



Measurement of GHG emissions from livestock houses

Paul Robin, Mélynda Hassouna

► To cite this version:

Paul Robin, Mélynda Hassouna. Measurement of GHG emissions from livestock houses. Elevage et Changement Climatique, 2015. hal-02793927

HAL Id: hal-02793927

<https://hal.inrae.fr/hal-02793927>

Submitted on 5 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

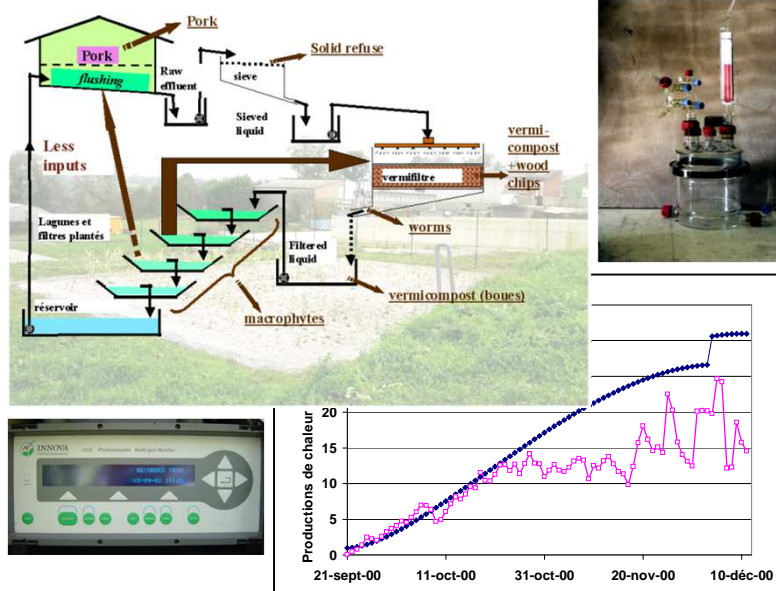
Training Course Programme

Livestock and Climate Change

12th-14th January 2015, Dakar

Measurement of GHG emissions from livestock houses

Paul Robin, Mélynda Hassouna



12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONNEMENT



Outlines

- **Introduction:** better measurement for better management
- **Typology of methods:** objective, users, principles
- **Method description**
 - reference methods: necessary, continuous, expensive
 - simplified methods: high number of farms
- **Uncertainties:** definitional & measurement
- **Take home messages**



12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONMENT



Introduction

1. Why measure?

- ❖ Objectives, measurement **users**, budget

2. Better measurement....

- ❖ Quality of the methods
- ❖ Skills of the operators
- ❖ Appropriateness of the measuring devices

3. Better management....

- ❖ Global evaluation at (inter)national scale
- ❖ Local monitoring for farm purposes



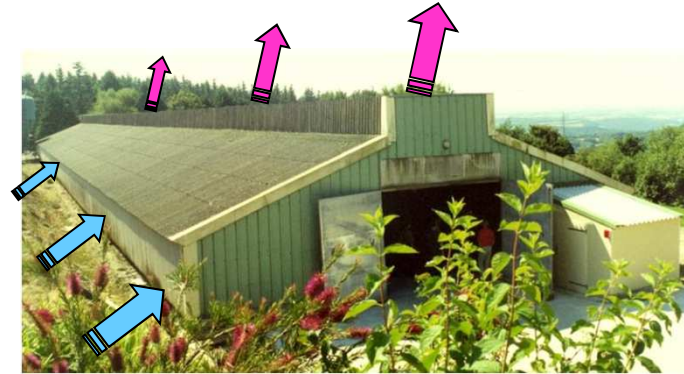
12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONNEMENT



Typology of methods

**Confined animals => concentration increase
in H₂O, CO₂, CH₄, NH₃, N₂O, etc.**



$$\text{Gas_losses} = \text{Ventilation_rate} * \text{volumic_mass} * \text{concentration_gradient}$$

