



## Proxy measures of methane: novel techniques in development

John Newbold, Ruminant Science Director, Provimi Holding BV  
31 Oct 11

## Proxy measures of methane [in individual animals]: novel techniques in development

- Introduction
- ~~Breath~~
- Milk
- Faeces
- Other?

## What is the objective?

### **Research**

- Experimental unit = individual animal
- Experimental unit = group of animals

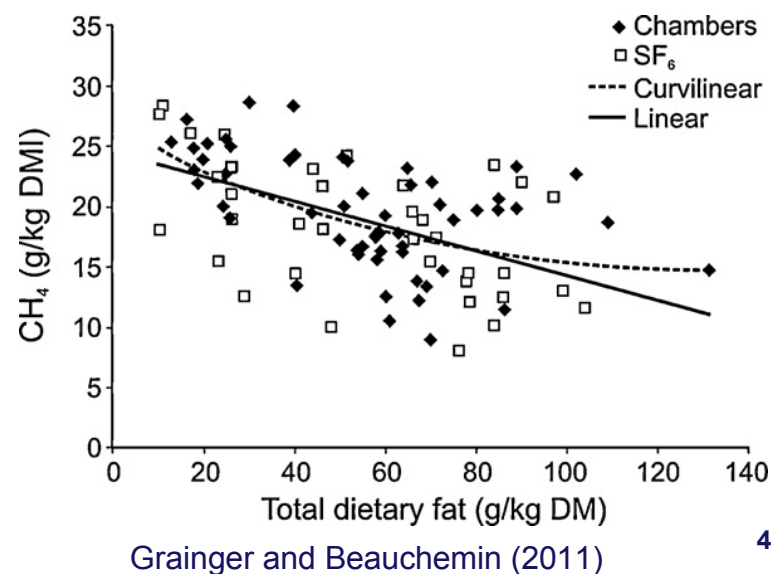
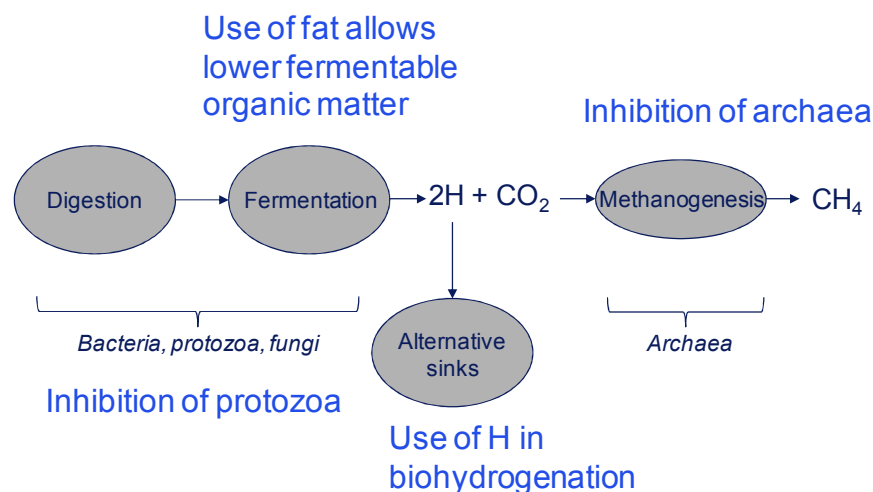
### **Monitoring: certification**

### **Monitoring: informal**

### **Different methods may suit different purposes**

## Milk fatty acid (FA) profile

- ➊ Milk FA profile partly reflects dietary FA profile
- ➋ Dietary FA can affect methane production
  - Dilution of fermentable organic matter
  - Consumption of H in biohydrogenation
  - Reduction in H via partial defaunation and toxicity to cellulolytic bacteria
  - Reduction in CH<sub>4</sub> via effects on archaea
- ➌ Can a simple milk FA profile predict effect of dietary FA on methane?



## Simple milk fatty acid profile

- Weill et al. (2009): tool to monitor effect of extruded linseed**

→  $CH_4 \text{ (g/l)} = (11.368 \times \text{sum of FA } \leq \text{C16:0}) \times ((\text{kg milk per year})^{-0.4274})$

- Chilliard et al. (2009): developed mainly from linseed experiments**

→ Eqn. 1:  $CH_4 \text{ (g/d)} = (9.46 \times \text{C16:0}) - (9.76 \times (\text{c14C18:1} + \text{t16C18:1})) + (13.3 \times \text{forage DMI, kg/d}) - (78.3 \times \text{c9C14:1}) + (77.4 \times \text{C18:2}) - 21.2$

