Adapting the measurement methods to the different purposes

Paul Robin, Mélynda Hassouna

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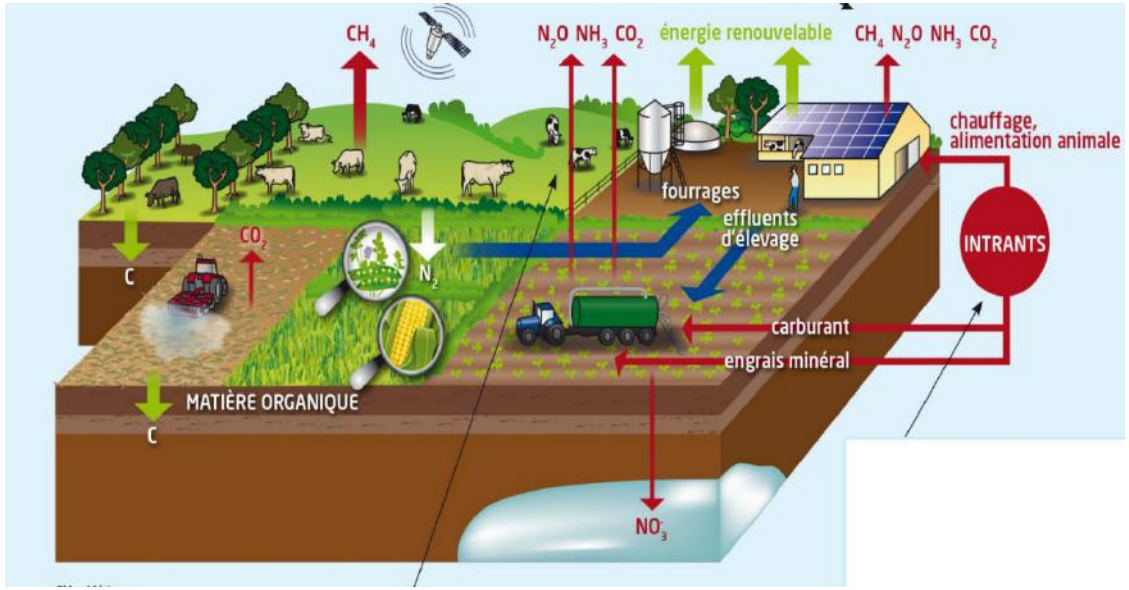
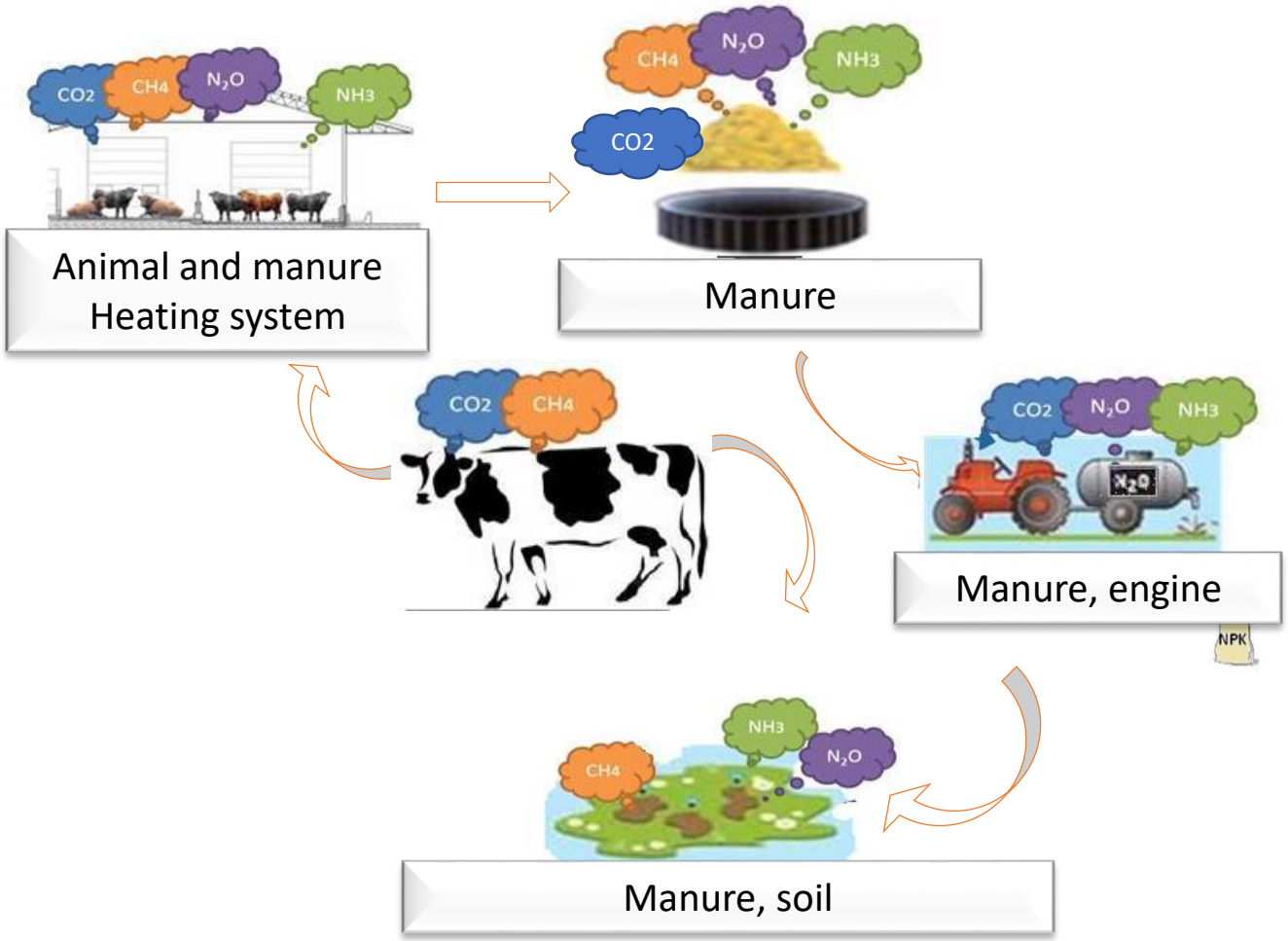
Mélynda Hassouna, Paul Robin

