Report of the Short Term Scientific Mission of Thomas Denninger

(Agroscope Posieux and ETH Zurich)

COST Action FA1302
Host institution: CRA-W Gembloux
Period: 24.10.2016 – 28.10.2016
Reference code: COST-STSM-ECOST-STSM-FA1302-35474

1. Purpose of the STSM

In course of the MethaGene COST Action and my current Ph.D. project at Agroscope Posieux ILS, we carried out a comparison of different methane measurement techniques in grazing cattle. During 1 period covered 6 days of measurement we compared the methane yields per day of the GreenFeed system (C-Lock, Inc. Rapid City, USA), the SF_6 tracer technique and the milk mid-infrared spectra in grazing dairy cattle. During the periods the data obtained from the two method were collected simultaneously on the pasture.
Especially, the SF_6 tracer technique and the prediction of the methane emissions from milk mid-infrared are considerable new for our group.
The group of F. Dehareng is very familiar with these methods and we can benefit from their experiences. In Addition, the CRA-W in Gembloux currently started to measure/estimate methane emissions with the GreenFeed system.
The focus of the STSM was on the methane measurement by SF_6 tracer technique. We are highly interested to improve and establish the method. One important part was the analysis of gas samples (SF_6 and CH_4) which were collected into evacuated canisters during the experiment.
Moreover, further objective of STSM were to exchange of experiences with the GreenFeed system and the application MIR spectra.

2. Description of the work carried out during the STSM

2.1. The SF_6 tracer technique

The SF_6 tracer technique, developed by Johnson et al. (1994) is a well-established CH_4 measurement technique. This technique is suitable for experiments on pasture. Comparisons of the tracer technique and the respiration chambers showed that both measurement techniques are in the same range.
Before the measurements started, the cows were equipped with a calibrated permeation tube releasing SF6 (figure 1), which was administered orally in the forestomach using a balling gun. During a certain period, daily individual respiration gas samples were collected into evacuated canisters fixed on the cows' back; a collection tube with capillary controlled flow was connected with the canister and mounted on a halter such as to position it close to the nostril.

Fig.1: Equipment of the SF_6 tracer technique on a grazing cow

2.1.2 Analysis of the collected gas samples

80 breath samples of the experimental cows, containing respired and eructed gas, were stored under overpressure and were analysed using a GC (Varian Chrompack, CP-9003). A canister and the GC were connected by means of a Swagelok connection (figure 2 and 3).

Fig. 2: Evacuated canister

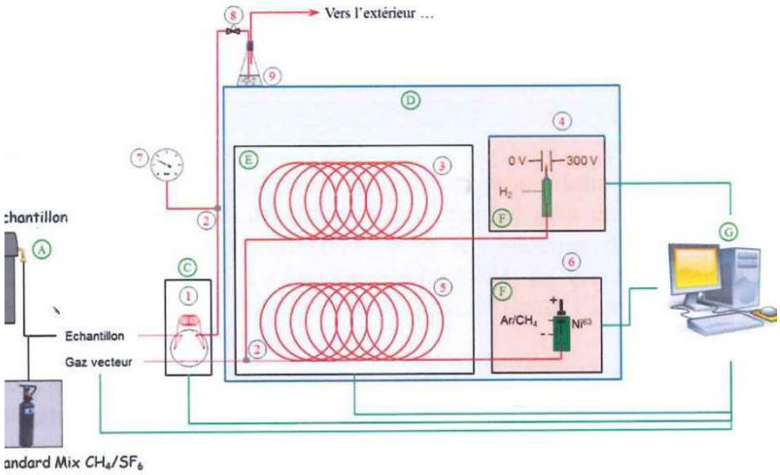

Fig. 3: Schematic representation of the GC

The gas samples were injected into GC directly from the canister. After the Swagelok connection there is a gas sampling loop (1 mL) and an automatic injection valve (1). The GC is fitted with an electron capture detector and a flame ionization detector which were used to determine the concentration of SF_6 and CH_4, respectively. The analyses takes approximately 3 minutes.
Daily CH_4 emission (CH_4Q in g/d) was calculated from the SF_6 release rate (SF_6Q in mg/d), CH_4C/SF_6C ratio of the concentrations of the gas sample, taking background concentrations of the two gases (CH_4B/SF_6B), and the molecular weight (MW) of the gases into account:

$$CH_4Q = (CH_4C - CH_4B)/(SF_6C - SF_6B) \times SF_6Q \times MW\ CH_4/MW\ SF_6$$

CH_4 emission was calculated after the analysis and expressed in g of CH_4/day. Later, we will compare the calculated emission and looking for relationships between the estimated methane emissions obtained from the GreenFeed system and the predicted methane emissions from milk mid-infrared spectra.