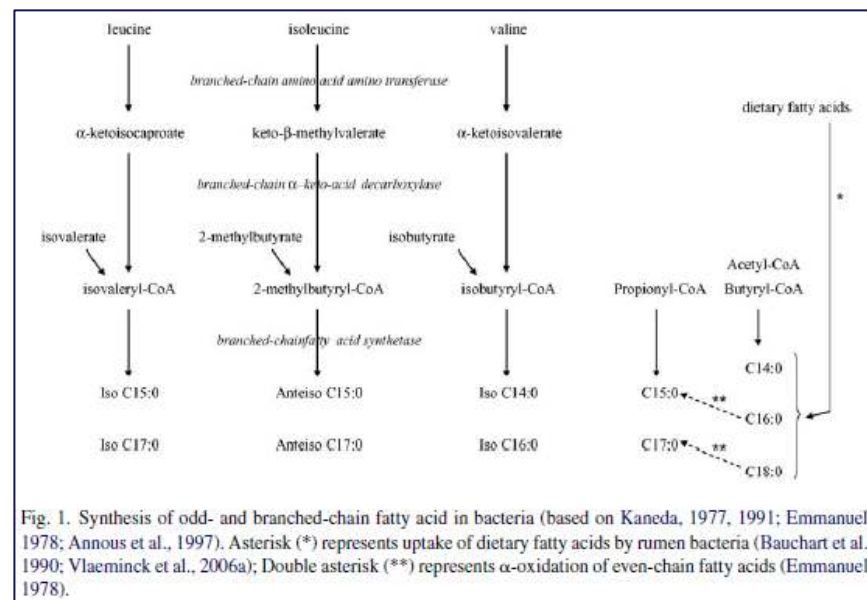
→ Eqn. 2:  $CH_4 \text{ (g/d)} = (-100.8 \times (\text{c14C18:1} + \text{t16C18:1}^*)) + (6.78 \times \text{C16:0}) + (13.1 \times \text{forage DMI, kg/d}) - 80.1$

- Limited inference space**

## Odd and branched-chain fatty acids

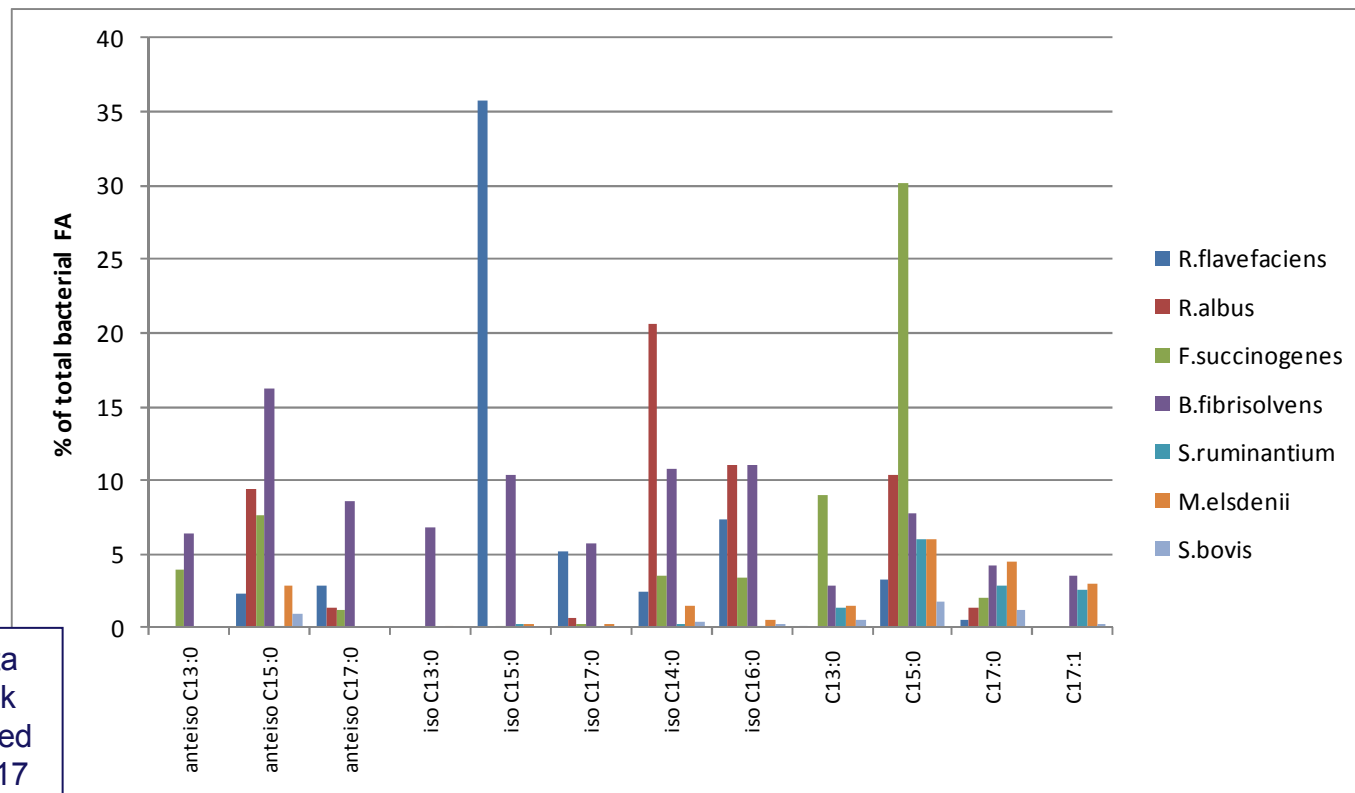
### More complete FA profile may reflect dietary effects on specific microorganisms

