



DEVELOPMENT OF A PRACTICAL AND ECONOMICAL TECHNOLOGY TO MEASURE N₂O AND CH₄ EMISSIONS FROM LIVESTOCK BUILDINGS

JOAHNN H. PALACIOS*¹, ARACELI DALILA LARIOS^{1,2,3}, STÉPHANE GODBOUT¹, DAN ZEGAN¹, PATRICK DUBÉ¹ & BEATRIZ DELGADO CANO^{1,4}

Introduction

Livestock production systems results in gas emissions such nitrous oxide (N₂O) and methane (CH₄).

Several efforts have been made to inventorying and reduce such emissions. However, sophisticated emission measurement techniques involve high costs and the displacement of delicate instruments and qualified personnel to remote locations.

Objective

To develop an economical and practical method to measure N₂O and CH₄ emissions from livestock buildings using the passive flux sampling (PFS) technique .

Material and Methods

TECHNIQUE

In passive flux sampling, a relatively small device containing therein an adsorbent material is placed into or near the building ventilation. Part of the flow containing gases passes through the sampler and the target gas is then captured by the adsorbent.

After the sampling period, the gas adsorbed is thermally desorbed in laboratory. The concentration is quantified by gas chromatography and the mass and emission are calculated.

Two conditions must be met:

- 100% of the target gas going through the sampler is adsorbed
- The sampler aerodynamic allows a proportional ratio between the flow inside and outside the sampler.

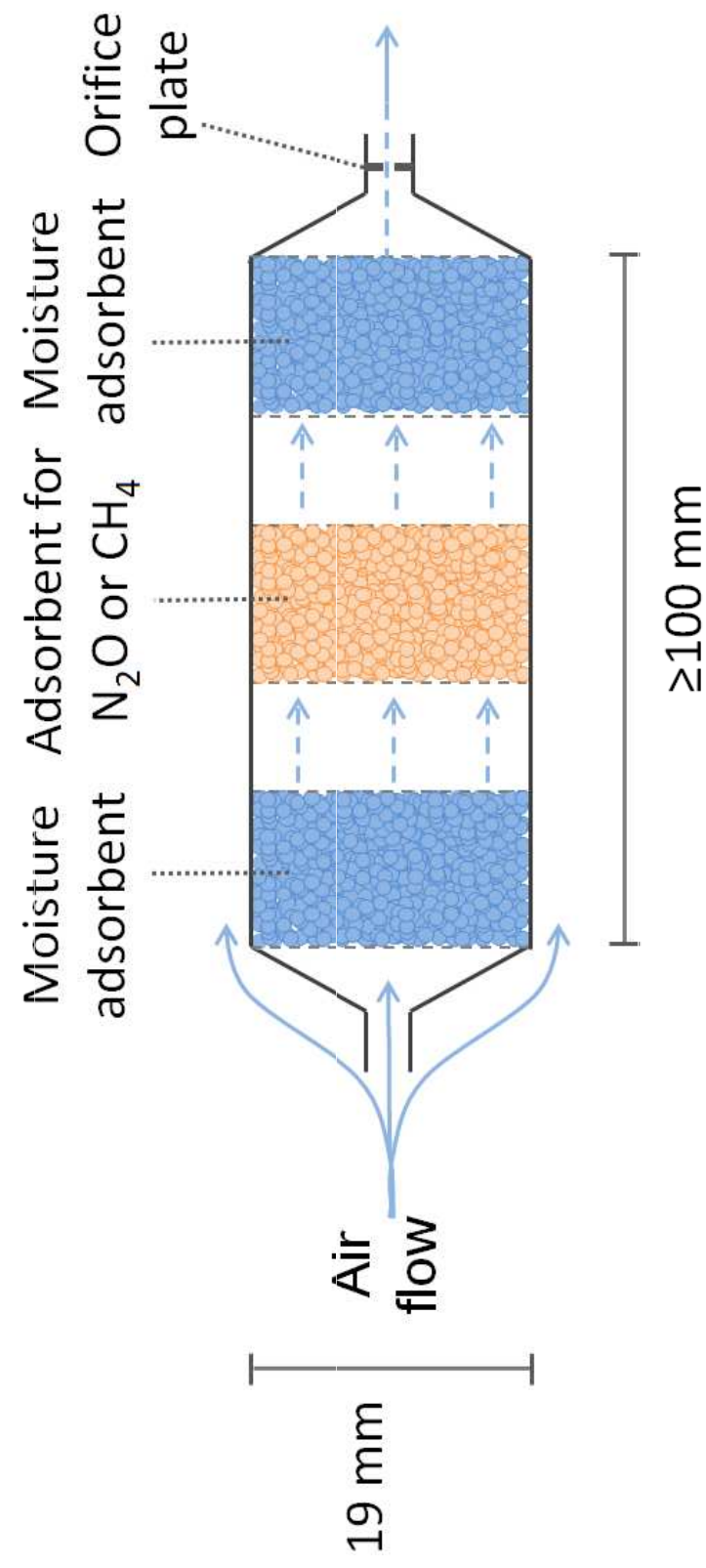
Therefore, in contrast to other techniques, the main advantage of PFS is that gas concentrations and air speeds are not measured in the field, simplifying the protocol.

