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# Environmental traits and feed efficiency

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# The dilemma

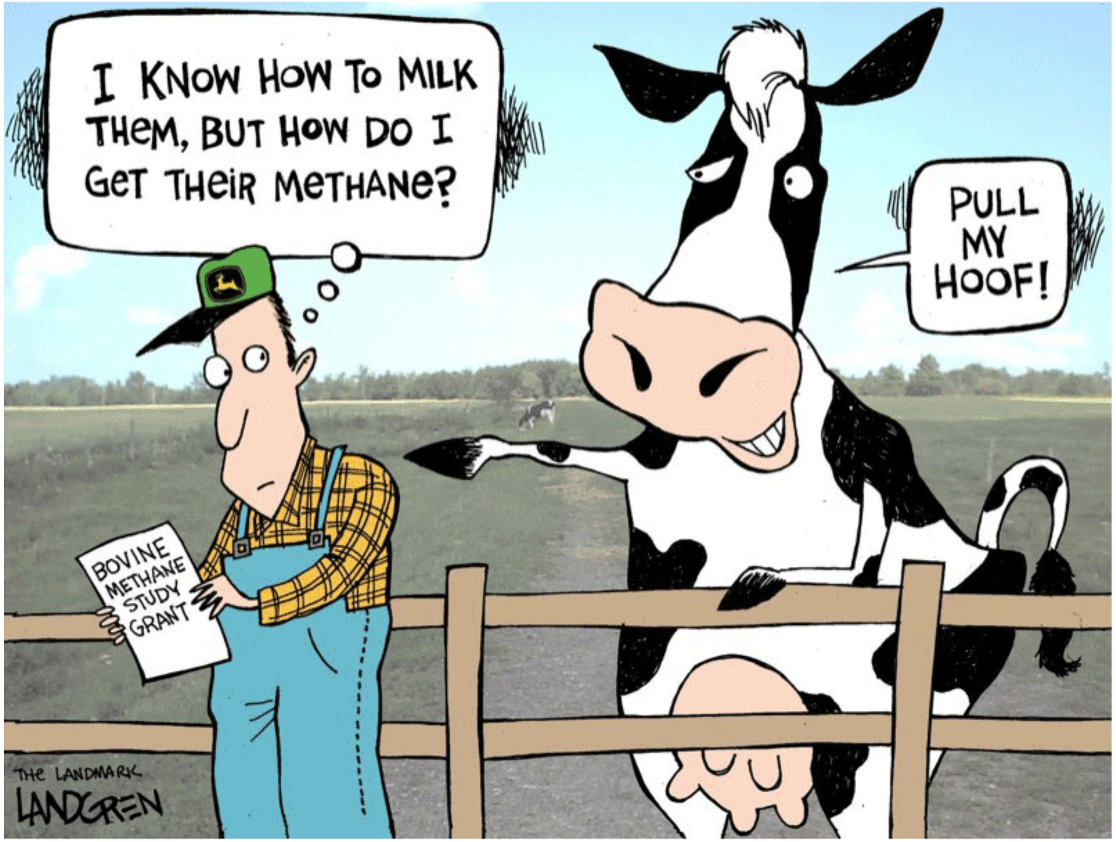
- 10 billion people in 2050 ( ~ 7,5 today)
- BRIC with huge growth - larger % of people in middle class
- Western civilisation will hardly change
- Fossil fuel will be on demand – more biofuel
- In 2020 EU will reduce green house gas with 20% compared to 1990
- In 2050 we need to have doubled food production compared to 2010

# Energy turnover in cow

| Feed intake | = | Product | + | Emission | + | Manure |
|---|---|---|---|---|---|---|
| Kilojoule | | Milk | | Methane | | Faeces |
| Nutrient | | Faetus | | Respiration | | Urine |
| | | Growth | | Activity | | N / P |