INRAe-UMR SAS-FRANCE

GHG emissions in animal systems
Different gases from various sources





Specificities of agricultural emissions



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FUGITIVE
Diffuse

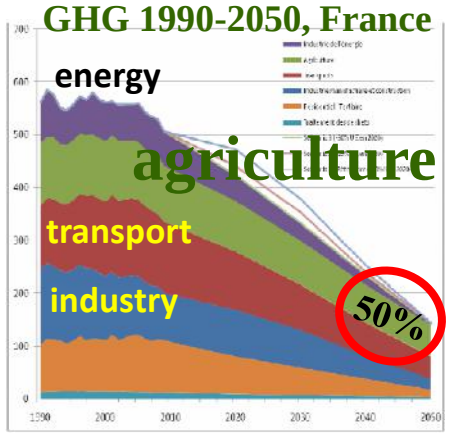
CHANELED

Animal species, genetics, climate, manure management, farmers practices….

HIGH DIVERSITY

Why quantifying agricultural emissions?

-> MITIGATION



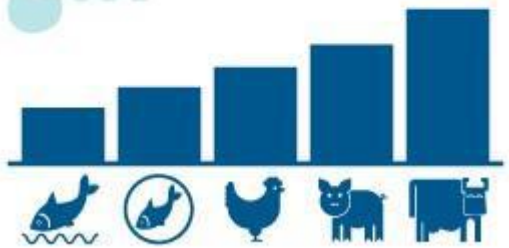
Certification of mitigation techniques and emission levels (regulation)

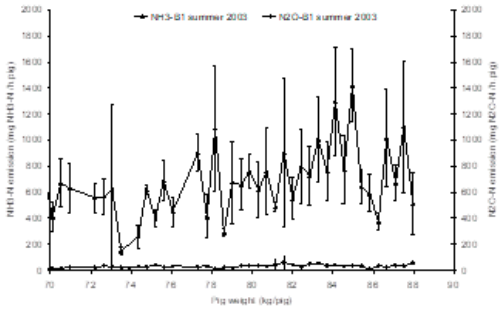
Environmental assessment

Emission Factors (GHG, NH_3, PM)

Inventories

Scientic needs





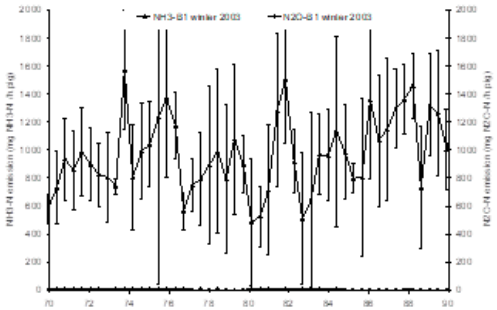
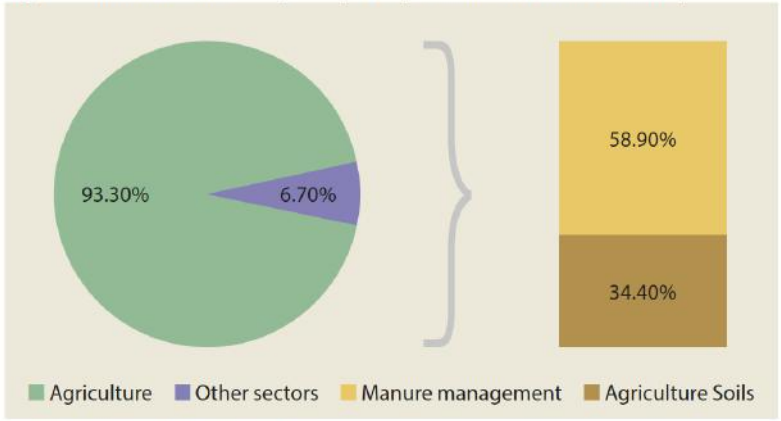


Figure 1. Ammonia emissions, EU-28, 2013 (% of total ammonia emissions).



