Nitrogen supplies and manure handling improve feed efficiency and reduce emissions in dairy cattle

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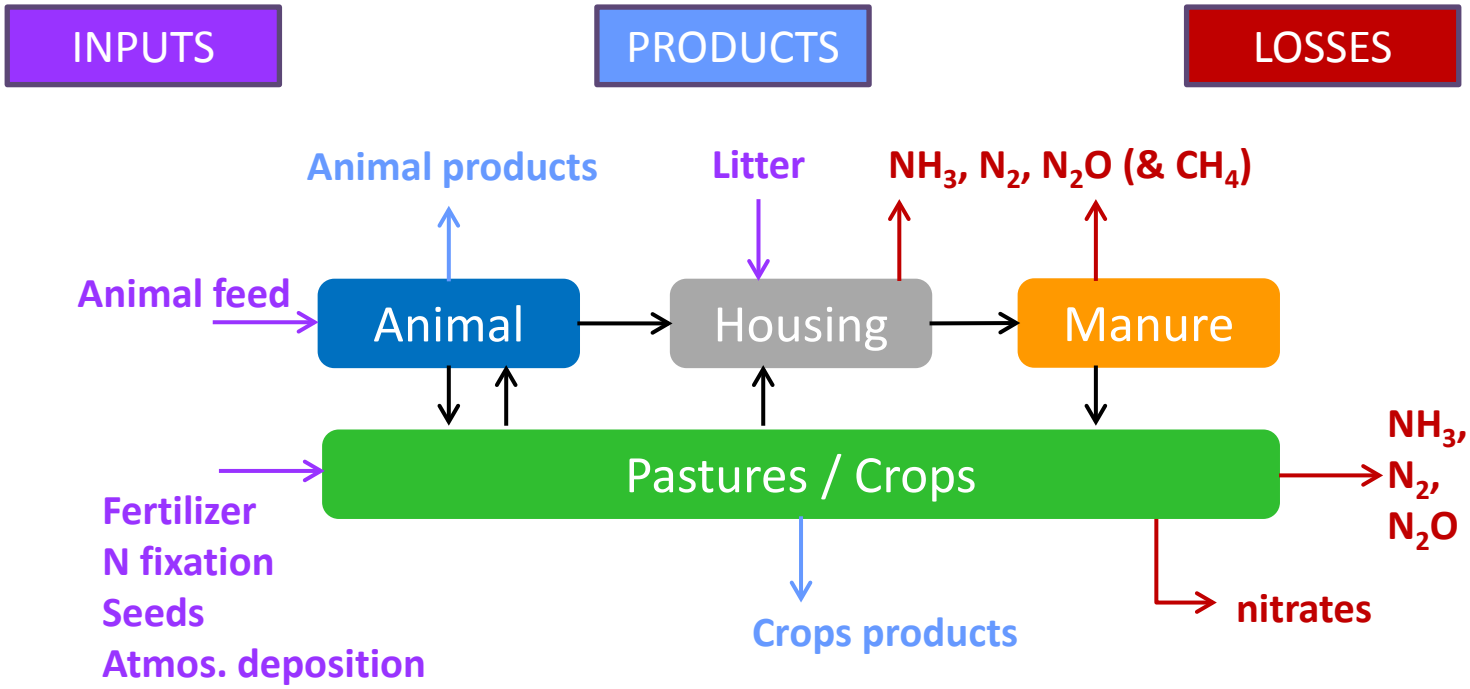
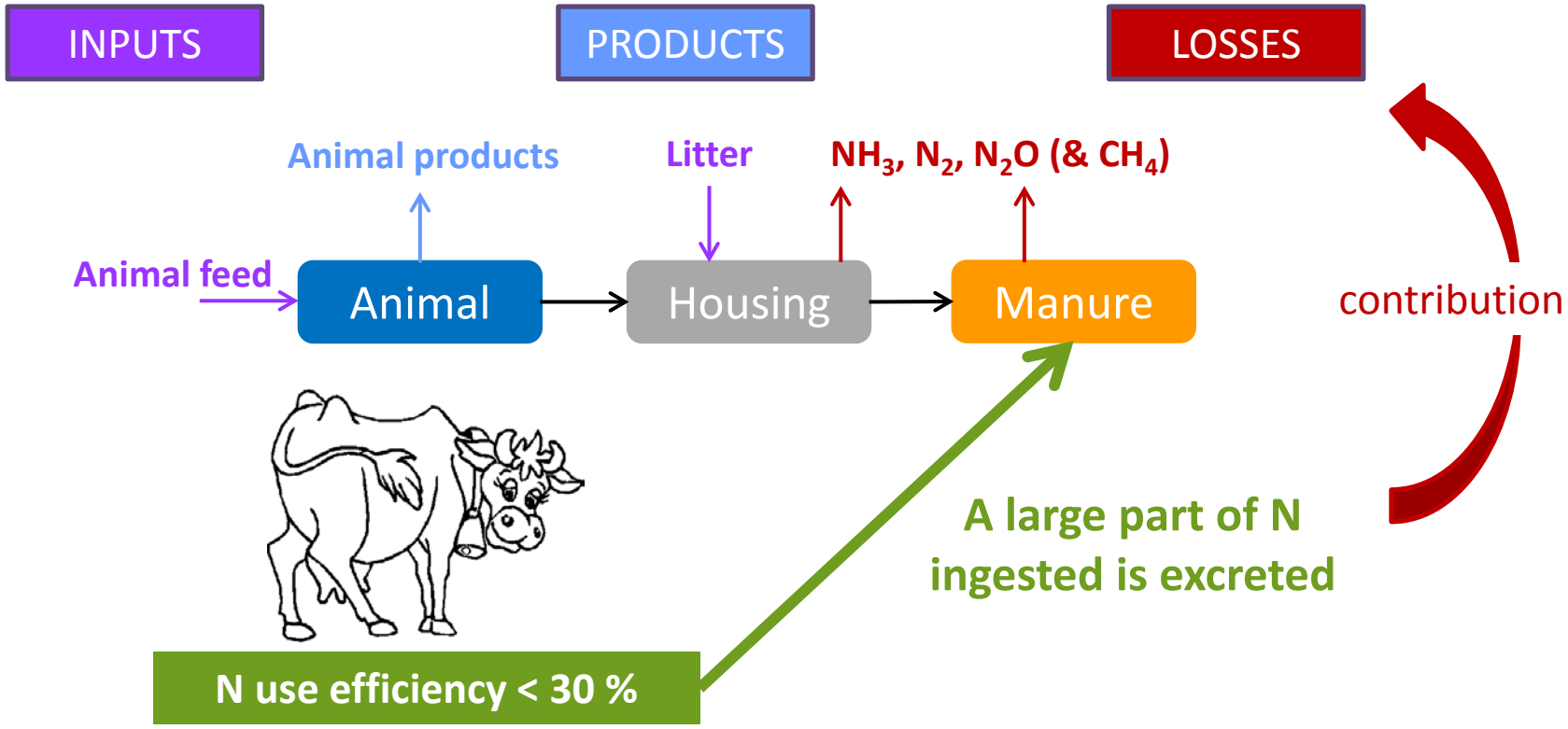
Nitrogen flows in dairy cattle systems



