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Feed Utilization in Nordic Cattle
FUNC

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Partners

- MTT Agrifood, Finland
- University of Helsinki, Finland
- Norwegian University of Life Sciences, Norway
- Swedish University of Agricultural Sciences, Sweden
- University of Copenhagen, Denmark
- Aarhus University, Denmark
- Knowledge Centre of Agriculture, Denmark

Funding

- **Primarily funded by the dairy industry in the participating countries!**
  - Different funding models and rules
  - Different reporting requirements
  - Different degree of public support
  - Different possibilities for cofunding from the involved universities
  - Difficult (~impossible) to move funding accross country borders

However:

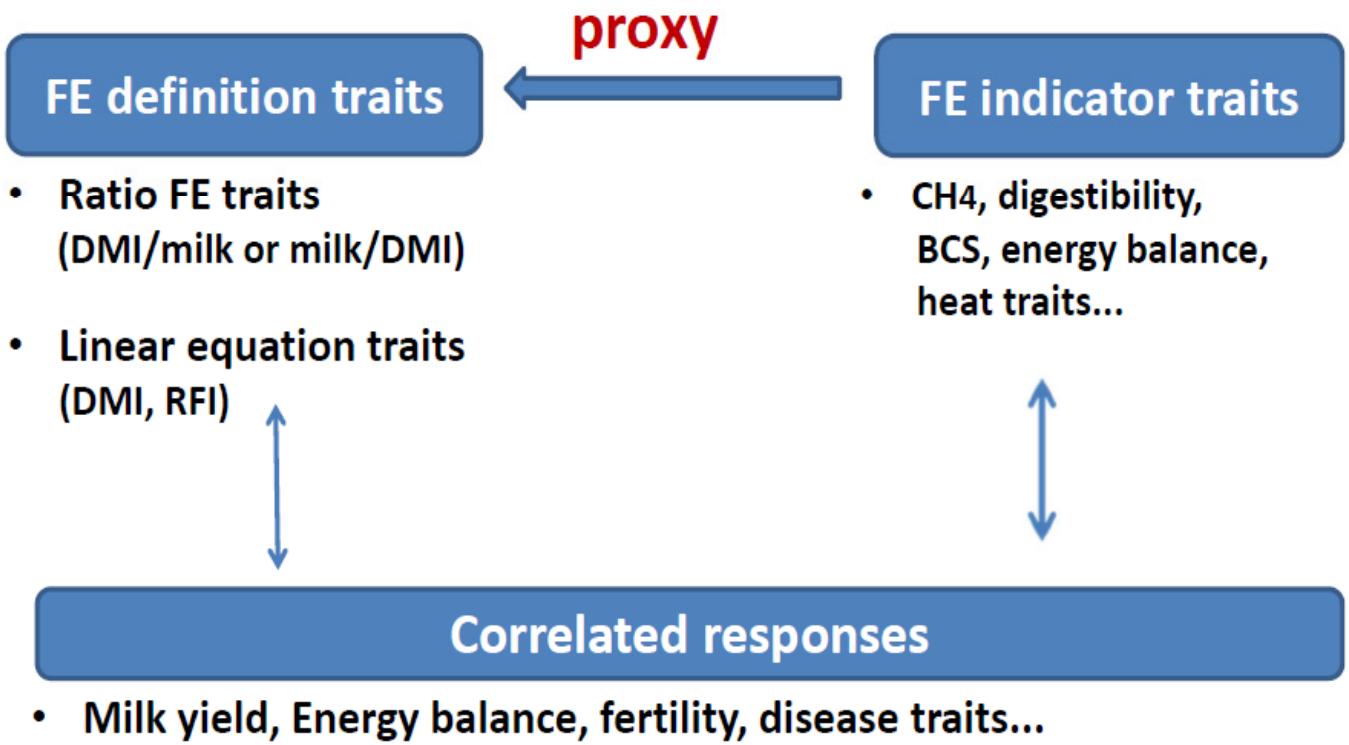
- ➢ Strong support form the Nordic Dairy Cattle R&D Committee (NDC)
- ➢ General and strong interest in collaboration for the benefit of dairy farmers
- ➢ The program runs in the period 2013-2016

Project Goals

- Joint use of research facilities
- Better definitions of feed efficiency
- Develop and test indicators of feed efficiency
- Genomic predictions for feed efficiency
- Selection strategies for feed efficiency
- Nutrional strategies for improving feed efficiency
- Development of systems models to improve overall feed efficiency

Background

- Alternative definitions of Feed Efficiency (FE) and proxy FE indicator traits.