**Mass budget:
feed, animals,
water, manure**

**Mechanical or
natural ventilation,
number & position
of inlet & outlet**

**Gas analysers, air
sampling, inside &
outside the house
(distance?)**

**Decrease inside the house
because Temperature &
moisture increase**

**Existing knowledge, reliable and representative
(e.g. water evaporation close to water loss)**



12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONNEMENT



Typology of methods

Globale; non intrusive



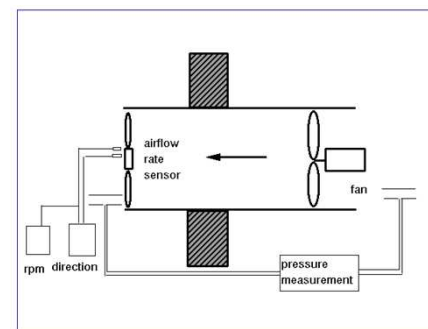
Tracing gas



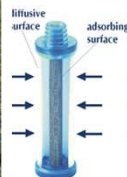
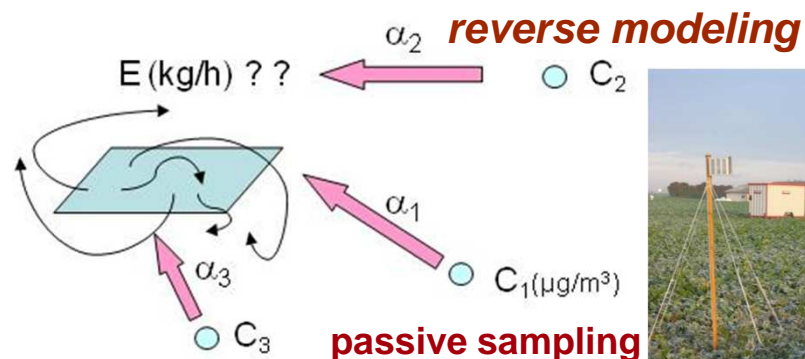
Indirect



**Direct
anemometer**



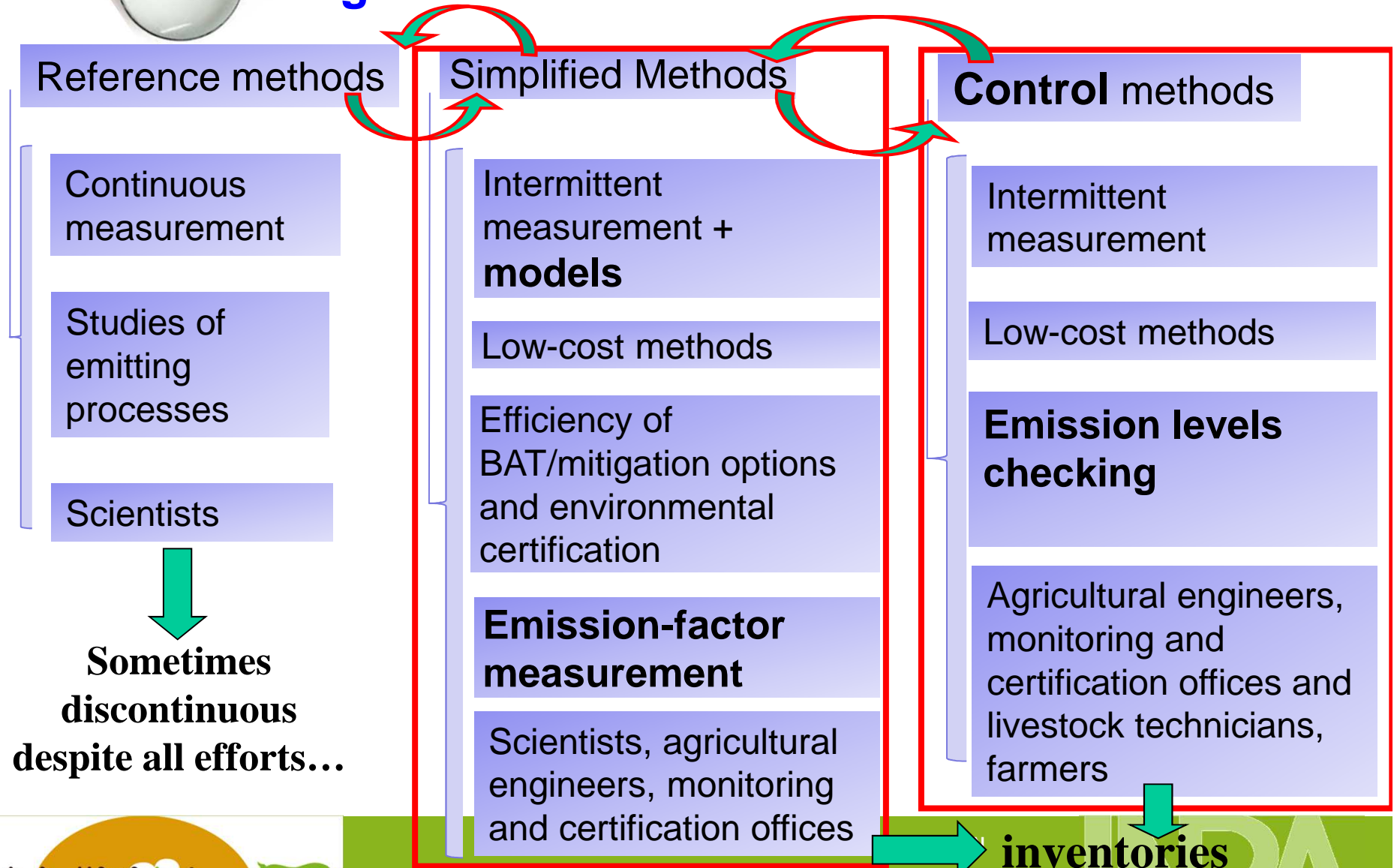
**Sampling & concentration measurement
point/volume/line**





