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# Greenhouse gases and ammonia emissions assessment from dairy housing by means of a simplified method

FIORELLI J.L. and DURPOIX A.



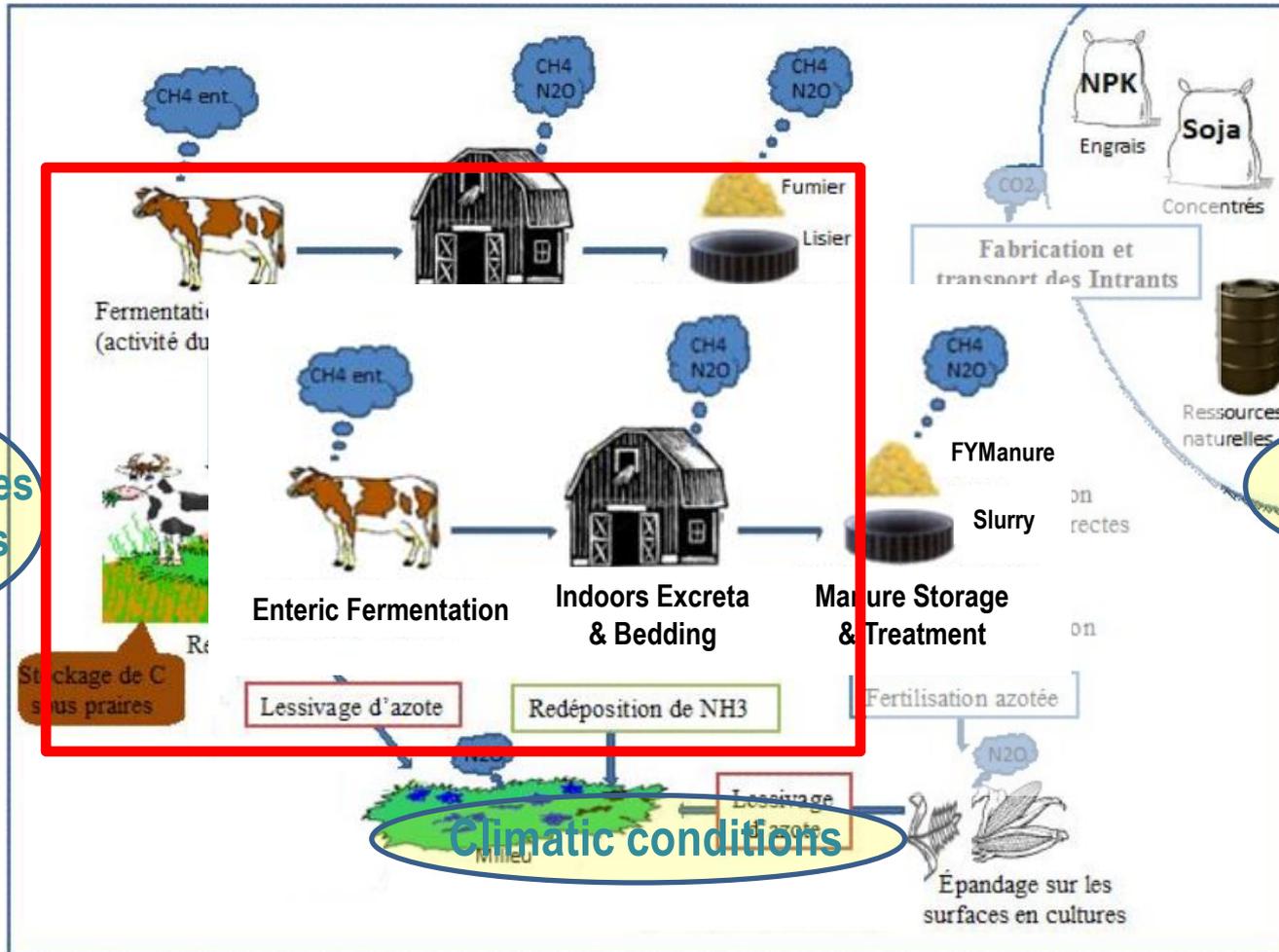
INRA SAD ASTER-Mirecourt  
France



# GHG sources in animal agriculture

IPCC

Animals' features  
Feeding factors





## Two dairy systems, two types of sheds and three types of manure...



# A systems experiment in Mirecourt (Eastern France) since 2005



- 2 environment friendly systems
- 2 sparing and self sufficient systems



As sustainable agriculture prototypes...