This technique has not been used for the measurement of N₂O and CH₄ emissions.

DEVICE

The last prototype developed has a layer of adsorbent for N₂O between two layers of adsorbent for moisture. Length is adjustable from 100 mm according to the desired amount of adsorbent therein.

An orifice plate is placed at the outlet in order to reduce the air flow passing into the sampler and to allow linearity between the external air velocity and the internal flow.



TESTING

The main experiments conducted so far aimed to:

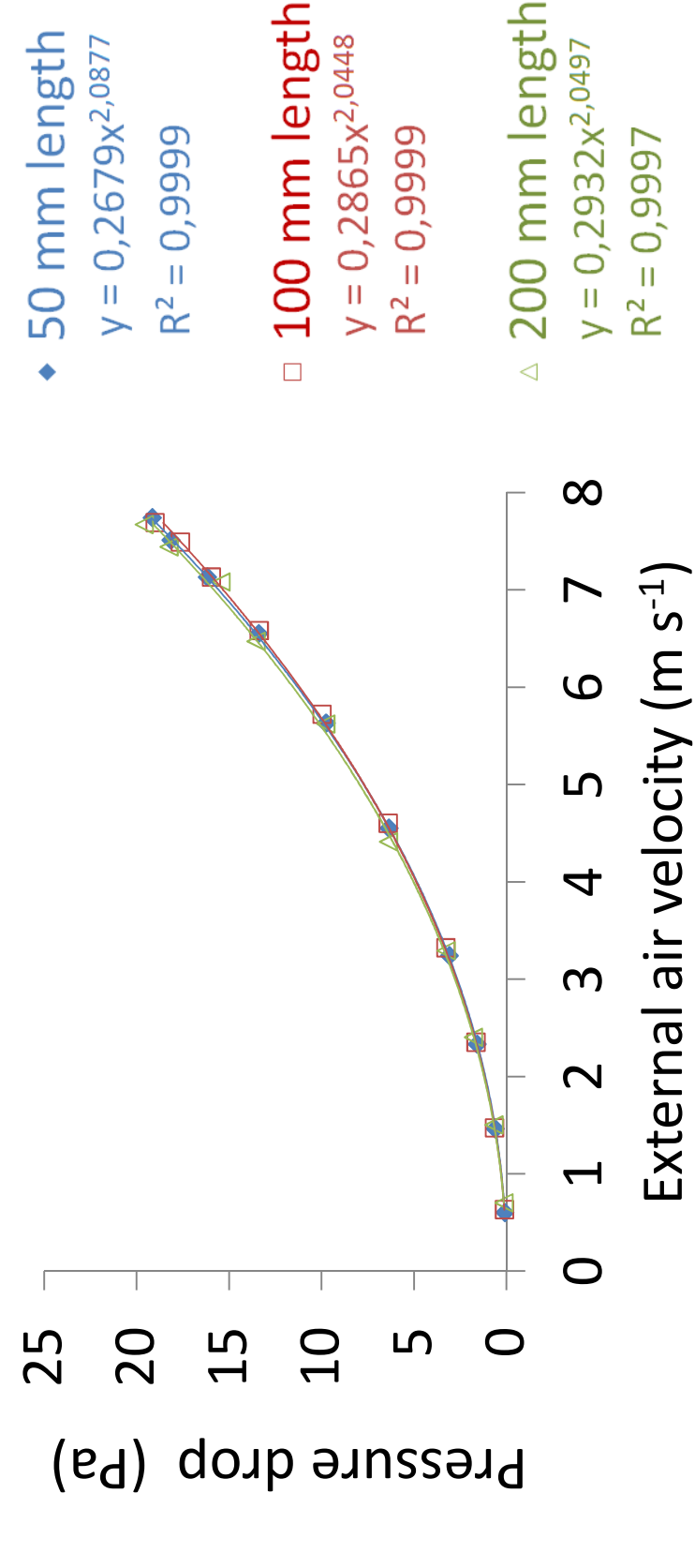
- Evaluate the sampler aerodynamic to allow a linearity among the external air velocity and the internal flow by analyzing the relation between pressure drop across the orifice plate and the internal flow rate
- Evaluate the efficiency of the adsorbent (Zeolite 5A) to capture N₂O
- Evaluate the risk that humidity adsorbent capture also N₂O
- Compare two different techniques for the N₂O desorption: oven vs. headspace coupled in a gas chromatography-mass spectrometer (GC-MS).

