Methane emission of dairy cows reflected by sensor measurements

Warsaw / August 31, 2015

Marleen.Visker@wur.nl

Marleen Visker
Rik van der Tol
Henk Bovenhuis
Johan van Arendonk

Dairy greenhouse gasses

Dairy cattle GHG emissions

- Dairy sector: 2.7 – 4% global GHG emissions (FAO 2010)
- Enteric methane: ~ 50% of cattle milk GHG (FAO 2013)

Mitigation through breeding

- Improved productivity
- Improved longevity
- Lower enteric methane production

→ Methane phenotypes for large numbers of animals

Obtaining methane phenotypes

Climate respiration chambers

- Golden standard
- Not feasible for large numbers of animals

Sensors in automatic milking systems

- Record large numbers of animals
- On commercial dairy farms

Sensors in automatic milking systems

Different measurements, similar phenotypes?

- Different equipment
- Different duration and timing
- Different setting
- … …

Aim

Compare methane emission recorded by sensors with methane emission recorded in climate respiration chambers

Materials and methods

Setup

- 20 dairy cows
- Housed individually in climate respiration chambers
- Sensors installed in chambers

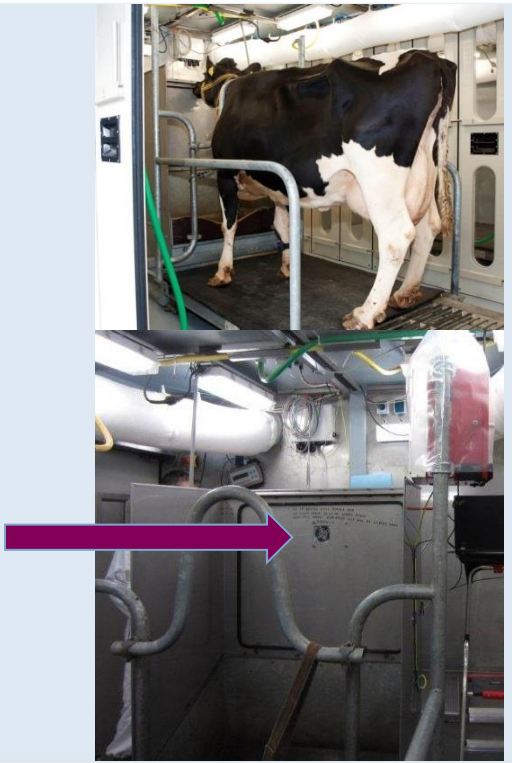
Data

- CH_4 from chambers (1/12 min)
- CH_4 and CO_2 from sensors (2/sec)
- 3 full days

Materials and methods

Phenotypes

- CH_4 production from chambers
- CH_4 concentration from sensors
- CH_4/CO_2 ratio from sensors
  - ➢ CO_2 as measure for amount of breath
    (Madsen et al. 2010; Lassen et al. 2012)