## A mixed crop-dairy system

*"Doing with" the diversity of available feeding resources*

62 Cows, calving: Aug-Nov



Deep litter and scraped passageways



FarmYard Manure

Housing period:  
November to April

13.7 m<sup>2</sup> / LU    **8.7 Kg Straw / LU / day**



Slurry

## A grassland dairy system

*Maximising grazing period Milk without concentrate*

37 Cows  
Calving: Jan-Apr



Cubicles & Rubber Mats

Housing period:  
December to March

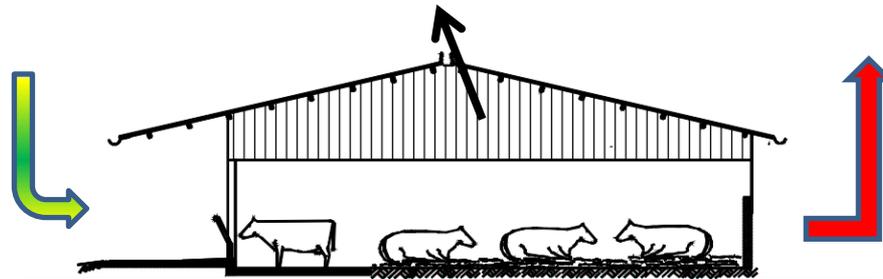
12.5 m<sup>2</sup> / LU    **0.2 Kg Straw / LU / day**



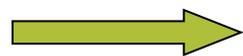
# A mass balance approach at the building level

$$C \text{ Losses} = \underbrace{Q_{C\text{ingested}} + Q_{C\text{stray}}}_{\text{INPUTS}} - \underbrace{Q_{C\text{milk}} - Q_{C\text{pregnancy}} - Q_{C\text{growth}} - Q_{C\text{mobilisation}} - Q_{C\text{manure}}}_{\text{OUTPUTS}}$$

$CO_2, CH_4, N_2O, NH_3, (N_2)$



$$\text{Gases emissions} = C \text{ Losses} + N \text{ Losses}$$



$$E_{C-CO_2} = \underbrace{C \text{ Losses}}_{\text{Through measurements, models and analyses}} / \left[ 1 + \underbrace{\left( \text{Gradient}_{C-CH_4} / \text{Gradient}_{C-CO_2} \right)}_{\text{Through contents measurements}} \right]$$

Through measurements, models and analyses

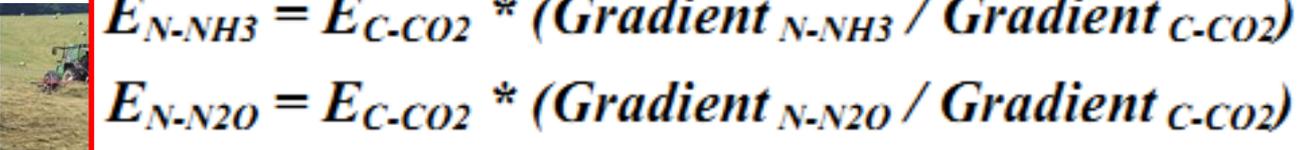
Through contents measurements



$$E_{C-CH_4} = E_{C-CO_2} * \left( \text{Gradient}_{C-CH_4} / \text{Gradient}_{C-CO_2} \right)$$

$$E_{N-NH_3} = E_{C-CO_2} * \left( \text{Gradient}_{N-NH_3} / \text{Gradient}_{C-CO_2} \right)$$

$$E_{N-N_2O} = E_{C-CO_2} * \left( \text{Gradient}_{N-N_2O} / \text{Gradient}_{C-CO_2} \right)$$



