Developing sustainability indicators to evaluate changes in farm level nutrient management efficiency through time

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Introduction

• Legislation in the area of water quality
    ➢ “Good Status by 2015 / 2021”
    ➢ Diffuse and point sources pollution from Agriculture

• Policymakers - Indicators of environmental sustainability?

• Milk quota abolition in 2015
  - Milk production in Republic of Ireland constrained
  - Expansionary phase
  - Food Harvest 2020 targets – 50% increase in milk production
    ➢ Food wise 2025

• Effect of extra milk production?
Research Framework

• Derive indicators in the area of nutrient use efficiency at farm level – **Nitrogen** (and Phosphorus)
  ❖ Temporal trend in relevant nutrient use indicators?

• Using the Teagasc National Farm Survey which is part of the EU Farm Accountancy Data Network (FADN)
  ❖ National dataset required under EU legislation
  ❖ Each EU member state required to return a set of national farm accounts
  ❖ Each farm selected at random to represent a section of the national farming population. Total sample circa 1,000
  ❖ Developed in Rep. of Ireland to collect relevant data to derive economic, social and environmental indicators.
Data / Methods

- Focus on dairying system
  - Most intensive systems – source pressure
  - Likely expansion
  - Specialist dairying systems
    - 2/3 output comes from milk production

- Case study panel of dairy farmers
  - N=92 farms in NFS between 2000-2014
    - Tracking over 15 years
  - Average population weight (5,425)
    - Not elite farms, represent a cross section of the population
### Sample production profile 2000-2014 (mean values)

<table>
<thead>
<tr>
<th>Production Profile*</th>
<th>2000</th>
<th>2001</th>
<th>........</th>
<th>2013</th>
<th>2014</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size (hectares)</td>
<td>39.9</td>
<td>40.6</td>
<td>........</td>
<td>48.1</td>
<td>49.0</td>
<td>+21%</td>
</tr>
<tr>
<td>Grassland (hectares)</td>
<td>38.7</td>
<td>39.5</td>
<td>........</td>
<td>47.4</td>
<td>48.4</td>
<td>+23%</td>
</tr>
<tr>
<td>Total livestock units</td>
<td>78.0</td>
<td>78.9</td>
<td>........</td>
<td>91.2</td>
<td>95.7</td>
<td>+23%</td>
</tr>
<tr>
<td>Dairy cow livestock units</td>
<td>43.6</td>
<td>43.8</td>
<td>........</td>
<td>60.0</td>
<td>62.3</td>
<td>+42%</td>
</tr>
<tr>
<td>Other livestock units</td>
<td>34.4</td>
<td>35.1</td>
<td>........</td>
<td>31.2</td>
<td>33.4</td>
<td>-5%</td>
</tr>
<tr>
<td>Grassland Stocking rate (livestock units ha⁻¹)</td>
<td>2.0</td>
<td>2.0</td>
<td>........</td>
<td>1.9</td>
<td>2.0</td>
<td>0%</td>
</tr>
</tbody>
</table>

(N=92, population weighted to 5,425)
1. Farm-gate balance
   - Indicator of source pressure
   - Inputs and outputs that cross the farm gate
   - Limits analysis to element within farmers control
   - Equalizes inputs and outputs into Kg N Ha\(^{-1}\)
   - N Inputs – N outputs = N balance (surplus/deficit) (Kg Ha\(^{-1}\))

2. Nitrogen use efficiency (NUE)
   - Indicator of agronomic efficiency in N use
   - N Outputs / N Inputs x 100

(Buckley, C., Wall, D. P., Moran, B., and Murphy, P.N.C., 2015. Developing the EU Farm Accountancy Data Network to derive indicators around the sustainable use of nitrogen and phosphorus at farm level. Nutrient Cycling in Agroecosystems, 102, 319–333)
Farm-gate balance

Source: Nevens et al., 2006
Nitrogen Imports Kg / Ha 2000-2014 (mean)
Nitrogen Exports Kg / Ha 2000-2014 (mean)
Nitrogen use efficiency 2000-2014 (mean)
Nitrogen surplus (kg N) per unit (Kg) of milk solids produced
Productivity in Milk Production per Cow

Year

Milk Solids cow (Kg Protein & Butterfat)

Productivity in Milk Production per hectare

![Graph showing productivity in milk production per hectare from 2000 to 2014. The graph indicates an overall increase in milk solids production area.]
Overview of Findings

- What is 15 year temporal trend showing
  - Volatility
    - Market forces, climate
  - Steady state trend suggests decline in N balances (Kg Ha\(^{-1}\))
    - Max (2002) to min (2011) years is circa 50 Kg Ha\(^{-1}\) or -27%
    - Outputs relatively static, gains on input side (chemical N)
  - Steady state trend suggests improvement in N use efficiency (%)
    - Max to min years is +4.5% / 23% improvement in efficiency
  - Improved efficiency / lower emission per unit of product produced
    - Nitrogen surplus (kg N) per unit (Kg) of milk solids produced declined max (2000) to min (2011) years by 26% (0.3 to 0.22).
    - Productivity per cow and hectare (12% and 26%)
  - Win-win / double dividend scenario – Increased economic returns to agricultural production and reduced source pressure