Eco-efficient pasture based dairy farming

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Outline

• Context: New Zealand
• Performance of well-managed dairy farm systems: NZ, NL and IL
• Options to further improve environmental performance
New Zealand
New Zealand
NZ – market conditions

- 95% of milk production is exported
- No subsidies
- Strongly fluctuating milk prices

![GDT Price Index Chart]

Source: GlobalDairyTrade, 20 May 2019

Photo: Environment Canterbury
NZ – dairy farm structure

- Perennial ryegrass – white clover pasture
- Spring calving, HxJ cross breds
- Year-round grazing
- Grazed crops in periods of low pasture production
- Little concentrated supplements used
- N fertiliser use has increased
**N use has increased**

<table>
<thead>
<tr>
<th>Canterbury</th>
<th>kg N/ha milking platform</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1993</td>
</tr>
<tr>
<td>Fertiliser-N on pasture</td>
<td>50</td>
</tr>
<tr>
<td>Supplements</td>
<td>0</td>
</tr>
<tr>
<td>Clover</td>
<td>90</td>
</tr>
<tr>
<td>Milk</td>
<td>63</td>
</tr>
<tr>
<td>N surplus</td>
<td>77</td>
</tr>
</tbody>
</table>

Chapman et al, 2014
Fast growth dairy in Canterbury

Conversion from dry-land sheep and beef to irrigated dairying

Photos: Environment Canterbury
Wintering systems
Well managed dairy farms – NZ

Pastoral 21 – system comparison:
• Reduce N fertiliser use
• Increase production per cow
• Improve cow longevity & fertility
• Reduce stocking rate
• Use low-N supplements
• Stand-off in high-risk periods of the year, or
• Use high yielding low-N winter grazed crop
Waikato – winter 2013

Mean nitrate leaching nearly halved

2013
Total reduction 40%
Reduced input 30%
Stand-off 10%

67 kg N/ha
38 kg N/ha
Well managed dairy farms
NZ vs Netherlands and Ireland

- New Zealand – research farmlets
  - Waikato
  - Canterbury
- The Netherlands – Cows & Opportunities
  - Organic
  - High input, no grazing
  - High efficiency, grazing
- Ireland – research farms
  - Solohead
  - Curtin
## Well managed dairy farms
NZ vs Netherlands and Ireland

<table>
<thead>
<tr>
<th></th>
<th>NZ Pastoral 21</th>
<th>NL Cows &amp; Opportunities</th>
<th>Ireland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NZ-C</td>
<td>NZ-W</td>
<td>NL-1</td>
</tr>
<tr>
<td>Pasture production</td>
<td>16.1</td>
<td>15.3</td>
<td>9.6</td>
</tr>
<tr>
<td>Harvested as silage (%)</td>
<td>5</td>
<td>3</td>
<td>93</td>
</tr>
<tr>
<td>Grazing time (h year$^{-1}$)</td>
<td>7540</td>
<td>5840</td>
<td>477</td>
</tr>
<tr>
<td>Supplements (kg N ha$^{-1}$)</td>
<td>9</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>CP ration lactation (%)</td>
<td>22</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>kg Milk cow$^{-1} \text{ year}^{-1}$</td>
<td>6,184</td>
<td>5,359</td>
<td>6,802</td>
</tr>
<tr>
<td>kg Milk ha$^{-1} \text{ year}^{-1}$</td>
<td>18,345</td>
<td>14,041</td>
<td>11,094</td>
</tr>
</tbody>
</table>
Well managed dairy farms
NZ vs Netherlands and Ireland

- Removed (kg N ha⁻¹)
- N surplus farm (kg ha⁻¹)
- NUE farm (%)
- Eco-efficiency (kg milk kg N surplus⁻¹)

N input (kg N ha⁻¹)
Further options

• Focus on urine patch: reduce surplus N intake
• Maintain or improve milk production

↓

• Multi-species pastures
• Integrating crops
Multi-species pastures

- Reduced N fertiliser use
- Increased milk production
- Reduced surplus N intake
- Increased plant N uptake
## Reduced fertiliser N use

<table>
<thead>
<tr>
<th>Aberystwyth (t DM ha(^{-1}) yr(^{-1}))</th>
<th>PRG (150 kg N)</th>
<th>High-N PRG (300 kg N)</th>
<th>PRG TF</th>
<th>PRG WC</th>
<th>PRG RC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUT</td>
<td>15.5</td>
<td>17.5</td>
<td>15.7</td>
<td>27.1</td>
<td>25.1</td>
</tr>
<tr>
<td>GRAZED</td>
<td>12.9</td>
<td>17.5</td>
<td>11.9</td>
<td>19.2</td>
<td>20.9</td>
</tr>
</tbody>
</table>

Source: Collins et al. (2014)
Increased milk production

Source: Roca-Fernandez et al. (2014)
# Reduced N surplus intake

**Woodward et al. (2012)**

<table>
<thead>
<tr>
<th></th>
<th>PRG/WC</th>
<th>MSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP (%) diet</td>
<td>18.6</td>
<td>15.0</td>
</tr>
<tr>
<td>N intake (g N/day)</td>
<td>466</td>
<td>350</td>
</tr>
<tr>
<td>Milksolids (kg/day)</td>
<td>1.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Urine N concentration (g N/L)</td>
<td>6.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Urine N excretion (g/day)</td>
<td>200</td>
<td>100</td>
</tr>
</tbody>
</table>
Urine patch N and N leaching

Nitrate leached kg N/ha

Urine application rate (kg N/ha)

Di and Cameron (2007)
Increased plant N uptake

(Urine applied at 1,000 kg N/ha in autumn)

Source: Malcolm et al. (2014)
Integrating crops

- Increased yield
  - Total DM
  - Feed available when pasture growth low
- Lower N content – reduced surplus N intake
- Increased N uptake/recovery
- Improved grass/clover establishment following crop
**High yield and low N: grazing fodder beet in winter**

All data: g or kg/cow/day, 500 kg cow

<table>
<thead>
<tr>
<th>Diet</th>
<th>DMI, N intake</th>
<th>Urine N</th>
<th>Faeces N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactating Medium N Pasture</td>
<td>15 kg; 430 g</td>
<td>160 g</td>
<td>170 g</td>
</tr>
<tr>
<td>Lactating High N Pasture</td>
<td>18 kg; 830 g</td>
<td>520 g</td>
<td>160 g</td>
</tr>
<tr>
<td>Lactating TMR</td>
<td>20 kg; 560 g</td>
<td>185 g</td>
<td>205 g</td>
</tr>
<tr>
<td>Non-lactating Fodder beet + pasture silage</td>
<td>10 kg; 205 g</td>
<td>145 g</td>
<td>50 g</td>
</tr>
<tr>
<td>Non-lactating Fodder beet + straw</td>
<td>10 kg; 165 g</td>
<td>100 g</td>
<td>50 g</td>
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</tbody>
</table>

Examples calculated by Waghorn (2015)
Combining the best of both worlds

- High quality multi-species pastures
- High pasture utilisation through grazing
- High yielding low-N crops for dry/cold seasons
- On-off grazing in high-drainage periods