Efficient use of N on grassland

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Moorepark
Annual Fertilizer N use and expenditure on fertilizer N in Ireland

Fertilizer N use (000 t)

Expenditure on fertilizer N (000,000 €)
Overview

The fate of N in the soil

Rainfall and evapo-transpiration

Sunlight and soil temperature

Meeting sward requirements

Stocking rates and application patterns

Making use of white clover on farms
The fate of N in the soil
(1) Uptake by the grass sward

(2) Leached from the soil

(3) Denitrified from the soil

5 to 8 Weeks
Ammonium $\rightarrow$ Nitrate $\rightarrow$ Leaching $\rightarrow$ Gaseous Emission

- $\text{NH}_4^+$
- $\text{NO}_3^-$
- $\text{N}_2$
- $\text{N}_2\text{O}$
- $\text{O}_2$
Rainfall & Evapo-transpiration
Rainfall & Evapo-transpiration

mm/month

Month

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
Soil Water Balance

Volatilization of ammonia

N losses
i. Denitrification
ii. Ammonia
iii. Nitrate
Sunlight & Soil Temperature
Global Solar Radiation (kiloJoules/cm²)

Month

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

kiloJoules/cm²
Soil Temperatures at 10 cm
Response to fertilizer N during the Spring

% of Y-Max.

1-Dec  
22-Dec 
12-Jan 
2-Feb  
23-Feb

80  
85  
90  
95  
100
Herbage production response to spring application of fertilizer N

Herbage DM yield (kg/ha) vs. Fertilizer N input (kg/ha)

- €90 per t DM
- €195 per t DM
Annual Grass Growth

(kg DM/ha/day)

Best Response to N
High Response to N
Poor Response to N
Summary: Rainfall & Evapotranspiration

High risk of loss during the spring

Split application during the spring

30 kg N/ha during mid-Jan to end Feb.

Followed 6 to 4 weeks later by second application

Volatilization during summer → CAN (CAN-type fertilizers)

N retained in topsoil during summer months

Cease applying fertilizer N by mid-September
Meeting Sward Requirements
Net mineralization of soil organic matter N

140 kg N/ha/year

Supply of Background N

Soil Organic Matter N Pool
~ 7000 kg/ha
Factors affecting fertilizer N use on farms

Background soil N availability (kg/ha)
The impact of soil pH on availability of N in soil
Meeting sward requirements

Background release of soil N

Background release of N from the SOM

(kg N/ha/day)
Matching supply with demand

Background release of N from the SOM

Compounds v. straights
N:K and N:S
Stocking Rates
&
Application Patterns
<table>
<thead>
<tr>
<th>Whole farm stocking density</th>
<th>Area harvested for silage</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First cut</td>
<td>% of farm area</td>
<td>Second cut</td>
</tr>
<tr>
<td>LU/ha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>43</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>45</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>47</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>49</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>51</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>53</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>55</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>54</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Nitrogen application throughout the year

Recommended rates of fertilizer N for grassland during the year where approximately half of the farm is cut for first-cut silage and the amount of second cut is kept to a minimum (0 – 30% of the grassland area). Rates of fertilizer N are presented in kg per ha (units per acre in brackets).

<table>
<thead>
<tr>
<th>Stocking rate (kg/ha organic N)</th>
<th>Jan/Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Total (kg/ha)</th>
<th>Total (u/ac.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 – 170</td>
<td>0</td>
<td>28 (23)</td>
<td>43 (35)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>25 (20)</td>
<td></td>
<td>164</td>
<td>(133)</td>
<td></td>
</tr>
<tr>
<td>170 – 180</td>
<td>28 (23)</td>
<td>28 (23)</td>
<td>43 (35)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>25 (20)</td>
<td></td>
<td>192</td>
<td>(156)</td>
<td></td>
</tr>
<tr>
<td>180 – 190</td>
<td>28 (23)</td>
<td>37 (30)</td>
<td>49 (40)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td></td>
<td>216</td>
<td>(175)</td>
<td></td>
</tr>
<tr>
<td>190 – 200</td>
<td>28 (23)</td>
<td>49 (40)</td>
<td>49 (40)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>25 (20)</td>
<td>253</td>
<td>(205)</td>
<td></td>
</tr>
<tr>
<td>200 – 210</td>
<td>28 (23)</td>
<td>49 (40)</td>
<td>49 (40)</td>
<td>51 (41)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>279</td>
<td>(226)</td>
<td></td>
</tr>
<tr>
<td>211 – 250</td>
<td>28 (23)</td>
<td>43 (35)</td>
<td>49 (40)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>34 (28)</td>
<td>25 (20)</td>
<td>247</td>
<td>(200)</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Nitrogen fertilizer for different stocking rates on the area available for grazing during the year. Rates of nitrogen fertilizer are presented in kg per ha

