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The Importance of Liming

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Clue is in the name

Limkilns Farm

- Lime kilns commonly found near lime source
- Or a coastal location or port
- Limestone heated to 900 degrees c to produce quicklime

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Macaulay Soil Maps

- Canonbie Series

Brown forest soil with non calcareous gleying

- Soil Capability

Mostly index 3.1 and 3.2 (wide range of crops)

Line of index 4.2 runs from east to west on line with Milnby Burn (mostly grassland with occasional cropping)

What do plants need to grow?

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- Light
- Water
- Heat
- Air
- Nutrients – soil, fert, FYM, slurry

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Essential Nutrients

- **Nitrogen** – proteins/amino acids needed for growth
- **Phosphorus** – root development, DNA, cell membranes
- **Potassium** – enzymes for photosynthesis and respiration
- **Magnesium** – chlorophyll
- Sulphur – secondary nutrient
- Trace Elements

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Where does lime come in?

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- Lime is not a fertiliser
- pH is a measure of how acid or alkaline the soil is
- pH is a measure of $H+$ ions attached to soil
- Low pH = high number of $H+$ ions
- The pH impacts on how available the soil nutrients are

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What Happens?

Removal of H^+ ions:

$CaCo^3 + 2H^+ \longrightarrow Ca^{2+} + HCO^3$

(carbonate)

$HCO^3 + H^+ \longrightarrow H^2O + CO^2$

(bicarbonate)

$CaCO_3 + 2H^+ \longrightarrow Ca^{+2} + H_2O + CO_2$

Important bit is the **CARBONATE CO^3** - not the calcium.

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What is pH?

Soil pH is a logarithmic scale to measure acidity
(Concentration of H+ ions)

pH3	pH7	pH11
Acid	Neutral	Alkaline

pH = -log 10 (H+ Concentration)

Soil of pH 5.0 is 10 times more acidic than a soil of pH 6.0

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Which is True?

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* Acid soils have a pH less than 7
* Soil pH 3 is 2 x as acidic as a soil of pH 6
* Soil pH 3 is 3 x as acidic as soil of pH 6
* Soil pH 3 is 1000 x as acidic as a soil of pH 6

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What happens?

- Lime displaces H+ ions attached to clay particles
- Flocculation occurs aiding soil structure and workability of soils
- pH rises improving essential nutrient availability

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What's the right pH?

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Depends on:

Crop

Soil Type

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In groups - list your crops and enter what you think is a the crop damaging pH level

List of Crop Type	Danger Level pH
PGRS	
TGRS	
S Barley	
W Wheat	
Potatoes	

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What's the danger level pH – arable crops?

Below 5		risk of failure of all arable crops
	5.0	Potatoes
	5.3	Oats
	5.5	Swede/Turnips
	5.5	Wheat
	5.7	Rape
	5.9	Barley
	6.0	Beans/Peas
Above 6.5 -		Induced Trace element deficiency risk

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What's the danger level pH – Grassland?

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5.3 Ryegrass, Timothy, Cocksfoot

5.6 White Clover

5.9 Red Clover

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What About Soil Type?

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Low pH 5.5 on a mineral soil

(below 12% organic matter)

- Iron & Aluminium are more soluble
- Interferes with plants metabolism
- Phosphate lock up occurs

Non mineral e.g. Humose and Peat soil do not contain either mineral so plant is less affected by low pH

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Soil Type and pH

Soil Type	pH
Other Mineral	6.3
Sandy Loam	6.2
Sands	6.1
Humose	6.0
Peats	5.7

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Soil Type and pH

- Sandy soils – larger soil particles compared with clay. Sands acidify more quickly than clays. Lime is leached from soil.
- Sandy soils need less lime at each application but require lime more often (‘*little and often*’ 3-4yrs)

Tonnes/ha lime requirement

	Sand		Sandy Loam		Other Mineral		Humose		Peat	
Soil pH	**Arable**	**Grass**	**Arable**	**Grass**	**Arable**	**Grass**	**Arable**	**Grass**	**Arable**	**Grass**
5.6	4	2	6	3	7	3	5	0	2	0

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Why do we need lime?

