



The University of  
**Nottingham**

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# Variability among dairy cows in methane, digestibility and feed efficiency

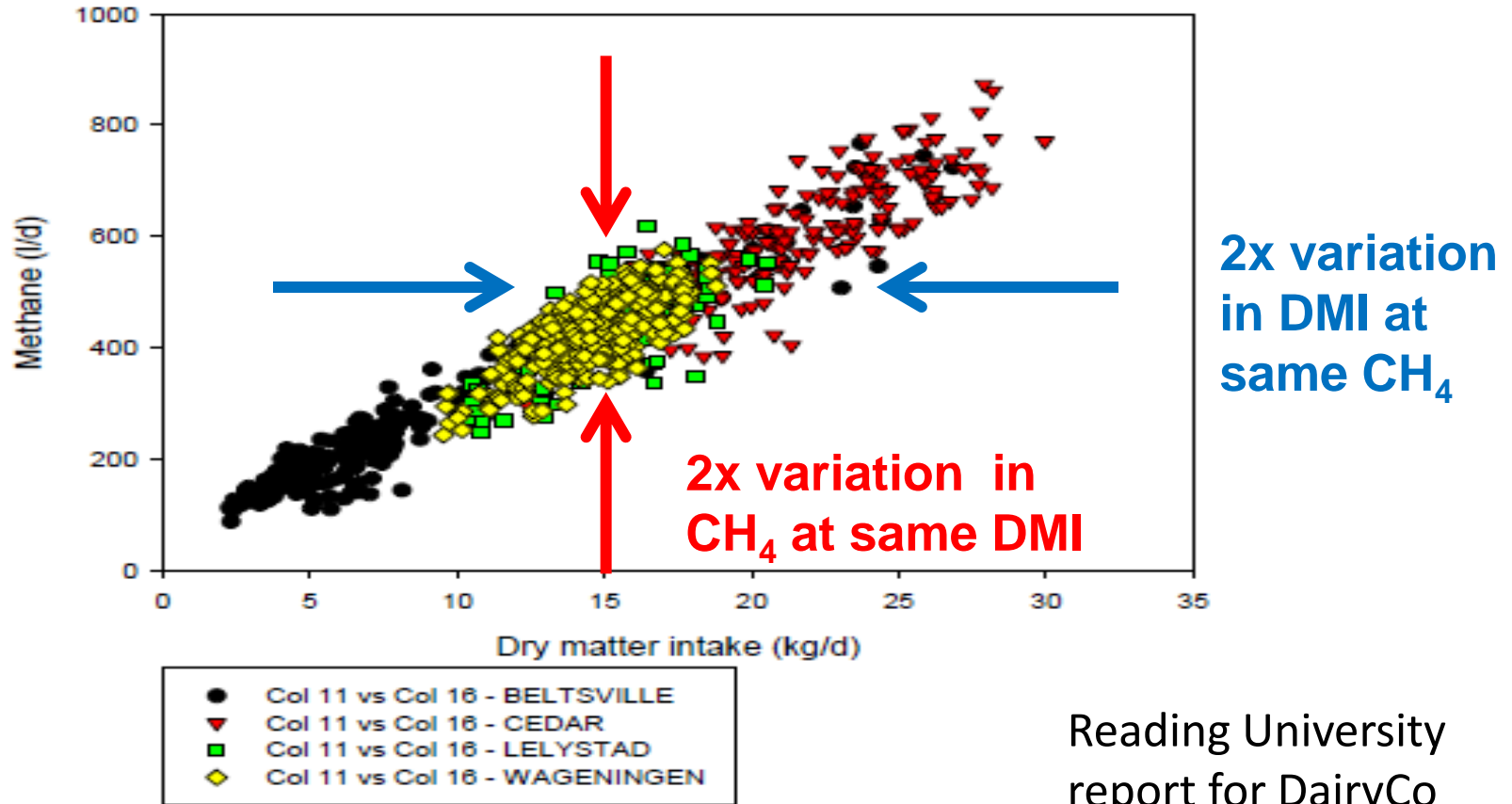
Phil Garnsworthy

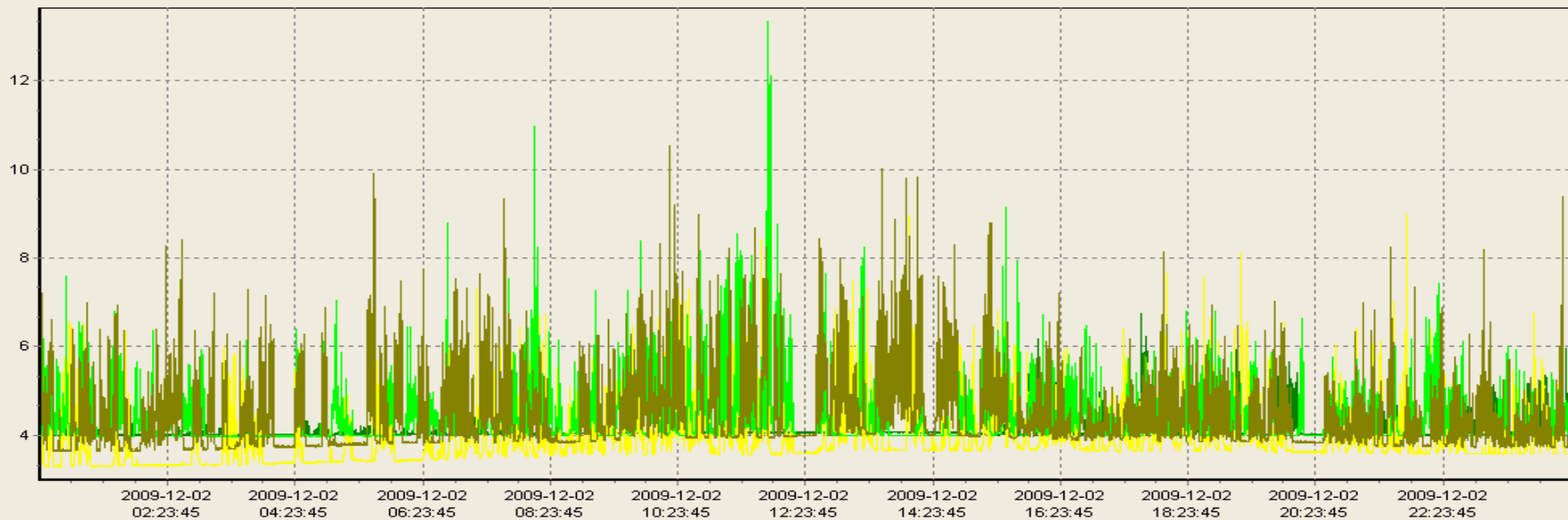
P.C. Garnsworthy, J. Craigon, E. Gregson, E. Homer,  
S. Potterton, P. Bani, E. Trevisi, P. Huhtanen, E. Garcia,  
K. Shingfield and A. Bayat

# Sources of variation in methane

- Methodology (Chambers, SF<sub>6</sub>, Sniffers, Proxies)
- Animals
  - Feed Intake, diet composition, digestibility
  - Physiological state (lactating, growing, pregnant)
  - Level of production (milk yield)
  - Diurnal variation
  - Individual variation in efficiency
  - Rumen microbial population