2.2 Comparison of the GreenFeed system and the SF_6 tracer technique procedure between both institutes

In order to reduce the inconsistencies in the application of SF6 tracer technique various sources of errors were discussed and compared: flow restriction, accumulation of SF_6, position of the collection tube, high background concentrations of the gases, oral administration of the permeation tube releasing SF_6, SF_6 releasing rate in general, storing of the gas samples and how to carry out the background sampling. Additionally, the SF_6 apparatus were compared in order to reduce the number of missing samples.
Furthermore, experiences made with the GreenFeed system were exchanged. In particular, the handling of the equipment, data collection, validation, analysis and interpretation of the measurements. The GreenFeed system was running during the time of the STSM and an on-farm application could be observed.

3. First results

Calculated CH_4 emission obtained from SF_6 tracer method

During a 6-day period daily individual respiration gas samples of 10 multiparous cows (n=10) were collected. The mean values as well as the coefficient of variation (CV) of each cow are shown in table 1.

Table 1: Calculated daily CH_4 emission of each cow (g/d), mean CH_4 emission (g/d) and CV (%)

Cow	**2101**	**2102**	**2103**	**2104**	**2106**	**2107**	**2109**	**2110**	**2111**	**2112**
Day1	572	482	502	370	576	438	637	469	465	411
Day2	475	493	537	620	834	486	570	471	695	405
Day3	536	455	487	398	662	474	561	455	754	421
Day4	453	454	554	781	722	758	441	439	820	362
Day5	419	464	894	398	685	439	536	448	558	410
Day6	422	461	426	534	758	411	539	469	589	374
Mean	479.4	468.3	566.7	516.9	706.1	500.9	547.1	458.5	646.8	396.8
CV(%)	13.0	3.4	29.4	31.2	12.4	25.7	11.7	2.9	20.5	5.9

4. Conclusion

In terms of the analysis of the collected gas samples, the STSM has been very successful. The calculated data are in the range of explainable individual daily methane emission. Further statistical analysis are foreseen in order to detect relationships between estimated/predicted methane emission obtained from the GreenFeed system and the mid-infrared spectra data of the milk.
The data from our experiment will be included into the equation developed by CRA-W to predict methane emissions from milk mid-infrared data.

Benefits from the STSM to the METHAGENE network

It is necessary to assess various methane measurement techniques in terms of their accuracy and reliability. Furthermore, it is important to test rapid low-cost proxies like the milk mid-infrared spectra in order to develop animal selection strategies to mitigate CH4 emissions. An enhancement of the milk mid-infrared equation would improve the prediction of the methane emission of a large number of animals.
Further collaboration between our institutes are planned for next year to exchange data and experiences of the different methods.
In the end I would like to thank Amélie Vanlierde for the good collaboration during the STSM.

5. Confirmation by the host institution of the successful execution of the STSM

(see letter of confirmation attached)

6. References

Johnson, K., Huyler, M., Lamb, B., Westberg, H. and Zimmerman, P. (1994): Measurement of Methane Emissions from Ruminant Livestock Using a SF6 Tracer Technique. Environ. Sci. Technology 28, 359-362.

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Letter of confirmation

Dear colleagues,

We hereby confirm that Mr. Thomas Denninger has performed a Short-Term Scientific Mission (STSM) in Gembloux, at the Walloon Agricultural Research Centre (CRA-W) from October 24th – 28th 2016 in framework of the COST action "METHAGENE".

The gas analyses of samples collected with the SF6 technique in Switzerland were carried out without any trouble. Those measurements would be additional information to include in the equation developed at CRA-W and ULg-GxABT to predict methane emissions from milk MIR spectra.
This STSM was also an opportunity to exchange more between the two concerned research teams.

We are looking forward for further collaborations with Mr. Denninger and his colleagues.

Cordially,

Pierre Dardenne

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