Definitions of feed efficiency

- **Digestibility**
- **Alternative expressions of efficiency**
- **Indicator traits**
- **Sensor technology**

Development of a cow-specific organic matter digestibility prediction method based on NIRS scans

Terhi Mehtiö

MTT

Raw data

- Organic matter digestibility based on NIRS scans

Lactation stage	N	Mean	SD	Min	Max
All	185	740	21.0	695	812
50 DIM	47	736	28.5	695	812
150 DIM	47	732	16.9	704	765
250 DIM	47	737	15.8	704	769
Dry period	44	755	11.9	732	782

Repeatability estimates between lactation stages (composite samples of 47 cows)

- PROC VARCOMP, SAS
- Model
  - Fixed effects
    - Feeding level
    - Lactation stage
    - Week of collection
  - Random effect
    - Animal

$$r_a = \frac{\sigma^2_{animal}}{\sigma^2_{animal} + \sigma^2_{\varepsilon}}$$

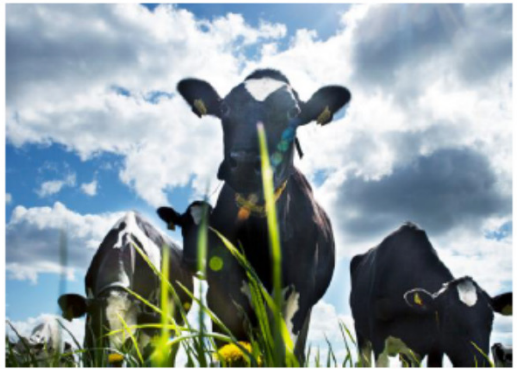
	σ^2_{animal}	σ^2_{error}	r
OMD	**37.87**	**119.79**	**0.24**
$OMD_{50,150}$	**56.91**	**110.50**	**0.34**
$OMD_{150,250}$	**42.00**	**100.76**	**0.29**
$OMD_{250,350}$	**11.18**	**113.46**	**0.09**

Conclusions

- Near infrared reflectance spectroscopy provides an opportunity to measure cow-specific organic matter digestibility from fecal samples
- Repeatability estimates indicated that improving dairy cattle digestibility by animal breeding is possible
- Further studies are still needed to make the method practically feasible
  - How many samples per week is the minimum?
  - In which lactation stage the samples should be collected?

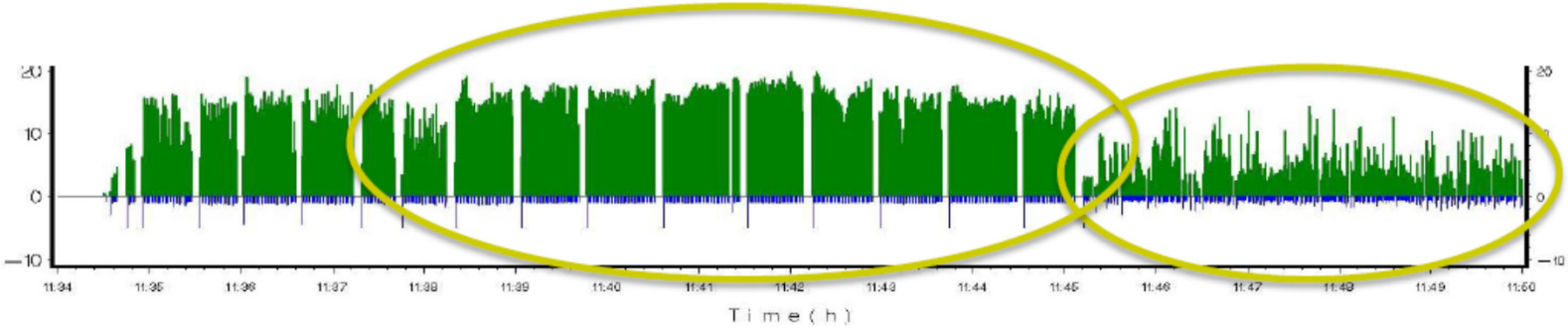
Rumination activity in relation to DMI and feed efficiency