# Variability among cattle in chambers

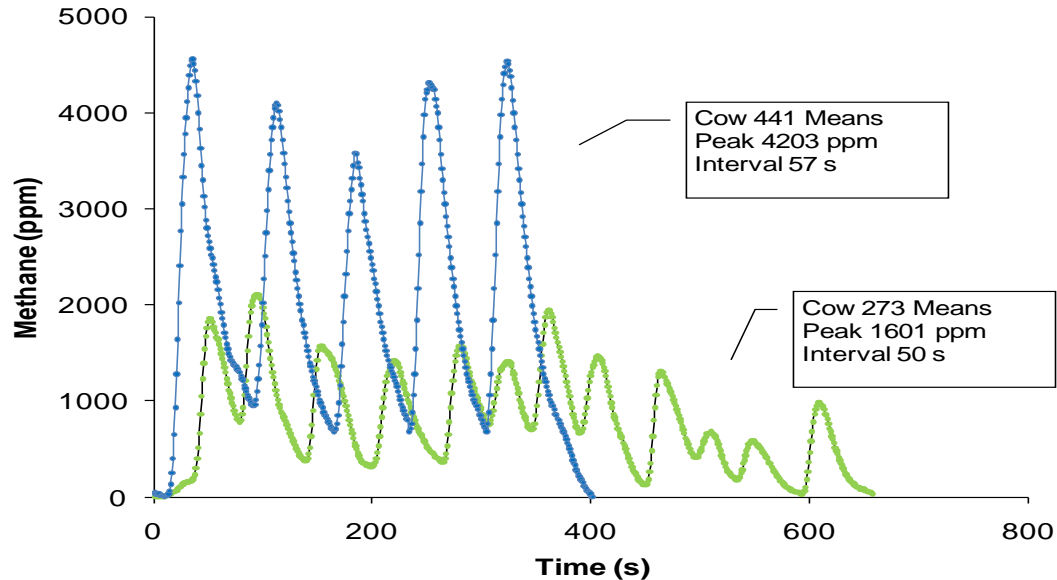




From date:  To date:



# Individual Cow Methane

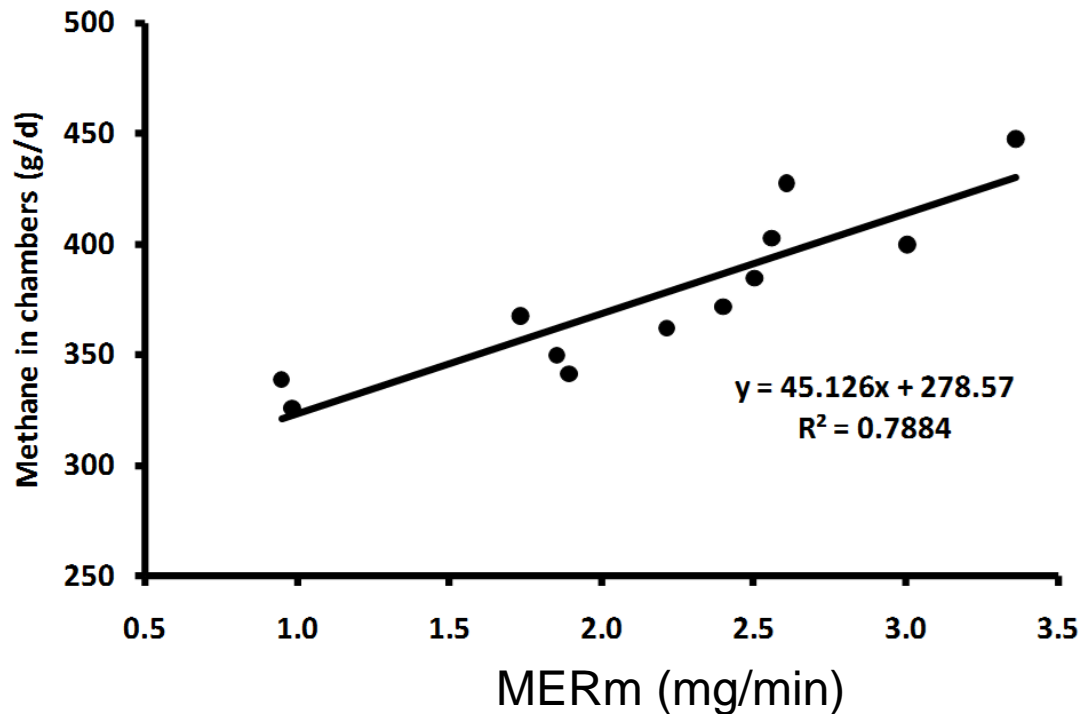


Individual cows vary in:  
Frequency of eructation  
Methane concentration in each eructation

## Similar systems

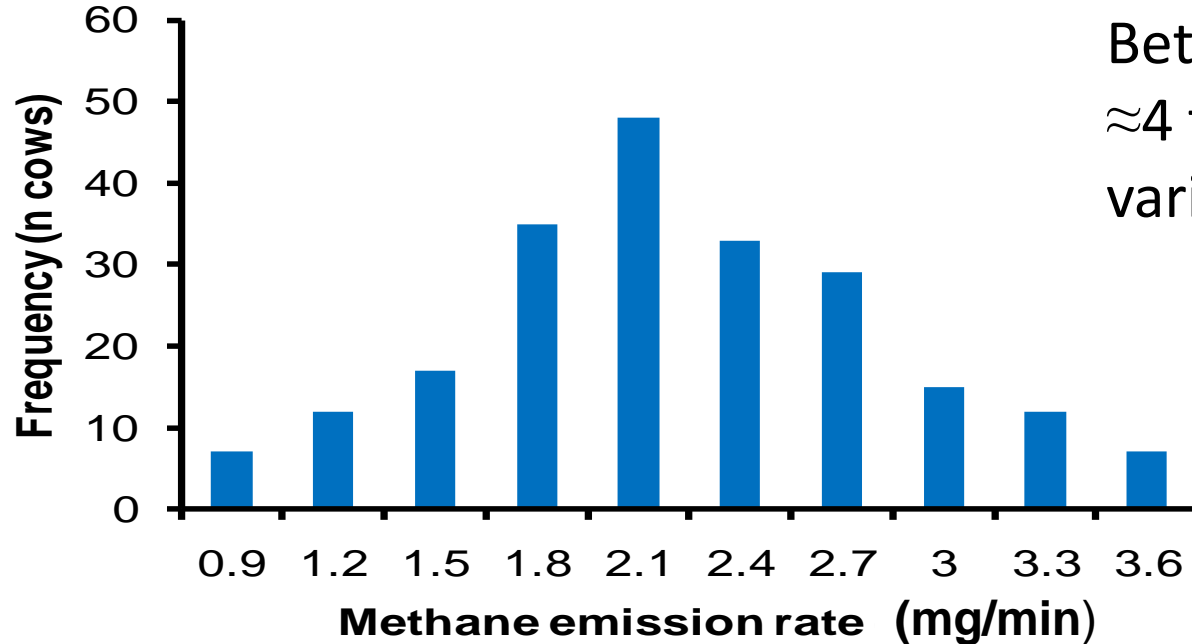
Robotic milking  
CO<sub>2</sub> ratio  
GreenFeed