Host genotype

Rumen microbiota


I KNOW HOW TO MILK THEM, BUT HOW DO I GET THEIR METHANE?
PULL MY HOOF!
BOVINE METHANE STUDY GRANT
THE LANDMARK
LANDGREN

# METHANE

# Methane – two stories

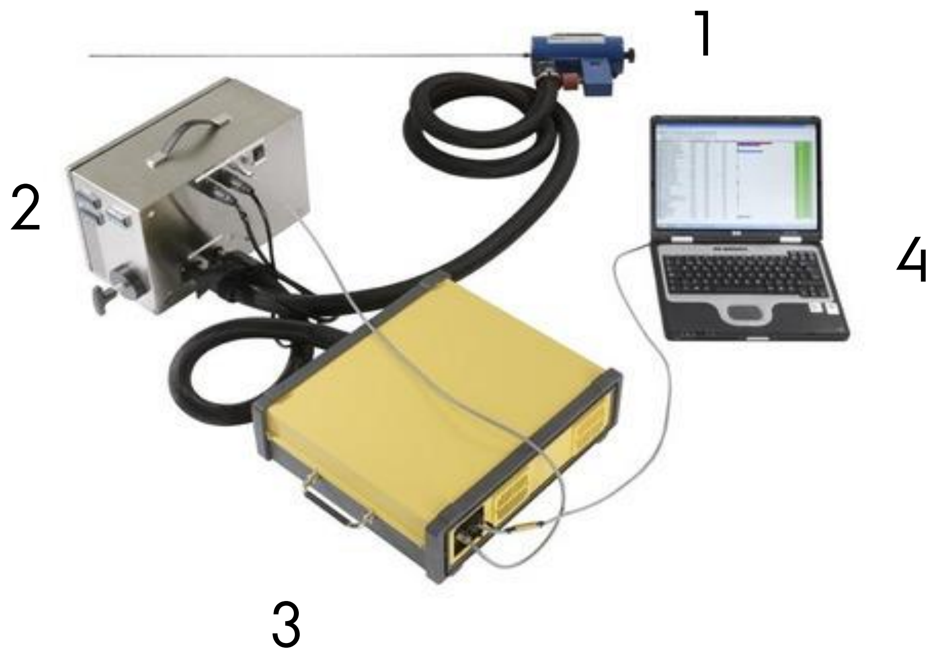
- Green house gas emission

- Indicator of feed efficiency

# Measuring methane for genetic analysis

- Precise measurements in large numbers (+10000)
- Respiration chambers is hardly the solution
- A number of new approaches are being tested

# Equipment for measuring in AMS




1. Sampling unit
2. Pump unit
3. Analyser FTIR – (GASMET DX-4000, www.gasmet.fi)
4. computer + software


DeLaval
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# Good and bad

- High capacity
- Non invasive
- Potential for other gasses

- Spot samples of biology
- No control of breath
- Expensive

# Data on methane emission

- 2104 cows with breath registrations from 15 herds
- Measured over a week long period during milking (5-30 visits pr cow)
- Measurement every 5 seconds
- Phenotype = $CH_4/CO_2$
- Weight data on 923 cows (Lely robots)
- Feed intake on 103 cows (research farm)
- Milk records on 2104 cows

# Quantifying methane emissions

- IPCC : PME (g/d) = **feed intake** (kg of DM/d) × 18.4 (MJ/kg of DM)/0.05565 (MJ/g) × 0.06 × {1 + [2.38 – **level of intake**] × 0.04} (de Hass et al JDS 2012)

- Heat: l/day = 5,6***weight**$^{0,75}$ + 22***ECM** + 1.6$^{-5}$***DCC**$^{3}$ * $CH_4/CO_2$ (Madsen et al LS 2010)

- $CH_4/CO_2$ : Ratio between methane and carbondioxide (Lassen et al JDS 2012, Madsen et al LS 2010)

