Improved Nutrient Management on Intensive Dairy Farms

Noeleen McDonald¹, Paul Murphy², Cathal Buckley ³ and Ger Shortle¹

¹Agricultural Catchments Programme, Teagasc, Johnstown Castle, Environmental Research Centre, Wexford
²Environmental and Sustainable Resource Management Section, School of Agriculture and Food Science, UCD, Dublin
³Agricultural Catchments Programme, Teagasc, Athenry, Galway
The Agricultural Catchments Programme (ACP)  
2008 to present

Drivers - Environmental and Economic
- Nitrates Directive – Member States required “to assess…action programmes”
- Water Framework Directive - attain and sustain at least good status waters
- Food harvest 2020 & Food Wise 2025 – SMART, GREEN, GROWTH,

Objectives
- Biophysical - evaluation of the GAP measures and nitrates derogation
- Socio-economic - farmers’ understanding/implementation, economic impact
- Dissemination of outcomes

Approach
- Integration – research/advisory
- Partnership – c.300 farmers in catchment + nationally
- A scientific body of evidence – over years and across catchments
- Finding the WIN:WINS e.g. Nutrient Management/Nutrient Use Efficiency
ACP Soil Census

- Initial sampling carried out at the establishment of each catchment 2009-2011 (baseline)
- 10cm depth
- Sampled every < 2 ha (5 ac)
- Analysed for P, K & pH
- Repeated sampling after 3-4 years (2013-2015)
- Results provide to ACP farmer by ACP advisor
Soil Fertility Trends of ACP Grassland Soils (2,379 samples)

- **Soil P trend**
  - 2% drop in risky P Index 4 soils
  - But alarmingly increase of 8% area with soils in Index 1, very deficient in P.

- **Soil K trend**
  - 3% increase area proportion of K Index 4 soils
  - Area proportion of very acid soils (<5.5) dropped by 8% & soils with pH optimum >6.2 increased by 4%.

- **Soil pH trend**
  - 25 to 17% dropped to 27 to 31%
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Soil pH trend
- 69% still below optimum pH
- 2% drop in risky P Index 4 soils
- But alarmingly increase of 8% area with soils in Index 1, very deficient in P.
- 3% increase area proportion of K Index 4 soils
- Area proportion of very acid soils (<5.5) dropped by 8% & soils with pH optimum >6.2 increased by 4%.
Trend in Good Overall Soil Fertility in ACP Grassland Soils ($n = 2,379$)

Baseline sampling

- 10% Good Overall Fertility
- 90%

Repeated sampling

- 13% Good Overall Fertility
- 87%

The Irish Agriculture and Food Development Authority
Soil Fertility Trends of Timoleague
*Intensive Dairy Catchment (452 samples)*

**Soil P trend**  
*Murphy et al., 2015*

- 8% drop in risky P Index 4 soils.
- Area proportion of P Index 2 soils reduced by 3%, optimum P Index 3 increased by 9%, however, Index 1 soils increased by 2%.

**Soil K trend**

- 6% combined increase for area proportion of K Index 3 & 4 soils.
- Area with very acid soils (<5.5) dropped by 17%.

**Soil pH trend**

- 35 to 18%
Soil Fertility Trends of Timoleague

Intensive Dairy Catchment (452 samples)

Soil P trend

- 8% drop in risky P Index 4 soils.
- Area proportion of P Index 2 soils reduced by 3%, optimum P Index 3 increased by 9%, however, Index 1 soils increased by 2%.

Soil K trend

- 6% combined increase for area proportion of K Index 3 & 4 soils.
- Area with very acid soils (<5.5) dropped by 17%.

Soil pH trend

- 70% still below optimum pH
Trend in Good Overall Soil Fertility
Timoleague (n = 452)

Baseline sampling (2010)
6% Good Overall Fertility
94%

Repeated sampling (2013)
9% Good Overall Fertility
91%
Case Study: Dairy Farm
Improved Soil Fertility Change
(40 samples)

- Whole Farm Stocking rate = 1.9 LU ha\(^{-1}\)
- Grazing Stocking rate = 2.5 LU ha\(^{-1}\)
- Farm-gate P balance:
  \((P \text{ inputs} - P \text{ outputs}) = 3.9 \text{ kg ha}^{-1}\)
- P use efficiency:
  \(\frac{P \text{ outputs}}{P \text{ inputs}} \times 100 = 74\%\)
- But, based on P build up (Index 1 & 2)
  Optimal P balance = -1.45 kg ha\(^{-1}\)

Soil P trend

Soil K trend

Soil pH trend

Index 1 P/ K / pH <5.50
Index 2 P/ K / pH 5.51-5.90
Index 3 P/ K / pH 5.91-6.19
Index 4 P/ K / pH >6.2
Case Study: On Farm Improved Soil Fertility Change *(40 samples)*

**Good on farm nutrient management practices:**
- Reduced risky P Index 4 soils by 16%
- Reduced the area proportion previously deficient in P, K & pH
- Convergence to optimum Index 3 for P & K and pH >6.2 = good overall soil fertility = benefits agronomy + environment *(WIN:WINS)*

<table>
<thead>
<tr>
<th>P &amp; K Index /pH thresholds</th>
<th>% Farm in P index</th>
<th>% Diff</th>
<th>% Farm in K index</th>
<th>% Diff</th>
<th>% Farm in pH threshold</th>
<th>% Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 / &lt;5.5</td>
<td>17</td>
<td>-10</td>
<td>5</td>
<td>-3</td>
<td>6</td>
<td>-5</td>
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<tr>
<td>2 / 5.51-5.90</td>
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<td>11</td>
<td>61</td>
<td>-15</td>
<td>27</td>
<td>-13</td>
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<tr>
<td>3 / 5.91-6.19</td>
<td>24</td>
<td>27</td>
<td>16</td>
<td>25</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>4 / &gt;6.2</td>
<td>38</td>
<td>-16</td>
<td>18</td>
<td>-5</td>
<td>37</td>
<td>5</td>
</tr>
</tbody>
</table>
Case Study: On Farm
Improved Soil Fertility Change

Good on farm nutrient management practices:
• Reduced risky P Index 4 soils by 16%
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Production & Profitability
Comparable with top 10% of national dairy farmers of 2012 that were averaging:
• Whole-Farm Stocking rate 2.47 LU ha\(^{-1}\)
• Milk production outputs of 14,356 l ha\(^{-1}\)
• Gross Margins of €3,261 ha\(^{-1}\)

Murphy et al., 2015
In Summary

• Since initial sampling, grassland soil samples within the ACP have improved from 10 to 13% for good overall soil fertility.

• Timoleague catchment had a positive change in soil fertility:
  ➢ Overall soil fertility improved from 6 to 9%.
  ➢ Reduction of risky P Index 4 soils by 8%.

• High percentage area of soils below optimum pH 6.2-6.3 is hindering good overall soil fertility.

• Evidence of soil fertility can be improved through good nutrient management practices on farms and benefit production and the environment.

• However, optimum soil fertility for catchment soils are alarming low.

• Mining built up P reserves on Index 4 soils needs to be continued.
Recommendations

5 steps to improving soil fertility

- Regularly soil sample - Every 3-5 years
- Timely draw up a yearly NMP - i.e. previous Nov/Dec.
- Create practical nutrient recommendation farm map - right place, product & rate.
- Follow fertiliser programme - right time & rate.
- Update NMP accordingly with any changes to on-farm practices
- Track progress by mapping on-farm soil fertility trends

The Irish Agriculture and Food Development Authority
Acknowledgements/thanks:

Farmers, ACP Team, Teagasc colleagues

www.teagasc.ie/agcatchments