Agri-Food and Biosciences Institute

Prediction and mitigation of enteric methane emissions from dairy cows

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Contents of my presentation

- AFBI measurements of enteric methane emissions from cattle
- Prediction of enteric methane emissions for dairy cows and heifers
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AFBI measurements of enteric methane emissions from cattle

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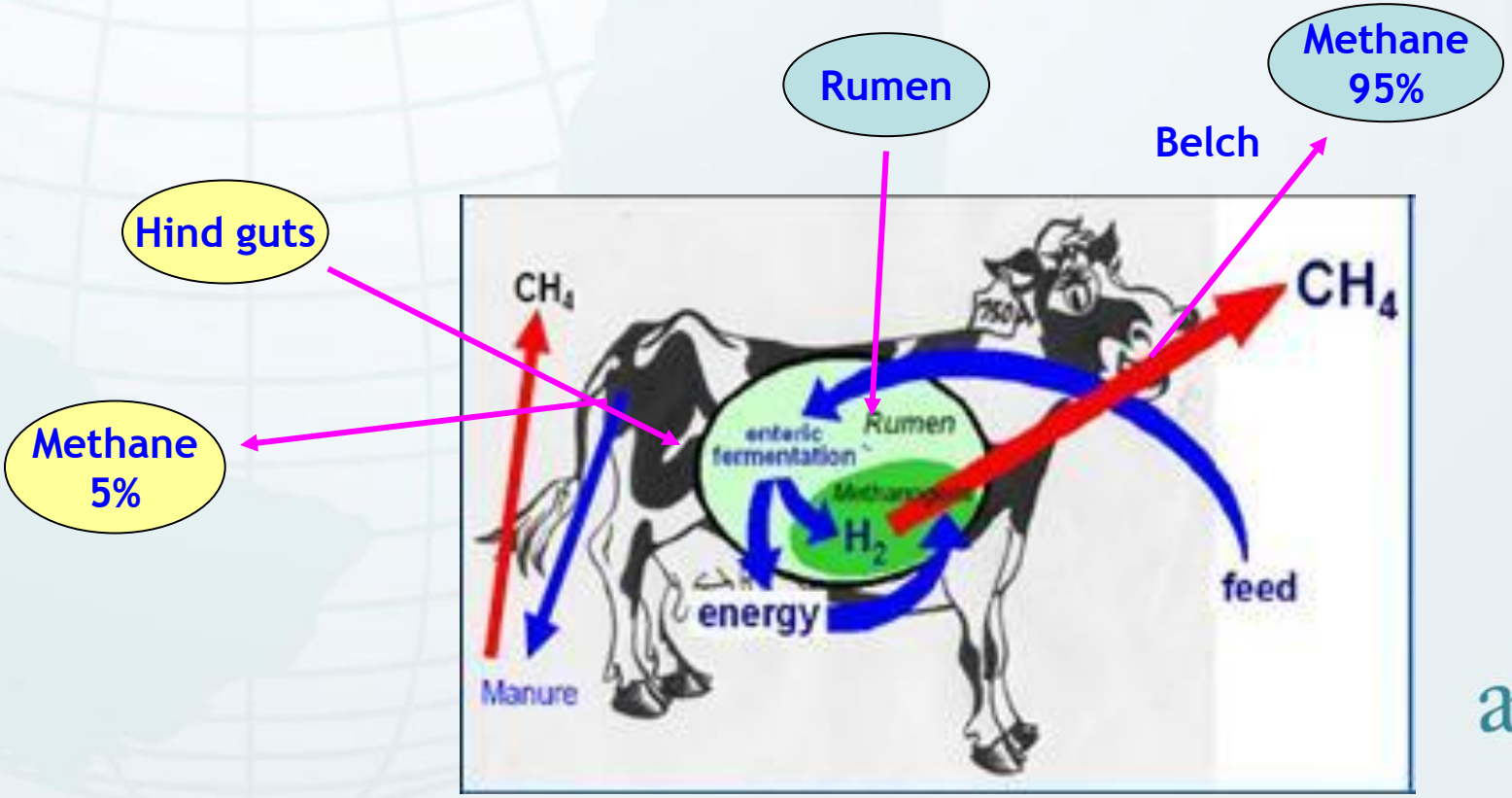
Methane emissions from ruminant animals

- Two sources – from enteric fermentation and manure management
- Enteric methane is a by-product of nutrient digestion in rumen and large intestine of ruminant livestock



