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## Adapting the measurement methods to the different purposes

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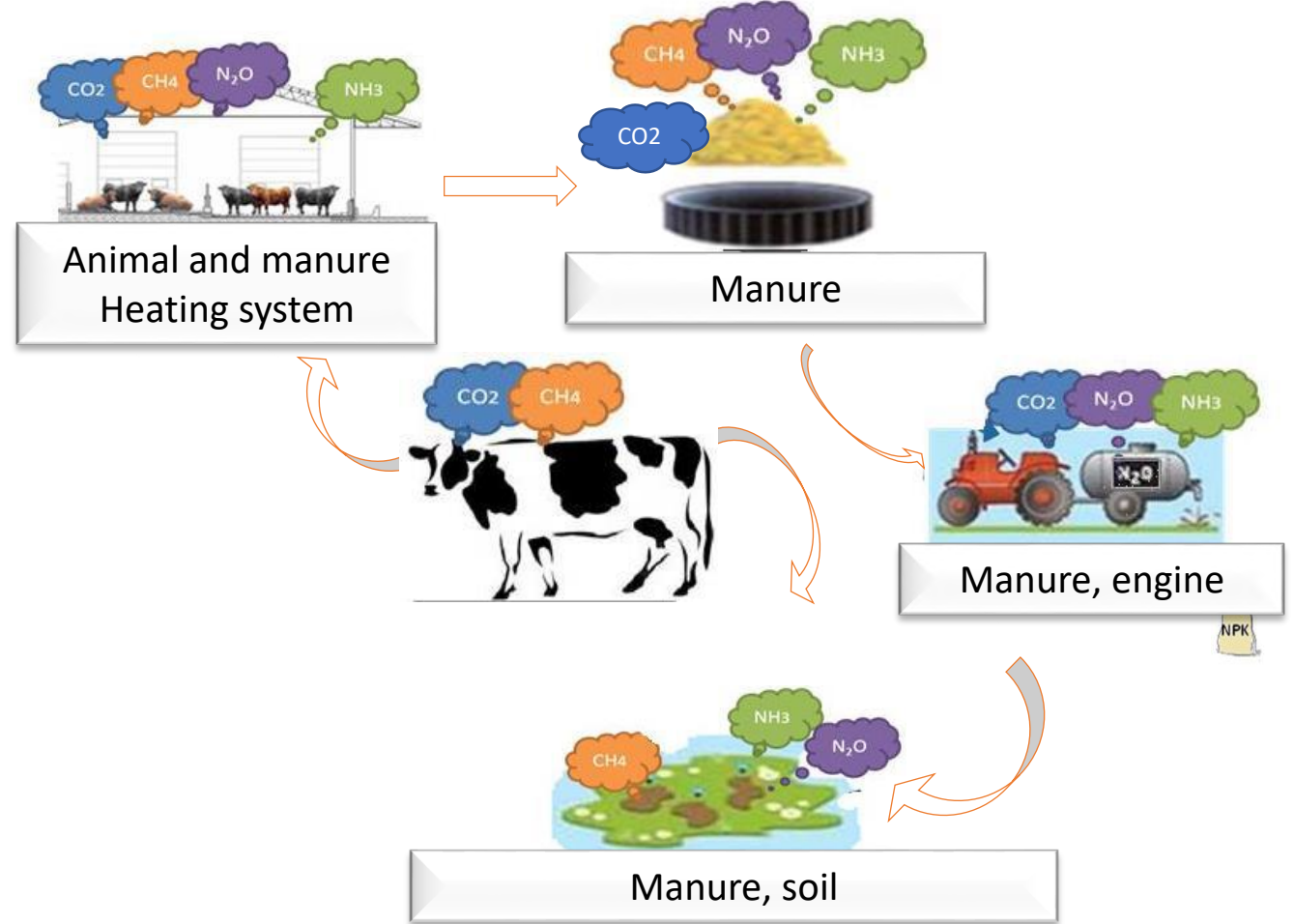
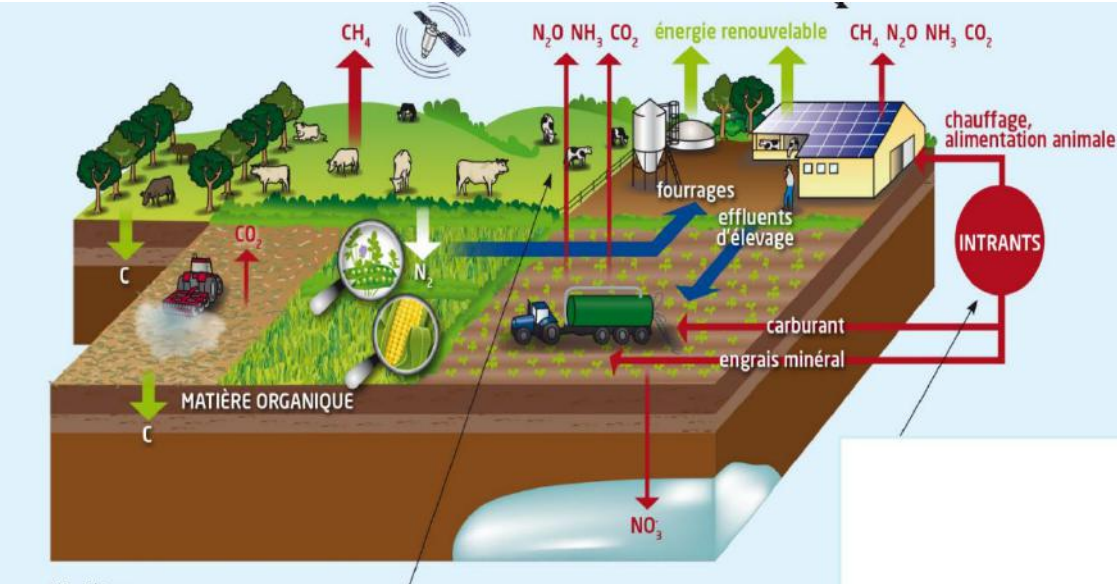
## ➤ Adapting the measurement methods to the different purposes