Results

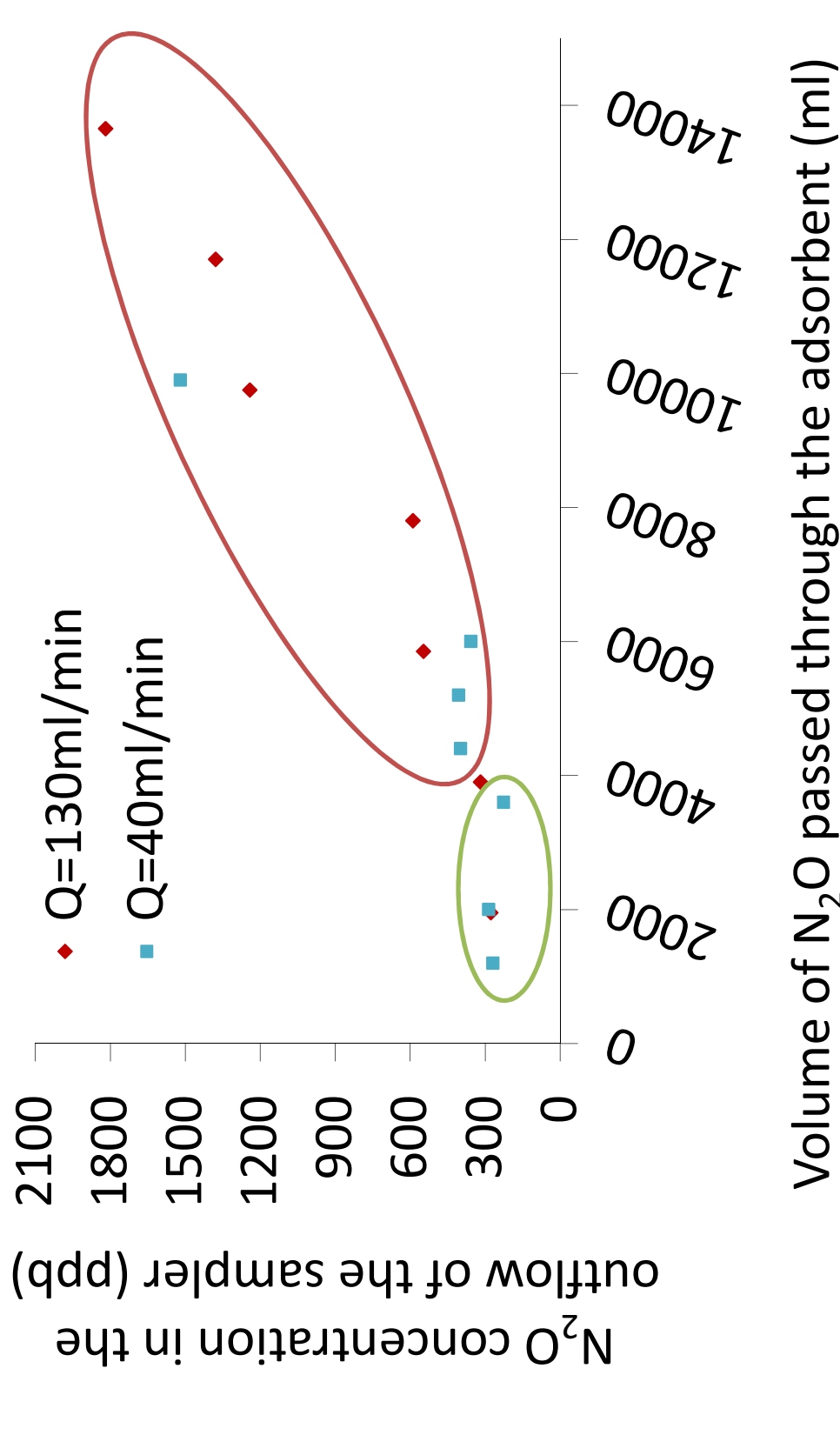
- The aerodynamic test showed an adequate quadratic relation (2.0448 – 2.0877; 0.99 R²) when the samplers were exposed to air velocities up to 7 m s⁻¹.

The more the relationship between pressure drop across the orifice plate and the internal flow rate is quadratic, greater linearity result among the internal flow and the external air velocity.

Moreover, no substantial differences were found between the evaluated sampler lengths.



- A steady flow of N₂O (2,000 ppb) was forced to pass through the sampler containing 4g of N₂O adsorbent at two different flow rates. It was found that the adsorbent has adequate adsorption efficiency when passing a volume of N₂O (2,000 ppb) up to 3,900 ml (14,037 mgN₂O) regardless the flow.