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AFBI calorimeter chambers

- Two cattle respiration calorimeter chambers installed in 1992 and refurbished in 2010

Installed in 1992

Refurbished in 2010

- Over 40 studies undertaken to determine energetic efficiencies and enteric methane emissions of dairy cows

- These data (>1000) used to develop a range of prediction equations and mitigation strategies for enteric methane emissions

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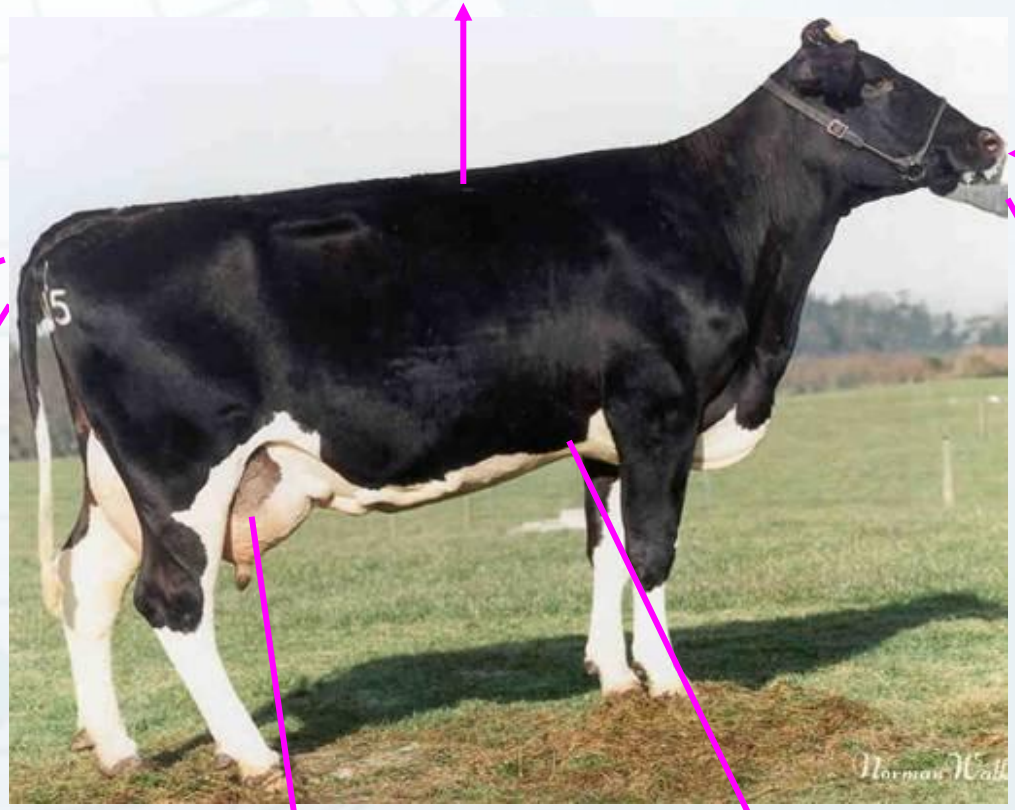
AFBI dairy cow methane data

- AFBI chamber data (n>1000) - average energy intake and outputs

37.5%
as heat production



Gross energy intake
300 MJ/d
(16.5 kg DM/d)

27%
in faeces

4%
in urine

6.5%
as methane

24%
in milk

1%
in body

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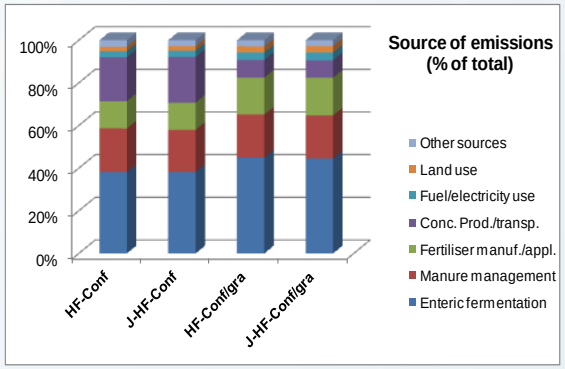
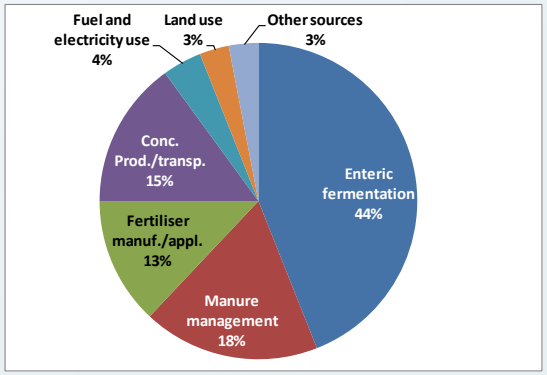
Enteric methane – a large source of GHG