- Selective incorporation of dietary FA into microbial lipids (bacterial cell wall)
  - 'The OBCFA profile of rumen bacteria seems largely determined by the fatty acid synthetase of the micro-organism, and to a lesser extent by physiological and culture conditions.'



## Odd and branched-chain fatty acids

- **Cellulolytic bacteria are relatively rich in iso FA**
  - *R.albus* rich in even iso FA (isoC14:0, isoC16:0)
  - *R.flavefaciens* rich in odd iso FA (isoC15:0, isoC17:0)
  - But... *F.succinogenes* rich in C15:0
- **Amylolytic bacteria relatively poor in iso FA, rich in linear odd FA**
  - C13:0, C15:0, C17:0



Graph drawn from data reviewed by Vlaeminck et al. (2006) Anim. Feed Sci. Tech. 131: 389-417

## More complete milk fatty acid profile

### Dijkstra et al. (2010)

- 3 experiments, 10 treatments, 50 observations
- all data from open-circuit indirect respiration chambers
- diverse dataset: fumarate, diallyldisulphide, MCFA, linseed, yucca
  
- $CH_4$  (g/kg DM) =  $24.6 + (8.74 \times \text{anteisoC17:0}) - (1.97 \times \text{t10+t11 C18:1}) - (9.09 \times \text{C18:1}) + (5.07 \times \text{c13 C18:1})$
  
- $r^2 = 0.73$

#### Relationship with methane

Positive	Negative	None
iso C14:0	trans 10+11 C18:1	C15:0
iso C15:0 anteiso C17:0		C17:0



## More complete milk fatty acid profile

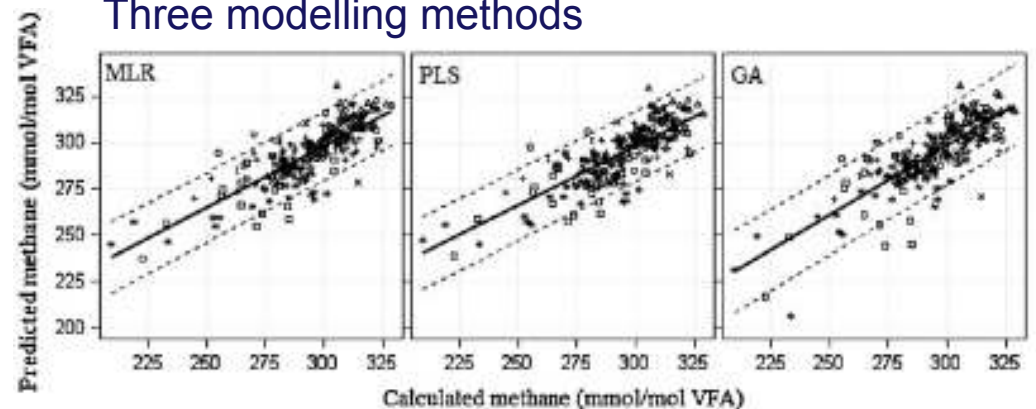
### Castro Montoya et al. (2011)

- 13 experiments, 224 observations
- Methane calculated stoichiometrically from VFA proportions, assuming constant H balance of 0.9
- Dataset mainly forage source and forage:concentrate ratio (not lipids and feed additives)

#### Relationship with methane

Positive	Negative
iso C14:0	trans 10+11 C18:1
iso C15:0	C15:0
anteiso C17:0	C17:0+C17:1

#### Three modelling methods



## Prediction of methane from milk fatty acid profile

- **All modelling exercises conducted so far have been limited in scope and scale**
  - use of narrow databases = small inference space
  - different methods of measuring (or calculating) methane
  
- **New data being generated**
  - e.g. ILVO/Ghent University
  
- **Do sufficient data now exist, globally, for a renewed modelling effort?**
  
- **Or is there another way?...**

## Prediction directly from milk MIR spectra

- Methane measured by SF6
- Methane predicted from milk MIR spectra measured at day 0, 0.5, 1, 1.5 and 2
- Spectra from day 1.5 gave best prediction
- 'There is also a close correlation between FA profile and methane emission at d 1.5. However...applying directly the developed methane equation gives a better prediction than the use of correlation between FA and methane.'