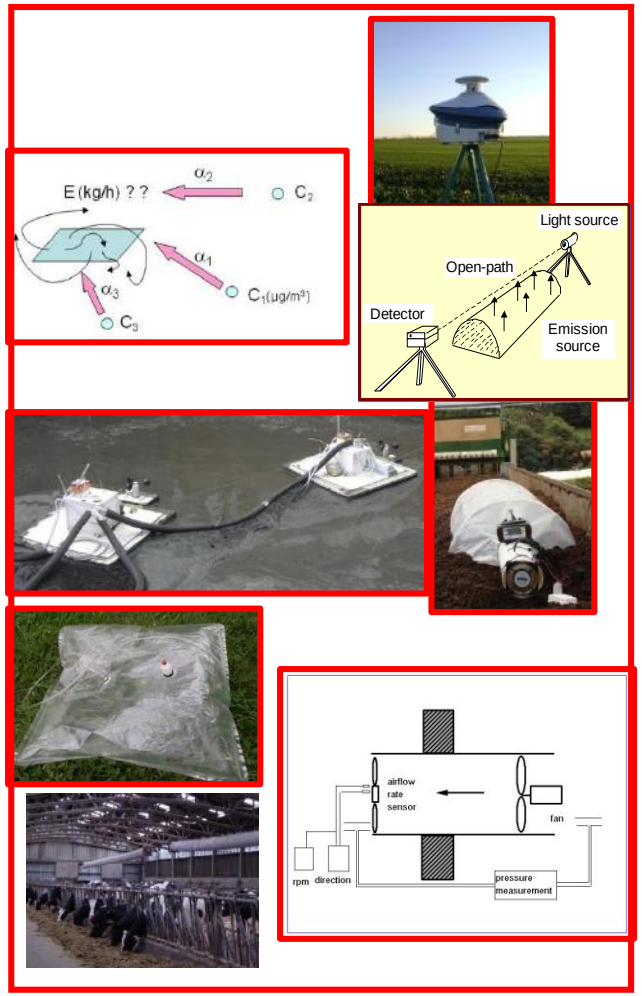
Source: European Environment Agency

Different methods adapted to the emission source

Many methods

Many devices/sensors

- Global (house/farm level)
  - Intrusive
  - Non intrusive
- Local
  - Intrusive
  - Non intrusive



Different kind of measurement objectives with various constraints

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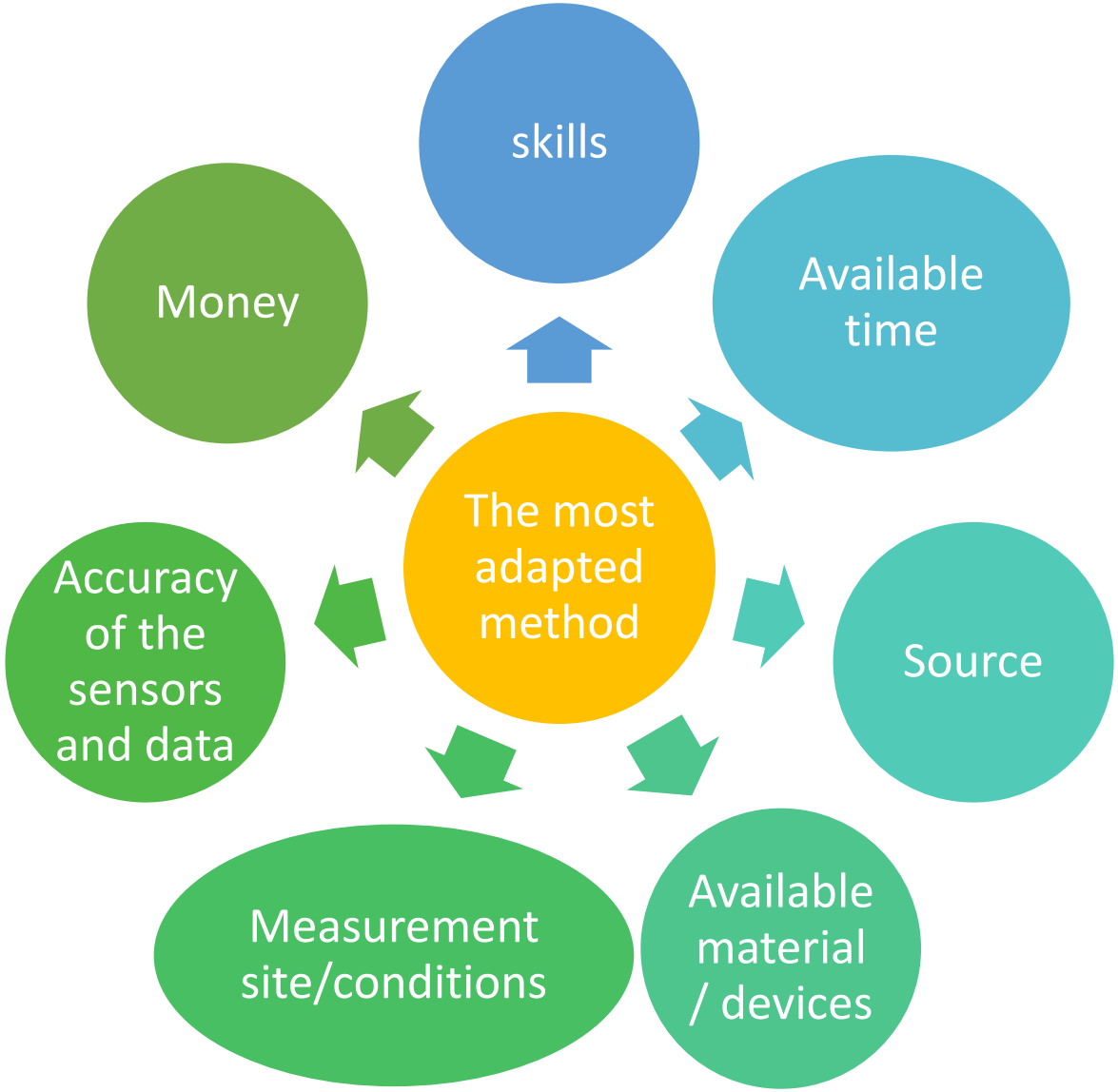
- Scientific research -> Continuous and accurate
- Pollution abatement ->Adapted level of accuracy with standard protocol
- Policy-making : national inventories, certification of mitigation techniques ->Easy to implement, low cost