- To neutralise soil pH conditions towards pH 5.8 – 6.5
- Helps create optimal conditions for nutrient uptake.
- Bacteria and micro-organisms – like about pH 6
- Phosphate availability – increases steadily until ~ pH 6 - 6.5 (but drops off again after pH 6.5)
- Potassium availability – increases steadily until ~ pH 6 - 6.5
- Calcium and magnesium availability – increases steadily as pH rises until ~ pH 7
- Nitrogen availability – increases steadily until ~ pH 6
- But: manganese decreases rapidly above pH 6.5

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AVAILABILITY OF ELEMENTS TO PLANTS AT DIFFERENT pH LEVELS FOR MINERAL SOILS

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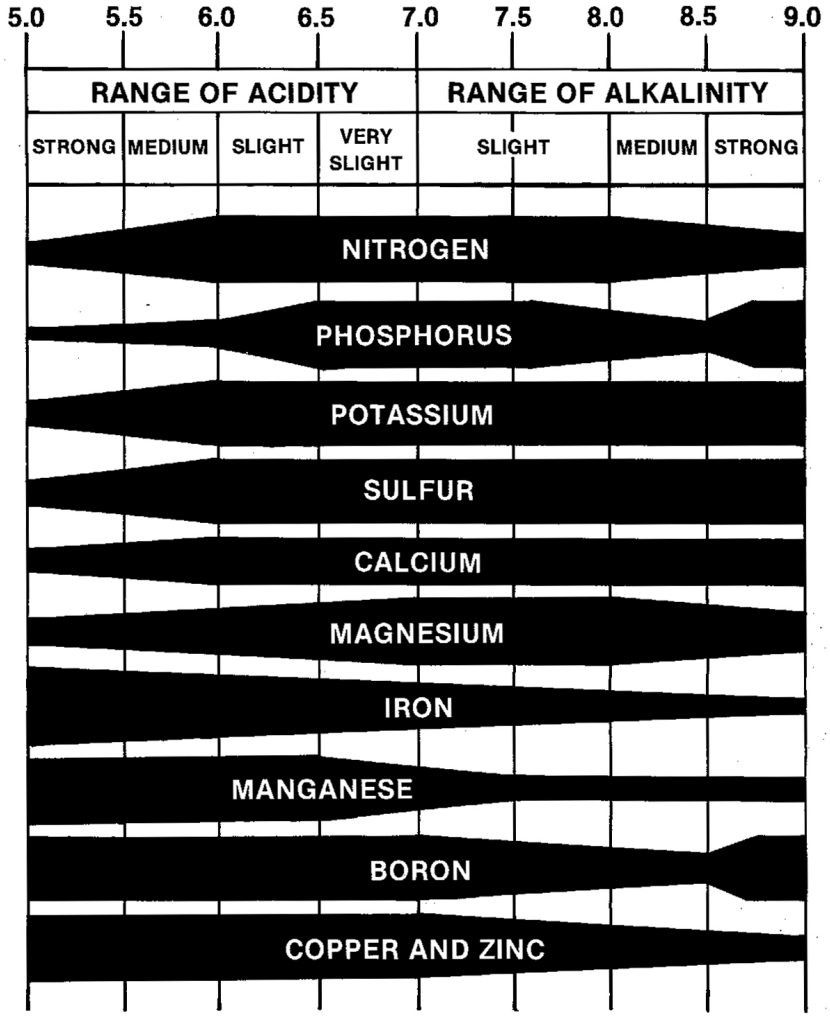

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Why Do We Need to Lime – Nutrient Availability

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% Nutrient Availability at different pH

	N	P	K
pH 5	53%	34%	52%
pH 5.5	77%	48%	77%
pH 6.0	89%	52%	100%

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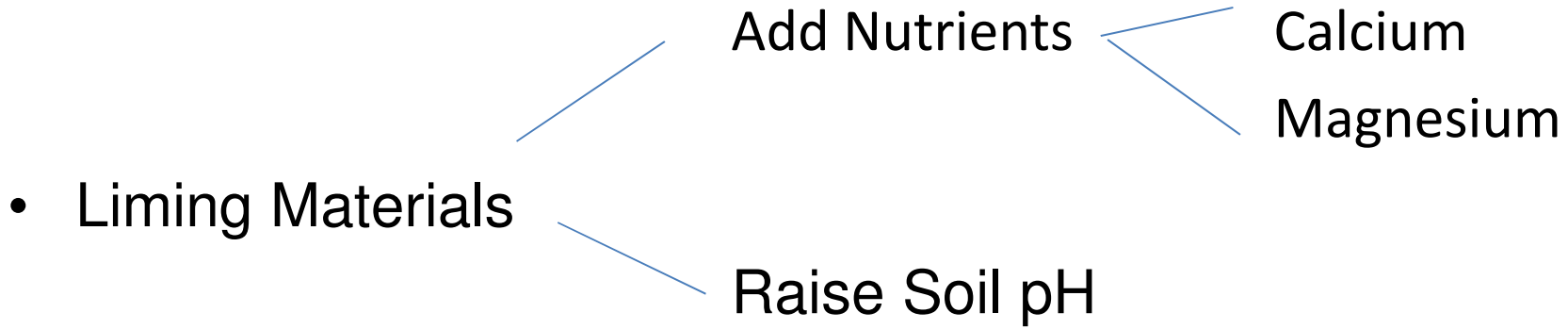
Effect of Liming Materials