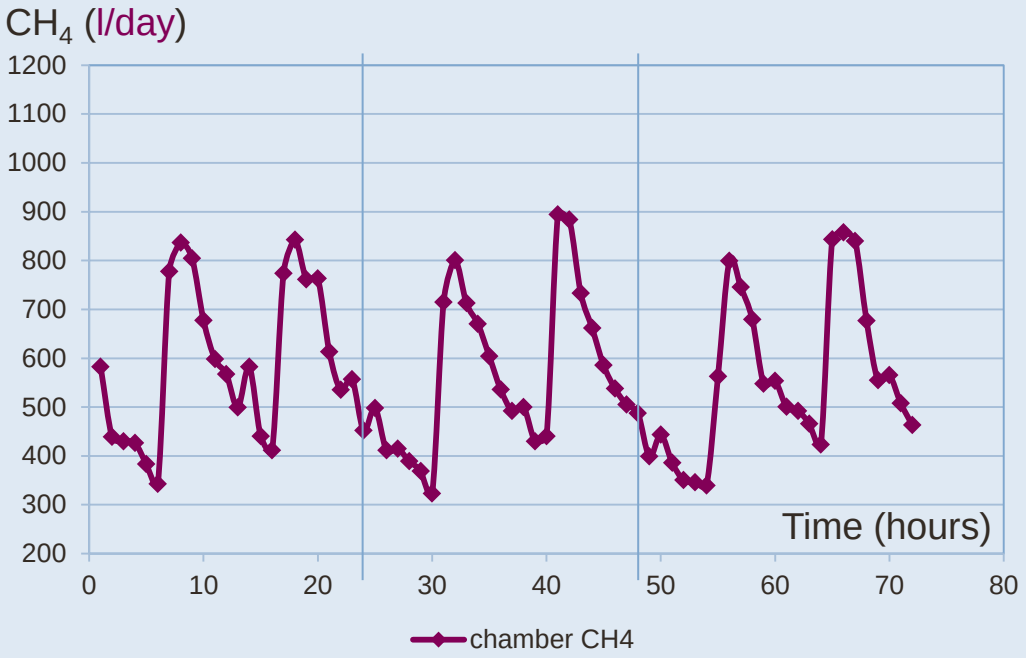


Results

Chambers

± 330 data points

per 3 days per cow



TI FOOD NUTRITION

Results

Chambers

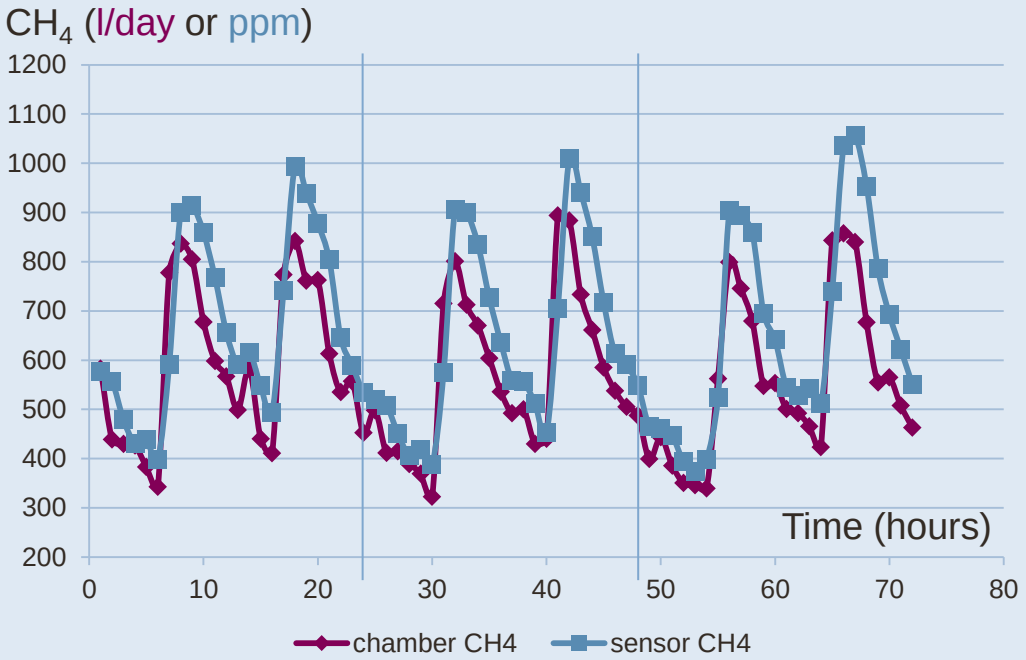
± 330 data points

per 3 days per cow

Sensors

± 520.000 data points

per 3 days per cow



TI FOOD NUTRITION

Results

Chambers

