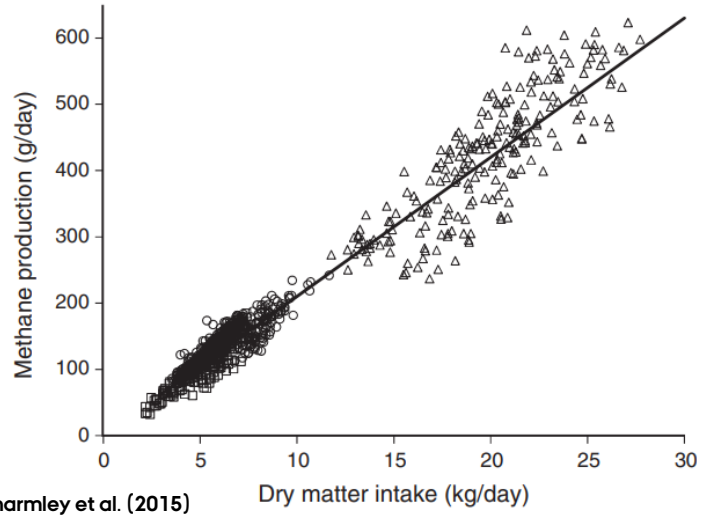
Feed Efficiency = Feed Saved

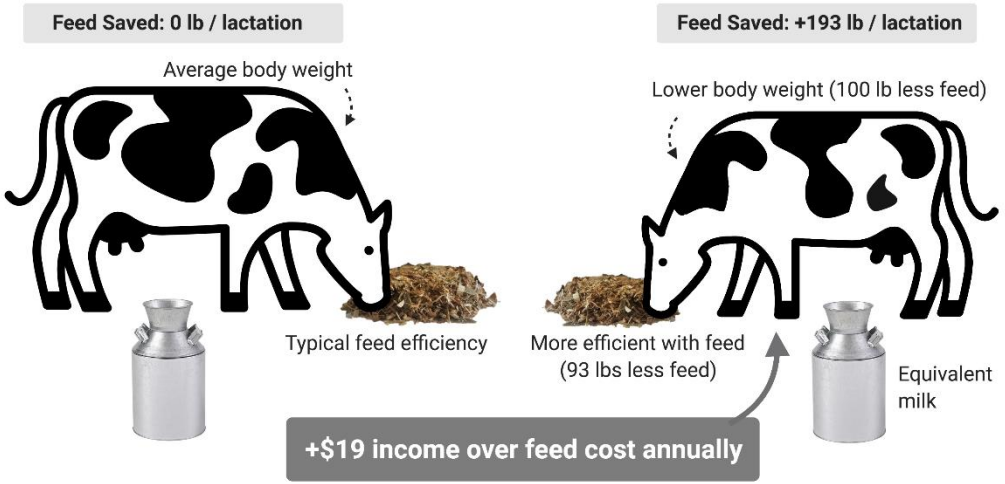
Easy to measure and model

Hard to measure and model

- Defined in Pryce
  Feed Saved, kg DM= Maintenance (**BW**) + Metabolic efficiency (**RFI**)
- We expect **genetic** selection for FS will **reduce CH_4 emissions**



Charmley et al. (2015)



Cattle Feed InTake

Individual measure of feed intake on in-house commercial dairy cattle using 3D camera technology

Abstract

Using 3D camera technology, feed intake was measured in a commercial farm. Results showed that measures were highly repeatable from day to day and from week to week in a period of 14 consecutive days. Also the feed intake measures were highly positively correlated to milk production, positively correlated to days in milk in the first 70 days in lactation and negatively correlated to days in milk from 70 days in milk and later. The method is cheap, noninvasive and does not affect the everyday routine for the farmer.