# Sampling and measuring gas contents

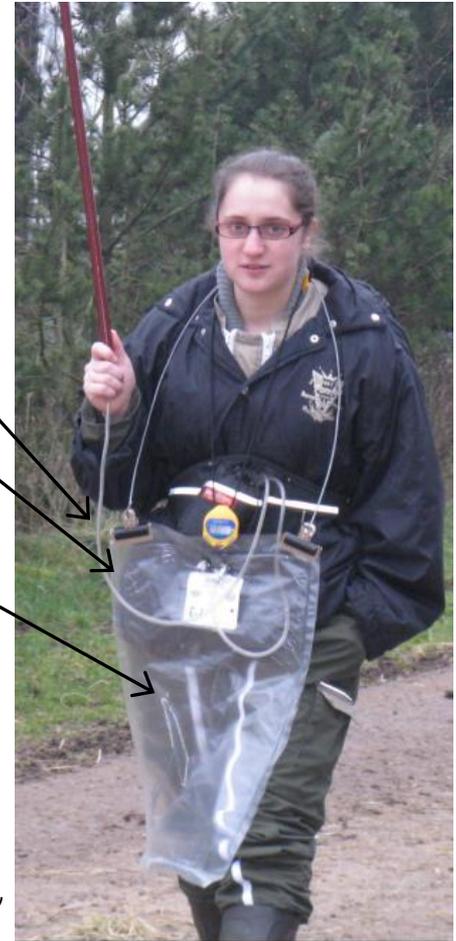
Gas analyser  
INNOVA® 1412



Electric pump

Flexible Tygon® tube

Tedlar® bag(10L)



Thermo-Hygrometer



# Results & Discussion

- **Two successive winter periods : 2009-2010, 2010-2011**
- **Measurements 7 times along a day (night included) without change in cowshed operations (scraping, strawing, milking time...)**
- **18 measurements dates**
- **13 validated dates for CO<sub>2</sub>, CH<sub>4</sub> and NH<sub>3</sub> (but only 10 dates for N<sub>2</sub>O)**  
considering... Gradient gas contents & enthalpy  
Grass silage not used  
Cows full housed

**Outside mean temperature ranged -6°C / 13°C**

**Diverse weather conditions**



# Results & Discussion

*Daily gas emissions from the dairy sheds in Mirecourt Unit, for grassland and mixed crop livestock systems during two winter periods (2009-10 and 2010-11)*

| g / LU / day        | C-CO <sub>2</sub> | C-CH <sub>4</sub> | N-N <sub>2</sub> O | N-NH <sub>3</sub>   |
|---------------------|-------------------|-------------------|--------------------|---------------------|
| <b>MS Mirecourt</b> | <b>8496 ± 233</b> | <b>804 ± 42</b>   | <b>1.40 ± 0.30</b> | <b>19.18 ± 2.37</b> |
| <b>GS Mirecourt</b> | <b>2260 ± 178</b> | <b>237 ± 17</b>   | <b>0.41 ± 0.05</b> | <b>3.70 ± 0.41</b>  |

**MS deep litter system has emitted 3 to 4 times more gases than the GS cubicles system**

**Our measurements appear consistent with Brachet (2007), except for NH<sub>3</sub>**



# Conclusion

- Simplified method rather easy to operate and non invasive
- Further calculations and analyses to do in order to check sampling method and analyses through H<sub>2</sub>O, P and K balances
- Impossible to conclude if the considered organic dairy systems are really less emitting than conventional ones:
  - from manure production to spreading, there are many ways...
  - even if GS seems very promising !





**Thank you for attention**

