Estimating N excretion and deposition for improved nutrient management on Australian dairy farms

Sharon Aarons, Cameron Gourley, Mark Powell, Murray Hannah

Agriculture Victoria, Department of Economic Development, Jobs, Transport and Resources
Agriculture Research Services, US Department of Agriculture
Background

Australian dairy industry

- Important economically
  - Third largest rural industry
  - AUD 14 billion (AUD 4 billion, farmgate)
  - Located most states and territories
  - Typically higher rainfall and greater access to water

- Year round access to pasture to support grazing base
  - Grazing & pasture management – feeding systems
Background

Australian dairy industry

- Historic feeding systems
  - Perennial pasture (grass + legumes)
  - Forages (typically conserved silage and hay)
  - Grain/concentrate (fed at milking)

- Intensification of dairy industry
  - More recent changes
    - Altered feeding systems
    - Increased pasture and fodder production
Background

Australian dairy industry

- 5 main feeding systems

- **Low**
  - Grazed pasture + other forages + up to 1.0 tonne grain/concentrates

- **Mod**
  - Grazed pasture + other forages + more than 1.0 tonne grain/concentrates

- **PMR**
  - Pasture grazed for most or all of year + partial mixed ration on feed pad ± grain/concentrates

- **Hybrid**
  - Pasture grazed for <9 months/year + partial mixed ration on feed pad ± grain/concentrates

- **TMR**
  - Zero grazing, cows housed & fed total mixed ration
Background

Australian dairy industry

• Locations cows spend time on grazing system farms
  – Grazed pasture
  – Laneways
  – Dairyshed and yards (concreted)
  ➢ Feedpads (concreted and not concreted)
  ➢ Holding areas (not concreted)

• Variable nationally
Australian dairy industry

- Intensification of dairy industry
  - Feeding systems
    - Altered feeding systems
  - Greater N fertiliser use
    - Increased pasture and fodder production
Background

**Australian dairy industry**

- Intensification of dairy industry
  - Average annual per farm data and metrics sourced from the Australian Bureau of Statistics (Stott and Gourley, 2016)
- Increased N inputs, surpluses
Why quantify N excretion and deposition?

**Intensification of dairy industry**
- Greater N inputs (feed and fertiliser)
- Changes in animal time on grazed pasture
  - Less N deposited to pasture
  - Manure capture for re-use
    - Direct and indirect
Quantification of N excretion and deposition

Intensification of dairy industry

- Greater N inputs (feed and fertiliser)
- Changes in animal time on grazed pasture
  - Less N deposited to pasture
  - Manure capture for re-use
    - Direct and indirect

Individual dairy farms
43 case study grazing systems
Farm data and samples collected
- 5 times over a year
N Excretion

1. Animal metabolic energy requirement
   – Milk production, Pregnancy, Grazing, Activity, Maintenance

2. Energy supplied by supplements fed
   – Grain, concentrate, by-products, fodder
     (Supplements provide 52% of cow’s energy requirements)

3. Calculated energy from pasture
   – Pasture sample ME
     ➢ Pasture DM Intake

<table>
<thead>
<tr>
<th></th>
<th>Supplement</th>
<th>Pasture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>1.0</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>9.2</td>
<td>9</td>
</tr>
<tr>
<td>Maximum</td>
<td>25.4</td>
<td>22</td>
</tr>
</tbody>
</table>
### N Excretion

4. **\( N \text{ excreted} = \text{Total } N \text{ intake} - N_{\text{milk}} \)**

<table>
<thead>
<tr>
<th></th>
<th>Intake (gN/cow/day)</th>
<th>Secretion</th>
<th>Excretion</th>
<th>NUE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>268</td>
<td>48</td>
<td>199</td>
<td>11</td>
</tr>
<tr>
<td>Mean</td>
<td>545</td>
<td>112</td>
<td><strong>433</strong></td>
<td>21</td>
</tr>
<tr>
<td>Maximum</td>
<td>983</td>
<td>190</td>
<td>793</td>
<td>39</td>
</tr>
<tr>
<td>SD</td>
<td>129.4</td>
<td>29.0</td>
<td>110.3</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>Intake (gN/cow/day)</td>
<td>Secretion (gN/cow/day)</td>
<td>Excretion (gN/cow/day)</td>
<td>NUE (%)</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Minimum</td>
<td>268</td>
<td>48</td>
<td>199</td>
<td>11</td>
</tr>
<tr>
<td>Mean</td>
<td>545</td>
<td>112</td>
<td>433</td>
<td>21</td>
</tr>
<tr>
<td>Maximum</td>
<td>983</td>
<td>190</td>
<td>793</td>
<td>39</td>
</tr>
<tr>
<td>SD</td>
<td>129.4</td>
<td>29.0</td>
<td>110.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Castillo et al, 2000
N Excretion

- N excreted over a lactation on the 43 dairy farms
  - compared with total N imports
    (Feed, fertiliser, livestock, N fixation, irrigation water)

➢ 60% of total N imported - excreted

<table>
<thead>
<tr>
<th></th>
<th>Excreted N load</th>
<th>Total N imports</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum</strong></td>
<td>6.8</td>
<td>8.8</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>34.4</td>
<td>55.1</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>154.9</td>
<td>245.2</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>29.6</td>
<td>49.0</td>
</tr>
</tbody>
</table>
Annual N deposition around grazing system farms

Apportioned for each farm according to the places cows visited and time spent there

- Loads deposited to feedpads & holding areas (<100m from dairyshed)
  - Similar to that in dairysheds and yards
- N deposited in feedpads & holding areas
  - Not always collectable
- More N deposited in paddocks close to dairyshed
  - Cows kept overnight
SW Victorian dairy farm

- 540 cows
- 460 ha
- 1.2 cows/ha
- 42% reliant imported feed
Annual N loading rate to paddocks

Based on the areas of paddocks cows visited on each farm

Does not include effluent (dairyshed manure) applied to paddocks
Solutions

N management on Australian dairy farms

• Calculation of N recycled through lactating animals
  – major pool of on-farm nutrients

• Estimation of N deposition in excreta
  – considered in calculation of nitrogen applications
  – Spatially non-uniform returns (based on locations animals visit most frequently)
    • potential point source losses

• N deposition on to concreted (collectable) and non-concreted (non-collectable) surfaces can be equivalent
  – Non-collectable deposited N needs specific management