Different methods, different uses, inter-validation

measuring standard methods



Sometimes
discontinuous
despite all efforts...



12th-14th January 2015, Dakar

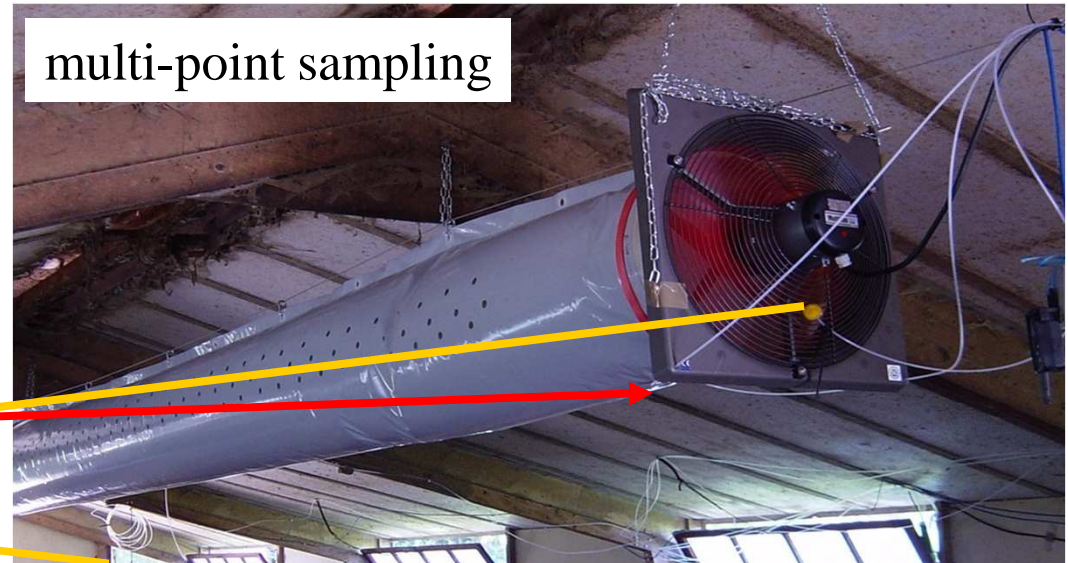
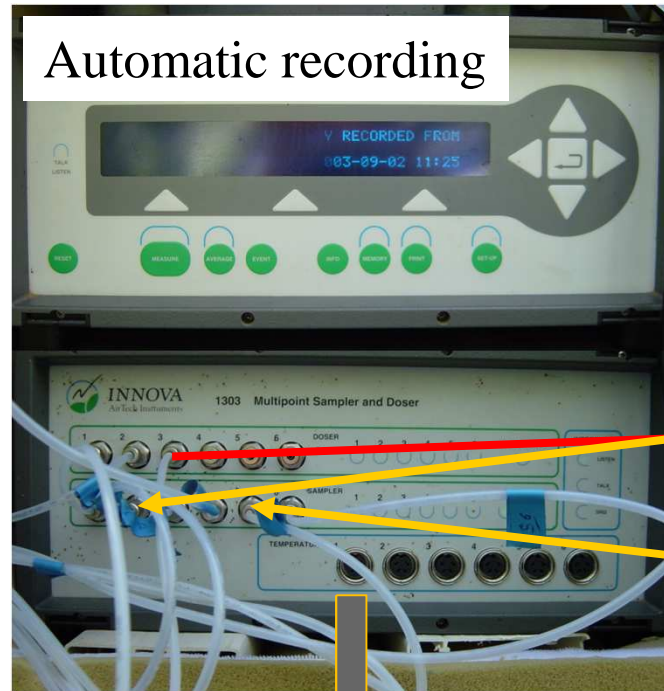
AGRICULTURE