# Phenotypic correlations

| | IPCC | Heat |
|---|---|---|
| Heat | 0,74 | |
| $CH_4/CO_2$ | 0,70 | 0,84 |

# Genetic model

| | | | |
|---|---|---|---|
| $CH_4/CO_2$ | = | Mean | |
| | | + Herd | Fixed class |
| | | + Robot(Herd) | Fixed class |
| | | + Lact nr | Fixed class |
| | | + DIM | Fixed reg |
| | | + Wilmink DIM | Fixed reg |
| | | + Animal | Random |
| | | + Residual | Random |

# Genetic parameters

| | $h^2$ | $R_g$ with milk |
|---|---|---|
| $CH_4/CO_2$ | 0,19 ± 0,04 | -0,44 ± 0,23 |
| Milk | 0,21 ± 0,06 | |

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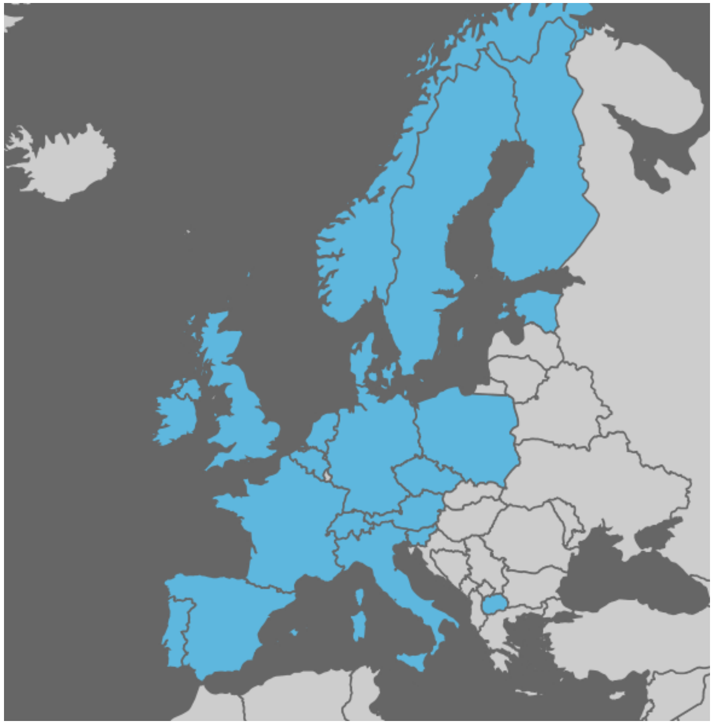
# METHAGENE – EU COST ACTION



- 4 year network project
- Comparision of methods
- Indicators
- Data base
- Exchange of personel
- Workshops
- ICAR, ASGGN

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# Methane data in Europe

| Person | Country | Breed | Method | Approx. number of animals | Feed data |
|---|---|---|---|---|---|
| **Yan Tianhai** | UK | Hol | SF6/chamber | 1000 | X |
| **Jan Lassen** | DK | HOL | Sniffer | 2500 | |
| **Eileen Wall** | UK | HOL | Laser | 200 | X |
| **Phil Garnsworthy** | Ruminomics | HOL/RED | Greenfeed/sniffer | 1000 | (X) |
| **Yan Tianhai** | UK | BEEF | SF6/chamber | 300 | X |
| **Gilles Renand** | F | BEEF | Greenfeed | 100 | X |
| **Yvette de Hass** | NL | HOL | Sniffer | 100 | X |
| **Enyew Negussie** | SF | FAY | Sniffer | 100 | X |
| **Phil Garnsworthy** | UK | HOL | Sniffer | 2000 | |
| **Britt Berglund** | Nordic | HOL/JER/RED | Sniffer/greenfeed | 500 | X |
| **Herman Swalve** | D | HOL | laser | 3000 (plan) | |
| **Et al** | Europe | | | 1000 | (X) |
| **Total** | | | | ~9000 (12000) | |

