

# A LOW COST DATABASE FOR THE MEASUREMENT OF AMMONIA AND GREENHOUSE GAS EMISSIONS OF ANIMAL HOUSES

Robin P., Amand G. , Aubert C. , Babela N., Brachet A., Charpiot A., Combo S.,  
Derudder M., Dubois R., Dollé J.B., Ehrlacher A., Espagnol S., Guingand N.,  
Hassouna M., Mov S., Paghent L., Ponchant P., Ramonet Y., Thiard J., Zhao L.



# Rationale

Rationale

Method

Results

Conclusion

- In France: high diversity of animal farms**

- Various climates and landscapes
- Different animal species

→ farm size:

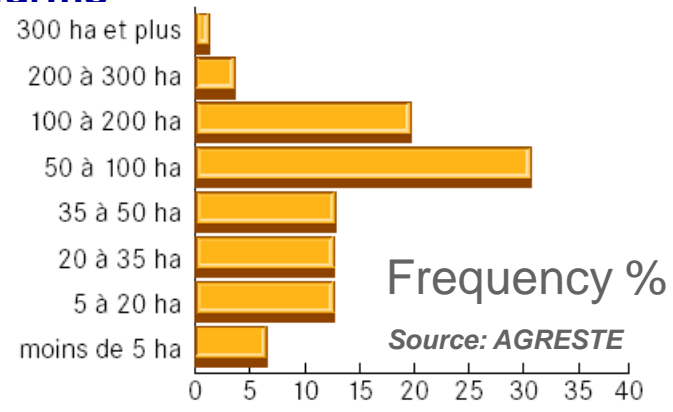
- 86,000 very small farms within 262,000 animal farms
- varying crop area

→ feed inputs / produced  
→ industry integrated

→ building / outdoor

→ rearing, feeding, ventilation practices

→ manure management



## Rationale

- In France: high diversity of animal farms
- High uncertainty of true emissions (e.g. 80% NH<sub>3</sub>)
- Mass budget of animal production is known
- « simplified method » (Hassouna et al., 2010)
- If controlled emission reductions concern a majority of animals, mitigation strategies can be tuned

**=> low cost method + large number of animal farms**

Rationale

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# Method

## Objective:

- for technicians and engineers who work in R&D or farm service companies: to allow qualitative assessment or emission control
- hypothesis: high number will reduce uncertainty

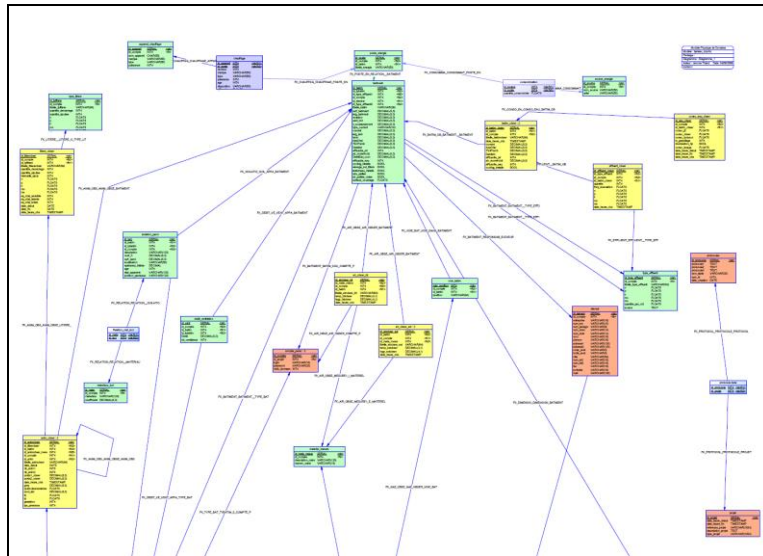
## Proposition of simplified measurements for extensive use on many farms:

- Based on the mass balance of one animal flock, and on the measurement of concentration gradients of CO<sub>2</sub>, H<sub>2</sub>O, NH<sub>3</sub>, N<sub>2</sub>O, CH<sub>4</sub>
- Protocols of air sampling – calculation – checking and control for meat poultry, laying hens, growing-finishing pigs, dairy cows
- Calculation in .xls datasheets and associated to a database
- Development of a bootable USB key containing all software (database, calculations, xls datasheets, documentation, standard procedures) based on Linux system, multilanguage, and opensource softwares



# Results: 1- software

→ 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<sub>2</sub>, CH<sub>4</sub>,  
NH<sub>3</sub>, N<sub>2</sub>O

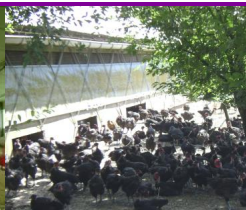


Emission  
estimates of  
CO<sub>2</sub>, CH<sub>4</sub>,  
NH<sub>3</sub>, N<sub>2</sub>O for  
laying hens,  
broilers, cows,  
growing pigs