ENVIRONNEMENT



Method description: reference method

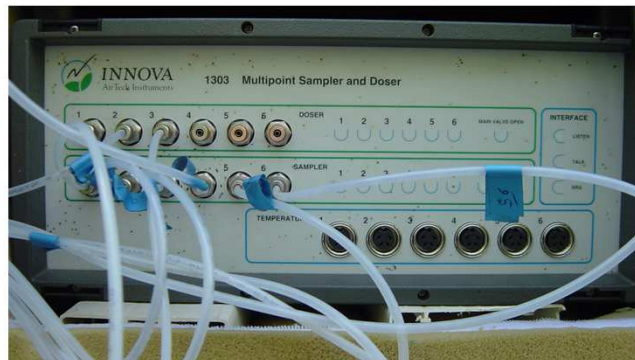
A mobile measuring device for continuous measurement



Gas concentrations: NH_3 , N_2O ,
 CO_2 , CH_4 , SF_6
 $\text{SF}_6 \rightarrow$ airflow rate
+ air mixing

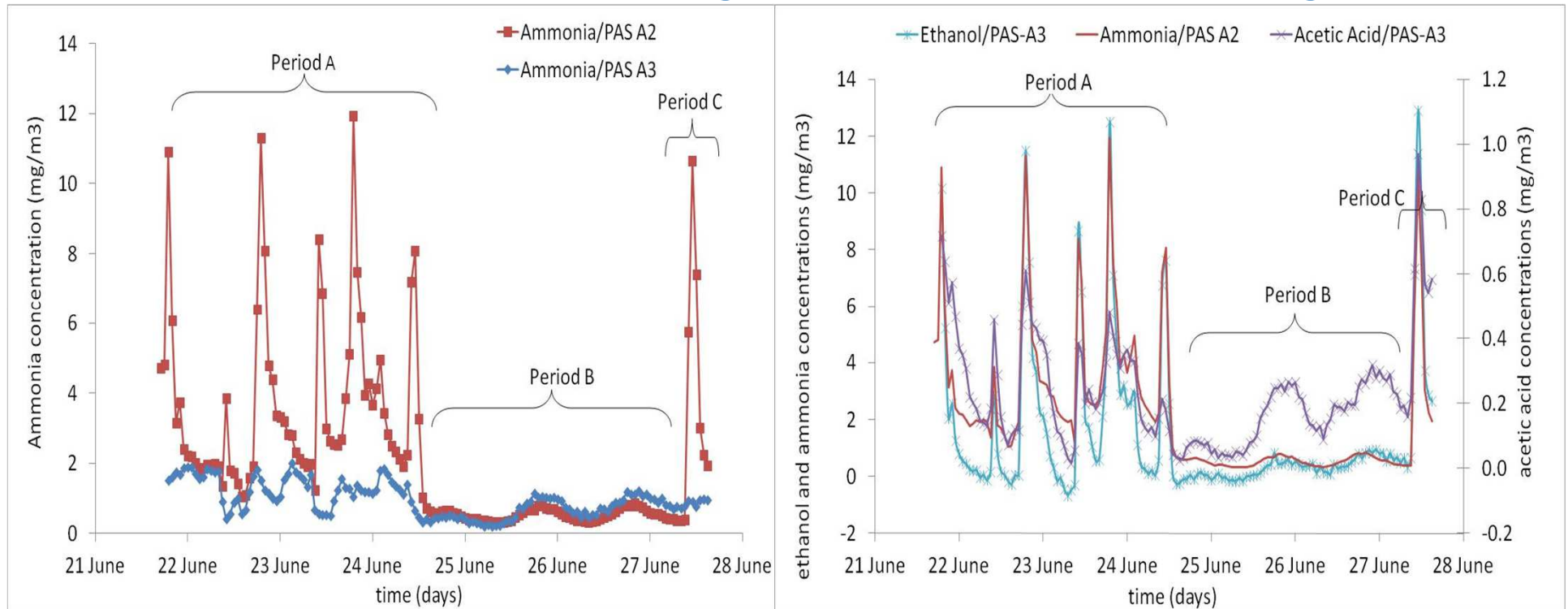


**specific room or mobile cab
outside the animal house,
heated pipes to avoid
condensation**



Method description: reference method

Interferences between gases can induce strong bias



- Strong differences for period A and C
- Observation of strong peaks for period with silage and with/without cows

- NH₃ concentrations with PAS-A2 are overestimated and mainly due to Ethanol and Acetic Acid emitted by silage