Jan Lassen, Jørn Rind Thomasen, Rikke Hjort Hansen, Glenn Gunnar Bri Nielsen, Eli Olsen, Peter Rene Bolvi Stentebjerg, Niels Worsøe Hansen, Søren Borchersen

Lassen, et al. 2018

J. Dairy Sci. TBC
https://doi.org/10.3168/jds.2022-23177

Repeatabilities of individual measure of feed intake and body weight on in-house commercial dairy cattle using a 3D camera system

J. Lassen,[1] J. R. Thomasen,[1] and S. Borchersen[1]
[1]VikingGenetics, Ebeltoftvej 16, 8960 Randers, Denmark

J. Dairy Sci. TBC
https://doi.org/10.3168/jds.2023-23405

Genetic parameters for feed intake and body weight in dairy cattle using high throughput 3D cameras in Danish commercial farms

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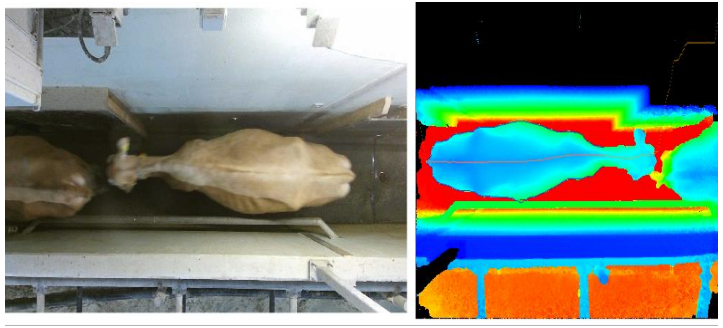
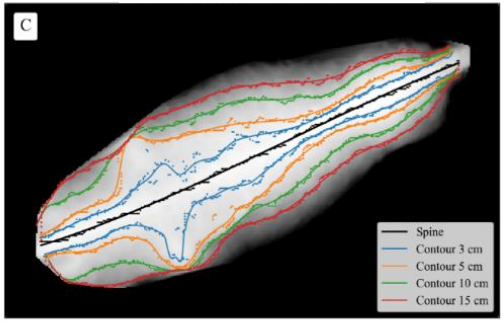
*Center for Quantitative Genetics and Genomics, Aarhus University, C. F. Møllers allé 3, DK-8000, Denmark
‡Viking Genetics, Ebeltoftvej 16, Assentoft, 8960 Randers, Denmark

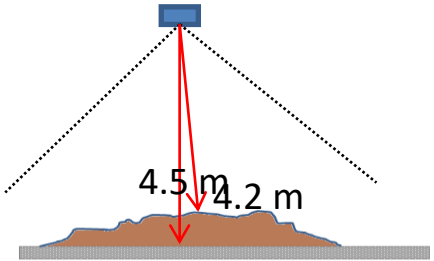
How does CFIT work?

