Measurements of enteric CH_4 from two non-invasive sensors for genetic evaluations

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Background

Mitigating enteric methane (CH_4) emissions from cows helps to reduce the environmental impact of dairy. Animal breeding can provide farmers a mitigation strategy that is cumulative, permanent, and cost-effective. However, to apply breeding, CH_4 emissions have to be recorded on thousands of individual dairy cows. Therefore, it would be beneficial if records from different recording devices can be used collectively in a genetic evaluation for lower enteric CH_4 emissions.

Objective

Our aim was to study if records from two CH_4 breath analyzers, GreenFeed units (Figure 1) and "sniffers" (Figure 2), are genetically correlated.

Figure 1. A GreenFeed unit can record CH_4 and CO_2 production (g/day) in a pasture or a barn.

Figure 2. The "sniffer" records CH_4 and CO_2 concentrations (ppm) in the feed bin of milking robots.

Results

Phenotypic analyses

The average CH_4 emission per week was 436 ± 97 g/day for GreenFeed and 325 ± 219 ppm for sniffer, the number of records are shown in Table 1. Both devices recorded a steep increase in emissions in early lactation (Figure 3). In addition, records from both devices, although recorded largely at different farms and on different cows, showed diurnal variation (Figure 4).

Table 1. Number of farms, cows, and weekly records for methane recorded only by GreenFeed, only sniffers, and both devices.

	N farms	N cows	N weekly records
GreenFeed	16	737	4,444
Sniffer	15	1,770	31,861
Both	4	183	342

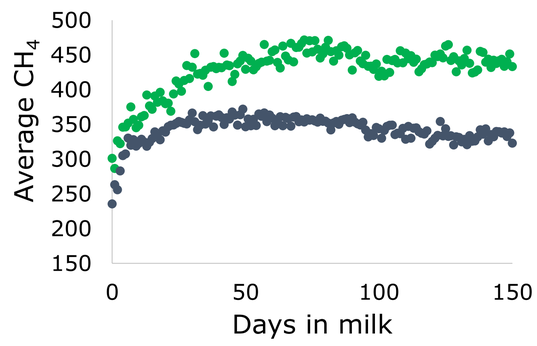


Figure 3. Average methane (CH_4) emissions per day in milk, recorded by GreenFeed (g/day, green) or sniffers (ppm, blue) in different herds.

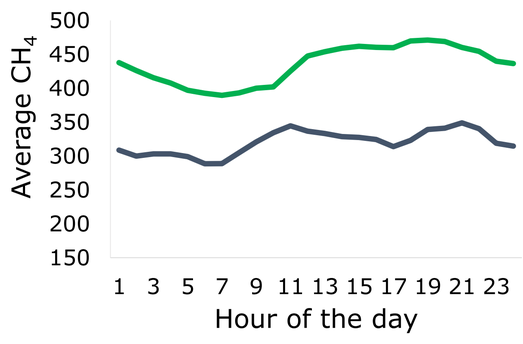


Figure 4. Average methane (CH_4) emissions per hour of the day, recorded by GreenFeed (g/day, green) or sniffers (ppm, blue) in different herds.

Genetic parameters

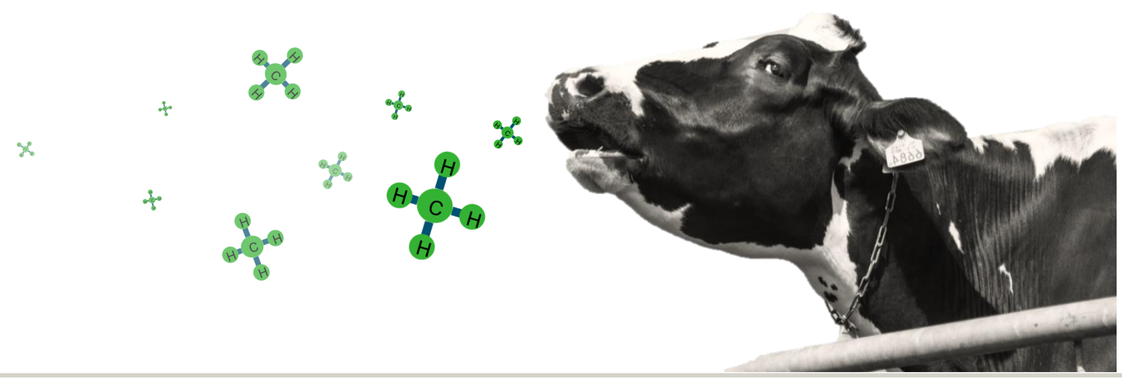
The heritability was 0.38 for GreenFeed and 0.36 for sniffer (Table 2). The genetic correlation between enteric CH_4 recorded by sniffers and GreenFeed was moderate (0.62 ± 0.13).

Table 2. Genetic parameters for average methane (CH_4) and carbon dioxide (CO_2) per week measured by GreenFeed (GF) (g/day) or sniffers (ppm). The phenotypic correlations are reported above the diagonal, the genetic correlations below the diagonal, and the heritabilities on the diagonal in bold (±SE).

	GF CH_4	GF CO_2	Sniffer CH_4	Sniffer CO_2
GF CH_4	**0.38 (0.04)**	0.75 (0.01)	0.42 (0.05)	0.24 (0.07)
GF CO_2	0.69 (0.04)	**0.42 (0.04)**	0.27 (0.07)	0.28 (0.07)
Sniffer CH_4	0.62 (0.13)	0.27 (0.07)	**0.36 (0.02)**	0.83 (<0.01)
Sniffer CO_2	0.48 (0.16)	0.47 (0.16)	0.92 (0.01)	**0.37 (0.02)**

Conclusions

- Methane measured by either device is heritable.
- The moderate genetic correlation suggests that, based on the genetic background of the cow, the two devices ranked cows similarly from low to high emitting and that selection for lower CH_4 with either method will have the same directional effect.
- Due to the high genetic correlation measurements from the two devices can strengthen each other in genetic evaluations. Sniffers can record CH_4 relatively cheap on a large number of cows and can complement the more expensive records from GreenFeed on CH_4 production in gram/cow/day.



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