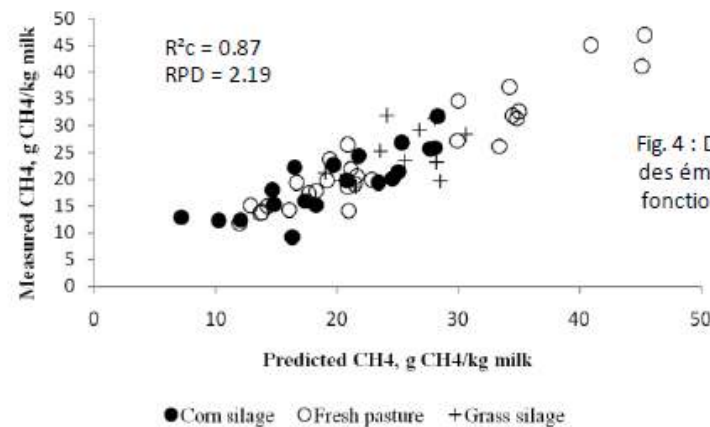


Fig. 4 : Droite de régression linéaire des émissions de CH<sub>4</sub> mesurées en fonctions des prédites au jour 1.5.

## Prediction of methane from faecal analysis

### **Bacterial membrane lipids**

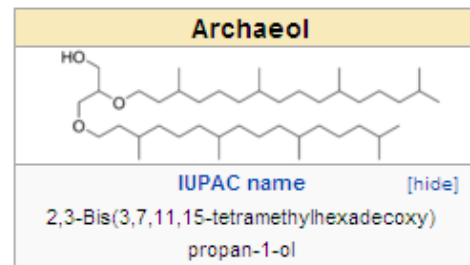
→ Glycerol, phosphate, 2 x fatty acids (ester links)

### **Archaeal membrane lipids**




→ Glycerol, phosphate, 2 x isoprenoid chains (ether linked)

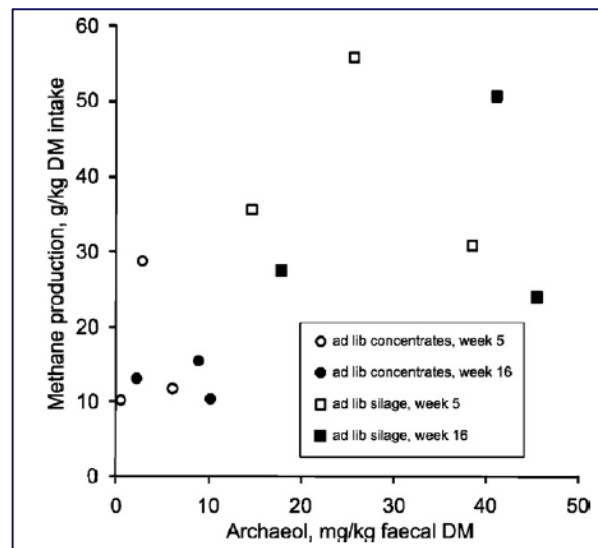
→ Archaeol is simplest example

### **Does the appearance of archaeol in faeces correlate with methane production?**



## Prediction of methane from faecal analysis

- 
**12 steers, high versus high concentrate plus grass silage**
- 
**Methane measured by SF6**
  
- 
**Generally poor relationship**
  - Measurement error
  - Variation in methane production rate per archaeon
  - Not all archaea are methanogens



Creating technologies that make shopping as personal as st  
Sponsoring tomorrow starts today. [LEARN MORE >](#)

8 June 2011 Last updated at 10:55 GMT

129 [Share](#) [f](#) [t](#) [e](#) [p](#)

## Cow methane proof 'is in the pat'

**Research suggests the amount of methane that ruminants such as cows produce is correlated to quantities of a molecule in their faeces called archaeol.**

Methane production by ruminants is a large unknown, and is relevant in climate science as it is a powerful greenhouse gas.

Current methane measurement methods are labour-intensive or invasive.

The new work, in **Animal Feed Science and**



The discovery is one step toward quantifying animals' contributions to greenhouse gases

## Conclusion

### **Different methods may suit different purposes**

### **Milk**

- Too early to conclude that prediction from milk FA profile won't work, at least for monitoring
- Prediction directly from MIR spectra holds considerable promise

### **Faeces**

- Initial studies with archaeol not encouraging

### **Other approaches?**

- I'm only reading the literature
- What do the practitioners think?