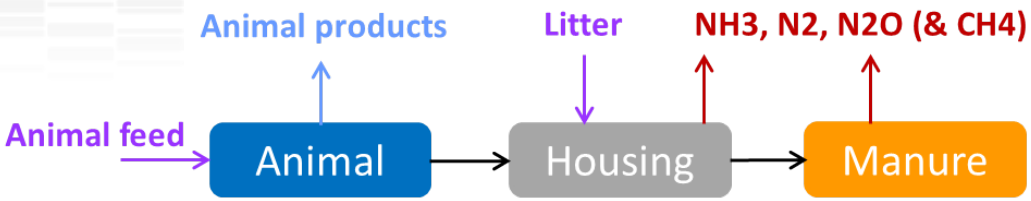
Assessment on nitrogen flows in livestock farming system in France. Main issues and options, INRA 2012

Nitrogen flows in dairy cattle systems



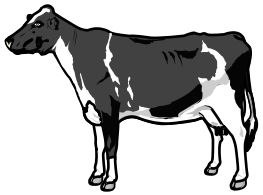
Assessment on nitrogen flows in livestock farming system in France. Main issues and options, INRA 2012

How to improve N use efficiency and reduce losses?



Diets varying in N content

↘ N intake



↘ **N** feces & **urine**

→ **N milk**

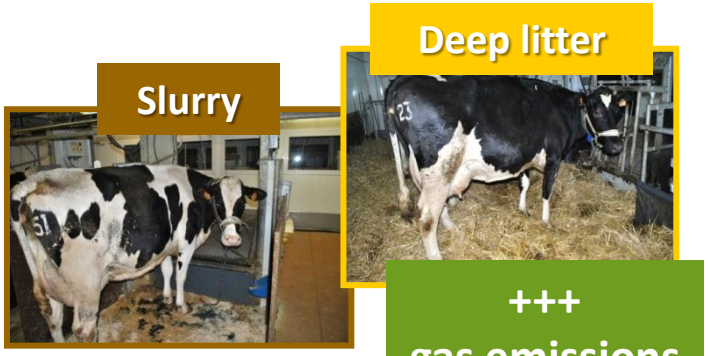
↗ **N use eff**

Castillo et al 2000 , Edouard et al 2011

But sometimes: ↘ **performances**

Kebreab et al 2001, Frank and Swensson 2002

Housing and manure management



+++ gas emissions

Edouard et al 2012, Webb et al 2012

How manure management as liquid or solid will influence gas emission processes and N use efficiency in relation with the amount of N excreted

Experimental design

≠ degradable N (PDIN),
= metabolizable N (PDIE)

2 groups of 3 dairy cattle, **2** diets varying in N content and **2** housing systems

producing 2 types of manure

Period	P1		P2	
Sub-P	SP1	SP2	SP1	SP2
Deep litter (DL)	Group A N+	Group A N-	Group B N-	Group B N+
Cubicles (CU)	Group B N+	Group B N-	Group A N-	Group A N+