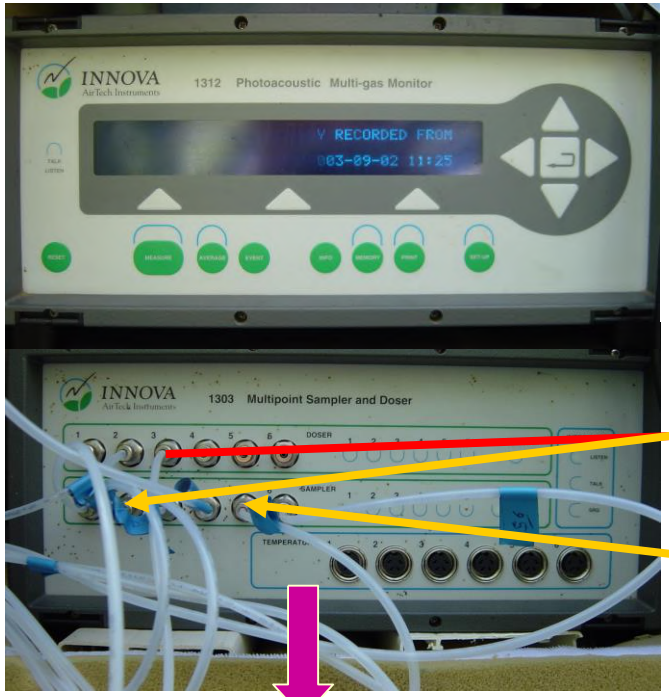
Different kinds of objectives with many possible constraints