Hassouna et al., 2013



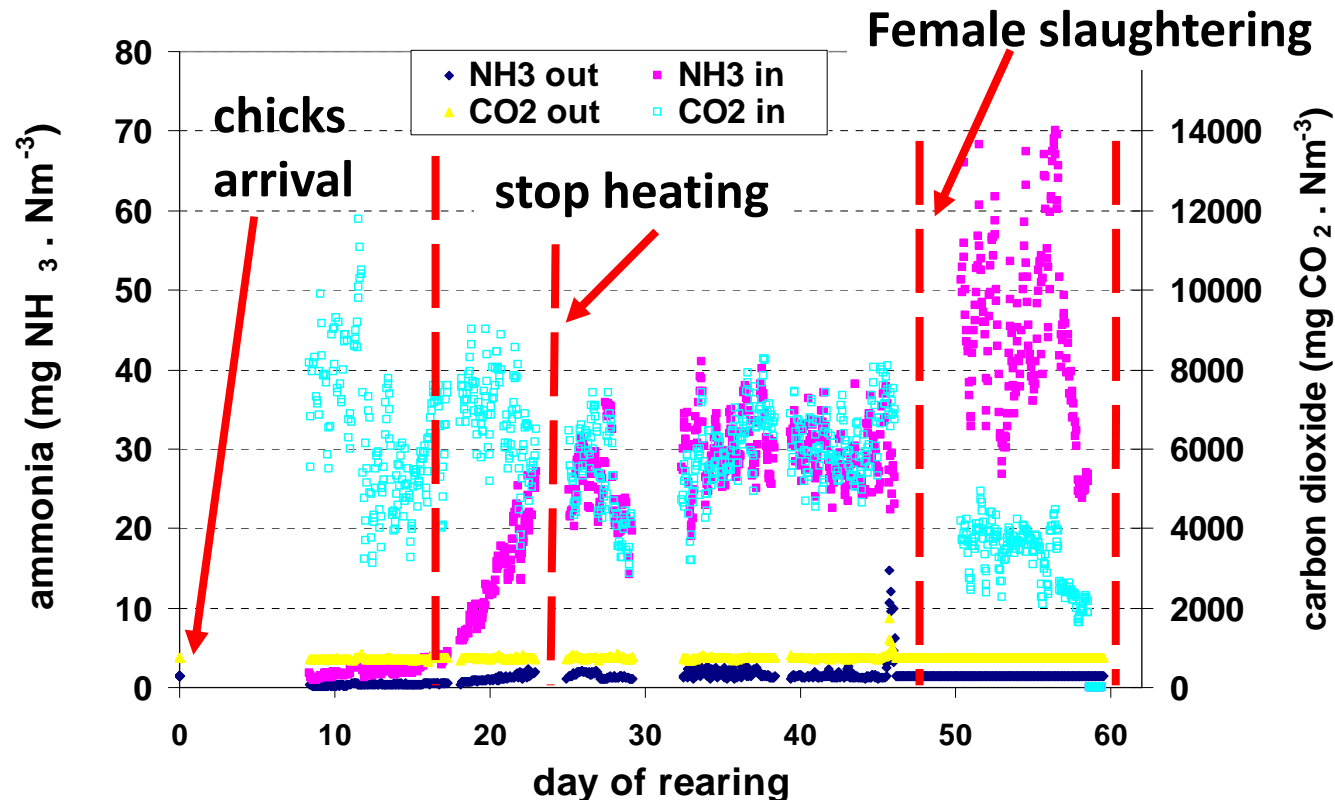
12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONMENT