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# ➤ GHG emissions in animal systems

## Different gases from various sources



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# ➤ Specificities of agricultural emissions



≠



**FUGITIVE**  
Diffuse

**CHANELED**

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

**HIGH DIVERSITY**



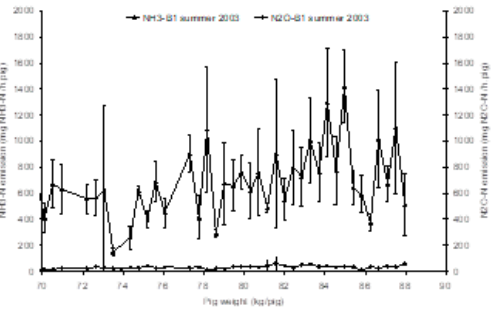
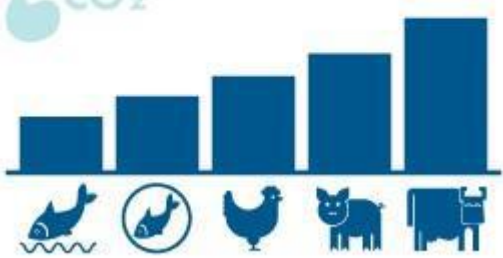
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# ➤ Why quantifying agricultural emissions?

-> **MITIGATION**



Environmental assessment

Certification of mitigation techniques and emission levels (regulation)

Emission Factors (GHG, NH<sub>3</sub>, PM)

Inventories

Scientific needs

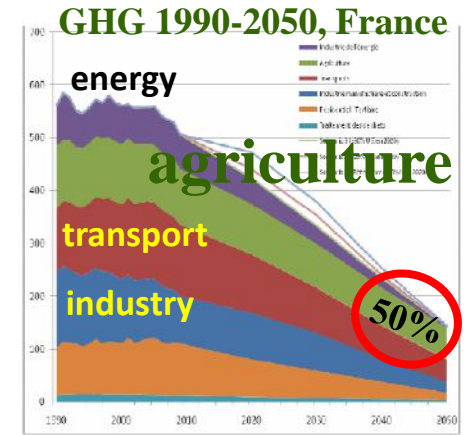
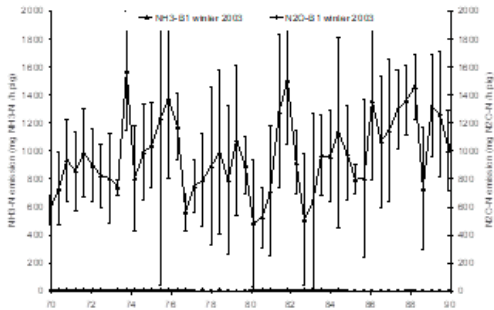
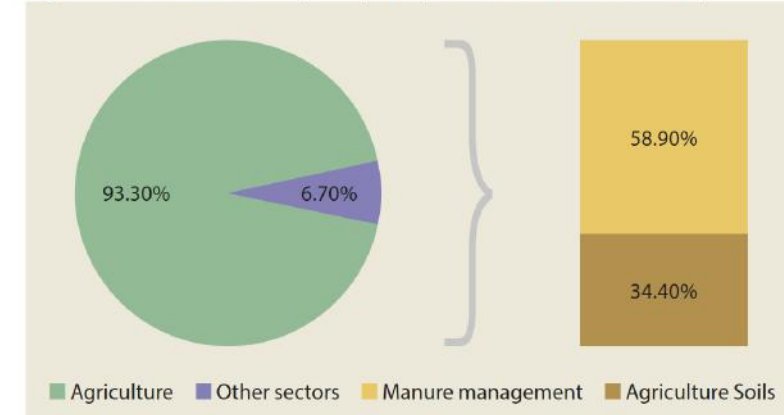


Figure 1. Ammonia emissions, EU-28, 2013 (% of total ammonia emissions).