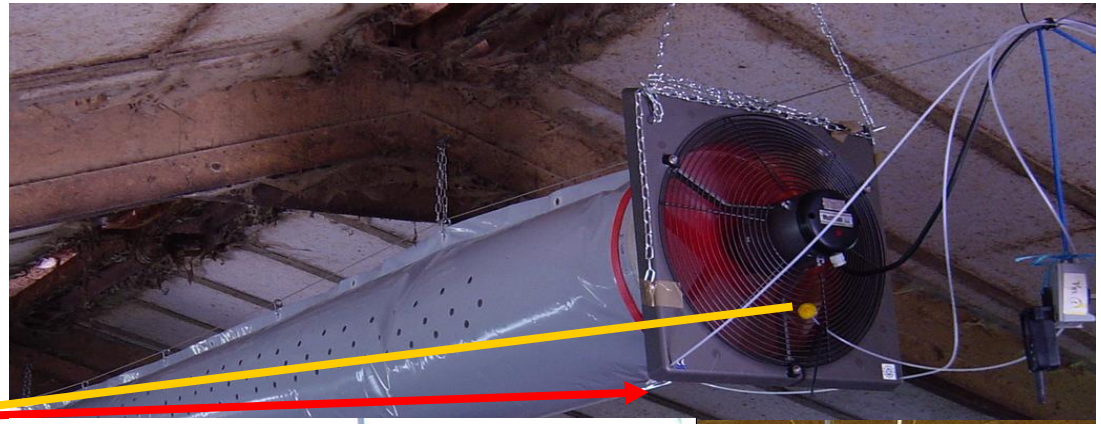


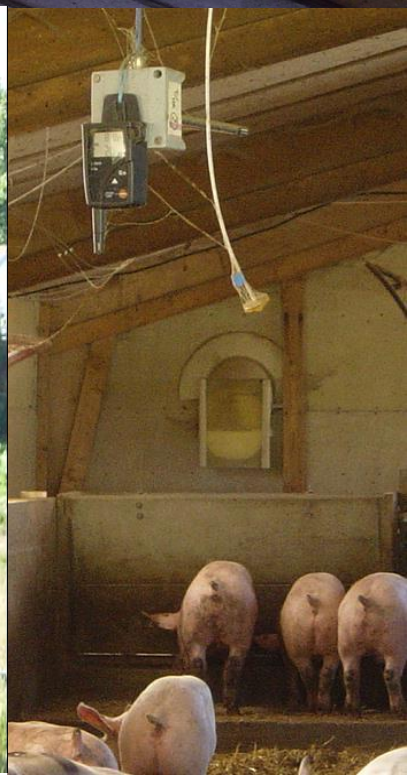
3 kinds of measurement methodology

Reference methods	Simplified Methods	Control methods
Continuous measurement	Intermittent measurement + models	Intermittent measurement
Studies of emitting processes	Low-cost methods	Low-cost methods
Scientists	Efficiency of mitigation options and environmental certification	Emission levels checking
	Emission-factor acquisition	Agricultural engineers, monitoring and certification offices and livestock technicians, farmers
	Scientists, agricultural engineers, monitoring and certification offices	

Reference methods







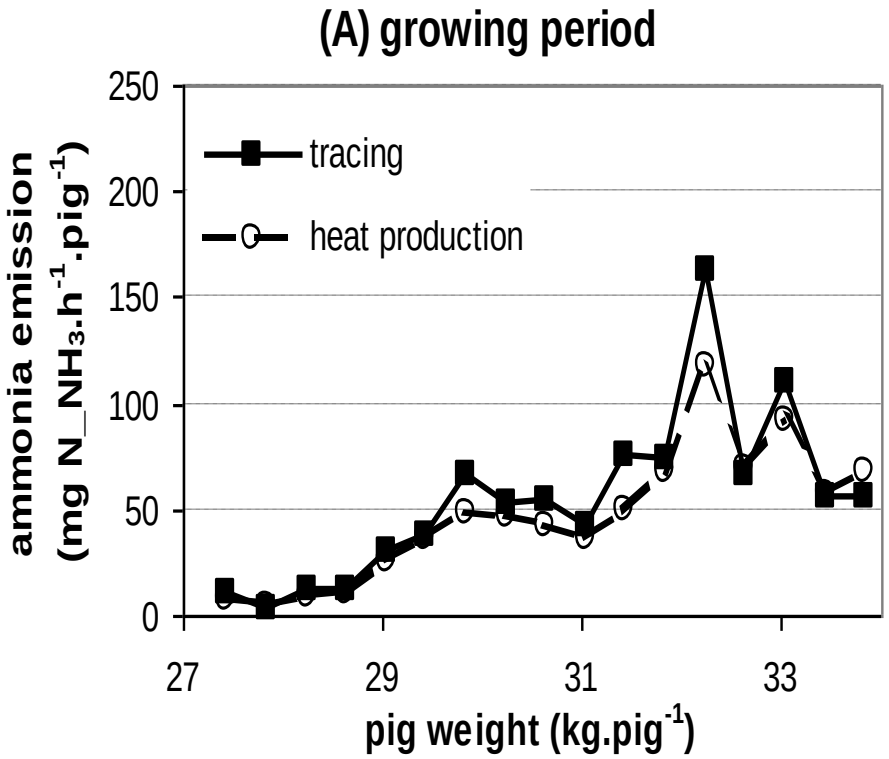
Gas concentrations : NH_3, N_2O, CO_2, CH_4, SF_6