FUNC meeting 3rd March 2014, Lövsta, Sweden
Malene Vesterager Byskov


Rumination activity - 2

- Rumination activity – how?
  - Regular pattern of jaw movements compared to eating activity



Rumination sensor - 1

- Rumination sensor
  - Records rumination time by sound of rumination pattern
  - Sensor placed dorsally on the left side
  - Detection of heat and diseases
  - Recording of activity in the same sensor for heat detection
  - Records rumination time in min per 2h intervals – 12.00.00 – 14.00.00
  - Daily rumination time – sum of 12 2h intervals over 24h initiated at midnight

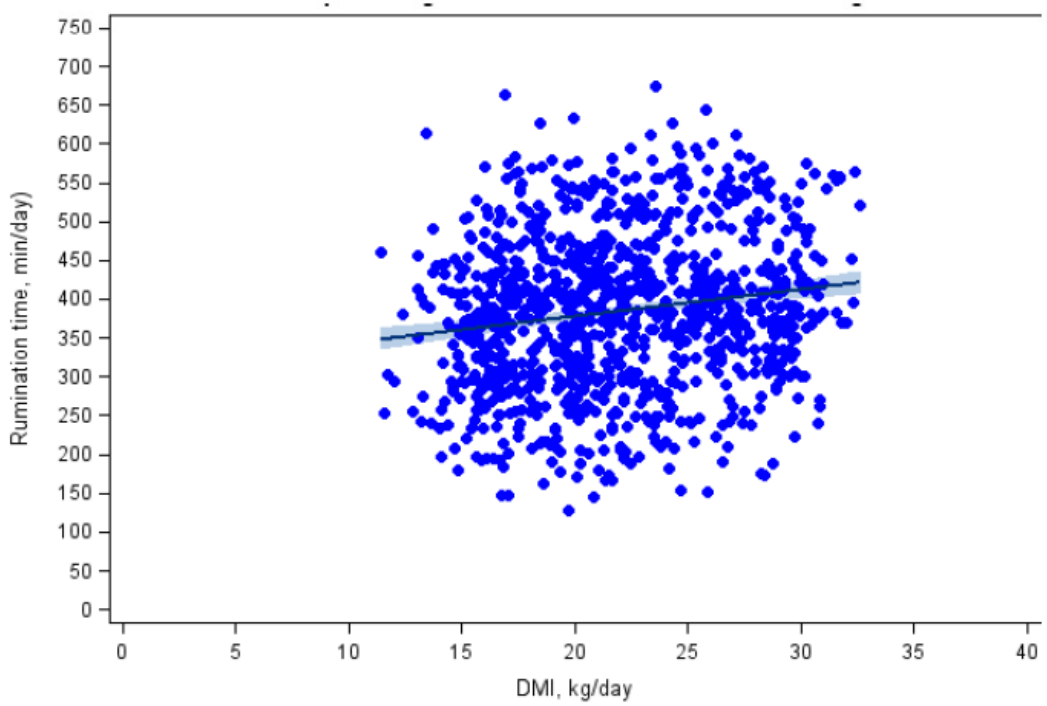
Repeatability

- Repeatability
  - $t = \sigma^2_{cow}/(\sigma^2_{cow} + \sigma^2_e)$
  - 131 Holstein cows and 51 Jersey cows
  - For all cows between 0 – 400 DIM in 1. – 3. parity
    r = 0.77

