Agricultural Lime – pH Matters

British Survey of Fertiliser Practice (and other matters)

Chris Dawson
The use of lime as an application to the soil is of high antiquity, and its utility has been recognised in almost every country in which agriculture has attained to any degree of perfection. In our country it has been called the basis of all good husbandry—and it certainly is more largely and more extensively used than any other mineral substance which has ever been made available in practical husbandry. I hope, therefore, I shall be rendering a service to agriculture by bringing together in the following little work the greater part of what we as yet know, in regard to the practice and theory of the use of lime.
Estimated use of lime in UK
(data from ALPC, MAFF, Defra & BSFP)

Lime subsidy removed
GB only
Matters for discussion

• Main factors influencing need for lime:
  – Acidic deposition;
  – Ammonium nitrogen;
  – N-fixing by legumes;
  – Use of elemental sulphur;
  – Leaching of anions.

• Use of liming materials in the UK:
  – BSFP;
  – PAAG.

• Conclusions.
Changes in sulphur dioxide emissions in the UK since 1850
Recent reductions in emissions of sulphur dioxide in W Europe (UNECE/EMEP, June 2001)

UK sulphur emissions 2010: 406 kt SO₂
Spatial distribution of rainfall acidity

1986

[Map showing acidity levels in 1986]

2008

[Map showing acidity levels in 2008]

www.rotap.ceh.ac.uk/
Application rates of nitrogen (N) on arable and grassland in the UK since 1950 (BSFP)

N on arable

N on all crops and grass

N on grassland

BSFP Reports: www.defra.gov.uk/statistics/foodfarm/enviro/fertiliserpractice/
Some chemistry on the need for lime

Nitrification of ammonium:
\[ \text{NH}_4^+ + 2\text{O}_2 = \text{NO}_3^- + 2\text{H}^+ + \text{H}_2\text{O} \]

Oxidation of sulphur:
\[ 2\text{S} + 3\text{O}_2 + 2\text{H}_2\text{O} = 2\text{SO}_4^{--} + 2\text{H}^+ \]

Leaching of anions:
\[ 2\text{NO}_3^- + \text{Ca}^{++} \quad 2\text{SO}_4^{--} + \text{Mg}^{++} \]
% arable area receiving lime, 
England & Wales and Scotland (BSFP data)

% arable area limed 
England and Wales 
Scotland

BSFP Reports: www.defra.gov.uk/statistics/foodfarm/enviro/fertiliserpractice/
% total managed grass area receiving lime, England & Wales and Scotland (BSFP data)
% GB areas receiving lime in 2011 season

- Winter wheat
- Spring barley
- Winter barley
- Winter oilseed rape
- Sugar beet
- Forage maize
- All tillage
- Grass under 5 years
- Grass 5 years and over
- All grass
- All crops & grass

% GB areas receiving lime in 2011 (Source: BSFP, 2011)
% GB areas receiving lime vs. 5-yr average

Winter wheat
Spring barley
Winter barley
Winter oilseed rape
Sugar beet
Forage maize
All tillage
Grass under 5 years
Grass 5 years and over
All grass
All crops & grass

% GB areas receiving lime (Source: BSFP, 2011)
Estimated tonnage of agricultural liming materials used in Great Britain

source: British Survey of Fertiliser Practice
Use of 'mainstream' and 'other' liming products in Great Britain

Source: British Survey of Fertiliser Practice
PAAG estimates of changes in soil pH:
1995-2003 average vs. 2004-2012

PAAG Reports: www.pda.org.uk/paag-soil-analysis.html
2009-12 average % of arable and grassland soil samples by pH bands (PAAG data)

- **Arable pH groups**
  - <5.0: 1.2%
  - 5.0-5.5: 15.4%
  - 5.5-6.0: 12.1%
  - 6.0-6.5: 20.8%
  - 6.5-7.0: 20.8%
  - 7.0-7.5: 11.7%
  - 7.5-8.0: 10.3%
  - >8.0: 2.7%

- **Grassland pH groups**
  - <5.0: 2.8%
  - 5.0-5.5: 20.8%
  - 5.5-6.0: 20.8%
  - 6.0-6.5: 20.8%
  - 6.5-7.0: 11.7%
  - 7.0-7.5: 10.3%
  - 7.5-8.0: 5.4%
  - >8.0: 2.7%

- **Average % of soil samples in each pH grouping**
  - Arable: 39.3%
  - Grassland: 58.5%
Distribution of pH in arable and grassland soil samples, 2011-12
(Source: PAAG report)

Arable soils     pH grouping     Grassland soils
% of samples analysed

<5.0            5.00-5.49       >8.0
5.00-5.49       5.50-5.99       5.50-5.99
6.00-6.49       6.00-6.49       6.00-6.49
7.00-7.49       7.00-7.49       7.00-7.49
7.50-7.99       7.50-7.99       7.50-7.99
>8.0            >8.0

41%          53%
General guidance

• About 375 kg lime/ha/year is needed to offset soil acidification from dry and wet acid deposition.
• About 500 kg lime/ha/year is required to offset the acidification from every 50 kg/ha of ammonium N.

Clover-based systems, fixing about 250 kg N/ha/year require about 400-800 kg lime per year.
An equivalent 250 kg N/ha/year from ammonium nitrate will require about 1000-1200 kg lime/year.

Updated from: IFS Proc 410, 'Lime, liming and the management of soil acidity', Goulding and Annis.
pH and nutrient availability

www.pda.org.uk/leaflets.html#lf24 (after Truog, 1946)
Conclusions

• Agricultural soils will become acidic naturally.
• Lime is a necessary input on non-calcareous soils.
• Many UK soils are inadequately limed, even though less lime is required than was needed historically.
• Lack of lime and a resulting low pH and shortage of calcium will lead potentially to:
  – poorer soil structure;
  – reduced nutrient use efficiency;
  – impaired crop performance and profitability.
• Regular soil sampling is essential, with liming as necessary.