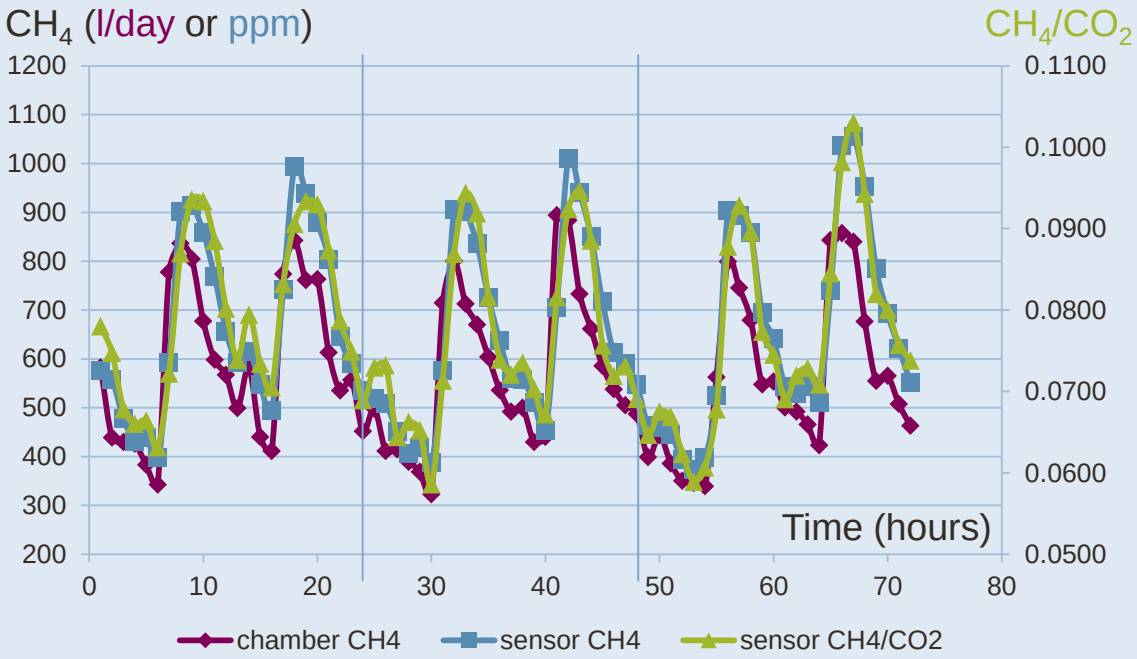
± 330 data points

per 3 days per cow

Sensors

± 520.000 data points

per 3 days per cow



TI FOOD NUTRITION

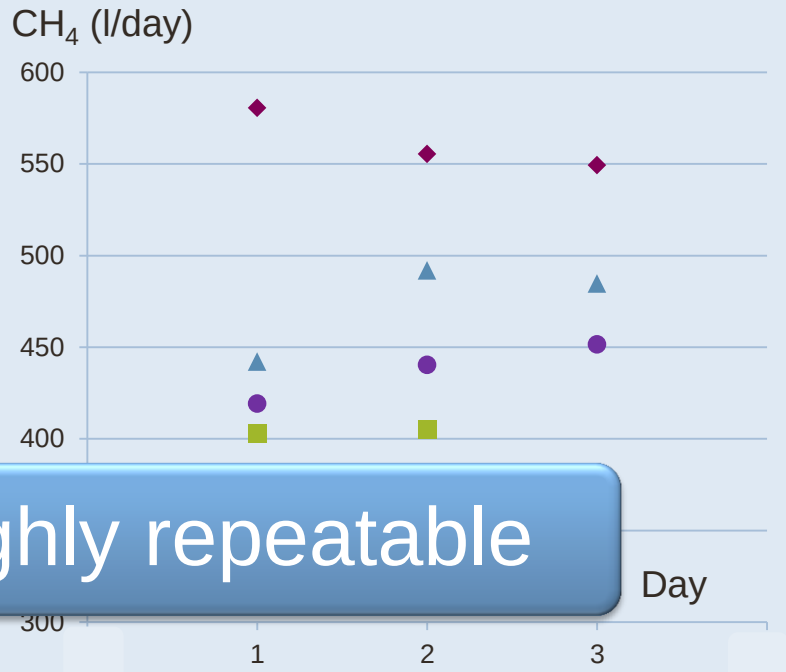
Repeatability – per day

Phenotype	repeatability
Chamber CH_4 (l/day)	0.87 (0.04)
Sensor CH_4 (ppm)	0.90 (0.04)
Sensor CH_4/CO_2	0.94 (0.02)