Identify the animal

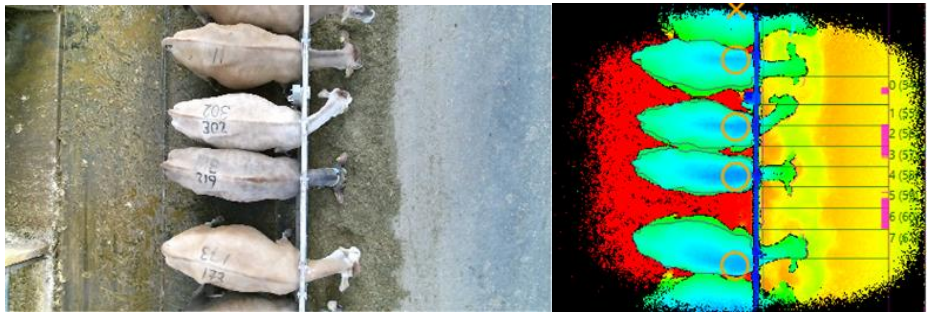


Predict body weight based on their back





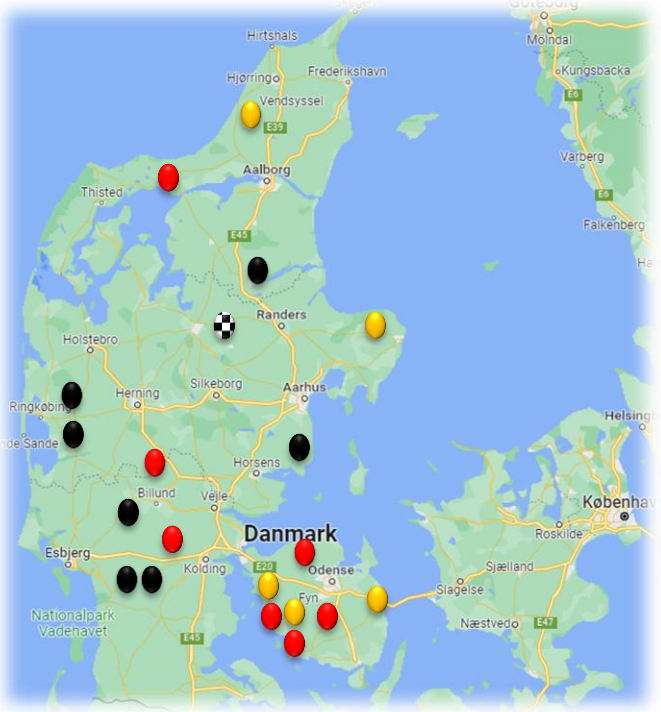
Measure individual feed intake



Data overview

Individual weekly **feed intake** measures from

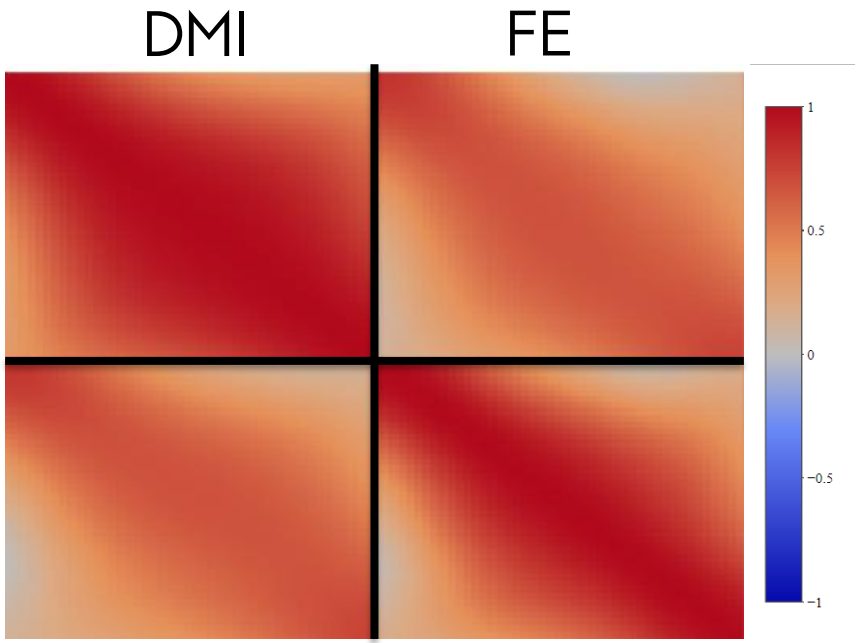
- **Cattle Feed InTake**, VikingGenetics
  - 3,873 HOL cows with 161K records, (2,564 primi)
  - 2,068 JER cows with 93K records, (1,505 primi)
  - 3,235 RDC cows with 139K records, (2,006 primi)
- Danish Cattle Research Center, **AU-Foulum**
  - 878 HOL cows with 50K records, (835 primi)



Preliminary Results Metabolic efficiency

- Genetic correlations during lactation for Danish **Jersey**
  - Clear genetic **differences** along lactation
  - Improve **efficiency** -> lower feed intake
  - **No** or **minimal** effect on production

- Improvement of 1 genetic SD unit
  - **~0.8** kg dry matter/day of a cow
  - **~50** €/cow-year
    - Feed price 0.20 €-cents/kg DM



Take home messages – Feed Efficiency

- Heritabilites from **CFIT** are on similar levels as **feed bins**
- **Feed efficiency** differ between **early** and **mid** to **late** lactation
  - Will add **economic** value to the breeding goal
- **3D** camera technology allows for continuous data **recording** at **large** scale in whole lactations

