NOVEL FORMULAS TO CALCULATE METHANE PRODUCTION FROM CONCENTRATIONS WHILE USING SNIFFERS

Session: Breeding for climate change – mitigation

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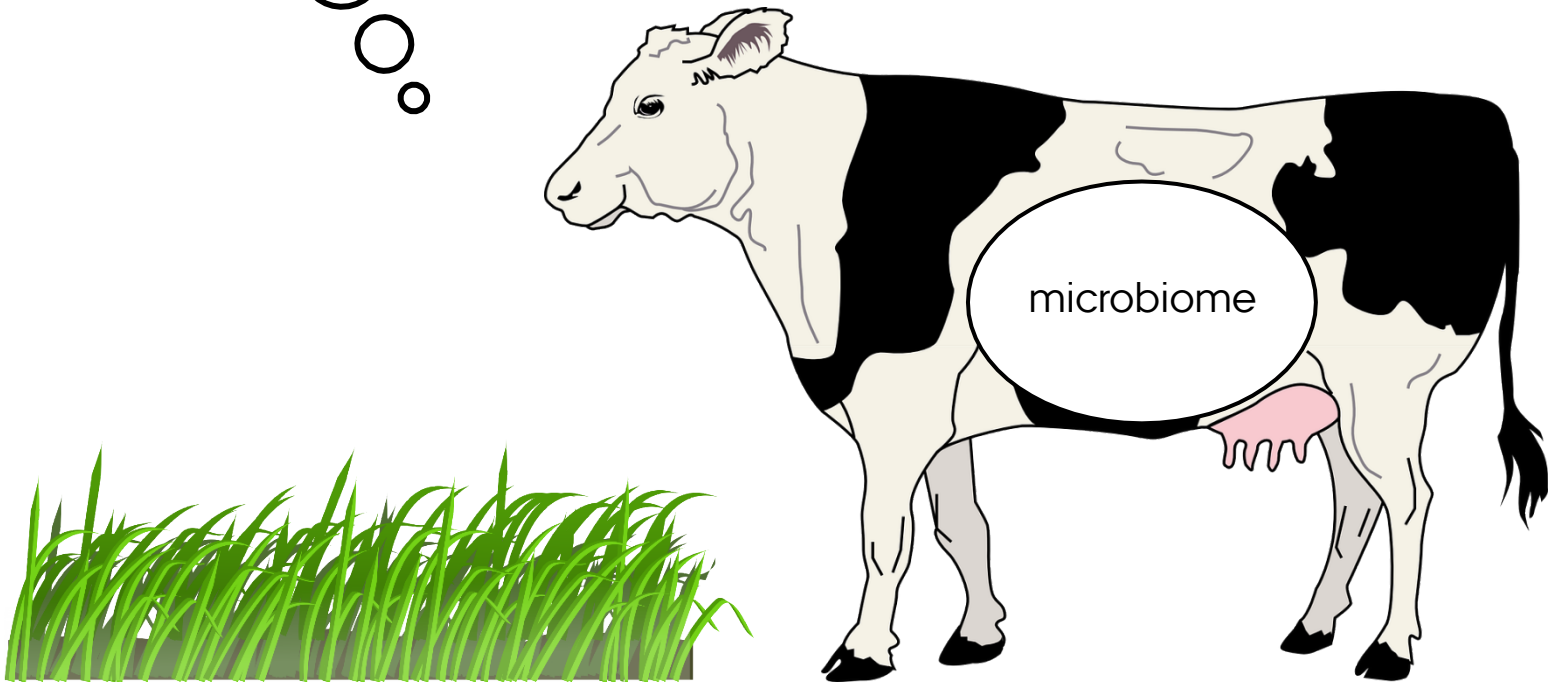
METHANE EMISSIONS IN CATTLE

CH_4 = 95%



SNIFFERS (BREATH ANALYSERS)

- ✓ relatively cheap
- ✓ non-invasive/disturbing
- ✓ large numbers
- ✗ snapshot
- ✗ requires AMS
- ✗ measure concentration

HOW TO CALCULATE CH_4 G/D

TRADITIONAL APPROACH

- Based on ratio **CH_4/CO_2**
- **Madsen et al. 2010**: CO_2 (L) = HPU /21.75 kJ per L CO_2 produced
- **Pedersen et al. 2008**: CO_2 (L/d) = 180 L CO_2/h/HPU * 24 hours
- Where HPU (heat producing unit) = is HP/1000 watt
- **CIGR, 2002**: HPU = 5.6 x kg $BW^{0.75}$ + 22 x kg ECM + $1.6*10^{-5}$ x number of days in pregnancy[3]

