Useful performance indicators to improve nitrogen management for dairy production

Cameron Gourley, Kerry Stott, Sharon Aarons, Innocent Rugoho
Global milk production increasing ~5% pa over the past 50 years currently ~800 b litres

Australian dairy farms produce ~ 10 b litres ~ 10% world milk trade

AUD$13 billion - farm, manufacturing and export industry
Employs nearly 40,000 Australians on farms and in factories

Changing nature of dairy production...globally and locally
Australian Dairy Production base
Range of dairy production systems

- 50% of the milk from 15% of the farms
Manure deposition and management

Annually ~10 million m³
- captured, separated, stored,
- eventually land applied

~ 6 x Volume of MCG each year

MCG volume = 1.6 M m³

Australia’s 2 M dairy cows
- Produce ~10 b litres milk
- Excrete ~50 million m³ manure
Dairy production systems are increasingly challenged with excess nutrients, particularly where nutrient fluxes are large and recovery in saleable products is relatively low.

3 key questions about N use and recovery......

1. How do Australian dairy farms compare internationally?
2. Long-term trends as a result of continued intensification?
3. Appropriate indicators which can inform improvements?
Commonly used farm-scale N indicators

- **N Use Efficiency**: Agricultural N output per unit N input
  
  (kg N / kg N expressed as a percentage)

- **N Balance per unit area** (kg N / ha)

- **Production N Balance** (i.e. g N / l milk)
  
  - akin to partial productivity used in production economics
Quantifying N efficiency and balance in dairy production

- Whole-farm nitrogen budget
- Importance of N flows and transformations
1. How does the diversity of Australian dairy production compare with international systems?

Nitrogen balance and milk production for conventional and organic dairy production

De Gall et al. 2009
Gourley et al. 2012
2. What are the long-term trends as a result of continued intensification?

<table>
<thead>
<tr>
<th>Farm and herd details</th>
<th>N Imports</th>
<th>N Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of dairy farms</td>
<td>Replacement milkers</td>
<td>Culls</td>
</tr>
<tr>
<td>Average farm size</td>
<td>Supplements used (concentrates, grains, forages, by-products)</td>
<td>Calves sold</td>
</tr>
<tr>
<td>Effective land grazed (contact area)</td>
<td>N Fertiliser used</td>
<td>Milk produced</td>
</tr>
<tr>
<td>Average herd size</td>
<td>Legume content of pasture</td>
<td>Milk solids</td>
</tr>
</tbody>
</table>

1990 ➔ 2012
2. What are the long-term trends as a result of continued intensification?

Net nitrogen imports and exports (kg N/ha) for an industry average Australian dairy farm

Stott and Gourley 2016
N recovery for Australian dairy production between 1990 and 2012.

Average N balance (kg N/ha)

N use efficiency (%)

Milk Production N balance (g N/l milk)
3. What are the appropriate metrics which can be used to inform necessary improvements?

16 pasture-based dairy farms in Victoria
- 2014/15 production year
1. Increasing reliance on imported feed
2. Increasing N fertiliser input
3. Excessive dietary N intake
   - High excreta N loads
4. Increasing time off pasture
   - Lack of manure collection
   - Heterogeneous excreted nitrogen distribution
No one number can convey this complexity

Key points of intervention
Conclusions

1. **Australian dairy farms vary widely - N use, balance & efficiency:** but ...... representative of dairy systems world-wide.

2. **Industry intensification:** - continuing decline in N recovery.
   - NUE, Whole-farm N balance and N balance/milk production
     - Useful industry-wide indicators to reduce N emissions.

3. **Individual farms:** - ‘Whole-farm’ N Balance is most useful.
   - Further component-based N indicators are needed
     - Provide insights into potential points of intervention
   - Standardisation and appropriate bench-marking of industry and farm indicators is important.