# Online monitoring agrees with chamber-measured daily emissions



12 cows  
measured on  
farm for 10 days  
then chambers  
for 3 days

# Survey 215 cows; 5 months; 66,734 milkings; 14,533 daily means

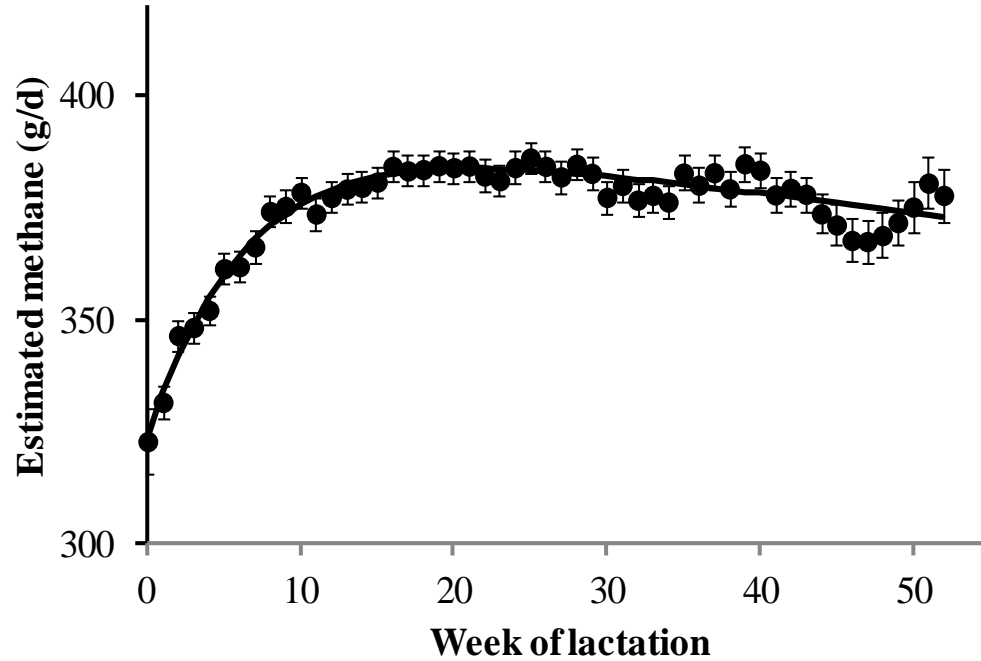


Mean 372 g CH<sub>4</sub>/d Range 304 to 440 g CH<sub>4</sub>/d

Between-cow variation  
≈4 times within-cow  
variation on same diet

**Significant:**  
Live weight  
Milk yield  
Parity  
Lactation week  
Sire of cow

# Week of lactation



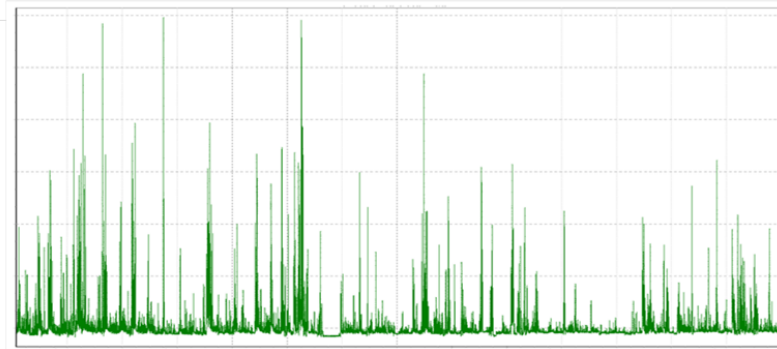
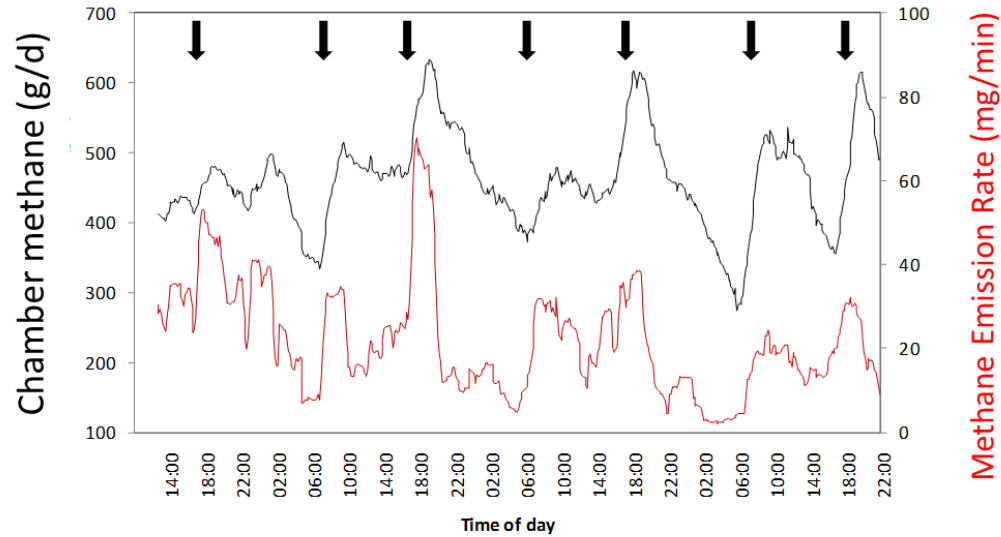
$$396 - 72 \times (0.86^{WL}) - 0.44 \times WL \quad (P=0.016)$$



