The Ammonia Working Group

Toward Scientific Consensus on the Measurement of Ammonia Flux from Open-Lot Livestock Facilities

The Holy Grail

A range of emission factors that expresses the most probable, scientifically justifiable, seasonalized, daily NH₃ emission flux from feedyards and dairies as a function of herd size, stocking density or other appropriate measure of capacity or throughput.

Where We Are Today

- There are nearly a dozen different ways of estimating the NH₃ flux from an open-lot AFO
- Today, we present results from several of them
- Getting at the true flux requires a convergence of results from multiple, independent methods, but even that’s not enough by itself
- The true flux is different from the flux to be used in dispersion modeling in the permitting or compliance-monitoring contexts

Available Methods

- Envelope approaches
  - Mass balance
  - Nutrient ratio (N:P)
- Direct approaches
  - Surface isolation flux chambers
  - Wind tunnels
  - Eddy covariance
- Dispersion/box models
  - Gaussian (ISCST, AERMOD)
  - Lagrangian stochastic – backward, forward
  - Integrated horizontal flux (IHF)
  - Flux-gradient
  - Box
### Findings

<table>
<thead>
<tr>
<th>Method</th>
<th>Beef</th>
<th>Dairy</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Balance</td>
<td>195</td>
<td>&lt;650</td>
<td>Uncertainty analysis nearly complete; 38% during winter, 70% during summer: Includes NH₃ and other gaseous N losses</td>
</tr>
<tr>
<td>N:P Ratio</td>
<td>213</td>
<td></td>
<td>Includes NH₃ and other gaseous N losses</td>
</tr>
<tr>
<td>Flux Chamber</td>
<td>82</td>
<td>38 (OL)</td>
<td>Dairy #1 (FS): 54 ± 27 (S), 21 ± 22 (W), Dairy #2 (OL): 34 ± 3 (S05), 17 ± 2 (S04)</td>
</tr>
<tr>
<td>Flux-Gradient</td>
<td>191</td>
<td></td>
<td>Uncertainty analysis underway</td>
</tr>
<tr>
<td>bLS/OPL</td>
<td>182</td>
<td></td>
<td>Uses open-path lasers to measure N</td>
</tr>
<tr>
<td>Box Model</td>
<td>191</td>
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</tbody>
</table>

**Flux Chamber**
- Varies from 20-51% depending on source material (fresh manure, pen surface, compost)
- Includes NH₃ and other gaseous N losses
- Dairy #1 (FS): 54 ± 27 (S), 21 ± 22 (W)
- Dairy #2 (OL): 34 ± 3 (S05), 17 ± 2 (S04)  
- Beef in summer

**Uncertainty analysis**
- Nearly complete (beef)
- Assumes all sources of bias (systematic error) have been eliminated

**NH₃** presents steep challenges because of its:
- High reactivity with anions and surfaces
- High aqueous solubility
  - Deposition
  - Condensation
- Kinetically limited redox pathways with NOₓ species
- Numerous pools and pathways in real systems
- Sensitivity to pH

**Accounting** for all of those factors in a single measurement scheme is complicated.

**Comments**

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<tr>
<td>N Balance</td>
<td>44</td>
<td>&lt;80</td>
<td>Uncertainty analysis nearly complete (beef)</td>
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<tr>
<td>N:P Ratio</td>
<td>48</td>
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<td>Varies from 20-51% depending on source material (fresh manure, pen surface, compost)</td>
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<tr>
<td>Flux Chamber</td>
<td>18</td>
<td>3 (OL)</td>
<td>Herds are ~15% dry cows, ~85% lactating; excreted N is 79% of fed N</td>
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<tr>
<td>Flux-Gradient</td>
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