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Methods to measuring methane emission in Italian Buffalo

Purpose of the STSM

The aim of this STSTM at the University of Nottingham was to learn and to train on the technique (Garnsworthy et al., 2012) implemented to measuring methane emission data from cows during milking on farm. Among all the techniques reviewed (Goopy, et al., 2016) this one(Garnsworthy et al., 2012) is very accurate and can provide repeatable data, and produce a large number of data in a short period of time.

Buffalo farming

There are about 250,000 buffalo heads in Italy (FAO, 2014) mostly (75%) distributed in the Campania region. Italian buffalo are kept under intensive farming system. Animals are milked twice a day for 270 days of lactation. Only the last month of lactation, when their milk production decreases, buffalo are milked once a day. The average number of buffalo per heard is 150 heads. However, there are few farms that breed up to 1,000 heads. Buffalo are breed for milk production that is all transformed in a very appreciated cheese named '*mozzarella di bufala*'.

Buffalo are usually milked in the milking parlour, while there are only few farms with the milking robots. In those farms buffalo showed a very good adaptability to this innovative milking system, so that more farmers are choosing to substituting their milking parlour with the milking robot. Moreover, today there are regional funds available that farmers can apply for to buying milking robots. Thus, the number of farms that will buy this innovative milking system will increase in the near future.

Description of the work carried out during the STSM

Introduction

Methane is a greenhouse gas with the global warming potential 25 times that CO_2 (Forster et al., 2007). Therefore methane accounts for a great part of the emitted CO_2-equivalents from agriculture. In ruminant animals, typically the most of the methane (>90%) is generated in the rumen during microbial fermentation of cellulosic feed materials (enteric methane) and a small part by decomposition of manure (Verge et al., 2007).

Globally the dairy sector is estimated to contribute 4% of greenhouse gas emission (FAO, 2010). Methane accounts for up to 50% of greenhouse gas emission from milk production, and its contribution can be up to 80% in in grassland systems (FAO, 2010).

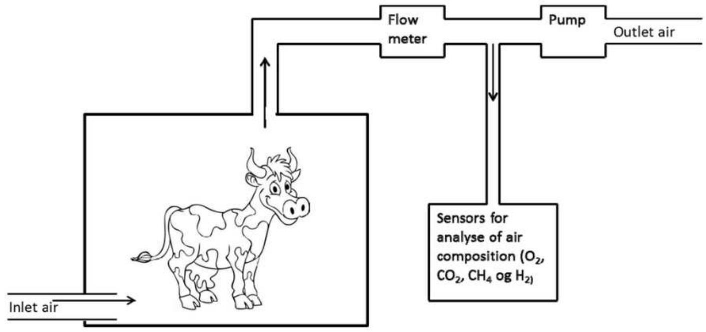
The total methane emissions on farm or on national level are calculated as the product of number of buffalo and emissions per buffalo. Therefore, develop a technique to accurately measuring methane emission in buffalo on farm, is of extreme importance.

Several direct and indirect methods have been developed in the last years to measuring and estimating methane emissions in ruminants. They can have different applications, advantages and disadvantages. Some methods are more suitable for grazing animals, some suit better for housed animals; some can handle many animals, some only few, some are cheap and some are expensive. The accuracy of the methods will affects the measuring results and interpretations. A very useful review of the methods for measuring methane emission was done by (Goopy, et al., 2016).

The reference method used for research purposes is the respiration chamber, in which an individual cow is confined for several days and methane emissions are calculated from gas flow and changing in gas composition between ventilation inlet and outlet ports (Grainger et al. 2007; Yan et al., 2010) (Figure 1).

Methane emission measurements from the respiration chamber are essential to validate any technique used to estimate methane emissions from individual cow on farm.