Source: European Environment Agency

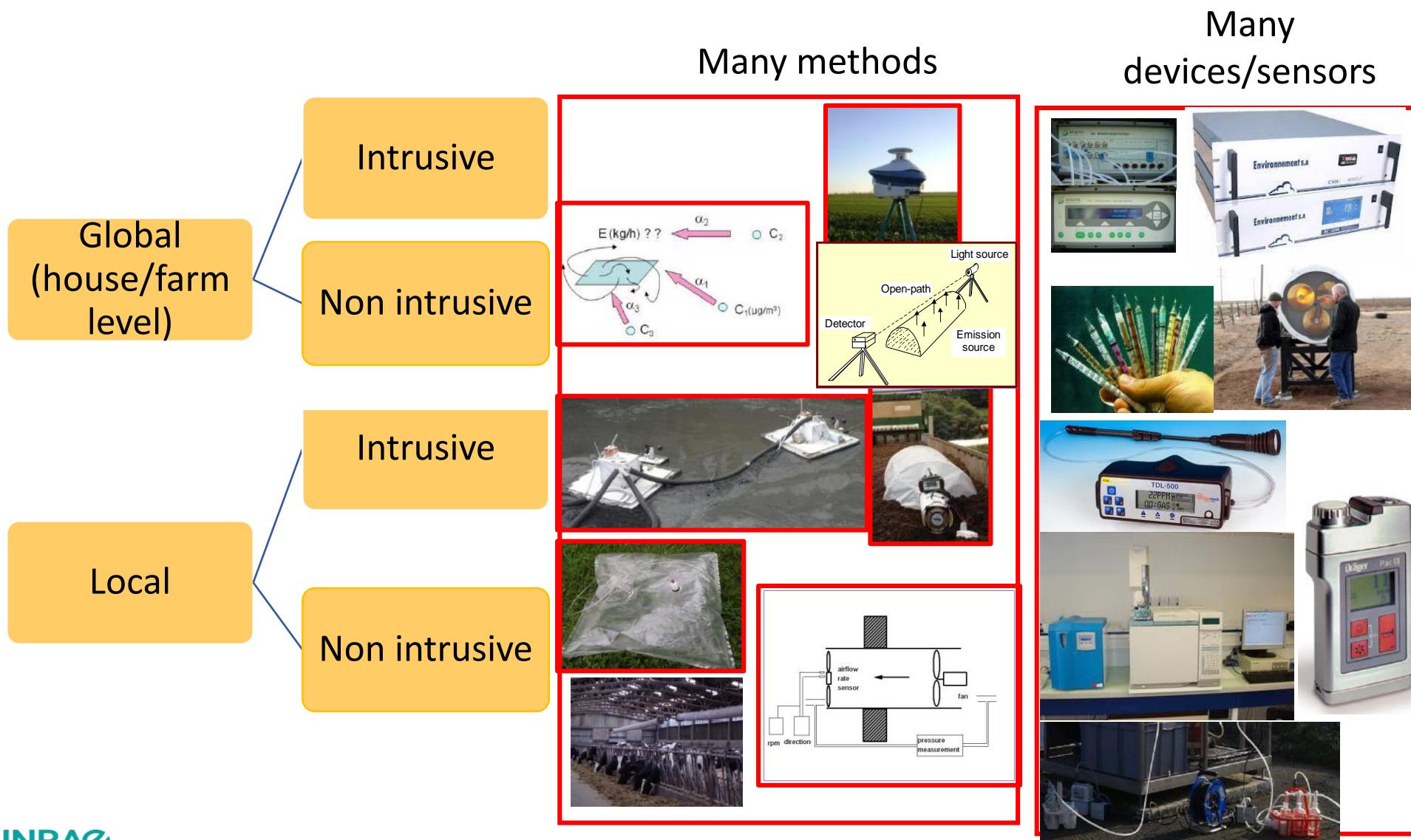


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# ➤ Different methods adapted to the emission source



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## ➤ Different kind of measurement objectives with various constraints

R

❑ Scientific research → Continuous and accurate

e

I

❑ Pollution abatement → Adapted level of accuracy with standard protocol

a

❑ Policy-making : national inventories, certification of mitigation techniques → Easy to implement, low cost