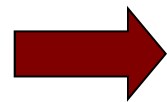


Method description: simplified method

Principle: ratio of concentration gradients and mass budget



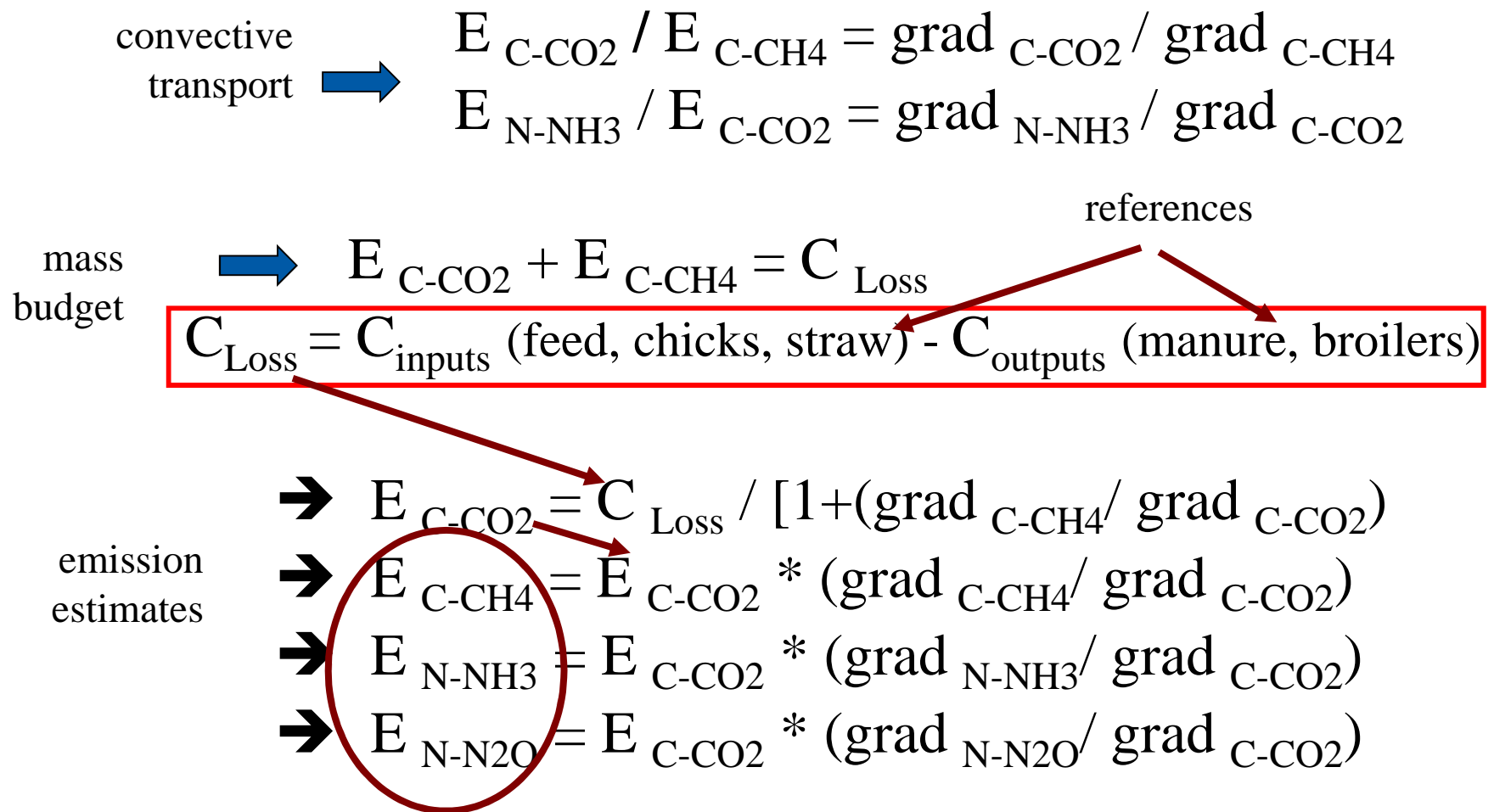
- broiler batch, December 2008, France
- CO₂ and NH₃ \pm proportional per period
- CO₂ and NH₃ depend on growth, stocking density, manure management



grad CO₂ / grad NH₃ characterizes one period

Method description: simplified method

Principle: ratio of concentration gradients and mass budget

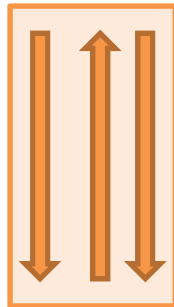


Method description: simplified method

Sampling inside and outside the house



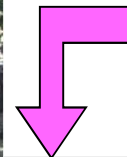
**Recommended material
for bags: flexfoil**