Figure 1. Respiration chamber

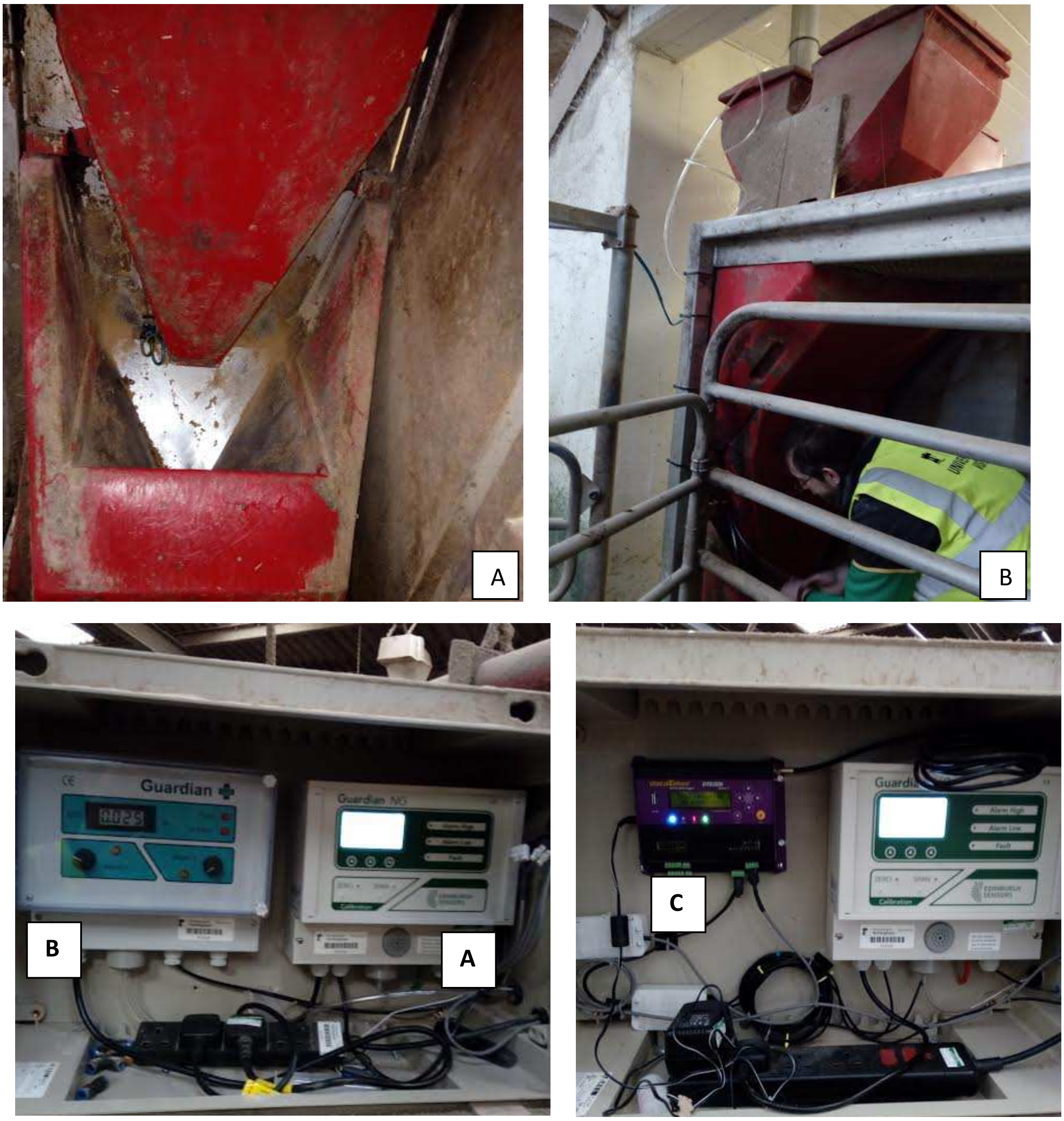


Description of the technique

On-Farm Methane Measurements during Milking

One of the most suitable techniques to measure methane emissions in ruminants under commercial conditions was reported by Garnsworthy et al. in 2012. This technique involves measurement of methane concentrations in air expelled through eructation by individual cow during milking. In fact, since cows are milked from 2 up to 6 times a day, milking represents an opportunity to measure methane emissions in cows in a repeatability and non-invasive way. This technique (Garnsworthy et al., 2012) was made up by initially observing that there is a large increases in methane concentration of exhaled air at approximately 1 minute intervals during milking, which corresponded to when cows released gas from the rumen by eructation. Therefore, the variations in eructation frequency and methane concentration in eructations are related to differences in daily emissions.