Comparing Liming Materials Effectiveness

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Legal requirement to give **Neutralising Value (NV)**

"Liming value expressed as a % of liming potential of Calcium Oxide"

e.g. NV 45 = 45% as effective

Fineness of Grinding

"Size of particles present and is measured through a series of standard sieves"

Finer the material the quicker it will act, but too fine – dusty or can wet up.

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Over to You

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In your group list liming products and its neutralising value

Liming Product	Neutralising Value
Magnesian Limestone	

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What's Available?

Liming Material	Neutralising Value of % of CaO
Calcium Carbonate	56%
Magnesian Lime (dolomitic)	50-56%
Ground Limestone	48-50%
pHastlime (mixed lime)	58%
Steel Slag	42-43%
Hydrated Lime	70%
Burnt Lime (Industrial)	80-90%
Shell Sand	30-40%
Limex	20%
Waste Paper (High Calcium)	7%

Gypsum & Plasterboard is not a liming material though it contains calcium and sulphur.

How Much Lime?
Rules of thumb

pH drops 0.1 unit/year on intensive land

Need 1t/ha to lift 0.1 unit pH

Acidic Effect of Fertiliser

50kg of 34%N needs 25kg of lime to neutralise

…. therefore repeated applications of fertiliser naturally result in acidification of soils.

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How Much to Spread

pH 5.5

Crop Requirement 9t/ha or 3.6t/acre

Safe maximum at one go 2-2½t/acre

Excessive applications of lime may lock up the uptake of certain nutrients, e.g. trace elements, esp if pH rises well above 6.5

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When to Spread

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Lime takes time to work

- Autumn for a spring crop = Spread before ploughing

Otherwise:

- Autumn: for an autumn crop = Spread after field ploughed
- Spring : for a spring crop = Spread after field ploughed

Be wary of spreader causing soil compaction in poor ground conditions. (low ground pressure tyres on tractor and spreader)

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Effect of Over-liming?

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Too much lime can lift pH and reduce uptake of

- Manganese >pH 6.5
- Copper, Zinc, Boron > pH 7.0

- Livestock trace element deficiencies?

– raising low pH pasture reduces Cobalt availability

- Availability of other potentially toxic elements including heavy metals – Cadmiun, Chromium etc

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Prilled Lime Products?

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- Very fine – works very quickly – fire-brigade liming
- Short-acting – need to reapply frequently
- More expensive than ground lime
- Use to save a crop or buy a year in combination with ground limestone – costly for routine use
- Use in short term lets instead of ground products?
- Can be used to sort a pH problem
- No contractor required

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Compare Products

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Cost per unit of neutralising value (NV)

Cost/tonne of product incl delivery and spread divided by NV.

Magnesian Lime £25/t divided by NV 50

- Cost of Neutralising Value = £0.50 per unit NV

Prilled Lime £110 divided by NV 56

- Cost of Neutralising Value = £1.96 per unit NV

Soil Sampling

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If crop only needs pH 6.0 why raise target pH to 6.5?

Soil variability within field

- Soil type and texture
- Historic field mergers
- Past inaccurate spreading of lime products and acidifying fertiliser
- Commonly an average field pH has a range of +/- 0.5 pH

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Soil Sampling

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Traditional

- W pattern across field
- Approx 1 sample per acre
- Sample merged fields separately
- Different soil type separately

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GPS Sampling

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Grid Sampling

- ¼ ha grids with 12 soil samples per grid to pick up pH variability in arable fields.

At this sampling level spreading maps can remove pH variability across a field

- Can be done at ½ ha with 12 samples per grid less accurate

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GPS Grid Sampling for pH

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GPS Texture Map

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- Scan soil electrical conductivity (EC) at two depths
- Create a soil map of texture
- Sample these different zones for pH

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GPS Soil Mapping

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Benefits

- Targeted application where lime is required
- Remove large pH variations with a field
- All the benefits of liming but across the whole field

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Benefits of Liming

- Create the optimum soil conditions for nutrient uptake
- Healthy productive plant growth
- Animal health – uptake of trace elements
- Good bacterial activity in soil
- Aids soil structure
- Efficient use of fertiliser
- Reduced diffuse pollution

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