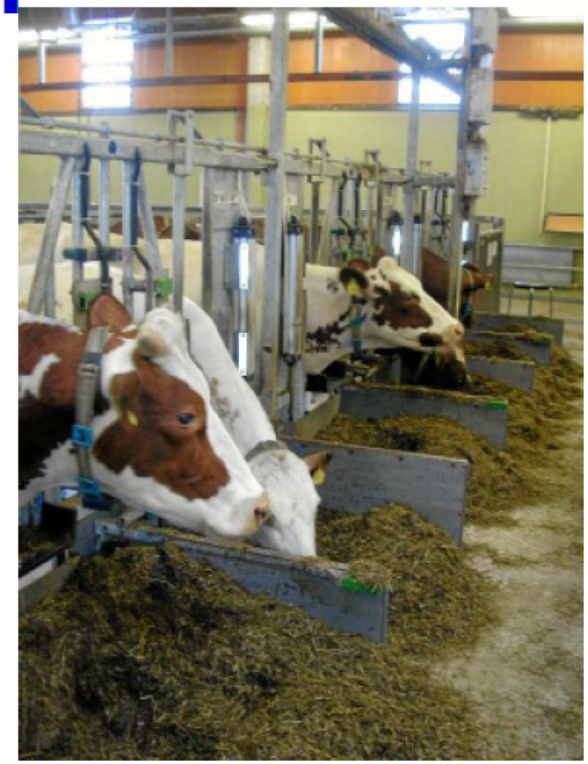
DIM	0 – 50	50 – 100	100 – 150	150 – 200	200 – 250	250 - 300	300 - 350	350 - 400
t	0.76	0.81	0.84	0.86	0.84	0.75	0.77	0.76

DMI and Rumination time - 1

- DMI and rumination time
  - Weekly averages of DMI and rumination time
  - 1,047 registrations from 110 Holstein cows and 42 Jersey cows



Methane mesurement at MTT with empahasis on Photoacoustic Infrared Spectroscopy Technique



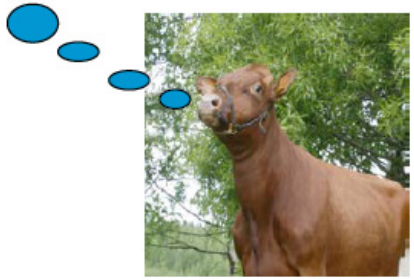
E. Negussie, P. Mäntysaari, E. A. Mäntysaari and M. Lidauer
MTT Agrifood Research Finland
Biometrical Genetics, 31600 Jokioinen

Introduction

Enteric methane main source of Methane(CH_4)

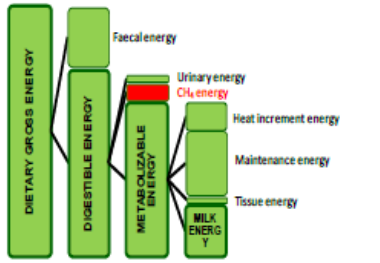
Accounts for 29% global CH_4 production

Contributes to global warming



Animal scientists – loss of feed energy

Ruminants lose 2-12% GE as CH_4



Partitioning of dietary gross energy intake into different energy pathways Xue et al. (2011)