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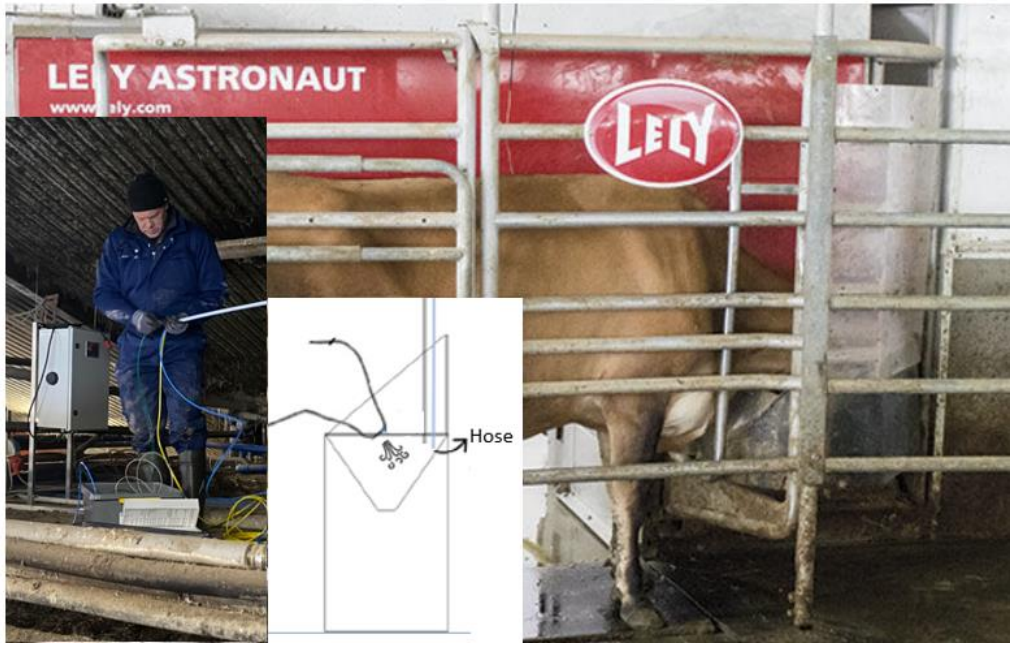
Genetic Selection for Methane Production

Need **many records**

Private herds

Methane Sniffer

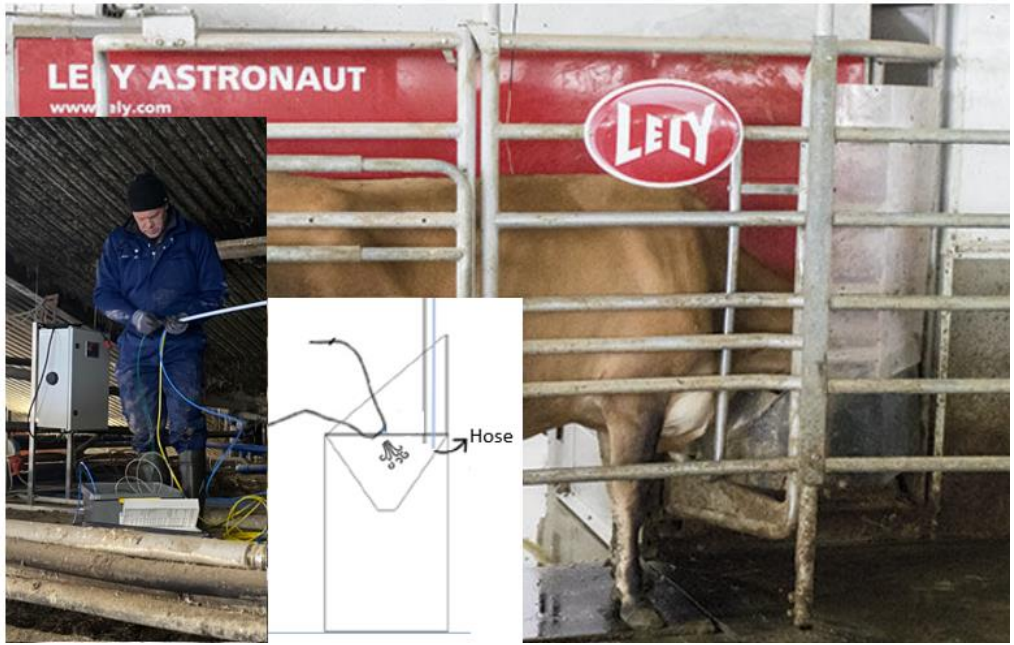
- **Pros:**
- Relatively cheap –cost effecient
- Not invasive
- Many records



