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

Nadège Edouard, Alicia Charpiot, Paul Robin, Elise Lorinquer, Jean-Baptiste Dollé, Philippe Faverdin
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

A large part of N ingested is excreted

N use efficiency < 30 %

Animal feed → Animal products

Animal → Housing → Manure

Litter → NH₃, N₂, N₂O (& CH₄)

INPUTS

PRODUCTS

LOSSES

INRA SCIENCE & IMPACT

Nadège Edouard / EAAP 2013 – 64th Annual Meeting of the European Federation of Animal Science
How to improve N use efficiency and reduce losses?

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

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

Deep litter

+++ gas emissions


INRA SCIENCE & IMPACT
Experimental design

- 2 groups of 3 dairy cattle, 2 diets varying in N content and 2 housing systems producing 2 types of manure

<table>
<thead>
<tr>
<th>Period</th>
<th>P1</th>
<th>P2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-P</td>
<td>SP1</td>
<td>SP1</td>
</tr>
<tr>
<td>Deep litter (DL)</td>
<td>Group A</td>
<td>Group B</td>
</tr>
<tr>
<td></td>
<td>N+</td>
<td>N-</td>
</tr>
<tr>
<td>Cubicles (CU)</td>
<td>Group B</td>
<td>Group A</td>
</tr>
<tr>
<td></td>
<td>N+</td>
<td>N-</td>
</tr>
</tbody>
</table>

- 4 x 4 weeks
  - N+ 18% CP
  - N- 12% CP

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

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)

SF6 tracer gas + H₂O, CO₂, NH₃, N₂O, CH₄
### Preliminary results: animal performances

<table>
<thead>
<tr>
<th></th>
<th>DL</th>
<th>CU</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N-</td>
<td>N+</td>
<td>N-</td>
</tr>
<tr>
<td>DMI kg/d</td>
<td>23.4 ±0.5</td>
<td>24.8 ±0.5</td>
<td>23.3 ±0.7</td>
</tr>
<tr>
<td></td>
<td>N- &lt; N+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk Yield kg/d</td>
<td>22.1 ±0.7</td>
<td>24.1 ±0.7</td>
<td>20.4 ±0.9</td>
</tr>
<tr>
<td></td>
<td>DL &gt; CU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk True Protein g/kg</td>
<td>36.8 ±0.5</td>
<td>34.9 ±0.5</td>
<td>36.9 ±0.7</td>
</tr>
<tr>
<td></td>
<td>DL &lt; CU</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Theoretical N use efficiency**

- DL: 0.28
- CU: 0.18
- N+: 0.26
- N-: 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

<table>
<thead>
<tr>
<th>g/d/cow</th>
<th>NH3-N</th>
<th>CH4-C</th>
<th>CH4/DMI (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N-</td>
<td>N+</td>
<td>N-</td>
</tr>
<tr>
<td>DL</td>
<td>23</td>
<td>85</td>
<td>396</td>
</tr>
<tr>
<td>CU</td>
<td>21</td>
<td>63</td>
<td>323</td>
</tr>
</tbody>
</table>

- **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

<table>
<thead>
<tr>
<th>g/d/cow</th>
<th>NH3-N</th>
<th>CH4-C</th>
<th>CH4/DMI(kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N-</td>
<td>N+</td>
<td>N-</td>
</tr>
<tr>
<td>DL</td>
<td>23</td>
<td>85</td>
<td>396</td>
</tr>
</tbody>
</table>

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

![Graphs showing NH3-N and CH4-C emissions with and without cows.](image)
**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)

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 \(\downarrow\) losses towards the environment and \(\uparrow\) N use efficiency
These results were amplified for deep litters \(\Rightarrow\) 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