<table>
<thead>
<tr>
<th>Stocking rate (LU/ha)</th>
<th>Nitrogen fertilizer kg/ha</th>
<th>Stocking rate (LU/ha)</th>
<th>Nitrogen fertilizer kg/ha</th>
<th>Stocking rate (LU/ha)</th>
<th>Nitrogen fertilizer kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mid March</strong></td>
<td></td>
<td><strong>May &amp; June</strong></td>
<td></td>
<td><strong>July &amp; August</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;1.2</td>
<td>0</td>
<td>&lt;3.5</td>
<td>28</td>
<td>17</td>
<td>&lt;2.00</td>
</tr>
<tr>
<td>1.2 – 1.4</td>
<td>28</td>
<td>3.50 – 3.75</td>
<td>28</td>
<td>26</td>
<td>2.0 – 2.5</td>
</tr>
<tr>
<td>1.4 – 1.6</td>
<td>28</td>
<td>3.75 – 4.00</td>
<td>38</td>
<td>34</td>
<td>2.5 – 3.0</td>
</tr>
<tr>
<td>1.6 – 1.8</td>
<td>28</td>
<td>4.00 – 4.25</td>
<td>49</td>
<td>42</td>
<td>3.0 – 3.5</td>
</tr>
<tr>
<td>&gt;1.8</td>
<td>28</td>
<td>&gt;4.25</td>
<td>49</td>
<td>51</td>
<td>&gt;3.5</td>
</tr>
</tbody>
</table>

Note: Jan/Feb, March, April, May, Jun, Jul, Aug, Sep refer to months.
Making efficient use of fertilizer N – Fertilizer N

Apply 23 units per acre in January/February (SR > 170 kg/ha)

Follow up with more fertilizer N within 6 weeks – mid-March

Third application to coincide with closing for silage in April

Maximise stocking rate on grazing area during April to June

Make all or most silage as first-cut – minimise second-cut

Large area of farm available for grazing from June onwards

Start building covers during late July or early August

Last application during early September
Making use of white clover on Farms
The relationship between white clover herbage yield and N fixation at Solohead Research Farm
The milk price (+) at which the profitability of WC would have equalled FN between 1990 and 2010 and projected to 2020 based on the increase in fertilizer N price between 1997 and 2010 (R² = 0.77; P < 0.001)
Actual milk price (●) and the milk price (+) at which the profitability of WC would have equalled FN between 1990 and 2010 and projected to 2020 based on the increase in fertilizer N price between 1997 and 2010 (R² = 0.77; P < 0.001)
Making efficient use of fertilizer N – White Clover

Large potential to cut fertilizer N use of farms – can be halved

Biological N fixation = 100 to 200 kg per ha per year

Recommended for stocking rates up to 2.5 LU per ha

Low fertilizer N input and tight grazing are important

Introduce clover by reseeding, over-sowing & management

Suits farms where a long grazing season can be achieved

Sensitive to shading over winter and poaching damage

Bloat & dock control are not serious impediments
<table>
<thead>
<tr>
<th>Two Farms – SR 2.2 cows/ha</th>
<th>Inefficient</th>
<th>Efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil pH</td>
<td>5.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Slurry management</td>
<td>after silage &amp; last grazing</td>
<td>Jan/Feb &amp; March - silage</td>
</tr>
<tr>
<td>White clover content</td>
<td>None</td>
<td>~20%</td>
</tr>
<tr>
<td>Background N (kg/ha)</td>
<td>115</td>
<td>150</td>
</tr>
<tr>
<td>Available N slurry (kg/ha)</td>
<td>5</td>
<td>35</td>
</tr>
<tr>
<td>N fixed by clover (kg/ha)</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td>Supply of non-fertilizer N (kg/ha)</td>
<td>120</td>
<td>305</td>
</tr>
<tr>
<td>Fertilizer N requirement (kg/ha)</td>
<td>275</td>
<td>90</td>
</tr>
<tr>
<td>Total soil N supply (kg/ha)</td>
<td>395</td>
<td>395</td>
</tr>
<tr>
<td>Cost of fertilizer (€/ha)</td>
<td>275</td>
<td>90</td>
</tr>
<tr>
<td>Cost on 50 ha farm (€)</td>
<td>13,750</td>
<td>4,500</td>
</tr>
</tbody>
</table>