TRADITIONAL APPROACH

CH_4 ppm

MeC

Used to determine ventilation in barns, and not to be used on individual animals

CH_4 g/d

MeP

FIRST DEVELOPED FORMULA*

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Model 1 ("Best Model"): CO_2 (L/day) = – 0.30×DIM + 23.6×MBW+ 176×DMI + b,

where b is – 106, – 39.8, – 26.0 for 1st, 2nd, and >2nd parity

Model 2 ("On-Farm Model"): CO2 (L/day) = 0.92×DIM + 62.2×ECM + 35.4×MBW + b,

where b is – 171, 11.8 and – 33.7 for 1st, 2nd, and >2nd parity

**GGAA conference in Florida 2022.*

NEW DEVELOPED FORMULA**

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Model 1 "Best Model" (BM) : CO_2 (g/d) = b_0 + (b_1 × DMI) + (b_2 × MBW) + (b_3 × CP) + breed + (DMI × breed) + (MBW × breed)

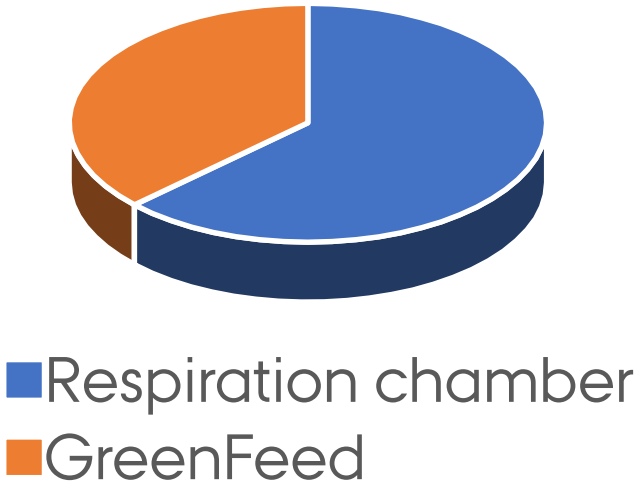
Model 2 "On-Farm Model" (OFM) : CO_2 (g/d) = b_0 + (b_1 × ECM) + (b_2 × MBW) + (b_3 × DIM) + breed + parity + (ECM × DIM) + (ECM × MBW) + (MBW × breed) + (DIM × breed) + (ECM × breed)

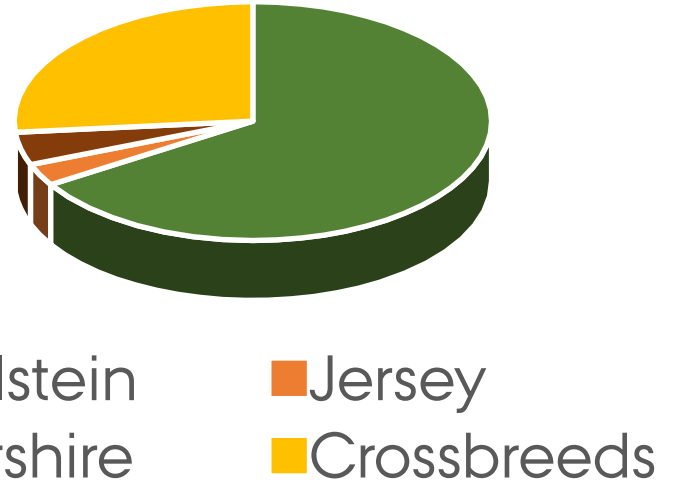
Model 3 "Reduced On-Farm Model" (ROFM) : CO_2 (g/d) = b_0 + (b_1 × ECM) + (b_2 × DIM) + breed + parity + (ECM × DIM) + (DIM × breed)

***To be published/Thesis.*

DATASET FOR FORMULA DEVELOPMENT

- After pre-processing
  - 2,169 animals (13 countries)
    - Multiple lactations





OBJECTIVES

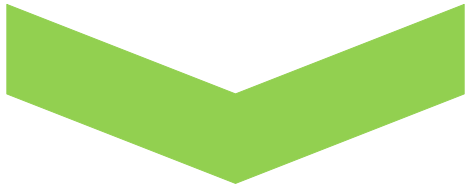
1) calculate CH_4 g/d with these updated formulas
2) estimate genetic parameters including genetic correlations with the previous formula
3) calculate EBV correlations between the formulas.