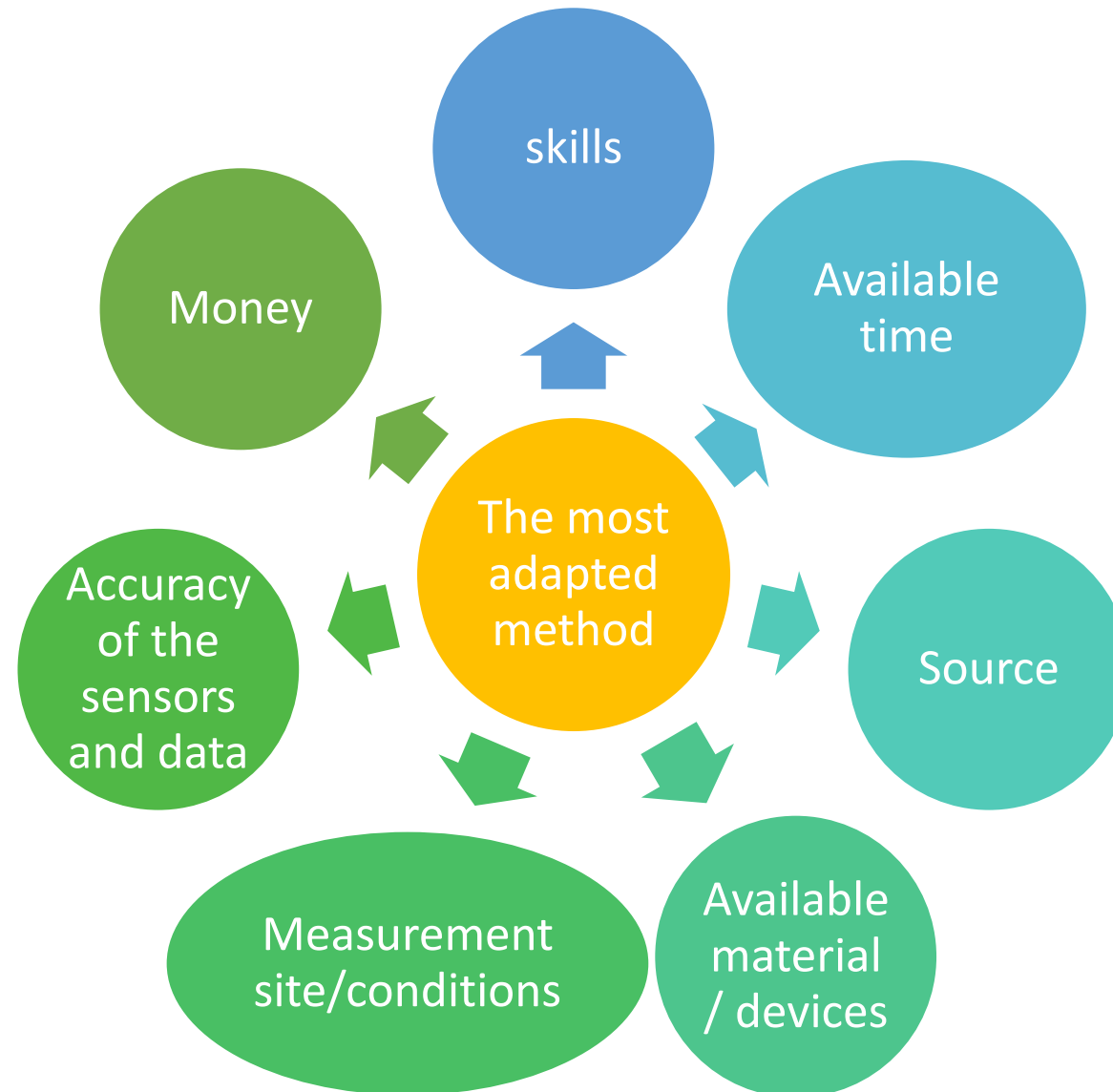
b

I

e



## ➤ Different kinds of objectives with many possible constraints





## ➤ 3 kinds of measurement methodology

### Reference methods

Continuous measurement

Studies of emitting processes

Scientists

### Simplified Methods

Intermittent measurement + models

Low-cost methods

Efficiency of mitigation options and environmental certification

Emission-factor acquisition

Scientists, agricultural engineers, monitoring and certification offices