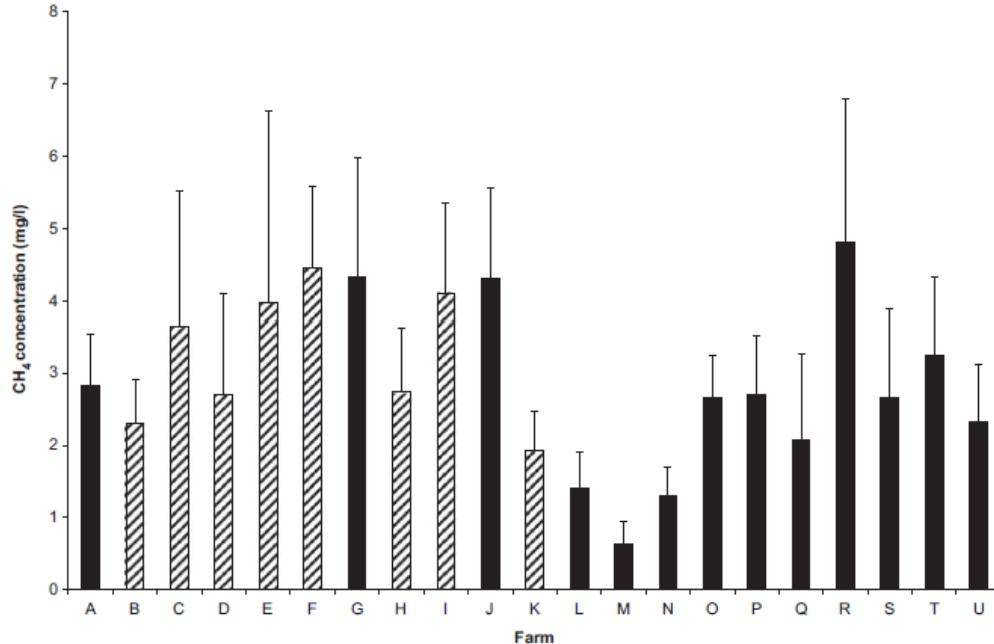
# Diurnal Variation – milking times



# Diurnal variation – sniffers in chambers

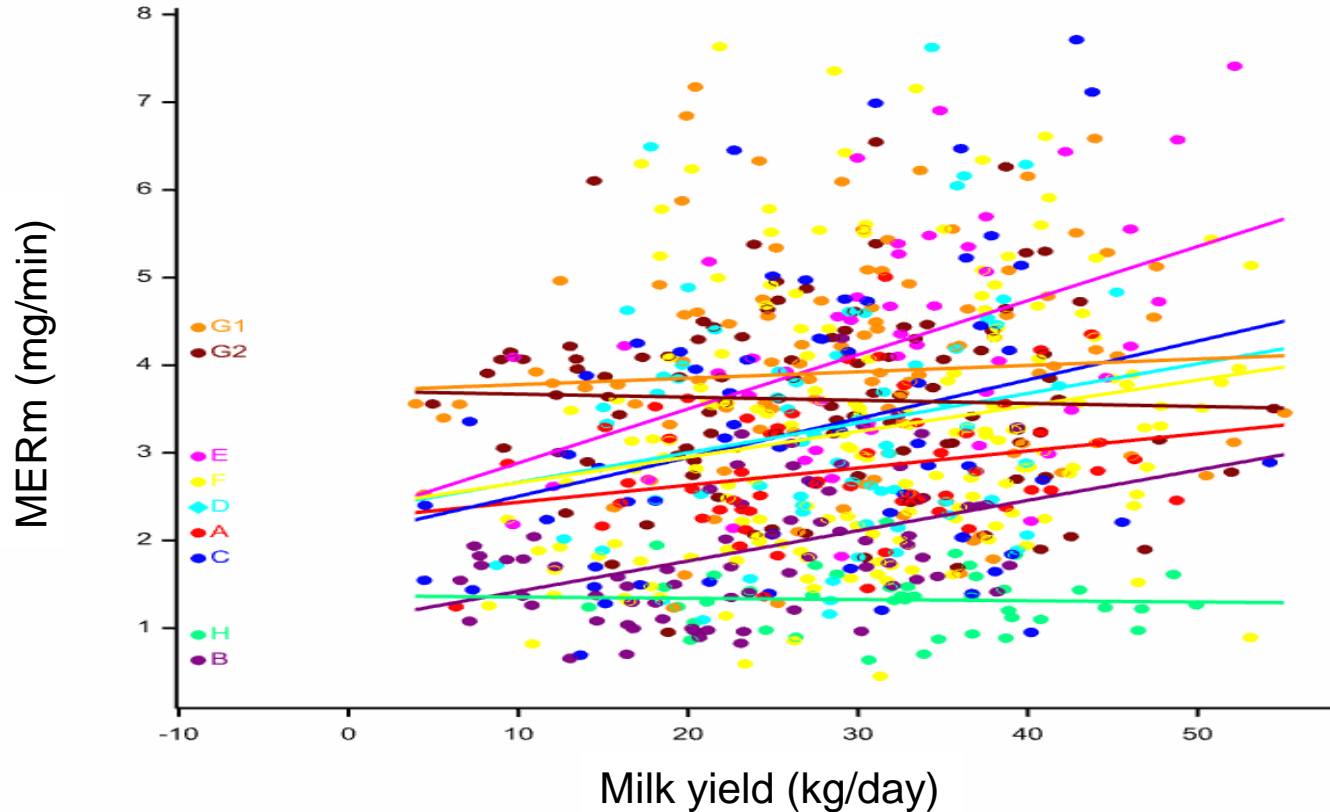


# Variation in methane on commercial dairy farms

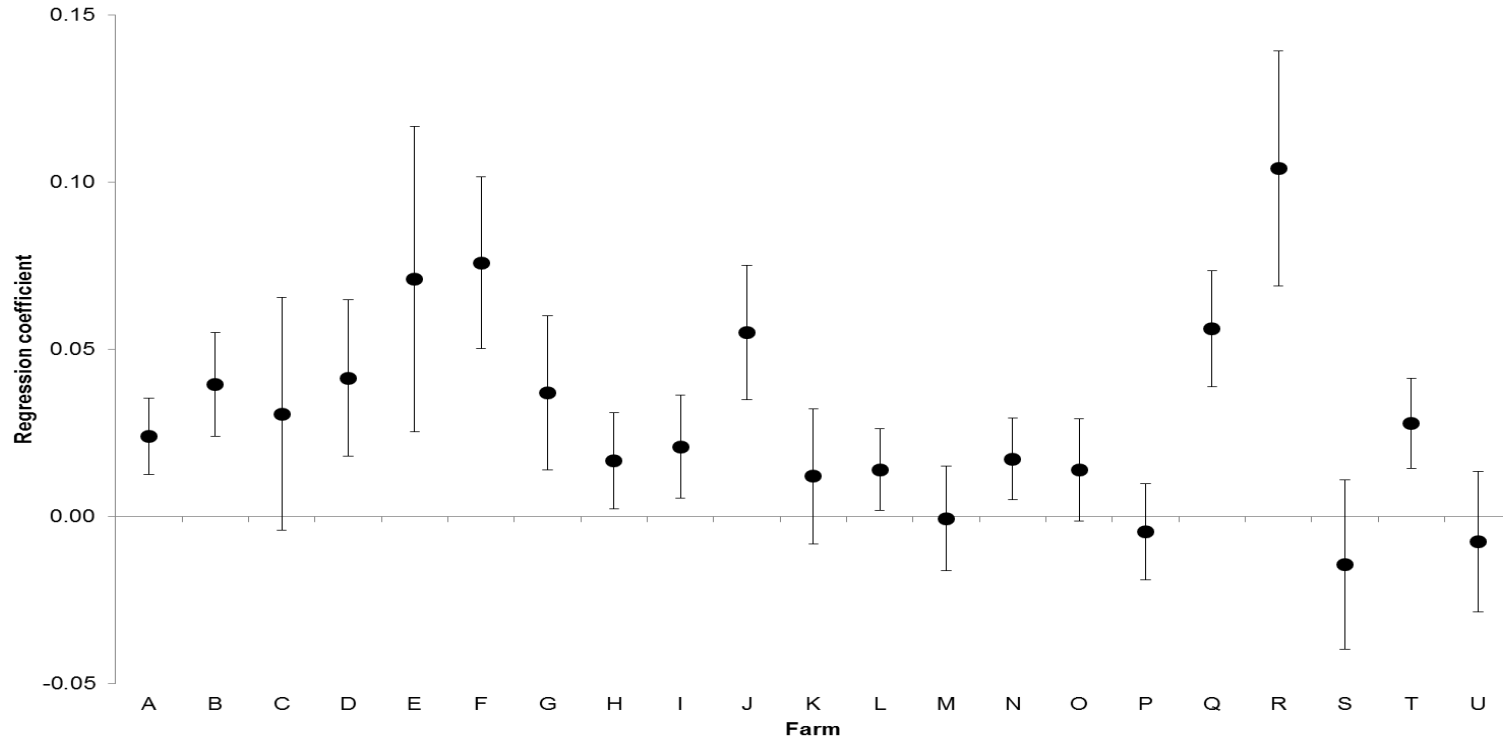


- 2,000 cows, 21 farms
- Variation between and within farms
- Due to diet, milk yield and individual cow
- Milk yield response varies with farm (feeding system)

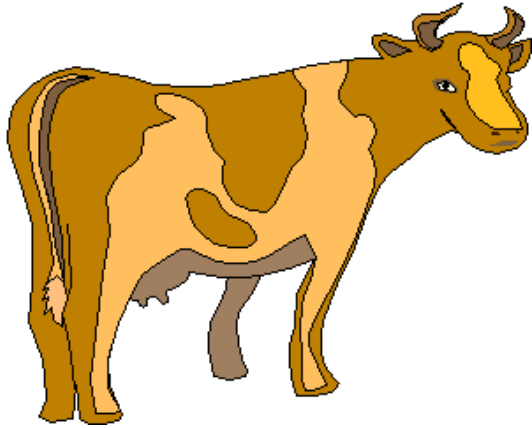
# Variation with milk yield



# Variation with milk yield



# RuminOmics (EU-FP7 project)



Linking the cow genome  
to the rumen microbiome  
and feed efficiency

Measuring CH<sub>4</sub> and rumen  
sampling 1,000 cows  
Feed intake  
Milk yield  
Digestibility

