No difference in PAC methane emission corrected for milk yield in three Norwegian dairy goat farms

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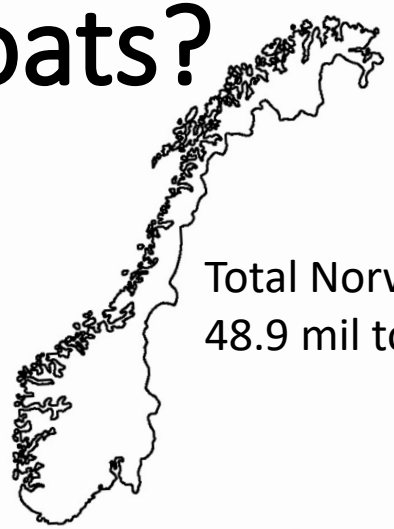
Why focus on methane on goats?

- ✓Global perspective ?
- ✓34 562 dairy goats in Norway
- ✓Proportionally, emission from Norwegian dairy goats is minor
- ✓All should contribute!
- ✓~50% of emission from agriculture is enteric methane
- ✓Norwegian agriculture sector has made agreement with the government to reduce GHG emission by 10% by 2030 relative to 2020
- ✓Need to measure



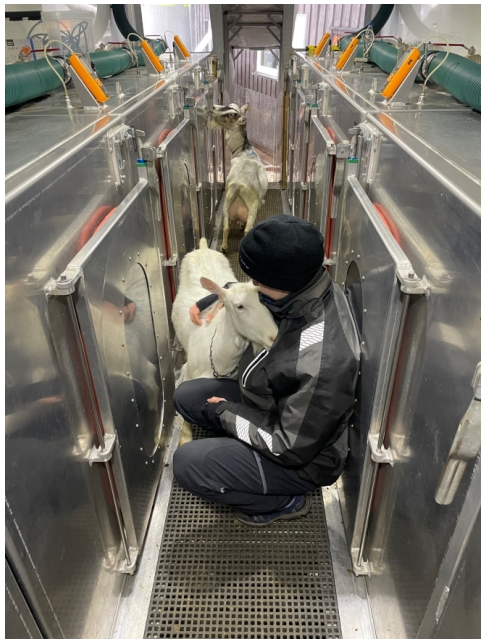
Total Norwegian GHG emission in 2022:
48.9 mil ton CO_2-eq (100%)

Emission from agriculture:
4.6 mil ton CO_2-eq (9.4%)

Emission from goats:
0.01 mil ton CO_2-eq
~0.2% of emission from agriculture

How to capture methane emissions?

- ✓Use of Portable Accumulation Chambers (PAC) to capture methane emission of sheep is widespread globally
- ✓Limited usage in goats (NZL, NOR)
- ✓Equally suitable for sheep and goats



Aim of study

- ✓Agreement with the government is to reduce methane intensity
- ✓Compare weight corrected CH_4 emission, milk corrected CH_4 emission and solid corrected CH_4 emission for three farms
- ✓Compare CH_4 emission from this study to national inventory
- ✓Evaluate if genotyped animals from farms in this study were genetically representative for the Norwegian Dairy goat population

3 farms, 3 days, 30 goats, 3 PAC visits per goat per day

- ✓ Housed indoor
- ✓ Early lactation (Av 70 d)
- ✓ Fed silage and concentrate
- ✓ Off feed one hour prior to measurement