### Control methods

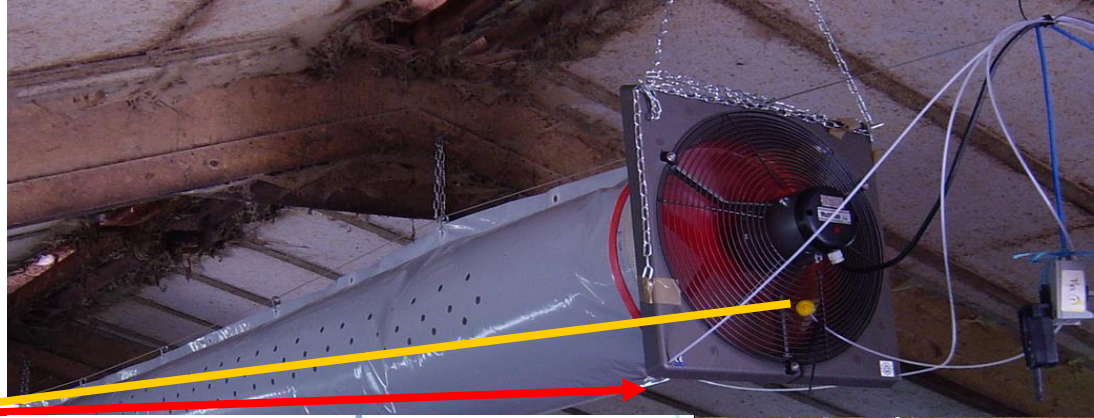
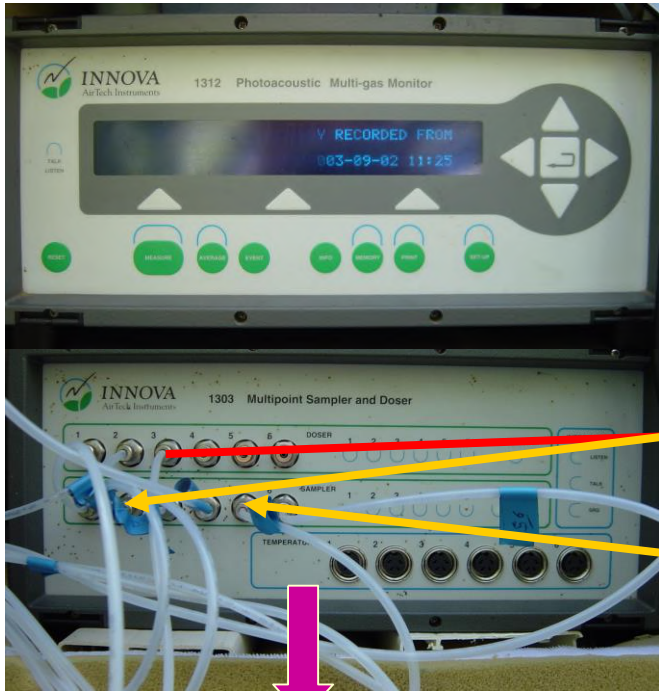
Intermittent measurement

Low-cost methods

Emission levels checking

Agricultural engineers, monitoring and certification offices and livestock technicians, farmers

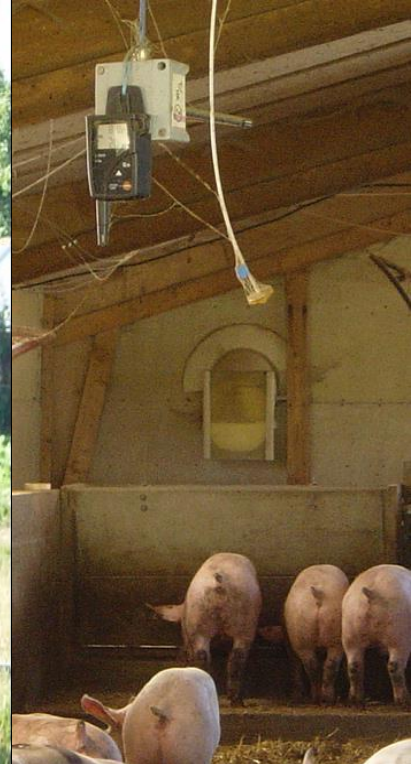
# ➤ Reference methods



Gas concentrations :  $\text{NH}_3$ ,  $\text{N}_2\text{O}$ ,  $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{SF}_6$