# FEED EFFICIENCY

# Trait definition

- RFI – residual feed intake (intake – expected intake)
- FCR – feed conversion rate (output/input)
- Individual digestability
- Nordic feed efficiency

# Joint estimation of RFI, DMI, GAIN and LW

› Random regression approach (Jensen, 2013)

› LW and DMI data from bull calves on test station

› GAIN estimated based on derivates of LW

› RFI estimated based on Cont Dist of DMI given LW and GAIN

› Applicable to dairy situation as well

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# Data from research farm Denmark (van Vliet et al., 2014)

| Total | DMI | Yield | LW |
|---|---|---|---|
| DMI | 0.22 | 0.60 | 0.16 |
| Yield | 0.68 | 0.23 | 0.07 |
| LW | 0.59 | 0.06 | 0.50 |

| Holstein | DMI | Yield | LW |
|---|---|---|---|
| DMI | 0.31 | 0.65 | 0.14 |
| Yield | 0.71 | 0.22 | 0.07 |
| LW | 0.64 | 0.22 | 0.53 |

| Jersey | DMI | Yield | LW |
|---|---|---|---|
| DMI | 0.19 | 0.48 | 0.14 |
| Yield | 0.83 | 0.41 | 0.11 |
| LW | 0.51 | -0.25 | 0.36 |

- 464 Hol, 218 JER
- Weekly phenotypes
- 35.000 reg HOL
- 15.000 reg JER
- SE ~0.05-0.2
- $r_g$, $r_e$, $h^2$

# Global dry matter initiative

**Table 1.** Number of lactations and animals as well as the mean, genetic standard deviation, heritability and repeatability of dry matter intake in all countries (i.e., All countries) or each individual country.

| Country | Lactations | Animals | Mean | SDg | $h^2$ | Repeatability |
|---|---|---|---|---|---|---|
| **Cows** | | | | | | |
| **All countries** | 10701 | 6953 | 19.7 | 1.13 | 0.34 (0.03) | 0.66 (0.01) |
| **Canada** | 411 | 202 | 22.2 | 1.01 | 0.19 (0.14) | 0.46 (0.06) |
| **Denmark** | 668 | 363 | 22.1 | 1.48 | 0.52 (0.12) | 0.62 (0.04) |
| **Germany** | 1141 | 1095 | 20.2 | 0.64 | 0.08 (0.06) | 0.84 (0.05) |
| **Iowa** | 398 | 398 | 23.5 | 1.48 | 0.41 (0.14) | |
| **Ireland** | 1677 | 827 | 16.7 | 0.88 | 0.41 (0.10) | 0.64 (0.02) |
| **Netherlands** | 2956 | 2241 | 21.4 | 1.15 | 0.39 (0.05) | 0.54 (0.03) |
| **UK** | 2840 | 1277 | 17.4 | 1.07 | 0.31 (0.06) | 0.72 (0.02) |
| **Wisconsin** | 507 | 447 | 25.3 | 0.61 | 0.11 (0.14) | 0.68 (0.07) |
| **Australia** | 103 | 103 | 15.6 | | | |
| | | | | | | |
| **Heifers** | | | | | | |
| **Australia** | | 843 | 8.3 | 0.77 | 0.20 (0.11) | |
| **New Zealand** | | 941 | 7.6 | 0.66 | 0.34 (0.12) | |

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# GENOMIC SELECTION

# Small scale to large scale

- Most females with methane phenotype is genotyped
- Direct traits together with indicators
- Method developement needed
- Contract herds – low density chip
- Need for collaboration

# Next step

- METHANE
  - Correlations to other traits
  - GWAS
  - COST, ICAR – definition, validation, data collection and merger

- FEED EFFICIENCY
  - Nordic data merger
  - gDMI project
  - RUMEN data
    - 2000 cows will be phenotyped and genotyped (~1000 now)
    - RUMINOMICS EU project

- GENOMIC SELECTION
  - Small scale phenotyping to larger scale genomic prediction
  - Contract herds

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