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

## Results: 2- measurements

- **equipment (all animal houses)**
  - Air pump
  - 1 TEDLAR bag (8 L) for inside sampling
  - 1 TEDLAR bag (3,8 L) for outside sampling
  - Innova analyser (N<sub>2</sub>O, CO<sub>2</sub>, NH<sub>3</sub>, CH<sub>4</sub>, H<sub>2</sub>O)
  - Thermo hygrometer



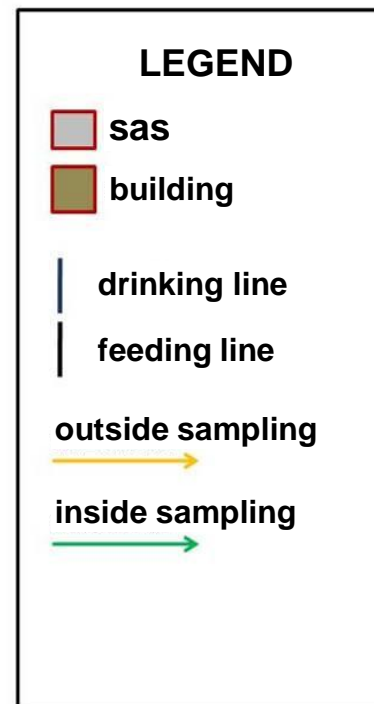
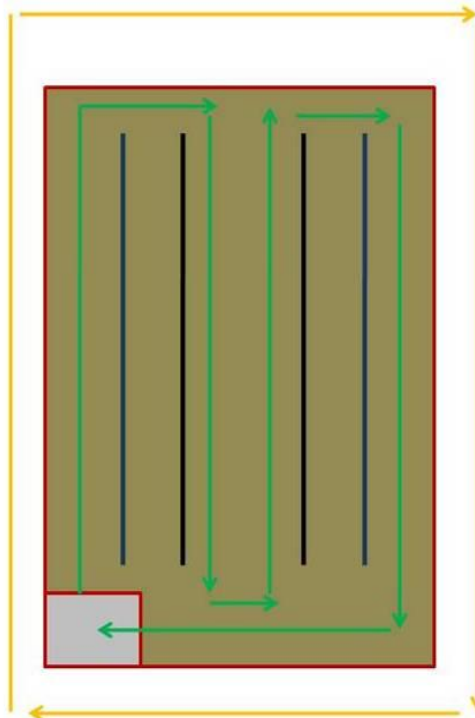
# Results: 2- measurements

- **air sampling**  
(adapted to house type  
and animal management)



e.g. broiler house

1. Start innova analyser
2. Outside sampling
  - Rincing TEDLAR bag
  - Sampling outside
3. Analysis of TEDLAR bag, discard first 3 values at least
4. Sampling inside house
  - Rincing TEDLAR bag
  - Sampling inside
5. Analysis of TEDLAR bag
6. Recommendation: between 2 inside sampling, since the TEDLAR bag with an air at low concentration
7. Avoid temperature drop of TEDLAR bag



## Results: 3- other data

- **Farmer questions**

(adapted to house type  
and animal management)

- **Technical data**

- Animal numbers and weights
- Weight of feed and water, compositions when available
- Weight of fresh litter
- Weight of manure, composition when available

- **National references as default values**





## Results: 4- calculations

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

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

$$\rightarrow E_{C-CH_4} = E_{C-CO_2} * (\text{grad}_{C-CH_4} / \text{grad}_{C-CO_2})$$

$$\rightarrow E_{N-NH_3} = E_{C-CO_2} * (\text{grad}_{N-NH_3} / \text{grad}_{C-CO_2})$$

$$\rightarrow E_{N-N_2O} = E_{C-CO_2} * (\text{grad}_{N-N_2O} / \text{grad}_{C-CO_2})$$

$\rightarrow$  grad = inside - outside ; average of the observed medianes (mg gas/m<sup>3</sup> wet air),



# Results: 5- example

RH% calibration



kg/house	Mass budget	Htot continuous/tracing	Conc. Ratio
E H <sub>2</sub> O	161005	207245	90044
E Carbone	20004	22406	20004
E C-CO <sub>2</sub>		22436	20018
E C-CH <sub>4</sub>		-30	-14
E Azote	771	442	322
E N-N <sub>2</sub> O		167	17
E N-NH <sub>3</sub>		275	306

detection limit + interferences

representativity  
intermittent vs  
continuous

- Checking results with mass balance is necessary
- Estimates of P, water, N budget indicate the reliability of one emission measurement
- Repeated measurements will improve representativity



# Conclusions

## Experiment

- Checking results with mass balance is necessary
- Estimates of P, water, N budget indicate the reliability of one emission measurement
- Repeated measurements will improve representativity

## Method

- Time of measurement can be optimized regarding daily representativity
- In opened stables (e.g. naturally ventilated dairy cows), time interpolation between observations can require modelling based on observed climate
- Concentration ratio, feed, manure practices can result in classifications different from present categories based on house and manure management

## Software

- Software is available but require further adaptation (user interface, database extraction, translation for specific contexts) and validation
- Network development is expected (e.g. ANGAEL network in France)