Parity	Group		
	A	B	C
1	4	4	4
2	3	3	3
3	3	3	3

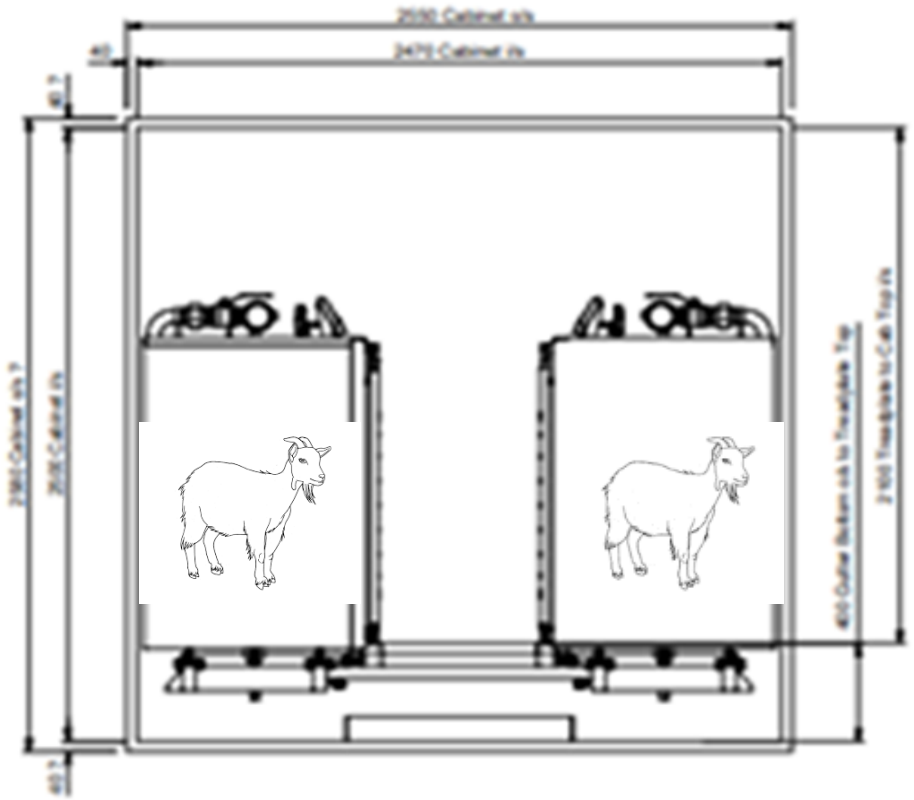
Wall clock time	Day 1-3
05:00 – 07:00	Milking
08:00	Group A
10:00	Group B
12:00	Group C
14:00	Group A
16:00 – 18:00	Milking
19:00	Group B
21:00	Group C
23:00	Group A
01:00	Group B
03:00	Group C

Data collection



- ✓Weighing animals prior to PAC measurement
- ✓Measuring CH_4, CO_2 and O_2 concentration at entry, after 30 min, after 45 min and at release after 60 min
- ✓Recording air temperature and air pressure outside chamber
- ✓Milk yield and milk content at official milk recording closest to PAC measurement

Computing gram CH_4 from concentration



Density of a goat to convert its weight to litres

- `Litres CH4/hour = ppm CH4/hour*(1146-Weight*1.01)/1000000`

Converting mBar to kPa

- `gram_CH4/hour = Litres CH4/hour * (0.1 * Air_Pressure,mBar) * 16.043/(8.3145*(Temperature+273.15)`

MW of methane

The Gas constant

Convert TempC to Kelvin

Phenotypic averages (1:2)

	CH_4 gr/hr	Weight, kg	Milk yield, kg/day	Solids* gr/day
Farm A	1.94	64.1	3.75	519
Farm B	1.37	49.9	2.73	381
Farm C	1.34	49.5	2.88	438

* SUM(gr fat + gr protein + gr lactose)

Phenotypic averages (2:2)

	CH_4 gr/hr /weight, kg	**CH_4 gr/hr /milk yield, kg/day**	**CH_4 gr/hr /solids, gr/day (*1000)**
Farm A	0.031	0.52	3.76
Farm B	0.028	0.51	3.64
Farm C	0.027	0.50	3.25

Proc GLM in SAS (1:2)

CH_4 g/hr / weight, kg =

Flock +

Parity +

Lot +

Dim_CH_4 (reg) +

Residual

Significant difference between farms

CH_4 g/hr / milk yield, kg/day =

Flock +

Parity +

Lot +

Dim_CH_4 (reg) +

Residual

NO significant difference between farms

Milk yield explains a larger part of the between farm variation in methane emission than live weight

Proc GLM in SAS (2:2)

CH_4 g/hr / milk yield, kg/day =

Flock +

Parity +

Lot +

Dim_CH_4 (reg) +

Residual

NO Significant difference between flocks

CH_4 g/hr / solids, gr/day =

Flock +

Parity +

Lot +

Dim_CH_4 (reg) +

Residual

Significant difference between flocks

Important to clearly define if methane yield is per kg liquid milk or per gram solid