- **Enteric methane production is a large source of GHG emissions from the dairy production sector calculated using life cycle assessment**
- **AFBI 4 management systems study: HF and Jersey-HF cows managed under total confinement and confinement/grazing, respectively**
  - **% of emission sources**
    Enteric fermentation: **38 to 45%**
    Other sources: 55 to 62%
    (Manure, fertiliser, concentrate, fuel & electricity, land use change and others)



- **DARD 100 farm survey data, representing a range of dairy farm conditions**
  - **% of emission sources**
    Enteric fermentation: **44%**
    Other sources: 56%
    (Manure, fertiliser, concentrate, fuel & electricity, land use change and others)



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Prediction of enteric methane emissions for dairy cows and heifers

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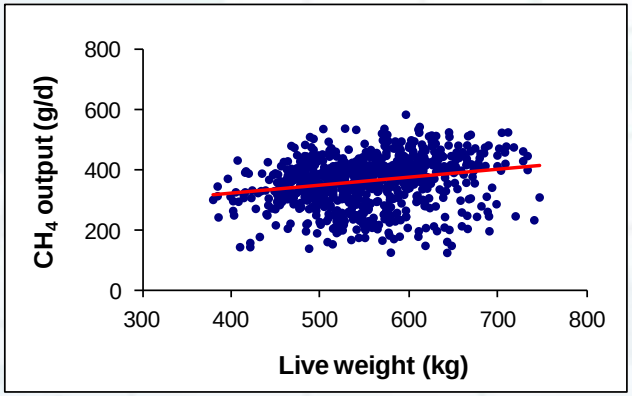
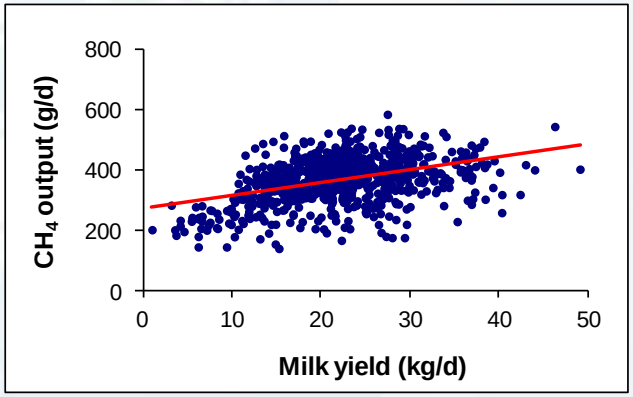
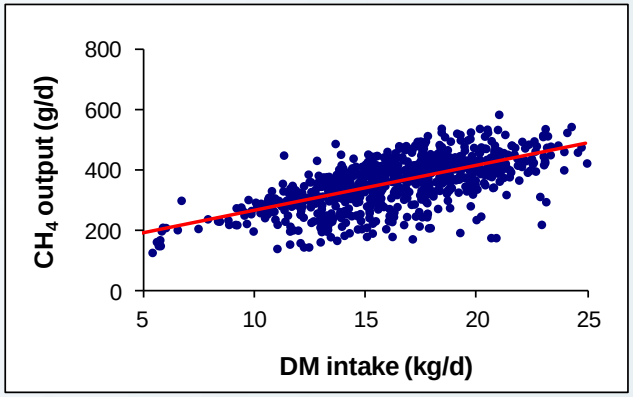
Predicting methane emissions for dairy cattle

- **Lactating dairy cows: AFBI methane data used to develop a range of models for prediction of methane emissions**







e.g.,

CH_4 (l/d) = [38.2 + 4.89 Forage%] DMI – 0.719 DMI^2 – 20

CH_4 (l/d) = 0.591 LW + 5.426 MY + 65

- **These equations used for development of AFBI GHG calculator for dairy production systems in NI**