$\text{SF}_6$  → Air flow rate

Gas emissions



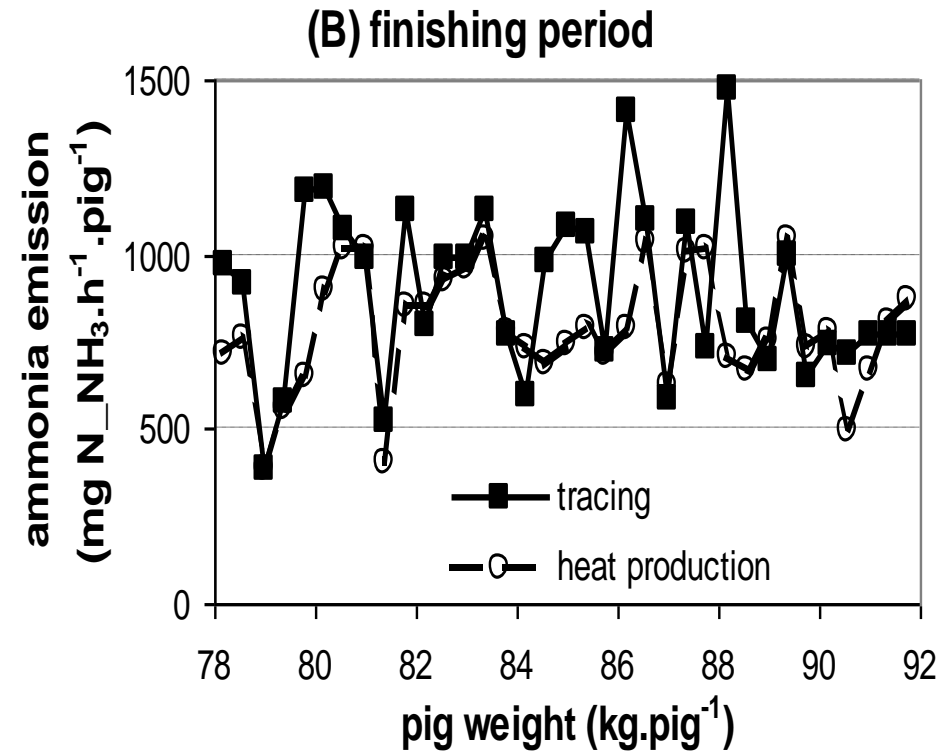
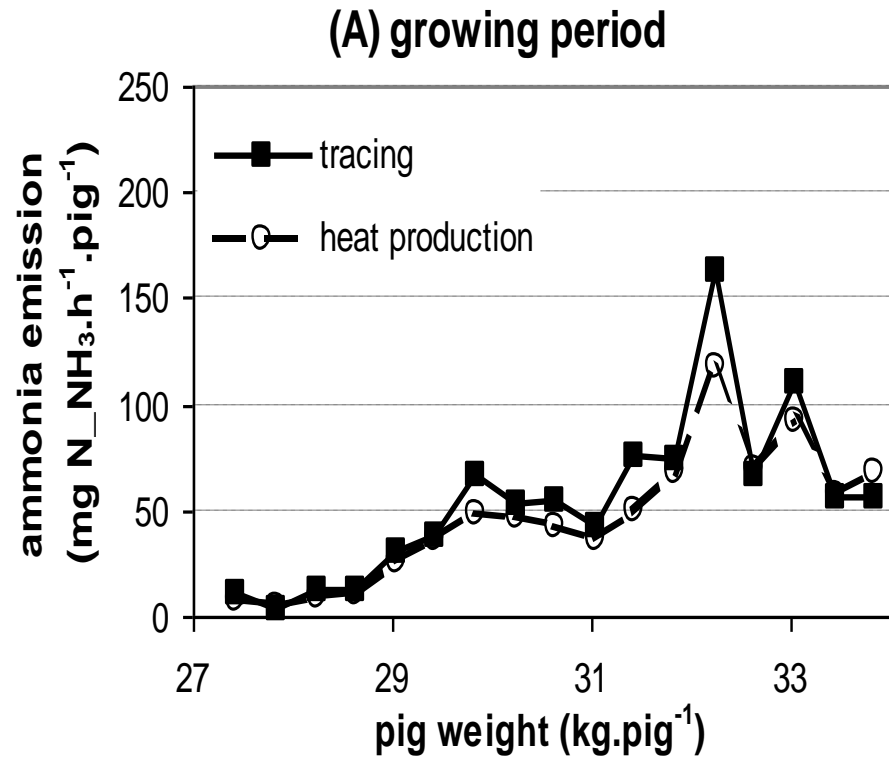
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# ➤ Reference methods

Continuous measurement of ER



Implementation in experimental facilities

Implementation in commercial conditions



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## > Simplified methods

### > Example : Ratio of concentration gradients and Carbon mass balance

Spot  
measurement of  
gas  
concentrations

Convective transport →

$$\frac{E_{C-CO_2}}{E_{C-CH_4}} = \frac{\text{grad}_{C-CO_2}}{\text{grad}_{C-CH_4}}$$
$$\frac{E_{N-NH_3}}{E_{C-CO_2}} = \frac{\text{grad}_{N-NH_3}}{\text{grad}_{C-CO_2}}$$