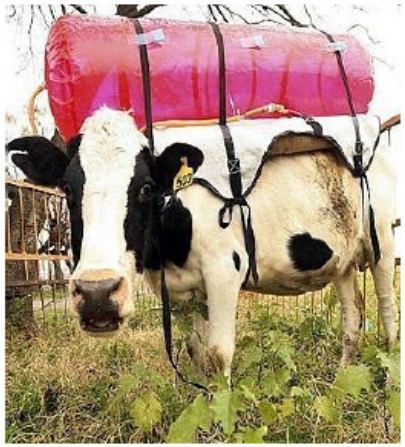
Mitgation of CH_4

Nutritional & environmental benefits

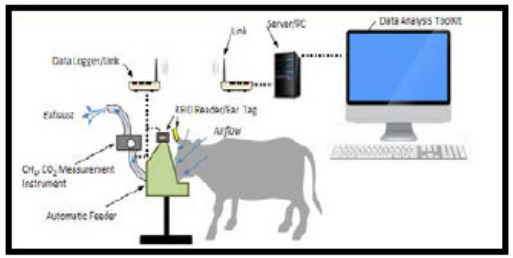
TECHNIQUES

Tedious & time consuming

Slow/ Expensive



Difficult & labour intensive



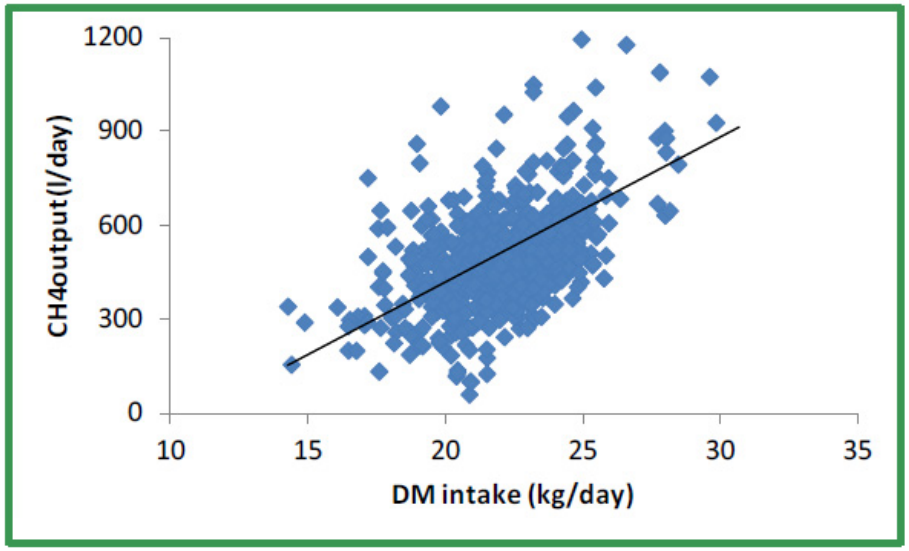
Techniques so far not suited for large scale measurements a requisite for genetic studies !

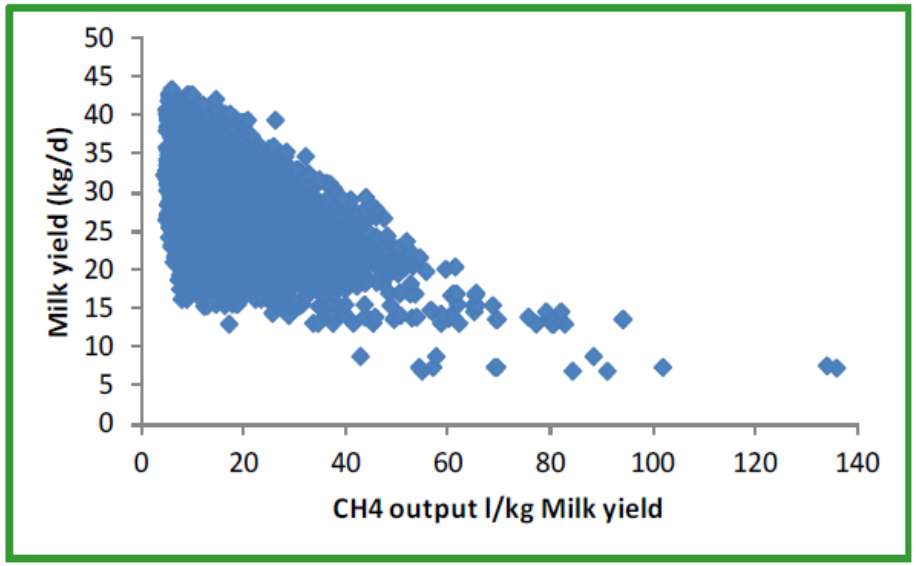
Data

- from ~100 cows
- Continuous 24/7 methane as well as intake and production measurements
- part or whole lactation CH4 measurements