Methane Sniffer

- **Pros:**
- Relatively cheap –cost efficient
- Not invasive
- Many records

- **Cons:**
- Concentration not volume
- Only AMS
- Snapshots
- Affected by environment
- Messy data



Collected Methane data on Jersey

- **Total:**
  - 12 Herds
  - ~3000 JER

- **Currently:**
  - 4 Herds
  - ~1100 JER

Data Flow

On-site Automated Milking System

On-site Sniffers System

Data Flow

On-site Automated Milking System

AMS database

On-site Sniffers System

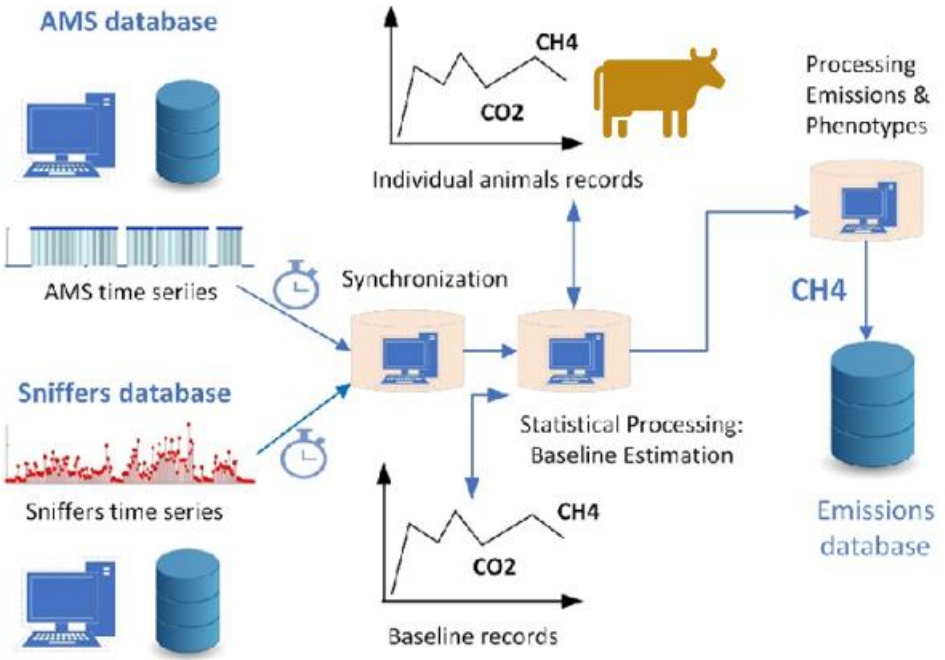
Sniffers database

Sniffers time series

Data Flow

On-site Automated Milking System

On-site Sniffers System



Automatized pipeline

Detection of equipment error

Filter environmental noise

Cleaned raw data

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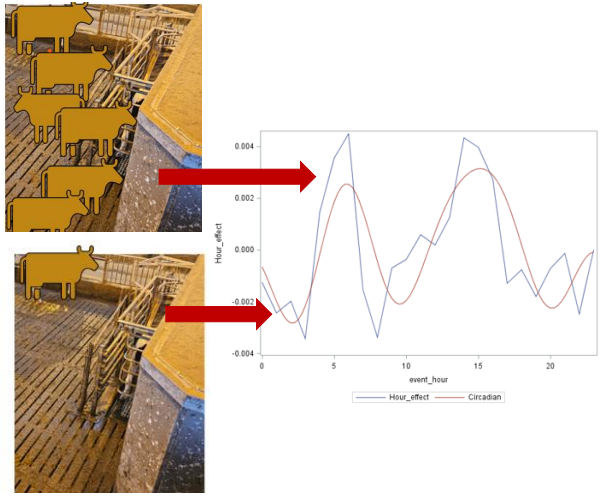