Repea

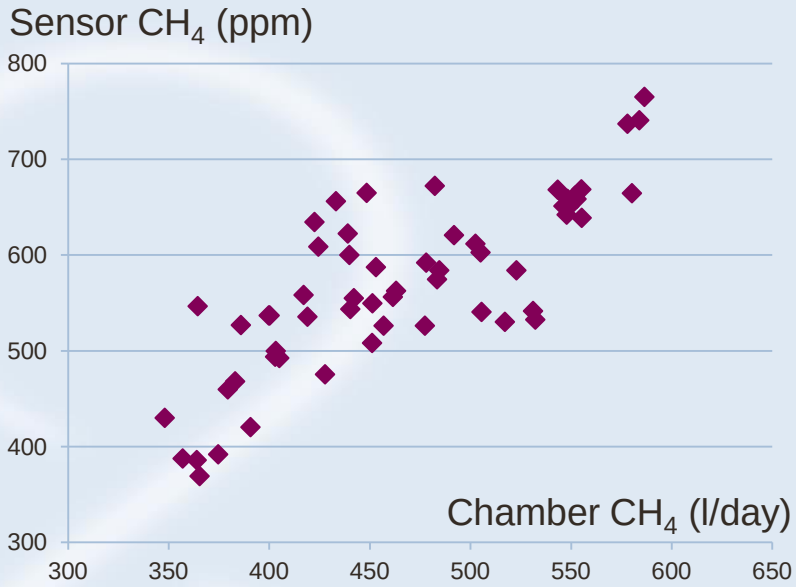
Y = μ

All 3 phenotypes highly repeatable



TI FOOD NUTRITION

Correlation – per day



Sensor CH_4 vs chamber CH_4

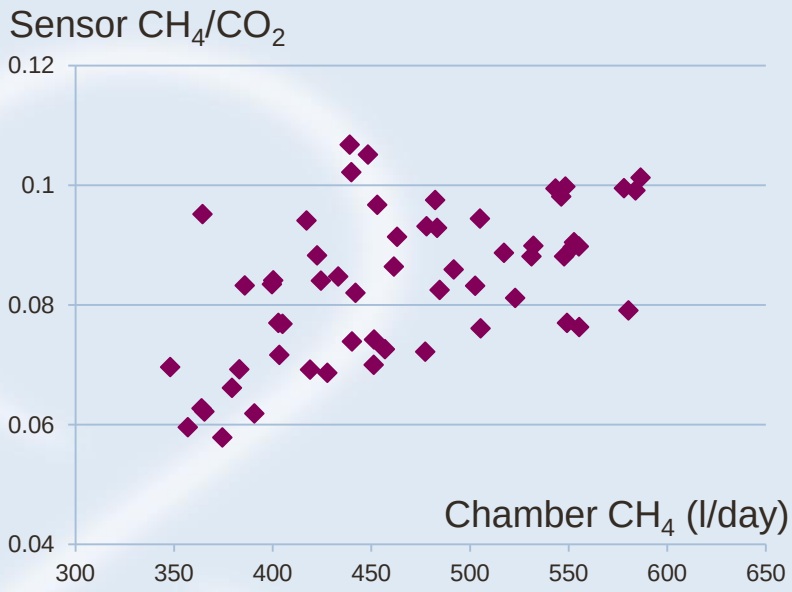
Correlation = 0.77

→ 60% of variation accounted for (R^2)

Rank correlation = 0.73

Sensor CH_4 fairly similar to chamber CH_4

Correlation – per day



Sensor CH_4/CO_2 vs chamber CH_4

Correlation = 0.49

→ 25% of variation accounted for (R^2)