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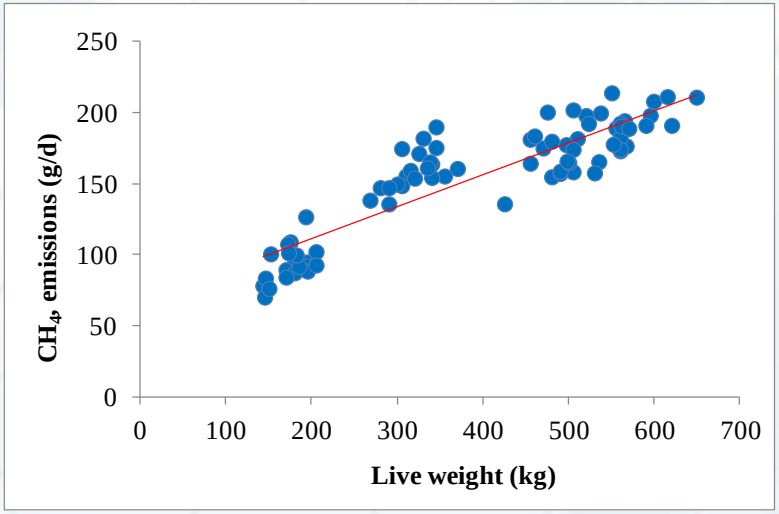
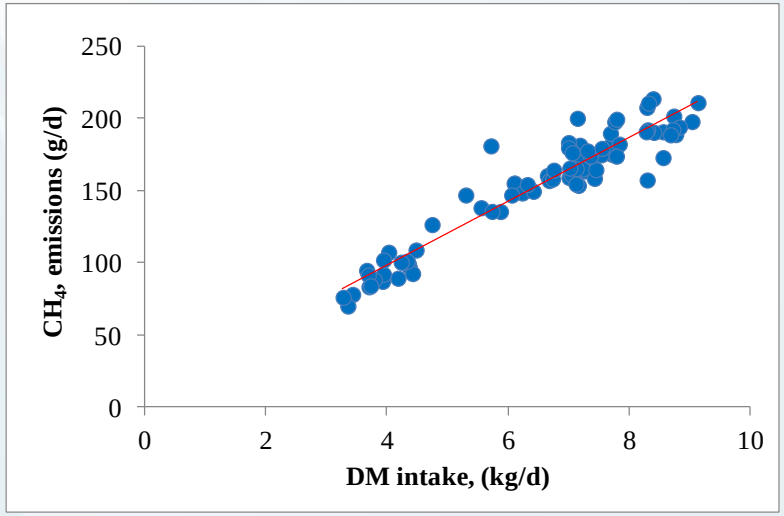
Predicting methane emission for young stock

- **Heifers/steers: AFBI methane data used to develop a range of models for prediction of methane emissions**





e.g.,

CH_4 (g/d) = 0.278 LW + 54.0

CH_4 (g/d) = 22.1 DM intake + 9.6

- **These equations used for development of AFBI GHG calculators for dairy and beef production systems in NI**

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Mitigation Strategies developed at AFBI