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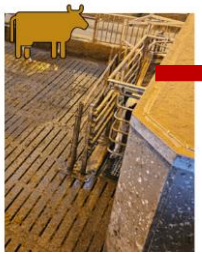

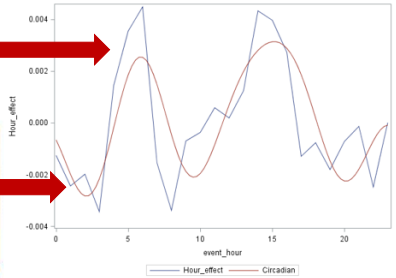

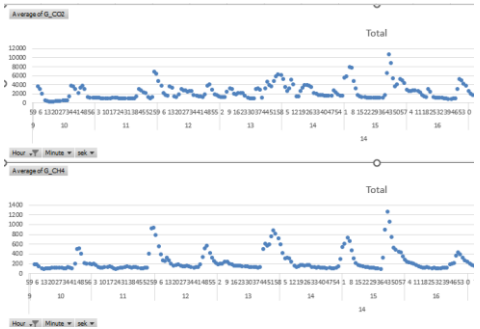

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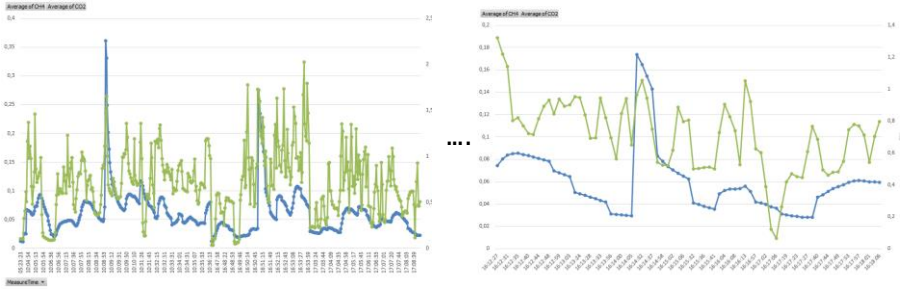


Concentration

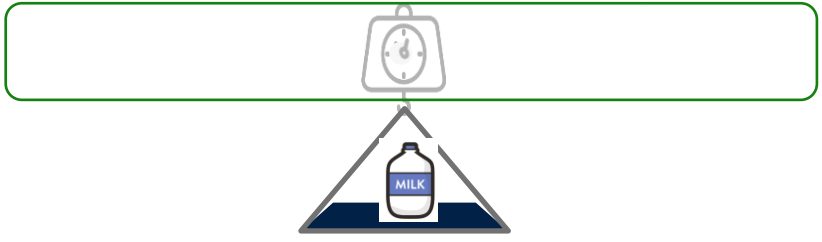
Ratio

CH_4

CO_2

CH_4/CO_2

"Reduced On-Farm model"



Daily CO_2 production

Daily CH_4 production

g/day

Predicting CO_2 production of lactating dairy cows from animal, dietary, and production traits using an international dataset

M.H. Kjeldsen • M. Johansen • M.R. Weisbjerg • ... C. Reynolds • S.R.O. Williams • P. Lund • Show all authors

Open Access • Published: May 14, 2024 • DOI: https://doi.org/10.3168/jds.2023-24414

Heritabilities for Methane Traits

- Examples, methane trait categories

Trait	Heritability
Concentration, ppm	0.20
Production, l/day	0.21
Intensity, g CH4/kg milk	0.18
Yield, g CH4/kg DMI	0.22