Rank correlation = 0.54

Sensor CH_4/CO_2 moderately similar to chamber CH_4

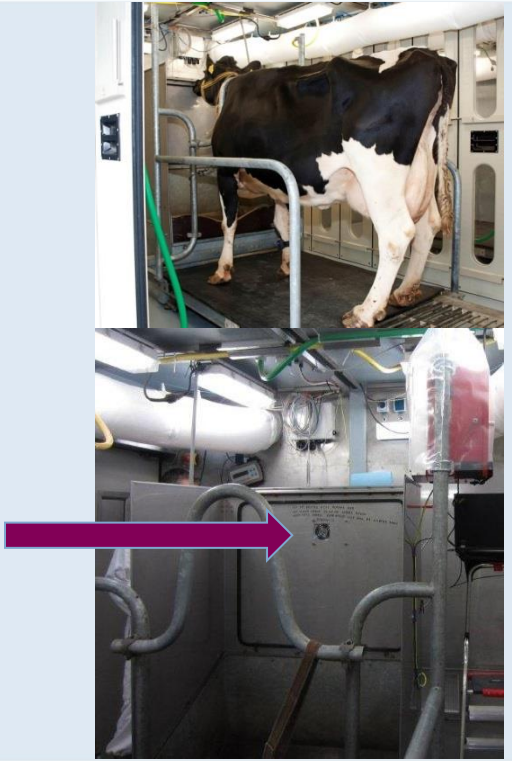
Materials and methods

Phenotypes

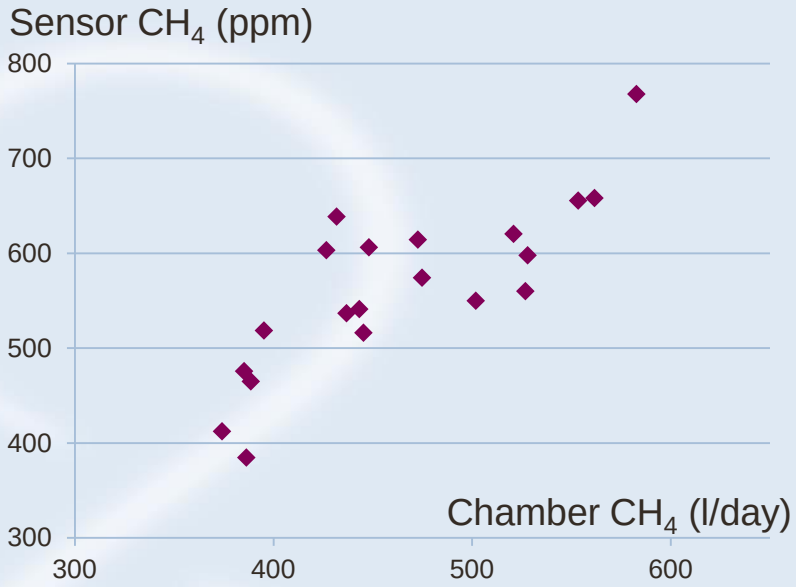
- CH_4 production from chambers
- CH_4 concentration from sensors
- CH_4/CO_2 ratio from sensors
  - CO_2 as measure for amount of breath
    (Madsen et al. 2010; Lassen et al. 2012)

Simulated milkings

- Random 8 x 7 min within 3 days, 10 reps



Correlation – 8 simulated milkings / 3 days



Sensor CH_4 vs chamber CH_4

Correlation = 0.81

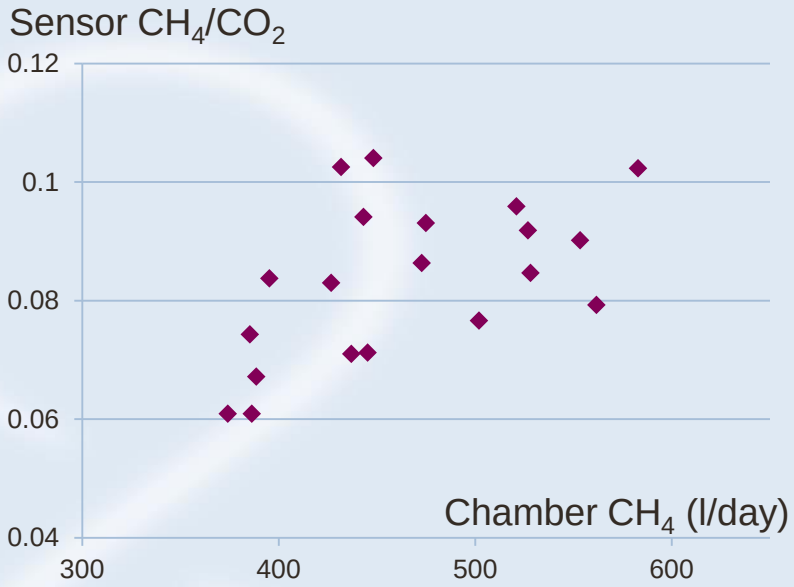
→ 65% of variation accounted for (R^2)

Rank correlation = 0.78

Sensor CH_4 milking fairly similar to chamber CH_4

TI FOOD NUTRITION

Correlation – 8 simulated milkings / 3 days



Sensor CH_4/CO_2 vs chamber CH_4

Correlation = 0.53

→ 30% of variation accounted for (R^2)

Rank correlation = 0.54

Sensor CH_4/CO_2 milking moderately similar to chamber CH_4

TI FOOD NUTRITION

Summary

- Methane sensors → repeatable phenotypes

- Sensor CH_4 → fairly similar to chamber CH_4
- Sensor CH_4/CO_2 → moderately similar to chamber CH_4

  ➡ No need to correct for amount of breath

- Measurements during milking only → represent daily production

But: effects of different setting (commercial farm) not accounted for

Conclusion

Methane measured with sensors during automatic milking is a valid representation of actual daily methane production

Marleen.Visker@wur.nl