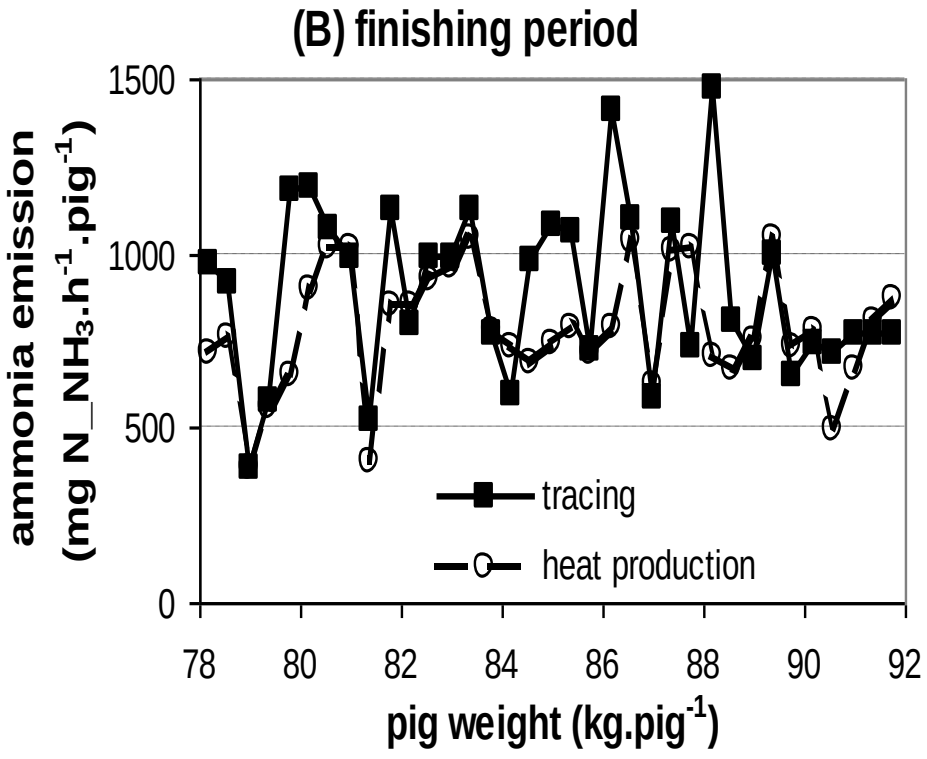
SF_6 → Air flow rate

Gas emissions

Reference methods

Continuous measurement of ER





Implementation in experimental facilities

Implementation in commercial conditions

Accuracy

Simplified methods

Example : Ratio of concentration gradients and Carbon mass balance

Spot measurement of gas concentrations

Livestock Data

Convective transport ➡

$$E_{C\text{-}CO2} / E_{C\text{-}CH4} = grad_{C\text{-}CO2} / grad_{C\text{-}CH4}$$

$$E_{N\text{-}NH3} / E_{C\text{-}CO2} = grad_{N\text{-}NH3} / grad_{C\text{-}CO2}$$

Mass budget ➡

$$E_{C\text{-}CO2} + E_{C\text{-}CH4} = C_{Loss}$$

$$C_{Loss} = C_{inputs}\ (feed, pigs) - C_{outputs}\ (manure, pigs)$$

Emission estimates

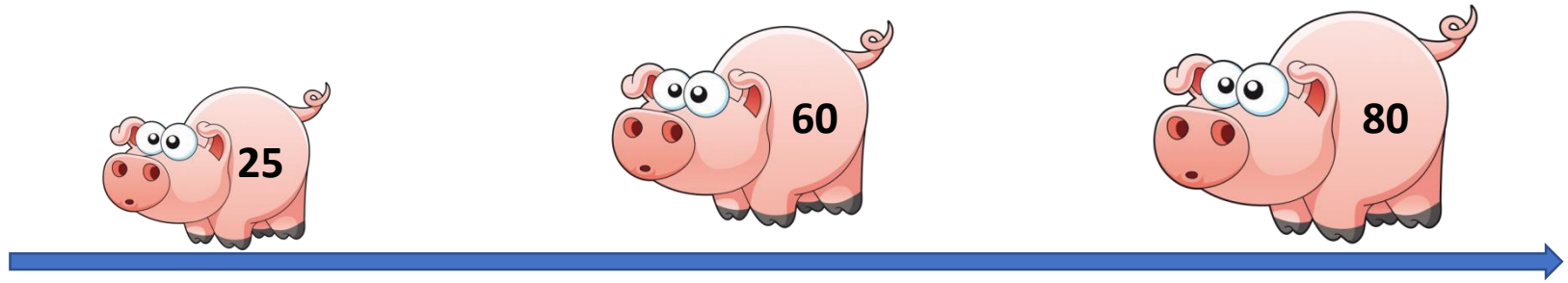
➔ $E_{C\text{-}CO2} = C_{Loss} / [1+(grad_{C\text{-}CH4} / grad_{C\text{-}CO2})$

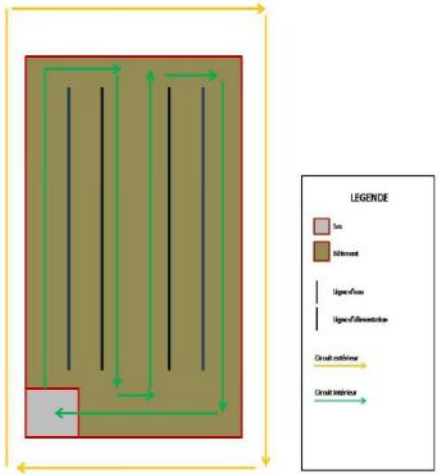
➔ $E_{C\text{-}CH4} = E_{C\text{-}CO2} * (grad_{C\text{-}CH4} / grad_{C\text{-}CO2})$

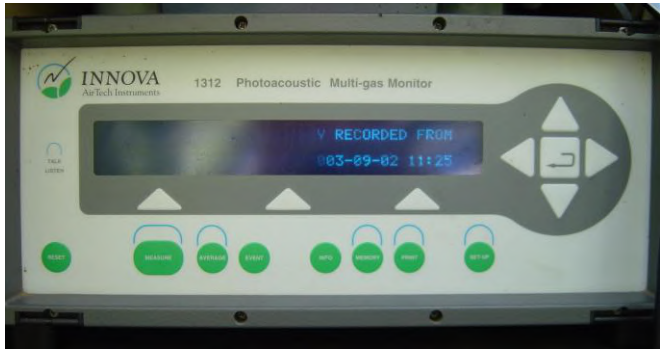
➔ $E_{N\text{-}NH3} = E_{C\text{-}CO2} * (grad_{N\text{-}NH3} / grad_{C\text{-}CO2})$