Daily Mean and SD of CH4 output traits

Traits	*Mean*	*SD*	r
CH4p (l/d)	462	81	0.40
CH4g (g/d)	330	58	0.40
CH4g/kg milk	13.5	3.8	0.41
CH4GE%	5.7	0.9	0.32


1200
900
600
300
0
CH4output(l/day)
10
15
20
25
30
35
DM intake (kg/day)


50
45
40
35
30
25
20
15
10
5
0
Milk yield (kg/d)
0
20
40
60
80
100
120
140
CH4 output l/kg Milk yield

Genetic of Feed efficiency

- **Genetic variation**
- **Relationships among traits**
- **Indicator traits**
- **Genomic information**

PhD project

Genomic and Phenotypic Indicators of Feed Efficiency

Bingjie Li

Supervisors: Britt Berglund (SLU)
Peter Løvendahl (AU)
Freddy Fikse (SLU)
Jan Lassen (AU)
Goutam Sahana (AU)

SLU

AARHUS UNIVERSITY

EGS ABG

Materials & Methods

Animals

- **830 primiparous cows**: 473 Holstein + 215 Jersey + 142 RDC

- **Feed**: a total mixed ration (TMR) ad libitum

- **Recording**
  - A weekly record of DMI based on the average of daily DMI
  - DMIs over 24 lactation weeks used in this study

- **Pedigree**
  A combined pedigree consisting of 15731 cows from Sweden and Denmark

Results & Discussion

Repeatability and Heritability

- Heritability for DMI: 0.16 to 0.35
- Early lactation: Large residual variance, low heritability for DMI.

Table 1. Number of animals, mean, standard deviation (SD), heritability (SE in brackets), and repeatability for daily DMI (kg) at different lactation stages.

Week	No. of animals	Mean	SD	Heritability	Repeatability
1-4	721	13.38	3.38	**0.16** (0.05)	0.26
5-8	708	17.16	2.83	**0.32** (0.09)	0.69
9-12	698	18.51	2.93	**0.32** (0.09)	0.69
13-16	652	18.97	2.92	**0.25** (0.09)	0.77
17-20	643	19.34	3.07	**0.35** (0.09)	0.73
21-24	634	19.54	3.15	**0.32** (0.10)	0.80

Conclusions

- **Heritability** for DMI varied across lactation stages with moderate estimates.
- **The beginning of lactation** has the lowest heritability, indicating low response to selection for DMI from early lactation.
- **A weak genetic correlation** between the beginning and mid lactation suggests a different genetic basis for DMI along lactation. Adjacent lactation stages are highly genetically correlated.

Associated projects

- **REMRUM (Denmark)**
- **Green Dairy (Finland)**
- **Feed Mileage (Norway)**
- **Global DMI Initiative (Several)**
- **Applications submitted:**
  - **CONVERSION**, EU, 22 partners
  - **REFFIKO**, Denmark

Scientists Involved

Ahvenjärvi Seppo (MTT), Britt Berglund, Egil Prestløkken, Enyew Negussie, Esa Mantysaari, Freddy Fikse, Goutam Sahana, Gunnar Klemetsdal, Haja Kadarmideen, Jan Bertilsson, Jan Lassen, Jarmo Juga, Juha Nousiainen, Just Jensen, Kevin Shingfield, Laura Nyholm, Louise Dybdahl Pedersen, Malene Vesterager Byskov, Martin Lidauer, Martin Riis Weisbjerg, Mehtiö Terhi, Mette Krogh Larsen, Mikaela Patel, MikkoJ. Korhonen Minna Toivonen Morten Kargo, Odd Magne Harstad, Ole Højberg, Pekka Huhtanen, Peter Lund, Peter Løvendahl, Päivi Mäntysaari, Rinne Marketta, Sairanen Auvo, Theo Meuwissen, Timo Sipiläinen, Torsten Eriksson, Troels Kristensen, Tuomo Kokkonen.

Summary

- Joint Internordic project on Feed Utilization in Dairy Cattle (FUNC)
- Better definition of feed efficiency
- Development of indicators
- Development of selection tools
- Development of better feeding strategies
- Economic evaluation of different strategies

- Early results are promising