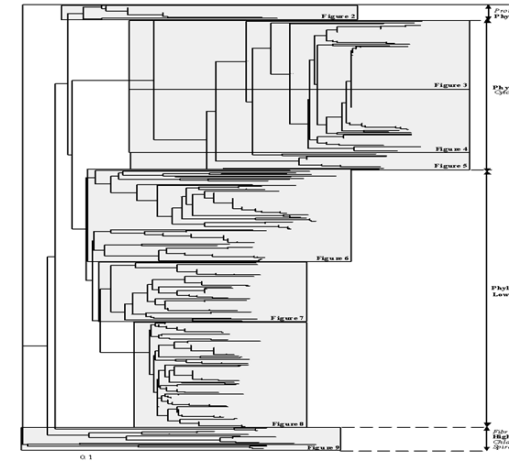


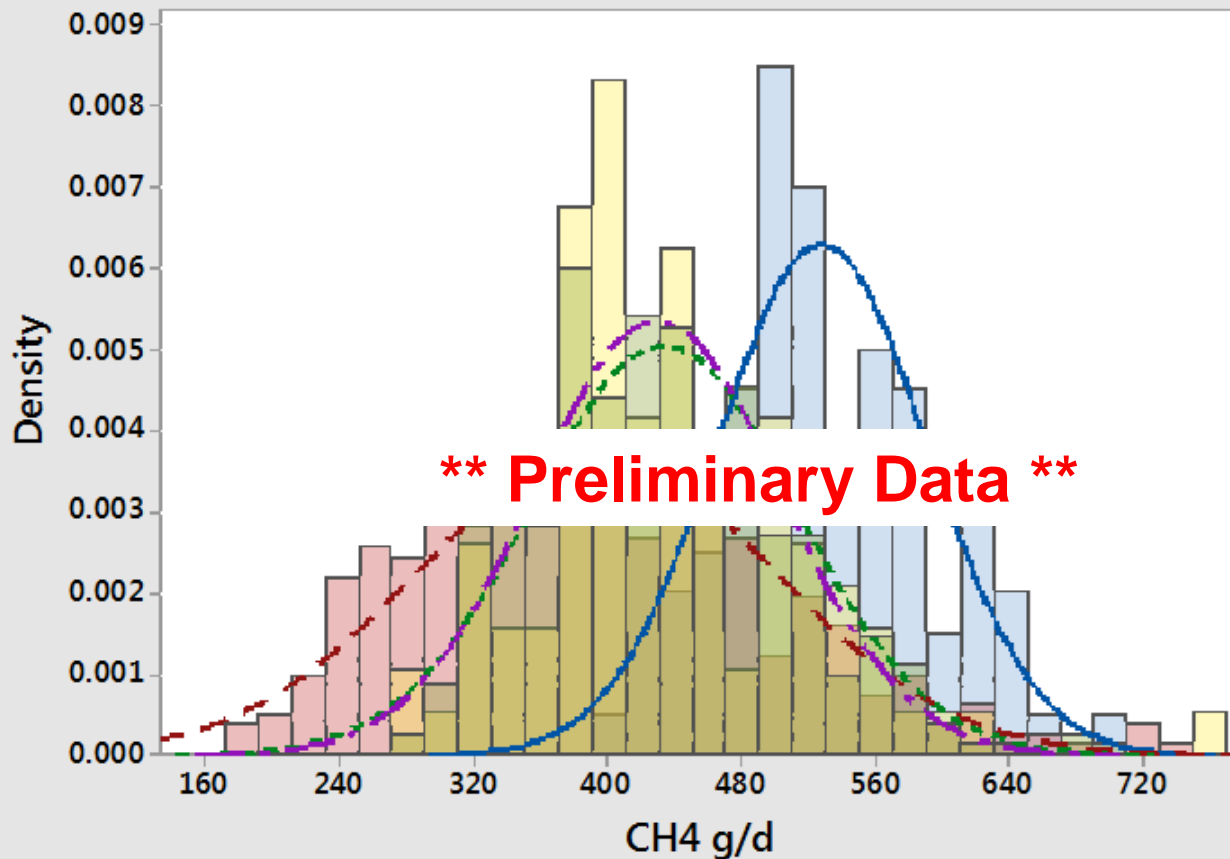
Figure 1: Phylogenetic tree of 16S rDNA rumen library sequence data.

# 1000-cow study

- **UK** 400
- **Italy** 400
  - Holsteins
  - Maize + Grass silage/ hay diets
- **Sweden** 100
- **Finland** 100
  - Red & White
  - Grass silage diets

# Histogram of CH4 g/d

## Normal

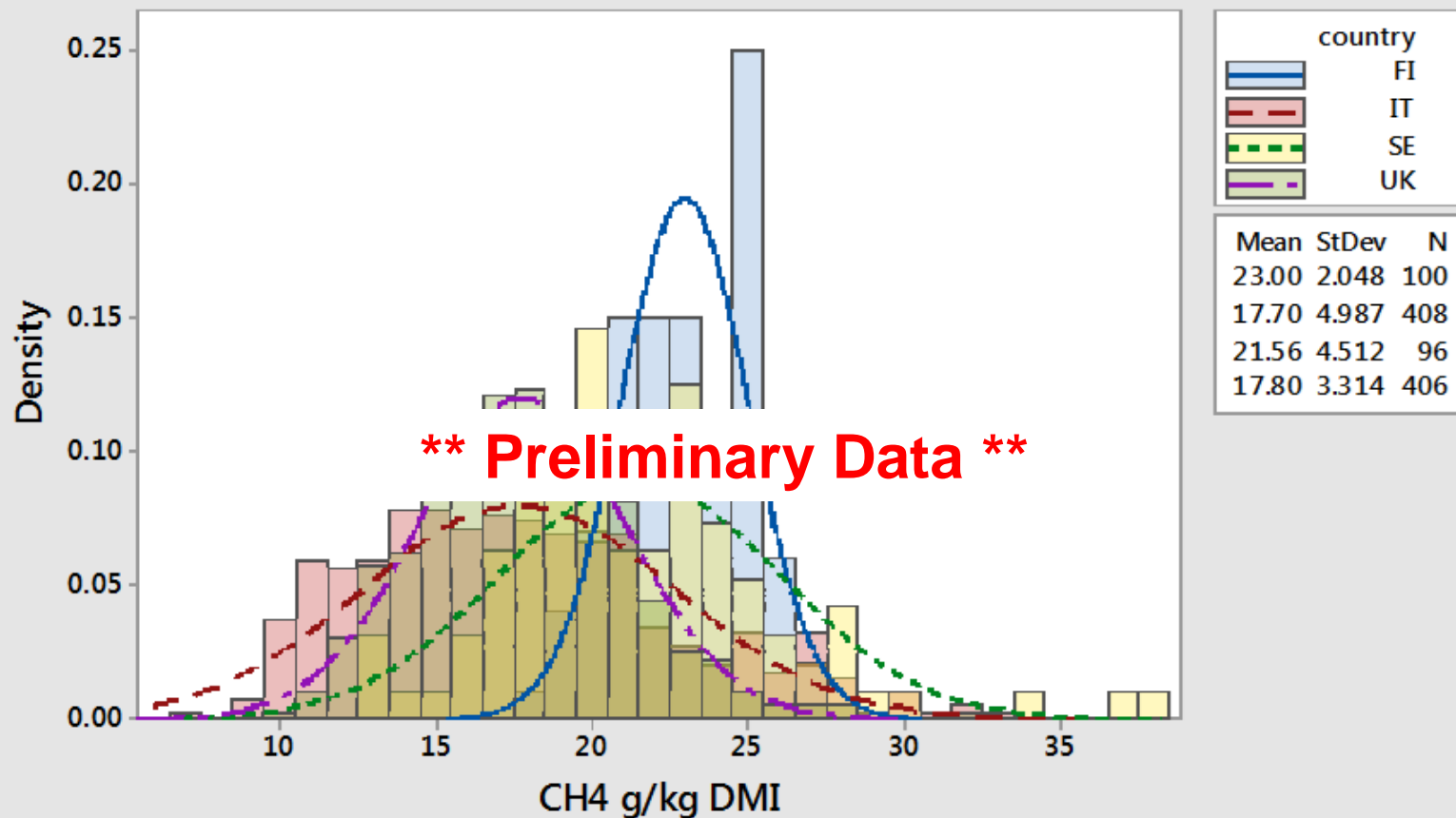


country	Mean	StDev	N
FI	528.2	63.26	100
IT	393.5	106.7	409
SE	433.9	78.82	96
UK	429.8	74.31	407