➔ $E_{N\text{-}N2O} = E_{C\text{-}CO2} * (grad_{N\text{-}N2O} / grad_{C\text{-}CO2})$

Simplified method







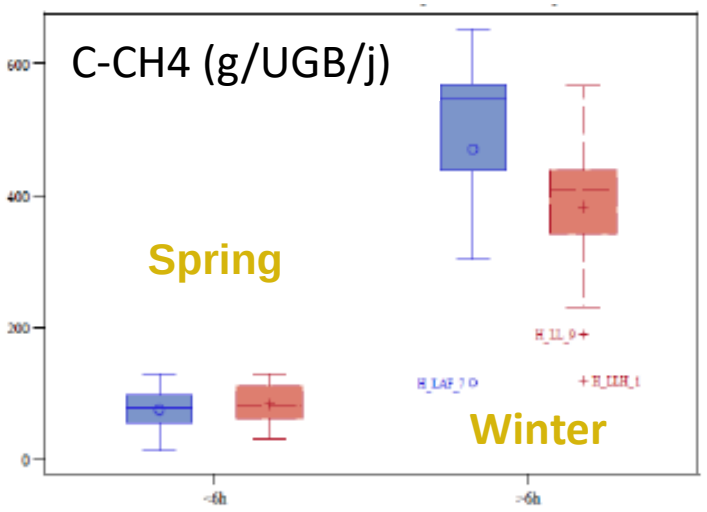
+ Zootechnical data

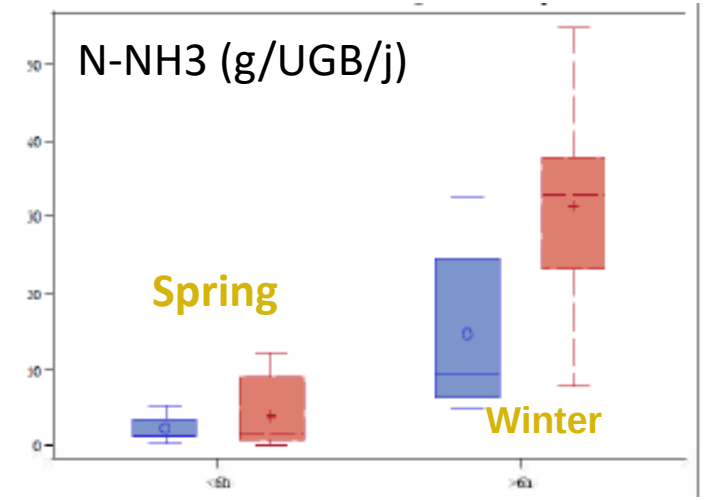
Implemented in 40 commercial pig houses to quantify EF
Still goes on