Methane concentration is measured during milking of the cows in the robot using one infrared methane analyser per milking station (Guardian Plus: Edinbuidual methane emission at eructation rgh Instruments Ltd., Livingston, UK) with a range of 0 to 10,000 mg/kg and one infrared carbon dioxide analyser (Picture 1)

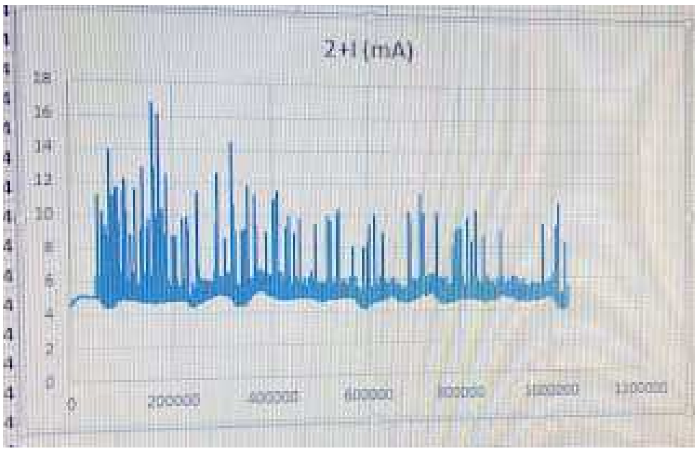


Picture 1. infrared methane analyser per milking station (A), one infrared carbon dioxide analyser (B), and one data logger(C)

Air is drawn through the instrument by an integral pump between the gas inlet port and analyser. Air is sampled continuously from the feed bins in the milking station at 1 L/min via an 8-mm diameter polyethylene tube, approximately 3 m in length, connected to the gas inlet port of the analyser (Picture 2b, Picture 2c). The exhaust port of the analyser is vented into the air at least 3 m clear of any sampling point. An inline combined particle filter with water separator (Air-Pro IF-14; Flotec Industrial Ltd., Loughborough, UK) is fitted to the sample tube approximately 50 cm from the analyser inlet port (Picture 2d). The inlet end of the tube is positioned into the rear of the feed bin in the milking robot (Picture 2a).

Picture 2. Inlet tube that sample the air in the bin rare (A). Air sampled through the instrument by an integral pump between the gas inlet port and analyser (B, C); Inline combined particle filter with water separator (D)

Methane concentrations measured in air sampled during milking followed a distinctive pattern of peaks. A designed programme is used to identify and quantify peaks. Raw data from the logger (Picture 3.) are transformed into values for peaks height and integral area under the peaks to measuring the total individual methane emission at eructation.



Picture 3. Row data from the data logger

Description of the main results obtained

This STSM provided me a better understanding of the technique utilized for measuring the methane emission in dairy cows for the commercial herd conditions. This innovative technique will provide the opportunity to measuring methane emissions data in dairy buffalo in a very accurate and economic way.

Description of benefits from the STSM to the METHAGENE network

The benefits from the STSM to the METHAGENE network, is that by applying this technique to the dairy buffalo, data on methane emission in buffalo will be soon available to the network for comparisons with the data obtained from the dairy cows.

Future collaboration with the host institution

There is already a letter of intent for a collaboration with the host institution regarding their supports in providing advice and assistance with design, construction and installation of methane measuring equipment; providing training in measurements, data handling and interpretation of results; joint discussions on design of studies, experimental plans and project management; joint publications and presentations; short visits and exchanges of researchers, technical staff and students.

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