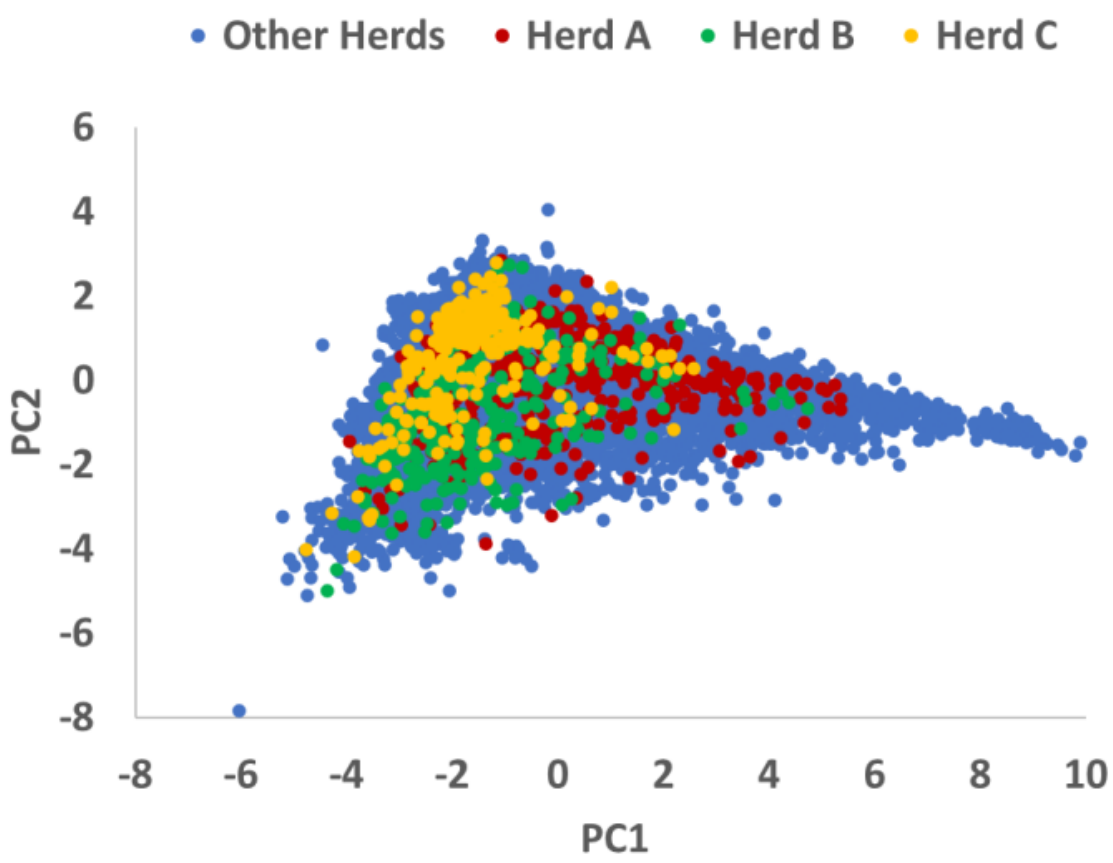
Comparison to national inventories ?

- ✓TIER 1 approach
  - # of goats * 13 kg CH_4 / year (Karlengen *et al*, 2012)
- ✓PAC measurements 70 days after kidding
  - Short window of yearly lactation
  - Repeated hourly emission
  - 37.2 g/day * 365 days = 13.6 kg CH_4 / year

- ✓**Comparison to national inventories should be done with caution!**

Genetically representative for the population?

- ✓10 806 genotyped individuals
- ✓Genotyped by GBS
- ✓1003 of these belong to herd A, B and C
- ✓PC analysis indicates genetic distance between individuals
- ✓Genetic overlap between animals from herds A, B and C and animals from other herds



Conclusion

- ✓Significant difference between farms in gram CH_4 / kg body weight and in gram CH_4 / gram solid
- ✓No significant difference between farms in gram CH_4 / kg milk
- ✓Milk yield explains a larger part of the between farm variation than live weight
- ✓Important to clearly define if methane yield is per kg liquid milk or per kg solid
- ✓Extrapolated yearly emission was 13.6 kg CH_4 / year, and close to factor used for national inventory, but should be interpreted with caution
- ✓Herds with CH_4 measurements are genetically representative for the population

Acknowledgements

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