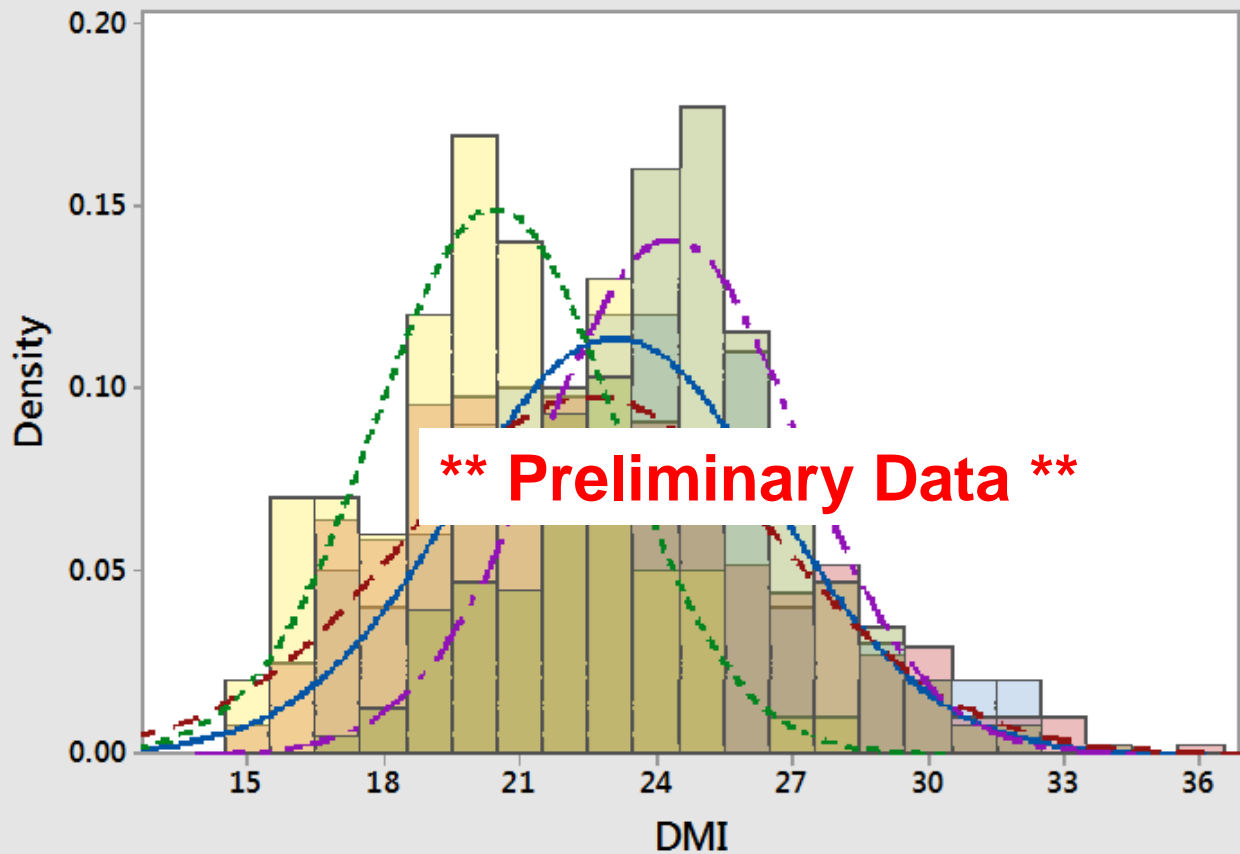
# Histogram of CH4 g/kg DMI

## Normal



# Histogram of DMI

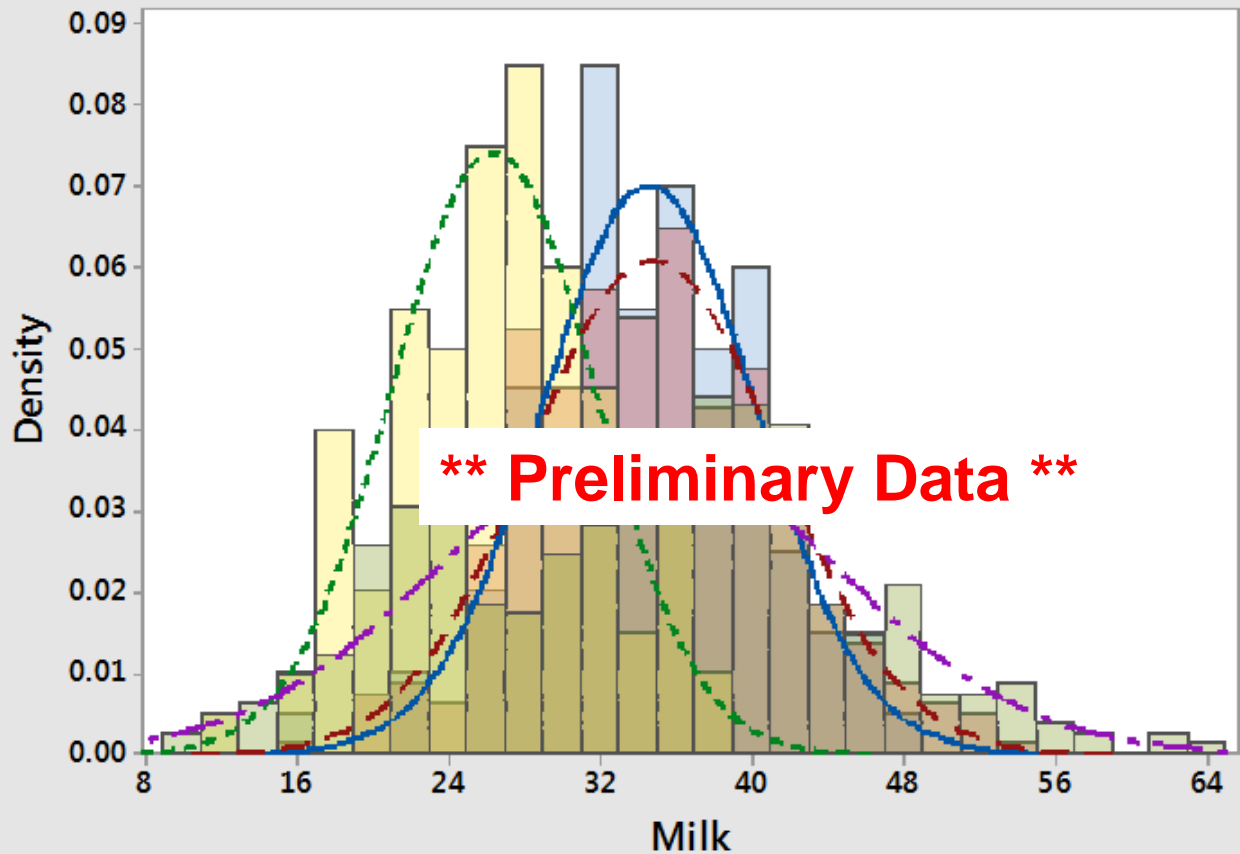
## Normal



country			
FI	IT	SE	UK
Mean	StDev	N	
23.15	3.495	100	
22.62	4.061	408	
20.50	2.664	100	
24.38	2.821	406	

