Farm-level economics and NZ nitrogen leaching policy: best friends or unhappy marriage?

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Introduction

- Agricultural intensification implicated with water quality decline
- On-farm economics and nutrient policy are linked:
  - Need for policy?
  - Cost of policy?
- How are they related in the context of nitrogen leaching in New Zealand?
- One of important issues facing NZ dairy industry
What is the problem?
Dairy industry is important to NZ

- Exports of $14.6 billion in 2012
- 25% of merchandise export earnings
- Third of world’s dairy trade
- Employment of ~45,000 people
North Island vs South Island
# Changes on NZ dairy farms

<table>
<thead>
<tr>
<th></th>
<th>1990/91 to 2010/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herds</td>
<td>-20%</td>
</tr>
<tr>
<td>Area</td>
<td>+60%</td>
</tr>
<tr>
<td>Cows</td>
<td>+89%</td>
</tr>
<tr>
<td>Average herd size</td>
<td>+134%</td>
</tr>
<tr>
<td>Milk production (kg/cow)</td>
<td>+31%</td>
</tr>
<tr>
<td>Milk production (kg/ha)</td>
<td>+50%</td>
</tr>
<tr>
<td>Milk production (total)</td>
<td>+248%</td>
</tr>
<tr>
<td>Stocking rate (cows/ha)</td>
<td>+15%</td>
</tr>
</tbody>
</table>
Dynamics of nitrate leaching

Based on Clark (2010).
The problem is not bull crap...

- 60-90% of N excreted
- 70% of N as urinary N
- Around 25% of paddock covered each year
- N loading rate under patch is 1 t N ha\(^{-1}\)

Source: Romera and Doole (2013)
Nitrate leaching (kg N/ha/yr)

KEY:
• Grey (0–2 kg N)
• Blue (2–5 kg N)
• Turquoise (5–10 kg N)
• Green (10–15 kg N)
• Yellow (15–20 kg N)
• Orange (20–30 kg N)
• Red (30–40 kg N)
• Purple (>40 kg N)
Water quality decline is evident
Policy focus on water quality

- Manawatu: regulate leaching in OnePlan
- Taupo: policy for protection of Lake Taupo
- Canterbury: water quality and quantity limit setting process being undertaken
- Very political issue
- Extensive legal action
Do we need policy for water quality improvement?
Adoption of mitigation practices

- Current systems are not compatible
- Moral suasion
- What is a win-win strategy?
- Can we rely on diffusion?
- Adoption theory: Pannell et al. (2006)
Relative advantage of an adoptable practice

• Economic benefits
  ❖ Profitability
  ❖ Riskiness
  ❖ Compatibility
  ❖ Complexity
  ❖ Observability
  ❖ Trialability

• Research in Aus. and NZ

• Value of farm modelling
Relative advantage of herbicides

- Herbicides vs hand weeding in Philippines
- Economic benefits
  - Profitability ✓
  - Riskiness ✗
  - Compatibility ✓
  - Complexity ✓
  - Observability ✓
  - Triallability ✓

Source: Beltran et al. (2012)
General lack of profitable mitigations

- Profitability is a key driver for adoption
- What incentive exists when a practice is unprofitable?
- General lack of win-win strategies

Source: Doole (2010)
Sam Howard: case study farm
Evaluation toolbox results

Cost-effectiveness of mitigations on a Waikato dairy farm.

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Change in annual profit (%)</th>
<th>Reduction in N leaching (kg N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrification inhibitors</td>
<td>-14</td>
<td>6–18</td>
</tr>
<tr>
<td>Low rate effluent application</td>
<td>-3</td>
<td>0–1</td>
</tr>
<tr>
<td>No nitrogen fertiliser</td>
<td>-49</td>
<td>25–35</td>
</tr>
<tr>
<td>Low N feed</td>
<td>-15</td>
<td>20–30</td>
</tr>
<tr>
<td>Restricted autumn-winter grazing</td>
<td>-9</td>
<td>20–35</td>
</tr>
<tr>
<td>Low-cost winter pad</td>
<td>-44</td>
<td>15–30</td>
</tr>
<tr>
<td>Herd shelter</td>
<td>-79</td>
<td>15–30</td>
</tr>
<tr>
<td>Construct wetland</td>
<td>-24</td>
<td>10–40</td>
</tr>
</tbody>
</table>
Is DCD the bronze bullet?

- DCD slows enzymes
  - ↑ pasture production (?)
  - ↓ environmental impact

- High cost of DCD
  - Profit ↑ by 2%
  - N leaching ↓ by 9%

- Negative feedback
  - SR ↑ by 5%
  - MP ↑ by 5%

- Residue problem!

Source: Doole and Parangahawewa (2011)
Lack of win-win solutions necessitates policy intervention.
Are there any policy challenges?
Finding policy solutions is hard

- Complex problem
- No clear policy solutions
- Difficulties:
  - Multiple farmers
  - Hidden actions
  - Unclear benefits
  - Stochastic impacts
  - Catchment modelling
Multiple farmers across space

- Predict actions of multiple farmers
  - Farms vary
  - Farmers vary
- Exacerbates uncertainty
- Model individual farms and farmers
- Match data availability

Source: Doole et al. (2013)
Predicting farmer behaviour?

- Do not know behaviour of farmers
- Monitoring is difficult and costly
  - When is stand-off used?
- OVERSEER is required
  - Cost
  - Quality

Source: Doole and Pannell (2011)
Unclear benefits

- Env. decisions need good data on values
- NPS for Freshwater Management 2011
- Set standards → evaluate cost
- Easier than linking to non-market values?
Annual variation of farm N leaching

Source: Doole and Romera (2013)
Catchment modelling is difficult

- Predict how mitigation use and land use change with policies

- Difficult to do well:
  - Quality of input data
  - Calibration
  - Time
  - Dynamics of land-use change

- Best we have?

Source: Doole et al. (2011)
Designing appropriate policy interventions is difficult.
Are there other on-farm issues we need to consider?
Debt pressures

- Dairy expansion has fuelled debt
- Interest of $1.5 kg MS, expenses of $5 kg MS
- High LVR
- 10-20% of farmers hold half of the debt
- Capacity to cope with abatement cost?

Source: RBNZ Annual Agricultural Survey (2012)
Pressure to increase production

- Milk prod. expected to grow by 15% to 2020
- Government investment in irrigation (420k ha)
- Key competition:
  - South America (low cost, large capacity)
  - India/China (↑35% by 2018)
- Product safety
Pressure on input costs

- Steady increase in input costs over last decade
- Fertiliser and feed costs are growing

Source: DairyNZ Economic Survey 2010/11
Pressure on system

- Increasing supplement use
- Farms using >10% supp. ↑ 30% over last decade
- Cost ↑ with supplement use

Source: Dillon et al. (2008)
New Zealand dairy farmers are under significant pressure.
Summary
Prognosis: Unhappy marriage

- Broad uptake could dispel problem
- Tension between economics and env.
- Motivates need for R&D
- Motivates need for policy
- Working together during policy setting
The future...

- There are no easy answers
- Readjustment of industry?
- Loss of competitiveness?
- Develop or find profitable mitigations?
- Can we design/adopt new systems?