Livestock Data

Mass budget →

$$E_{C-CO_2} + E_{C-CH_4} = C_{\text{Loss}}$$

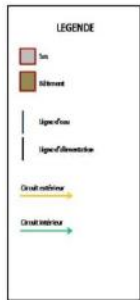
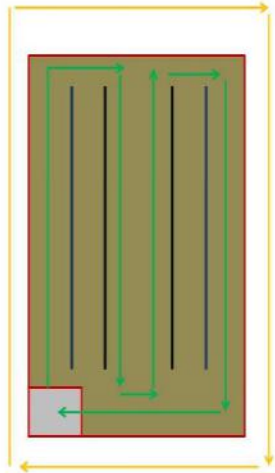
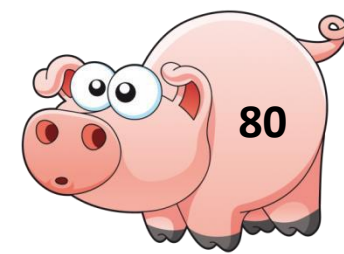
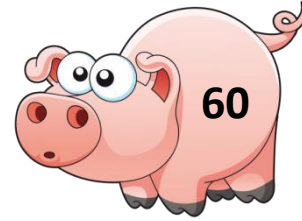
$$C_{\text{Loss}} = C_{\text{inputs}} (\text{feed, pigs}) - C_{\text{outputs}} (\text{manure, pigs})$$

Emission estimates

$$\rightarrow E_{C-CO_2} = C_{\text{Loss}} / [1 + (\text{grad}_{C-CH_4} / \text{grad}_{C-CO_2})]$$
$$\rightarrow E_{C-CH_4} = E_{C-CO_2} * (\text{grad}_{C-CH_4} / \text{grad}_{C-CO_2})$$
$$\rightarrow E_{N-NH_3} = E_{C-CO_2} * (\text{grad}_{N-NH_3} / \text{grad}_{C-CO_2})$$
$$\rightarrow E_{N-N_2O} = E_{C-CO_2} * (\text{grad}_{N-N_2O} / \text{grad}_{C-CO_2})$$

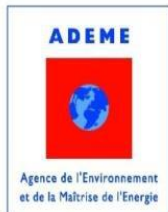


## ➤ Simplified method



**+ Zootechnical data**

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



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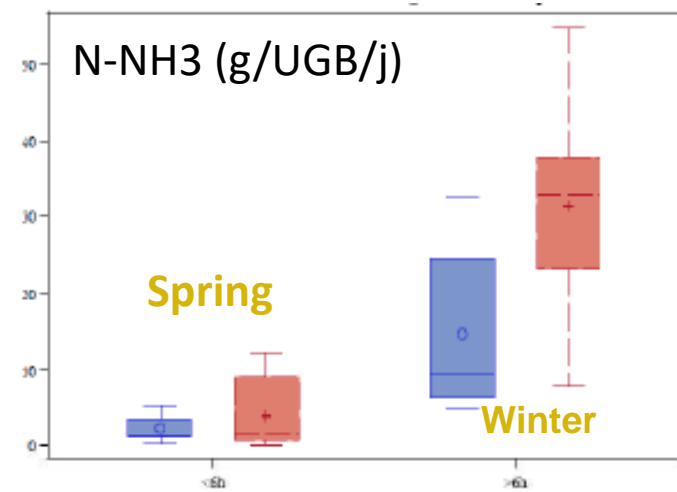
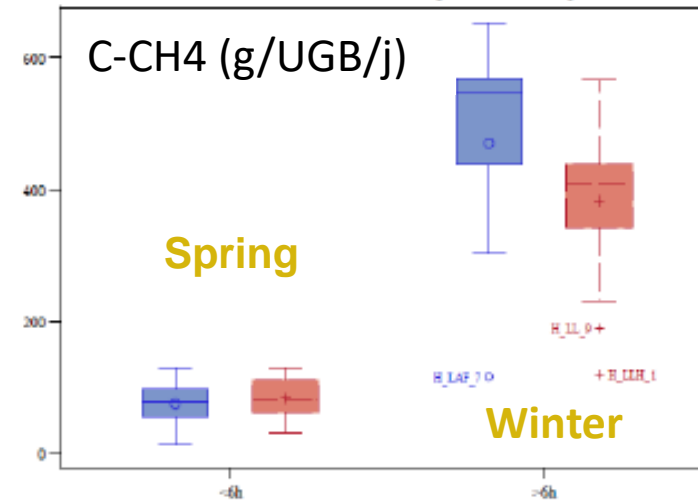
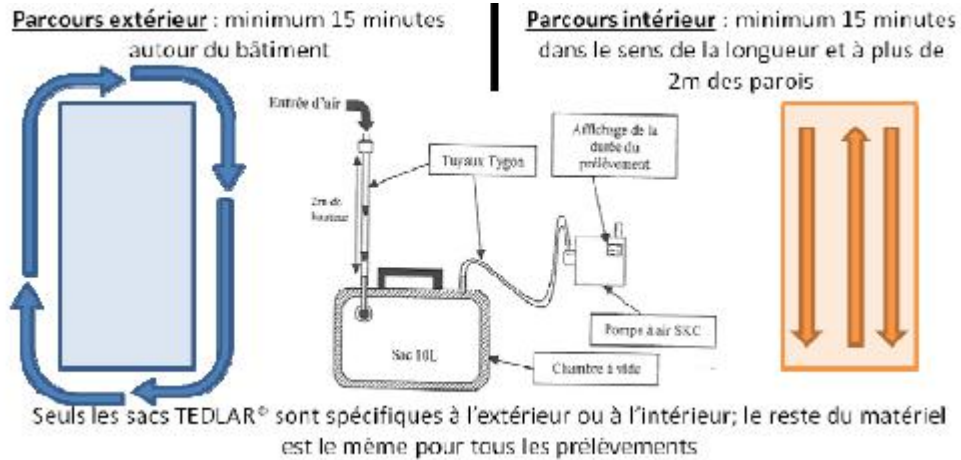