# Histogram of Milk

## Normal



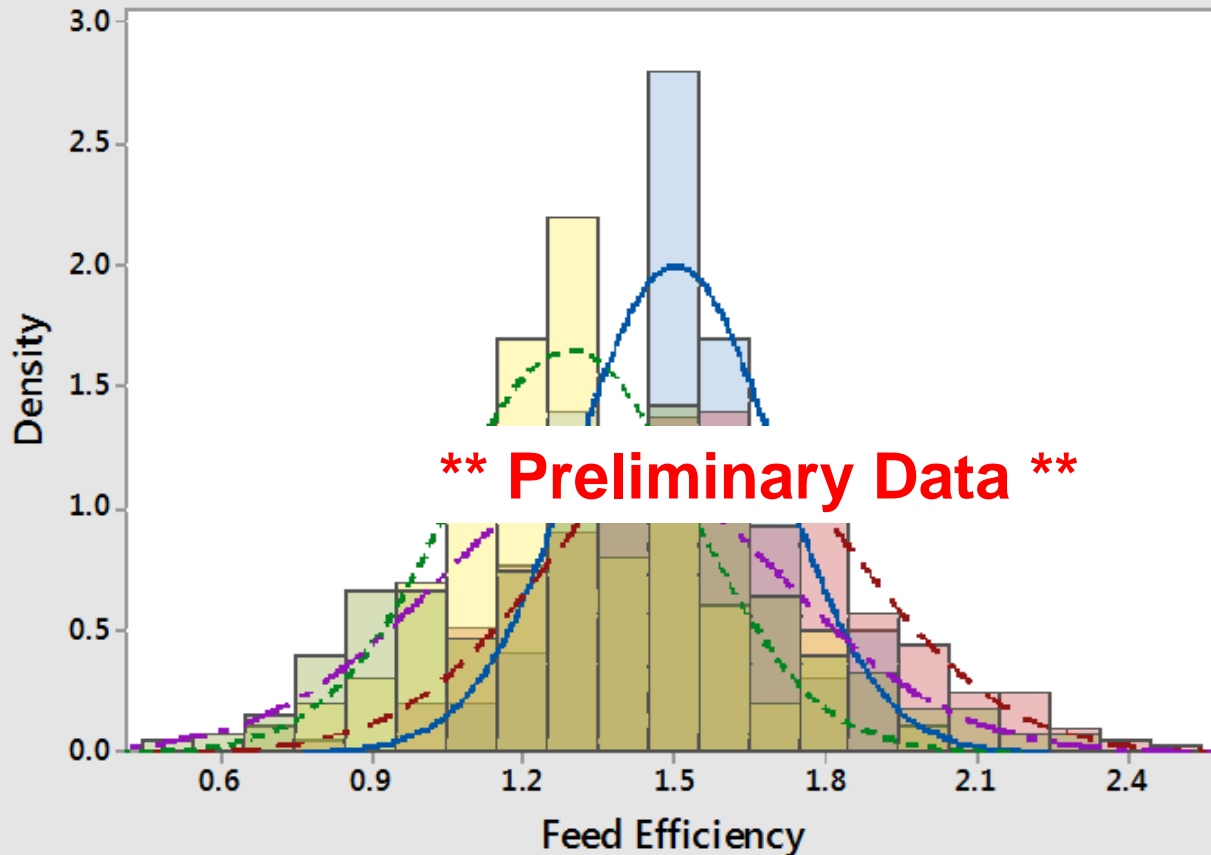
country		
FI	IT	SE
UK		

Mean	StDev	N
34.69	5.672	100
34.88	6.538	409
26.48	5.358	100
34.05	10.38	407

# Histogram of Feed Efficiency

## Normal



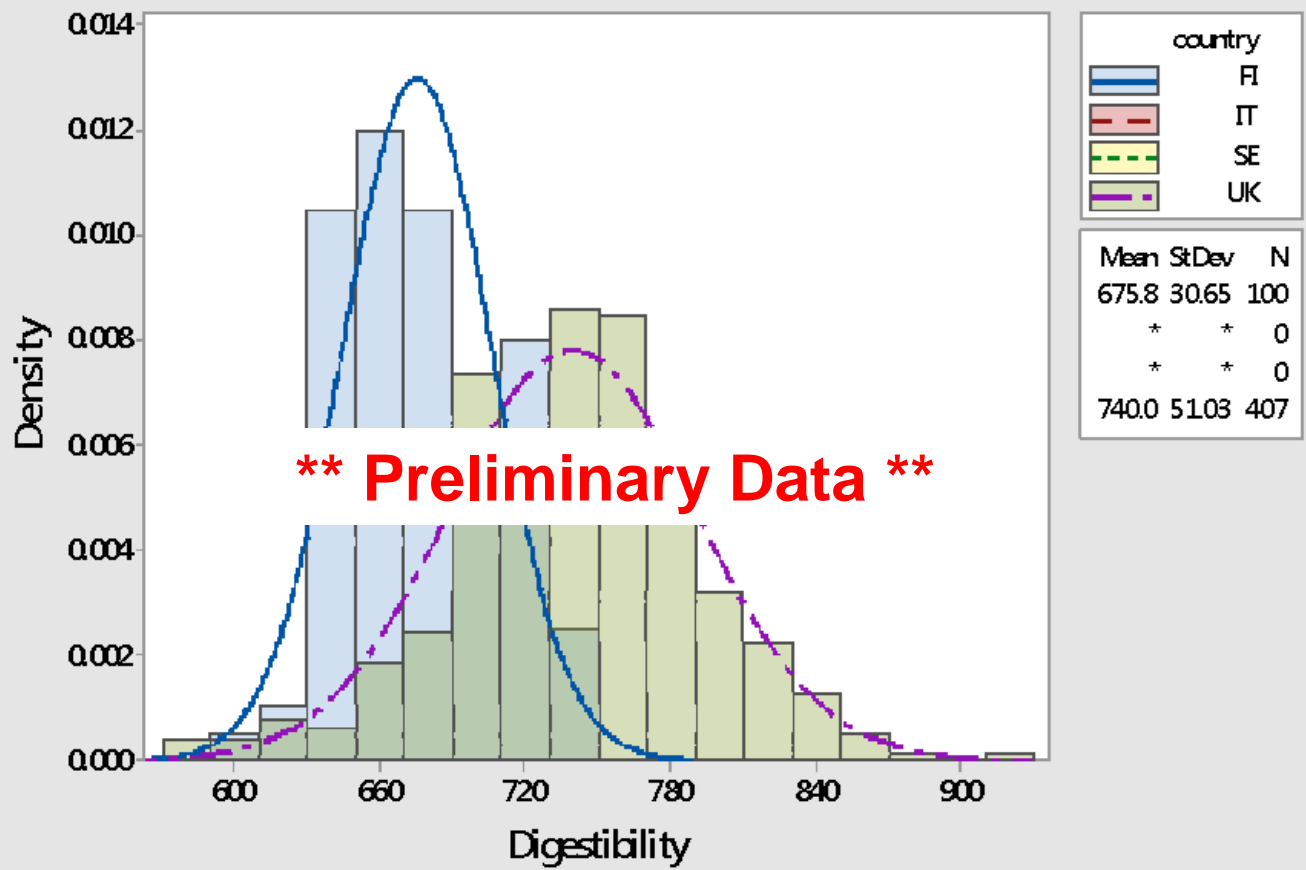
country		
FI	IT	SE
UK		

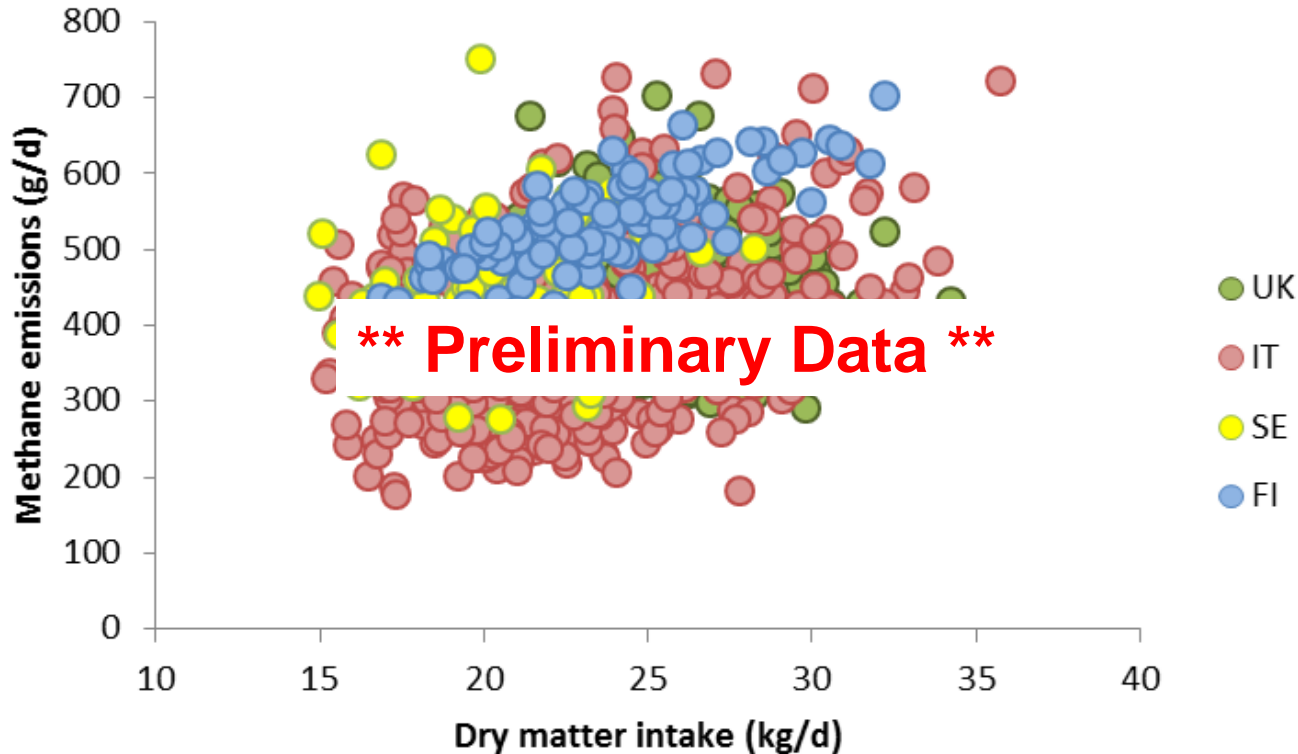
Mean	StDev	N
1.508	0.1993	100
1.566	0.3000	408
1.297	0.2411	100
1.381	0.3397	406

# Histogram of Digestibility

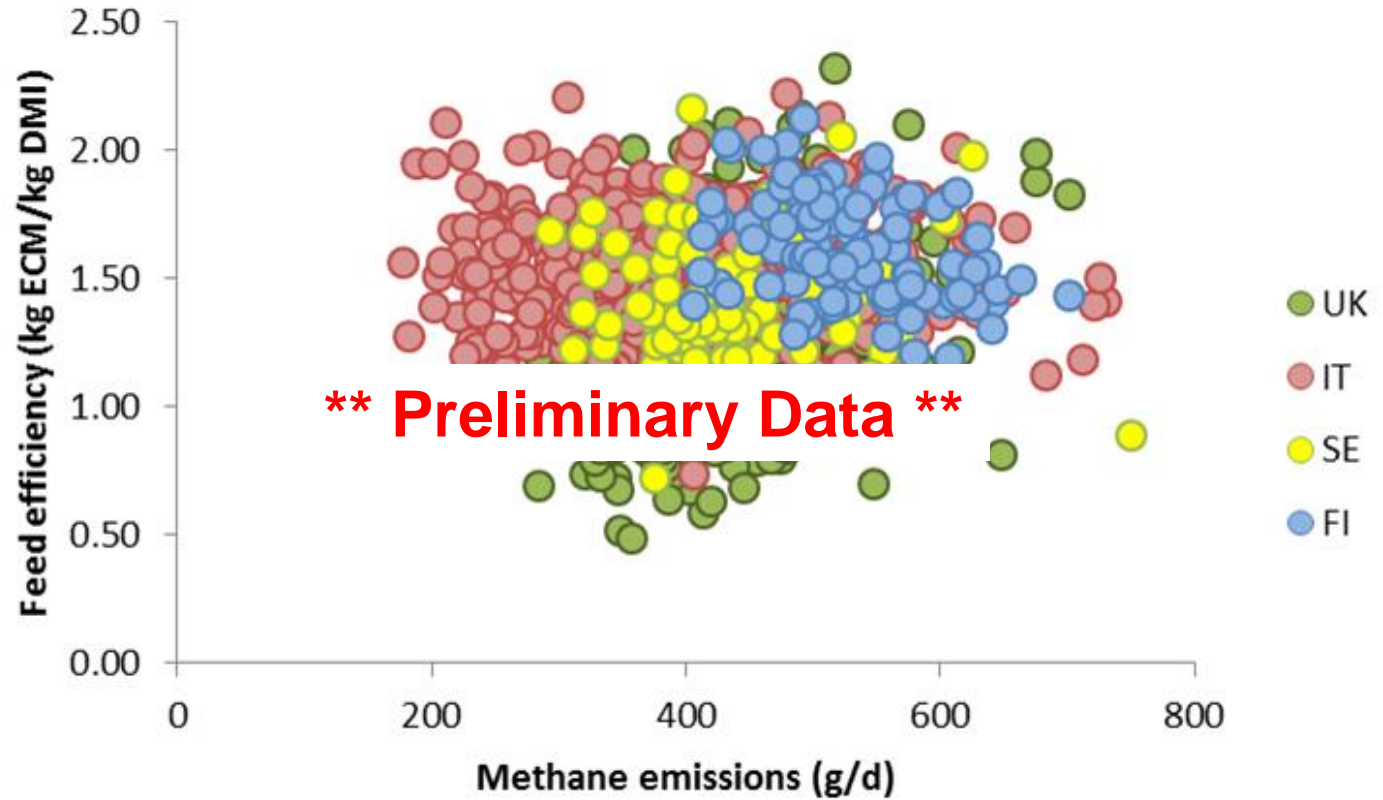
Normal



# Is methane related to intake on farms?



# Are low methane emitters more efficient?



# Conclusions

- CH<sub>4</sub> emissions vary widely between cows
- Emissions vary more on-farm than in chambers
- Cows eating equal amounts of the same diet can have different emissions (and vice versa)
- CH<sub>4</sub> is not necessarily related to efficiency
- Variation could be due to genetics, physiology, behaviour ...
  - ... Selection for low emitters needs caution ...
  - ... More research needed 😊