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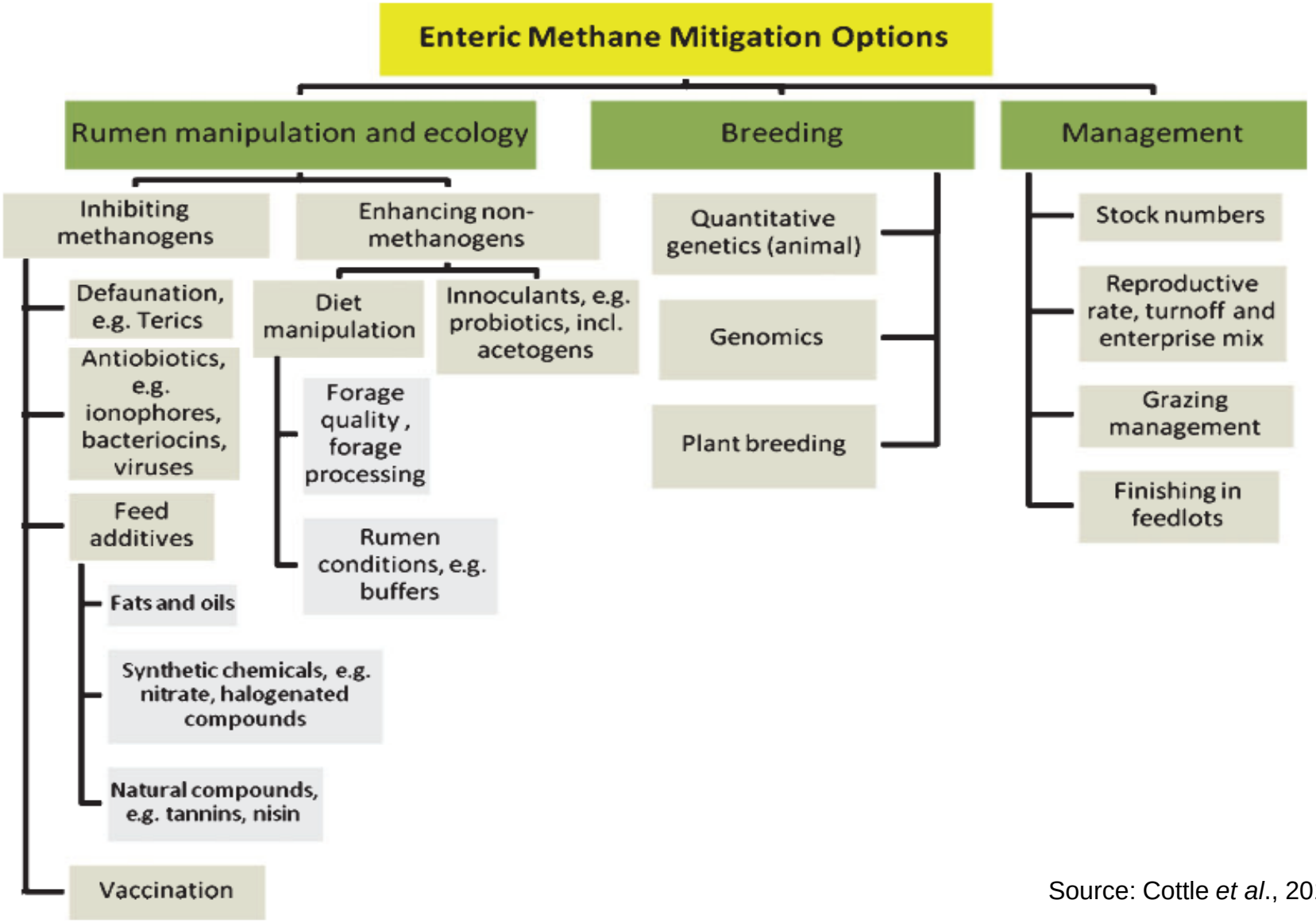
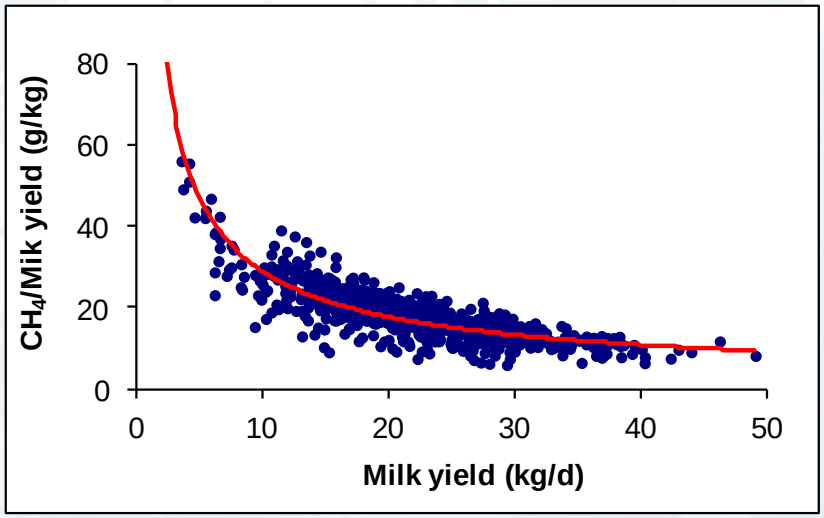
Mitigation options for enteric methane emissions