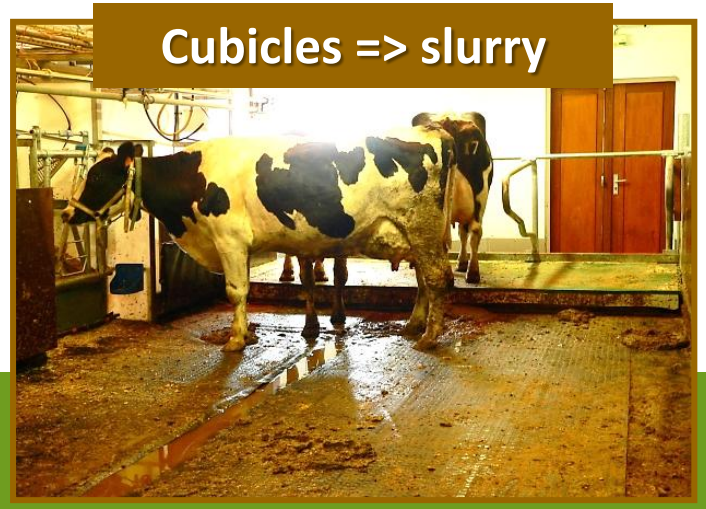
4 x 4 weeks

N+
18% CP

N-
12% CP

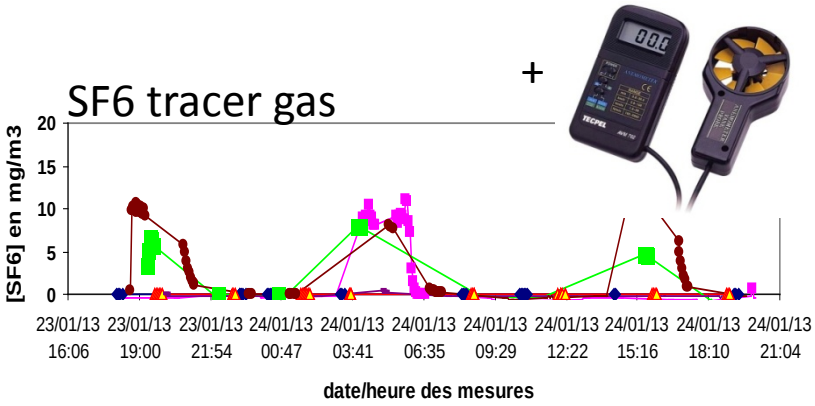
Deep Litter => FYM

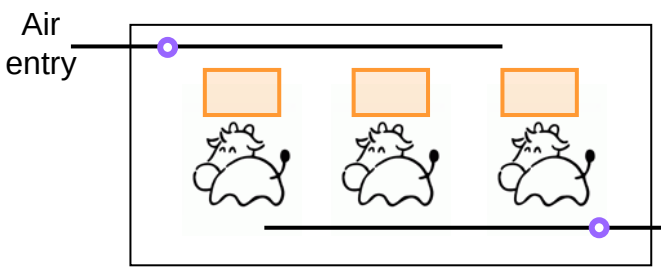
Cubicles => slurry



Measurements: performances and gas emissions

- **Animal production** (daily and individually): DM intake and composition, water intake, milk yield and composition, live weight gain (/period)
- **Manure characteristics** (individually): CU => faeces and urine production/composition
  DL => farm yard manure production/composition
- **Gas emissions**: - ventilation rates assessed punctually (tracer gas + anemometer)
  - gas concentration assessed continuously (INNOVA)





Preliminary results: animal performances

	DL		CU		P value	
	N-	N+	N-	N+	Manure	Diet
DMI kg/d	23.4 ±0.5	24.8 ±0.5	23.3 ±0.7	24.5 ±0.6	ns	* N- < N+
Milk Yield kg/d	22.1 ±0.7	24.1 ±0.7	20.4 ±0.9	21.8 ±0.9	* DL > CU	* N- < N+
Milk True Protein g/kg	36.8 ±0.5	34.9 ±0.5	36.9 ±0.7	38.1 ±0.7	* DL < CU	ns
Theoretical N use efficiency (N- 12%CP, N+ 18%CP)	0.28	0.18	0.26	0.18		

manure => no difference in DMI but straw intake cannot be excluded in DL
=> small variations in milk (higher production +2kg: DL more comfortable?)

diet => N+ enables a higher intake (+1kg) and a higher milk production (+2kg)

Preliminary results: mean gas emissions & kinetics

g/d/cow	NH3-N		CH4-C		CH4/DMI(kg)	
	N-	N+	N-	N+	N-	N+
DL	23	85	396	396	23.0	22.7
CU	21	63	323	321	19.2	18.4