**Large openings:
minimum CO₂
gradient \approx 50ppm**



**multigas analysis
+
discussion with farmer**



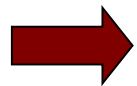
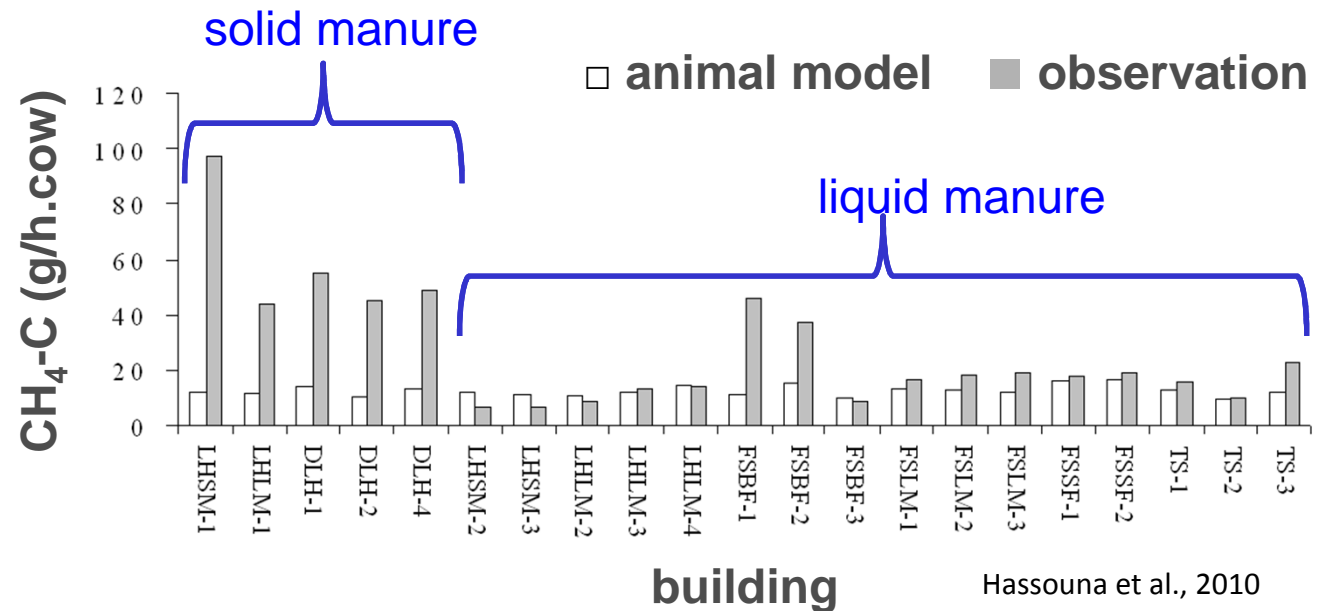
**Sampling, questions, calculations
specific of house and farm type**

Method description: simplified method

example: dairy cow houses

21 commercial dairy-cattle houses:

- \exists variability between farms >50%
- reproducible (50%) same season (2007-2012)
- not reproducible (50%) winter-summer



- grad CO₂ / grad CH₄ characterizes one period, one farm
- effluent management system is necessary but not sufficient to characterize the variability of emissions

similar results with NH₃ and N₂O



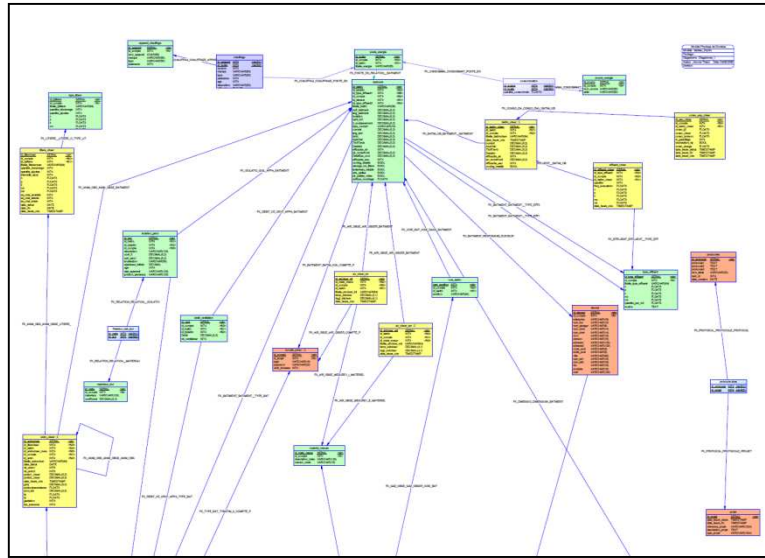
12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONMENT



Method description: simplified method

➔ **Database with emission calculations suited for a large number of animal houses + mobile measuring equipment**



National references
Farm references
Local observations

of
Animals
Feed
Litter
Manure
Housing

Mass balance

Gas
observations
of CO_2 , CH_4 ,
 NH_3 , N_2O



Emission
estimates of
 CO_2 , CH_4 ,
 NH_3 , N_2O for
laying hens,
broilers, cows,
growing pigs

➔ **Calculation scheme also in OpenOffice sheets;
system+database+software+documentation on a
GNU-licence, multi-language, USB key for further
public and international development**



**Schools
& R&D**



Uncertainties

1. Definitional uncertainty

- ❖ Describe the animals
- ❖ Describe the feeding & drinking management
- ❖ Describe the manure management
- ❖ Describe the house management

2. Measurement uncertainty: 5M approach

- ❖ Man
 - ❖ Machine
 - ❖ Mother nature (environment)
 - ❖ Method
 - ❖ Material
- Repeatability: same place, man, etc.
- Reproducibility: other place, time, man, machine, etc.