HOL, Manzanilla-Pech, et al. 2022

Heritabilities for Methane Traits

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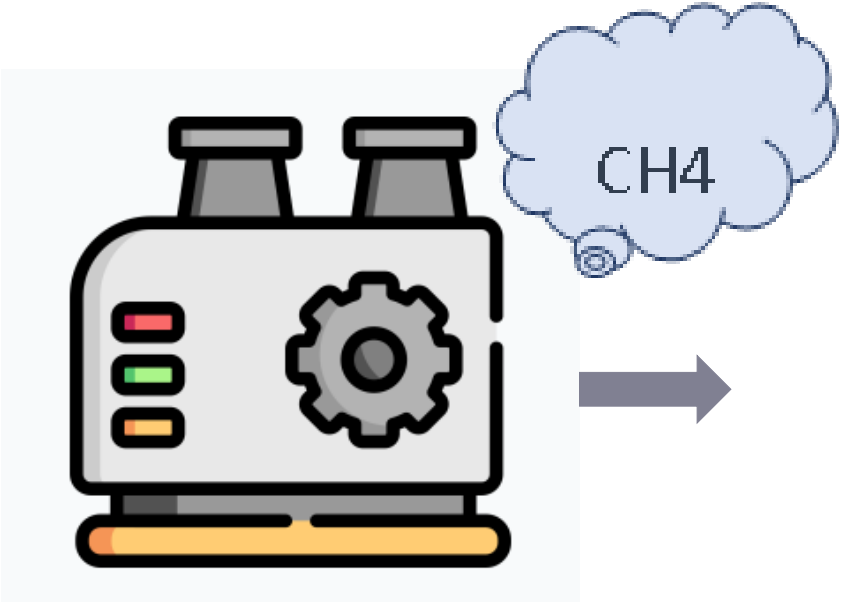
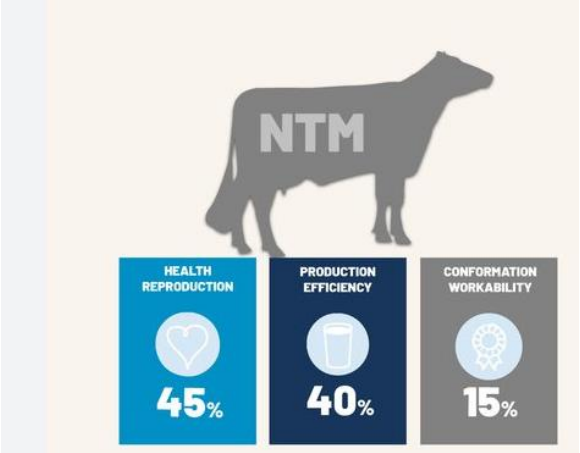
HOL, Manzanilla-Pech, et al. 2022

Selection for methane is possible!

Implementation by 2026





Take Home Messages – Methane

- A **carbon emission tax** is a **strong motivator** for reducing climate gas emission in dairy cows

- **Sniffers** are relative **cost-efficient** for large-scale measurements of gas emissions in dairy farms

- **Genetic selection** for lower methane production pr kg milk will be **on of the mitigation strategies**

Global Methane Hub

ENTERIC FERMENTATION R&D ACCELERATOR

Presenter: Rasmus Bak Stephansen, AU

Slides provided by
Birgit Gredler-Grandl, WUR
Robert Banks, GMH

ENTERIC FERMENTATION R&D ACCELERATOR

The largest-ever, globally coordinated public-good investment in breakthrough research tackling livestock methane emissions.

ACCELERATOR
ALREADY FUNDED AREAS

- Microbiome characterization
- Low methane genetics
- Low-cost measurement technology for grazing livestock
- Anti-methanogenic forage screening

Selecting for Reduced Emissions

- There is **genetic** variation in methane output
  - Both within breeds, and across breeds, in both cattle and sheep
- Moderate **heritability** ~15-25%
- Strong relationship with feed intake ~ but **not** 100%
  - We can likely select **against** methane and for feed intake (growth vs. production)
- Selection in a **breeding goal** is likely possible
  - Likely **1%** improvement per year

We need WJCB

- Grant Proposal for **Jersey** in preparation (CAN, DNK)
  - **Aim** – establish a world-wide database of methane data from Jersey
- We would be glad to include **World Jersey Cattle Bureau**
  - **Dissemination** of Breeding Goal Theory and New **Methane** Indices
- Do you know of **initiatives** in your home countries?
  - We would like data from **Sniffers**, **GreenFeed** and Respiration Champers

Acknowledgements

Arla
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Danish Agricultural Agency
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VIKINGDANMARK
Mælkeafgiftsfonden
Innovationsfonden
VIKINGGENETICS innovative breeding
TEKNOLOGISK INSTITUT

Thank you for your attention