NH3: strong diet effect, even more for DL

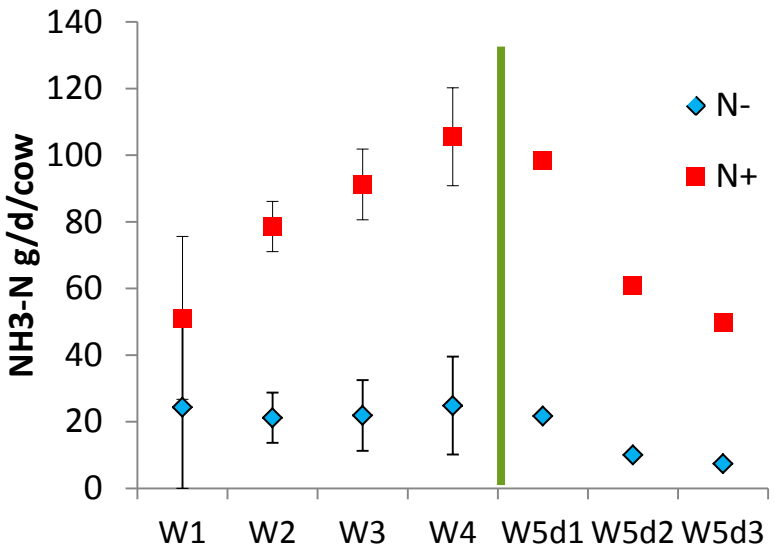
NH3: no difference btw DL and CU for N-

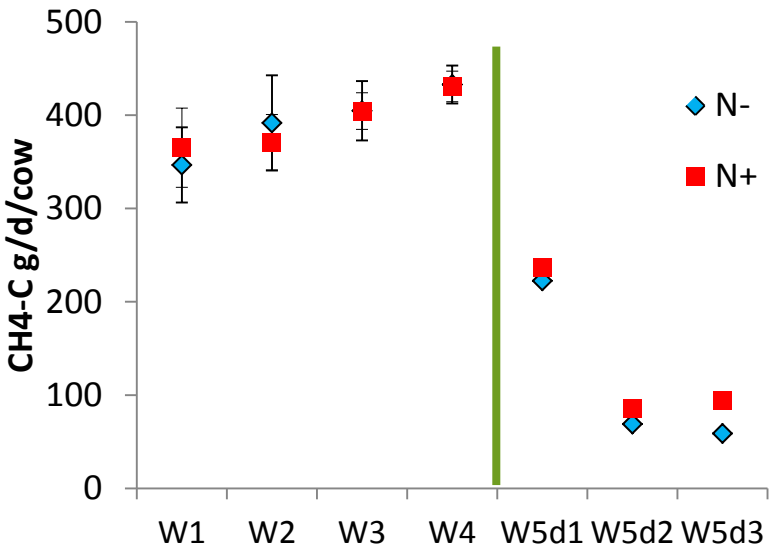
CH4: higher on DL (litter fermentation)

Preliminary results: mean gas emissions & kinetics

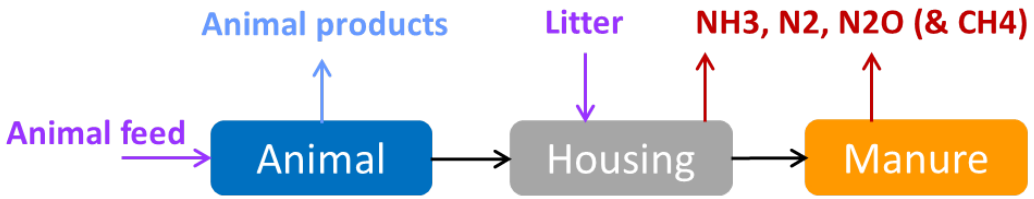
g/d/cow	NH3-N		CH4-C		CH4/DMI(kg)	
	N-	N+	N-	N+	N-	N+
DL	23	85	396	396	23.0	22.7

Kinetics: increase over straw accumulation, decrease after animals' exit





Conclusions



Diets varying in N content

❖ **Low degradable CP diet (N-) enables**

- **higher N use efficiency** (more than +50%) even if performances are slightly reduced

- **lower ammonia emissions** (divided by 3)

Housing and manure management

❖ **Manure management as solid FYM (DL)**

- **better milk production** (comfort?)

- **higher gas emissions:** +20% CH4
  +35% NH3 for **N+**

CU vs **DL**: does not consider gas emissions during storage, especially storage of slurry during DL accumulation

Feeding a low CP diet ↘ losses towards the environment and ↗N use efficiency
These results were amplified for deep litters => can be low emission systems when combined with adjusted N supplies

Thank you for your attention…

…And thanks to

For financial support

Co-authors, experimental farm, lab technicians