# ➤ Simplified method



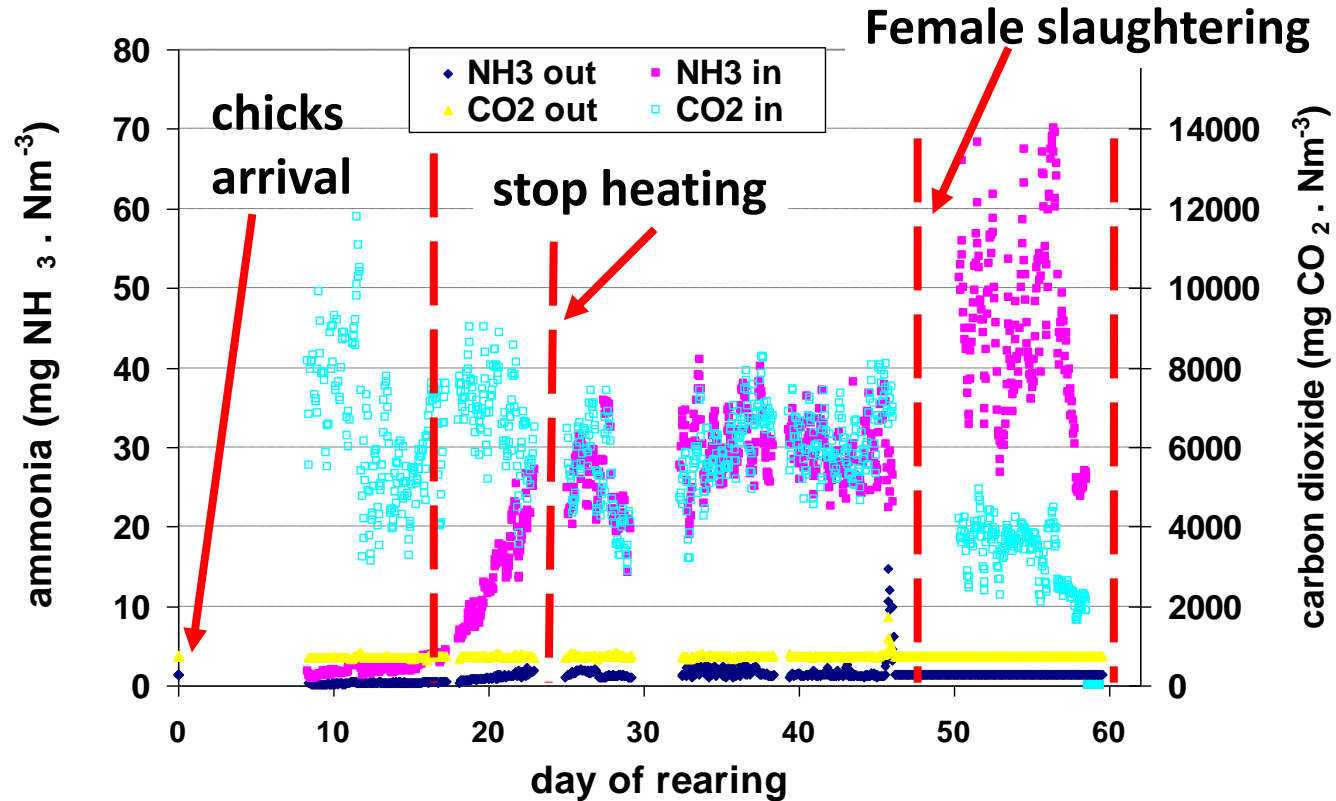
Dairy barns

Solid  
Manure  
Slurry



Time spent in the barn

## ➤ Control method



- broiler batch, December 2008, France
- CO<sub>2</sub> and NH<sub>3</sub>  $\pm$  proportional per period
- CO<sub>2</sub> and NH<sub>3</sub> depend on growth, stocking density, manure management

➔ grad CO<sub>2</sub> / grad NH<sub>3</sub> 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**



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# More information

Protocols :

[https://www6.inra.fr/animal\\_emissions/ADEME-Metrologie](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](https://www6.inra.fr/animal_emissions_eng/News/Measuring-gaseous-emissions-from-animal-farms)



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Thanks for your attention  
and your questions !

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