Simplified method

Dairy barns

Solid Manure Slurry

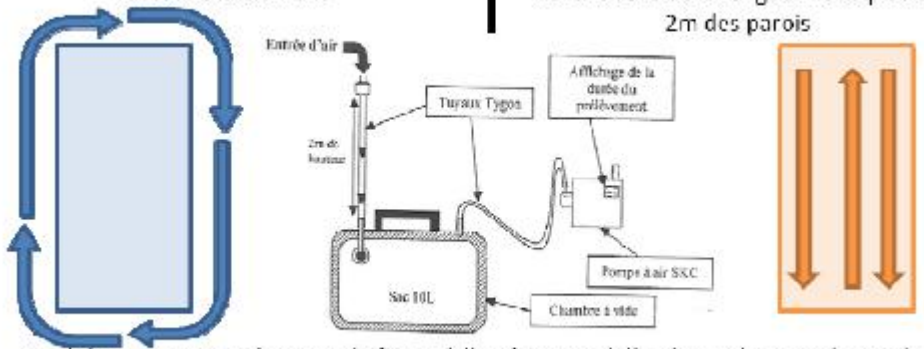




Time spent in the barn

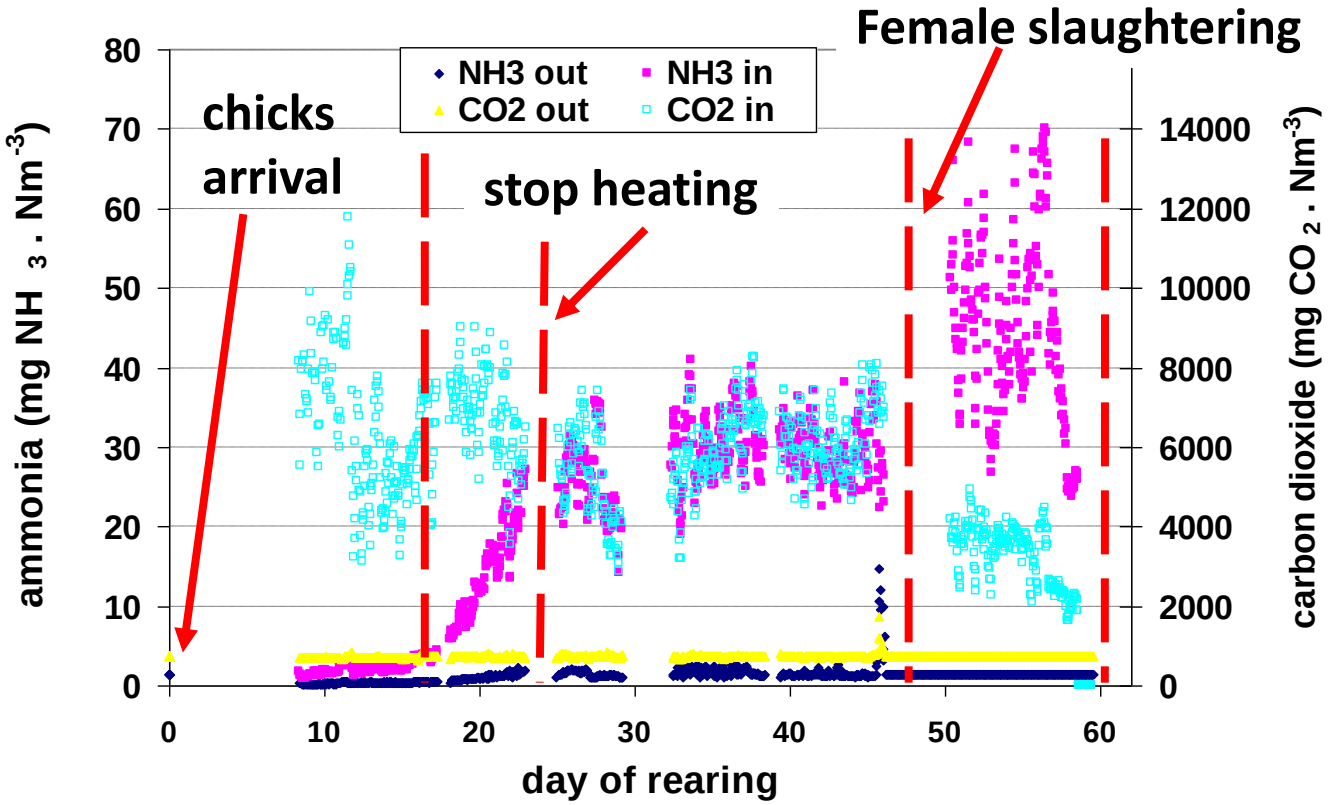
Parcours extérieur : minimum 15 minutes autour du bâtiment

Parcours intérieur : minimum 15 minutes dans le sens de la longueur et à plus de 2m des parois



Seuls les sacs TEDLAR® sont spécifiques à l'extérieur ou à l'intérieur; le reste du matériel est le même pour tous les prélèvements

Control method



- broiler batch, December 2008, France
- CO_2 and NH_3 ± proportional per period
- CO_2 and NH_3 depend on growth, stocking density, manure management

grad CO_2 / grad NH_3 characterizes one period

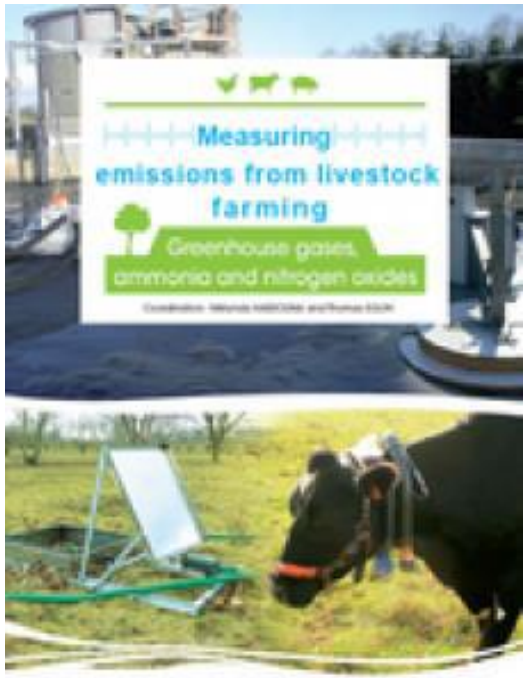
What are the future challenges

- Keep on working on the validation of simplified methods and control methods
- Standard protocols for measurement but also for uncertainty assessment and sensors calibration
- Guidelines for data reporting

To be more efficient, we should join our forces in an international network on measurement of agricultural gas emissions

More information

Protocols :
https://www6.inra.fr/animal_emissions/ADEME-Metrologie



Book Free download
https://www6.inra.fr/animal_emissions_eng/News/Measuring-gaseous-emissions-from-animal-farms

Thanks for your attention and your questions !

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