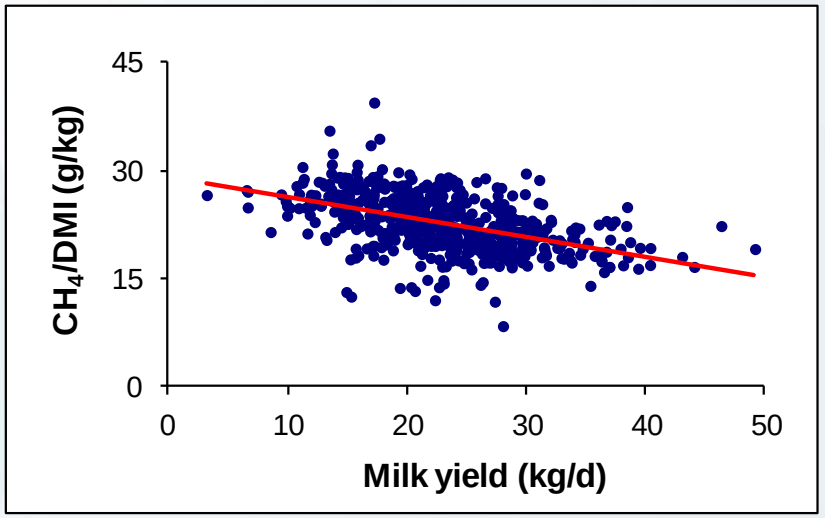


Source: Cottle *et al*., 2011

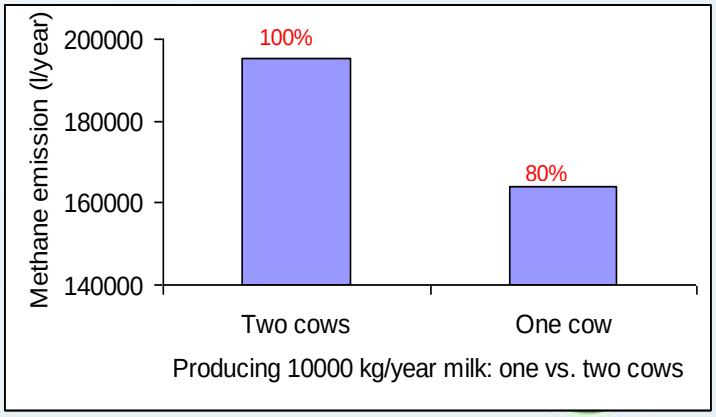
Do high yielding cows produce less methane?

- Increasing milk yield reduces CH_4 emission per kg milk yield or DM intake



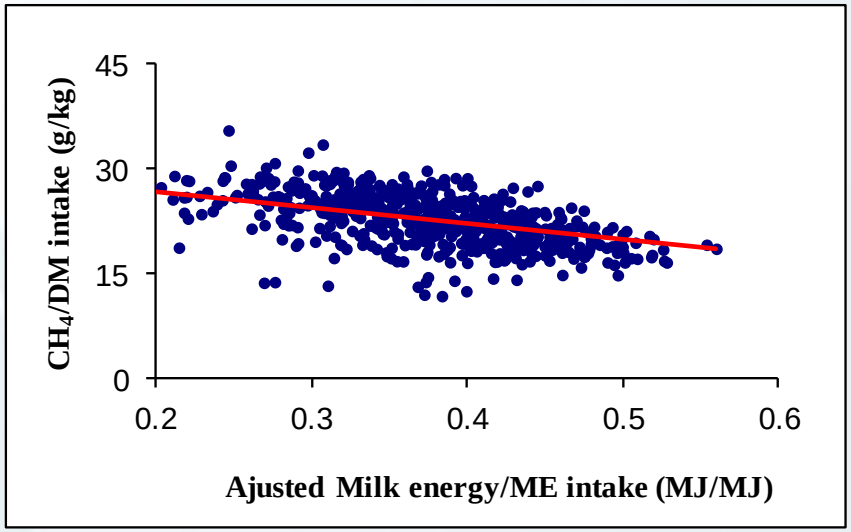


- For example, to produce 10,000 kg milk, using one high yielding cow, rather than two low yielding cows, could reduce CH_4 emission by 20% (if assuming no change in fertility, diet, etc.)