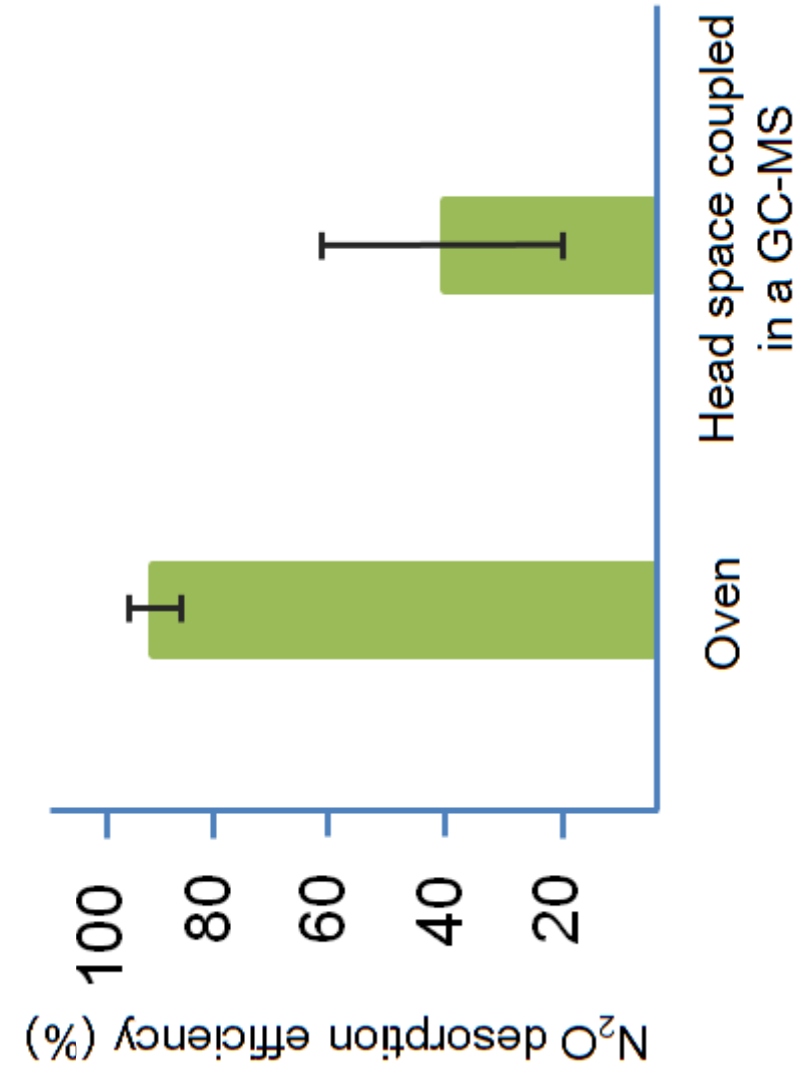
- ~20% of N₂O was not found in the outflow of the sampler when N₂O (2,000 ppb) was forced to pass through at two different flow rates containing 4g of moisture adsorbent. However, further tests should verify the hypothesis that N₂O is adsorbed by the moisture adsorbent, because less than 20% of N₂O was found in the desorption stage of the moisture adsorbent.

N ₂ O flow rate	time (min)	Total N ₂ O that passed through the moisture adsorbent (mg)	Total N ₂ O (possibly) adsorbed by the moisture adsorbent (mg)	(%)
130	90	42,123	9,081	21.6
130	90	42,123	8,545	20.3
40	280	40,323	9,478	23.5
40	280	40,323	7,804	19.4

- The oven method showed better N₂O desorption efficiencies (85-92%) compared to the headspace method coupled to a GS-MS (20-60%).

The high variability obtained with the headspace method was related to the amount of the adsorbent sample analyzed and the content of N₂O on the adsorbent.

The next tests will determine the optimum parameters (temperature, carrier gas flow rate and time) for the N₂O desorption with the oven method.



Conclusions

The results showed that PFS technique could be an appropriate technique for measuring N₂O gas emissions.

The prototype and the analysis method developed showed suitable characteristics for measuring N₂O emissions from animal production facilities in a practical and economical way.

Applying this technique for measuring CH₄ emissions is today a challenge because it has been difficult to find or produce an adsorbent with the ability to efficiently capture this gas at atmospheric pressures.

Further tests

In future tests, the sampler will be evaluated in semi-real and real conditions. For measuring CH₄ emissions, work is currently underway in order to find or develop an appropriate adsorbent because zeolite 5A was not appropriate (< 15% adsorption).

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FURTHER INFORMATION

JOAHNN H. PALACIOS
Research assistant, ing. Jr. M. Sc.
joahnn.palacios@irda.ac.ca