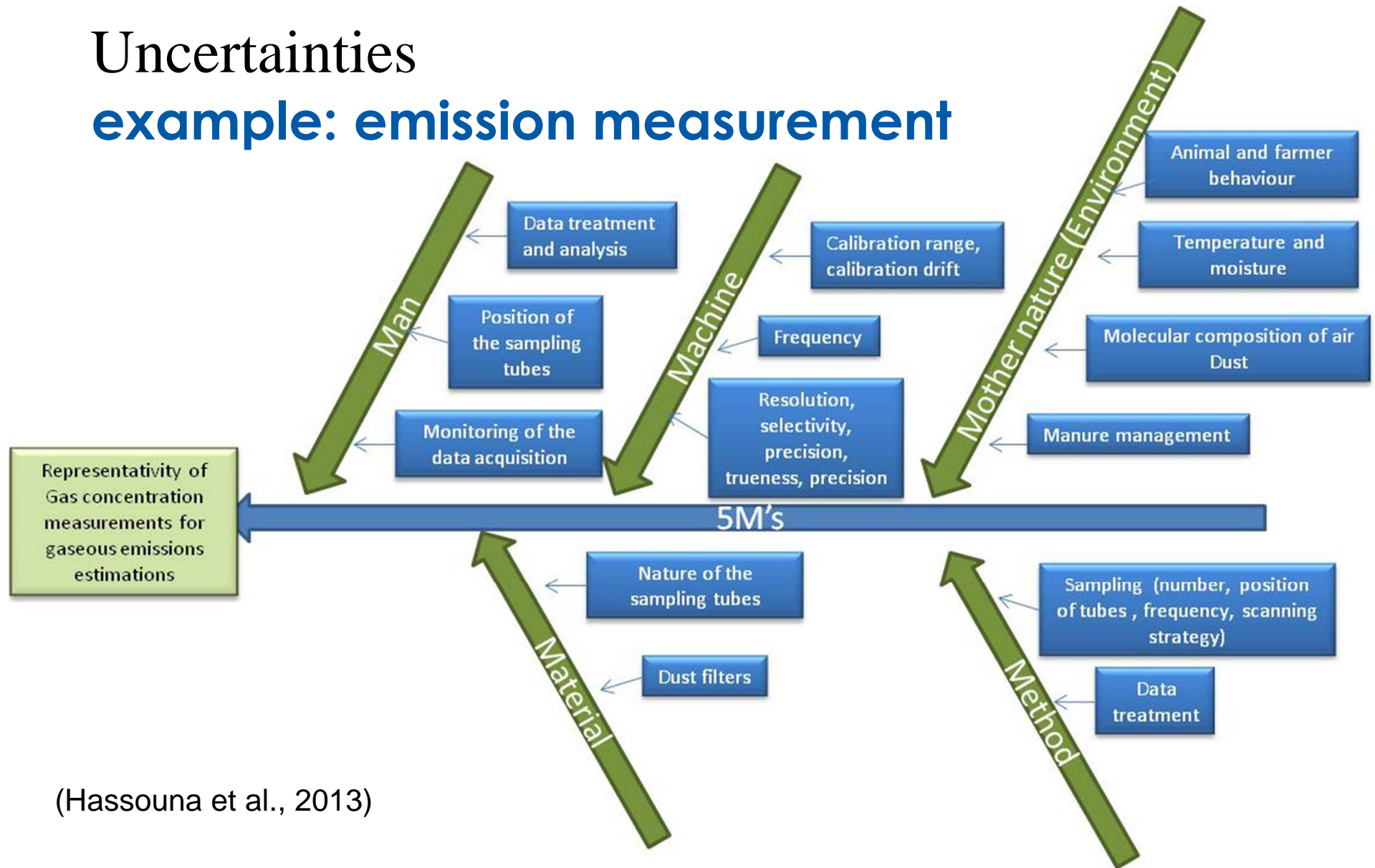
12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONNEMENT



Uncertainties

example: emission measurement



(Hassouna et al., 2013)

Take home messages

- ❖ First define objectives & measurement users
- ❖ Rely on your existing experience & knowledge: mass balance, definitional uncertainty
- ❖ Choose method:
 - ❖ http://www.inra.fr/animal_emissions/
 - ❖ Book in preparation related to measuring methods, funded by
 - ❖ Available descriptions, software & datasets for low-cost transfer
- ❖ Check observations: reference gas bottles, mass budget,...
- ❖ Exchange within networks: give time & save money through interactions on complex problems/simple solutions (e.g. ANGAEL)



12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONNEMENT



Thanks for your attention



EMILI 2015

International Symposium on **Emissions**
of Gas and Dust from **Livestock**

<http://www.emili2015.com.br/english.php>

EMILI 2015 - March 24-26, 2015 - Florianópolis, Brazil



12th-14th January 2015, Dakar

ALIMENTATION
AGRICULTURE
ENVIRONMENT