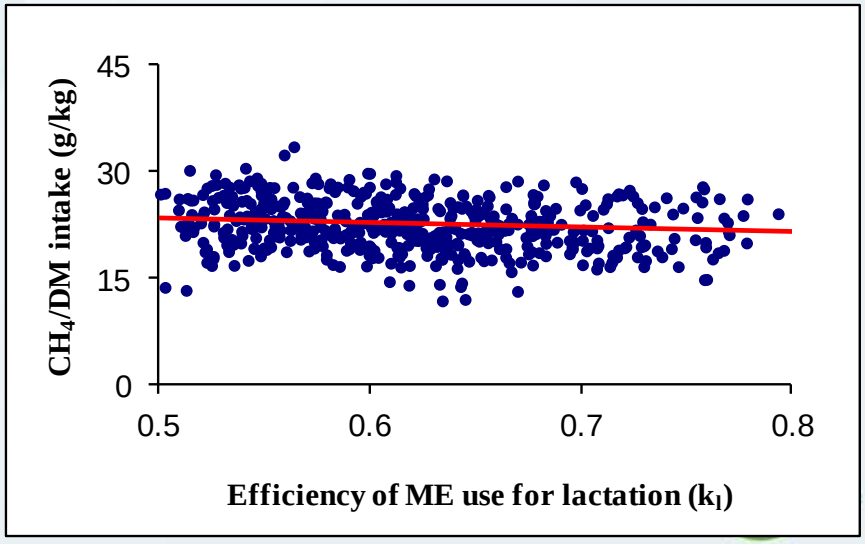


Do high efficiency cows produce less methane?

- Cows partitioning more consumed energy into milk production reduces CH_4 emission per kg DM intake

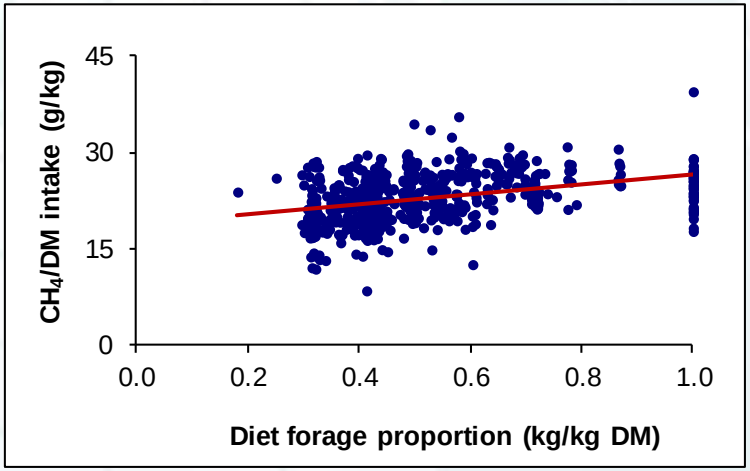


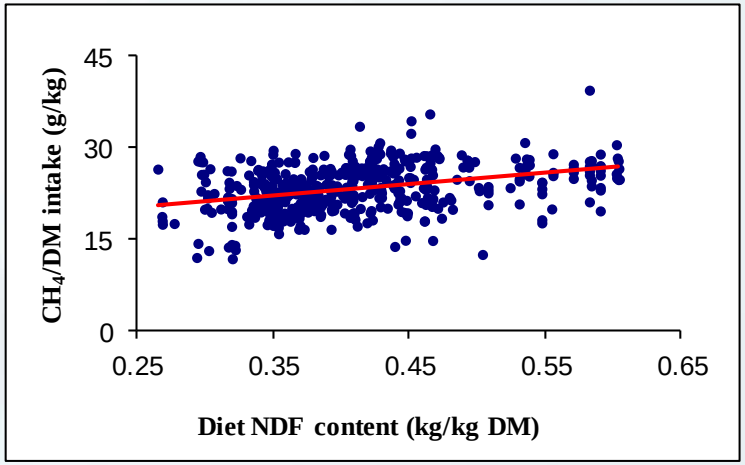
- Cows with high energy utilisation efficiencies (k_l) reduces methane production per kg DM intake



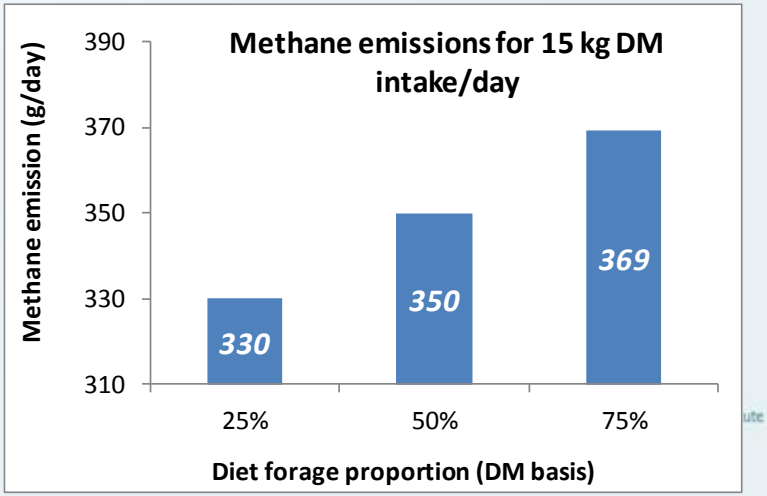
Does diet forage proportion affect methane emissions?