DATA DESCRIPTION FOR GENETIC ANALYSES

- Research farm (Danish Cattle Research Center; DCRC-DKC)
  - 650 Holstein cows with
    - 26K weekly CH_4 records
    - Measured during 2014-2020
    - Up to 6 parities

MODEL

$$y = Fixed\ Effects + a + pe + e$$



$$EYS + \mathrm{Lact}_{\mathrm{week}} + \mathrm{par(ACC)}$$

DATA STATISTICS

Trait	CH_4gr	CH_4gr_BM	CH_4gr_OFM	CH_4gr_ROFM
MEAN	337.9	312.1	301.4	297.7
SD	86.2	104.2	96.5	99.7

Pearson correlations	CH_4gr	CH_4gr_BM	CH_4gr_OFM
CH4gr_BM	0.71		
CH4gr_OFM	0.69	0.98	
CH4gr_ROFM	0.70	0.97	0.98

Traditional approach (TA) **Best Model (BM)** **On-Farm Model (OFM)** **Reduced On-Farm Model (ROFM)**

GENETIC CORRELATIONS AND HERITABILITIES

Trait	CH_4gr	CH_4gr_BM	CH_4gr_OFM	CH_4gr_ROFM
CH_4gr	*0.21 (0.03)*			
CH_4gr_BM	0.76 (0.09)	*0.22 (0.03)*		
CH_4gr_OFM	0.83 (0.08)	0.99 (0.00)	*0.18 (0.03)*	
CH_4gr_ROFM	0.87 (0.08)	0.96 (0.02)	0.97(0.01)	*0.18 (0.03)*

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GENETIC CORRELATIONS AND HERITABILITIES

Higher heritability

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Higher heritability

Higher correlation

Traditional approach (TA) **Best Model (BM)** **On-Farm Model (OFM)** **Reduced On-Farm Model (ROFM)**

EBV CORRELATIONS

Trait	CH_4gr	CH_4gr_BM	CH_4gr_OFM
CH_4gr_BM	0.73		
CH_4gr_OFM	0.75	0.94	
CH_4gr_ROFM	0.75	0.91	0.97

Traditional approach (TA) **Best Model (BM)** **On-Farm Model (OFM)** **Reduced On-Farm Model (ROFM)**

EBV CORRELATIONS

Similar correlations with traditional formula

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Traditional approach (TA) **Best Model (BM)** **On-Farm Model (OFM)** **Reduced On-Farm Model (ROFM)**

EBV CORRELATIONS

Similar correlations with traditional formula

All 3 approaches highly correlated

Trait	CH_4gr		CH_4gr
CH_4gr_BM	0.73		
CH_4gr_OFM	0.75	0.94	
CH_4gr_ROFM	0.75	0.91	0.97

Traditional approach (TA) **Best Model (BM)** **On-Farm Model (OFM)** **Reduced On-Farm Model (ROFM)**

THESE FORMULAS

Were developed including a large number of animals, breeds from different countries

Were built to cover several scenarios, e.g. including or not DMI and BW

Their purpose was to predict CO_2 g/d and use it as proxy for CH_4 g/d

CONCLUSIONS

Means and standard deviations are slightly lower than with traditional approach

Similar heritabilities as traditional approach

On-Farm Model had the larger genetic correlations with traditional approach

These formulas can be used alternatively to calculate CH_4 g/d

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	BM	OFM	ROFM
Intercept	– 289	– 2731	8338
DMI (kg/d)	176		
ECM (kg/d)		181	71.2
metaBW (kg)	63.3	102	
CP (g/kg DM)	3.69		
DIM (d)		–11.8	– 8.55

	Model 1	Model 2	Model 3
Breed			
- Ayrshire	0	0	0
- Holstein	130	1217	713
- Jersey	1707	1718	– 1784
- Others/crossbreeds	1261	2752	– 886

		Model 2	Model 3
Parity			
- 1st		0	0
- 2nd		487	1002
- 3rd and higher		542	1281

	Model 1	Model 2	Model 3
ECM × DIM		0.401	0.329
ECM × metaBW		- 1.22	
DMI × Ayrshire	0		
DMI × Holstein	144		
DMI × Jersey	157		
DMI × Others/crossbreds	214		
metaBW × Ayrshire	0	0	
metaBW × Holstein	– 17.0	– 4.67	
metaBW × Jersey	-33.9	– 3.81	
metaBW × Others/crossbreds	– 38.0	– 37.4	
DIM × Ayrshire		0	0
DIM × Holstein		2.54	3.61
DIM × Jersey		2.23	3.86
DIM × Others/crossbreds		10.2	8.86
ECM × Ayrshire		0	
ECM × Holstein		17.9	
ECM × Jersey		– 19.2	
ECM × Others/crossbreds		45.6	