- Increasing diet forage proportion increases methane emission per kg DM intake



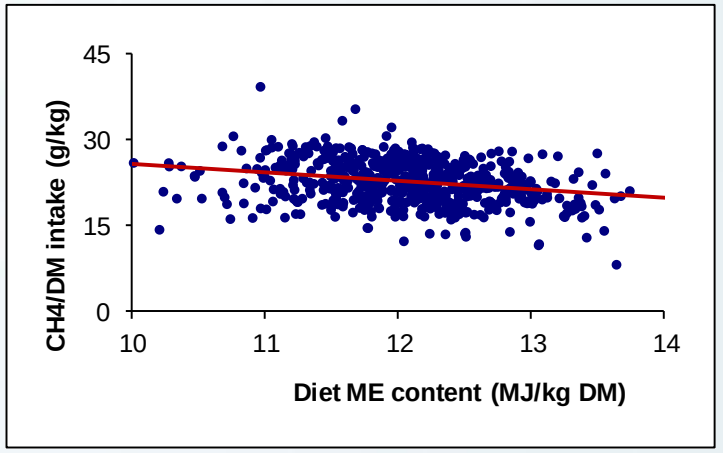


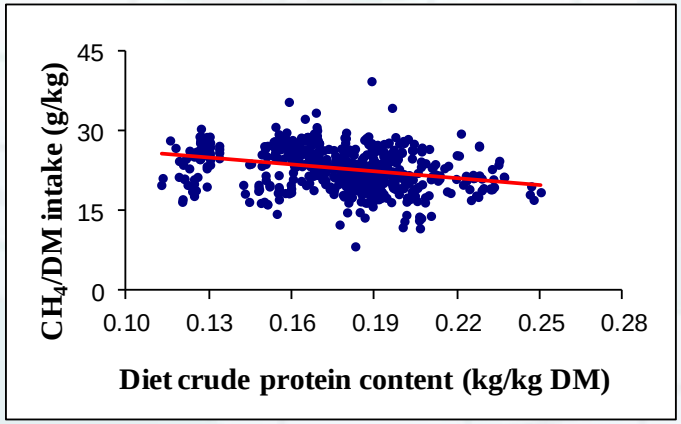
- For example, with 15 kg DM intake/day, using diets containing 75%, rather than 25% of forage, could increase methane output by 12%



Does diet quality affect methane emissions?

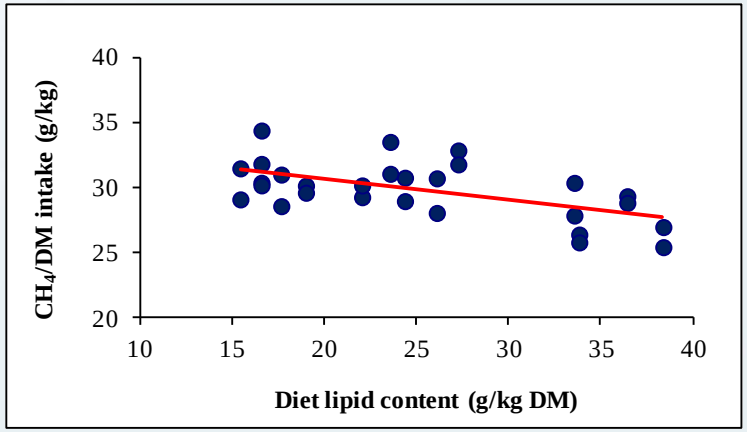
- Increasing diet ME contents reduces methane emissions per kg DM intake





- Increasing diet CP contents reduces methane emission per kg DM intake (but increases manure nitrogen output)

- Increasing diet lipid contents reduces methane emission per kg DM intake



Conclusions

- Methane emissions from dairy cattle can be predicted using diet and animal factors
- Methane emission per kg DM intake can be reduced by
  - increasing milk yield
  - increasing energy utilisation efficiency
  - decreasing diet fibre content (NDF and forage proportion)
  - increasing diet quality (ME, CP and lipid content)
- Diet manipulation and animal management are effective approaches to reduce methane emissions from dairy cows.
- However, manipulation of diets and section of animals could impact other sources of GHG emissions in the dairy production sector, so life cycle assessment required to identify environment-friendly dairy systems

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Thank you!