



WATSON SEEDS

pH & Soil Fertility

Unlocking your soil's potential to ensure our
grass & forage solutions deliver for your business



www.watsonseeds.com

INTRODUCTION

Watson Seeds have been providing a soil sampling service for our customers for more than a decade. In that time, we have built a large database of information. In 2015 & 2016 we identified 58.8% of the soils sampled, as below pH 6.0. In 2020 to 2022, 1446 samples were taken and still 3 in 5 samples were below 6.0 with 23% at 5.4 and lower. Phosphate levels showed 25% were deficient causing a 57% loss of DM production. Yet, 50% were index 3 & 4 and excessive but in many cases the Phosphate is locked up and unavailable due to other deficiencies in soil health.

No other soil characteristic is more important in determining the chemical environment of plants and soil microbes than the pH.

There are few reactions involving the soil, or its biological inhabitants, that are not sensitive to soil pH. Acidification is a natural process in soil formation that is accentuated in humid

regions where processes that produce hydrogen ions outpace those that consume them. Soil erosion, emissions from power plants and vehicles, as well as inputs of nitrogen into agricultural systems, are the principal means by which human activities accelerate acidification.

Soil pH also effects the activity of beneficial soil microbes. Bacteria and actinomycetes prefer alkaline pH levels, while fungi do better in acid conditions. Earthworms prefer a more neutral pH. Plants grow better when beneficial organisms are abundant in the soils, so a soil pH range of about 6.3 to 6.5 is ideal for most soils and most crops.

This brochure is intended as a simple guide for our customers that brings together a lot of information and data, much of it gathered during the era of "Food from our Own Resources" the April 1975 white paper on agricultural policy.



SAMPLING INSTRUCTIONS

WHEN TO SAMPLE

Samples for routine analysis should not normally be taken within 2 years of applying lime. Two months should elapse before sampling following an application of compound fertiliser, organic manure or more than 50kg/ha nitrogen.

WHERE TO SAMPLE

It is advisable to sub-divide large fields, even though they may appear uniform, and submit separate representative samples from every 4ha (10 acres). Separate samples should also be taken from areas of the field which have been manured differently or have different soil types or topography, even when there is only one crop.

Avoid the following areas: Headlands. Near Gates where loads of lime or manure may have been dumped and areas where livestock are fed or congregate.

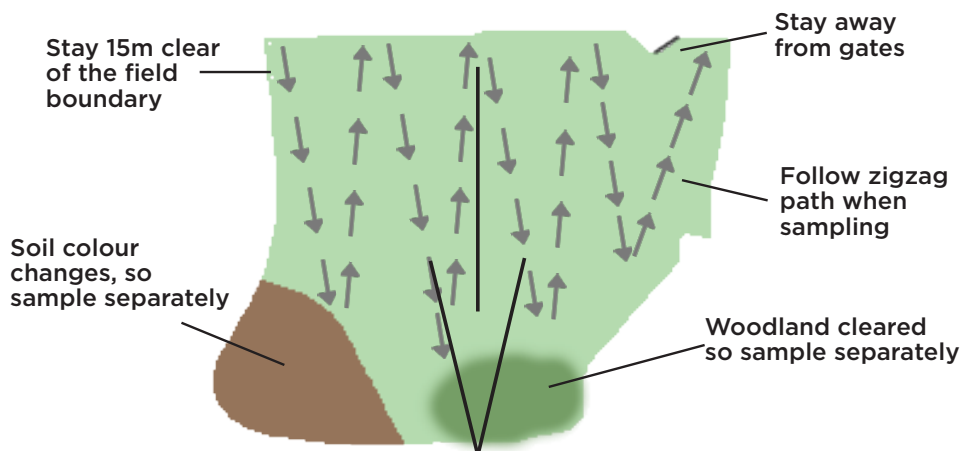
HOW TO SAMPLE

Soil pH varies with depth, so take care not to sample too deeply. Grassland should be sampled to 10cm (4 in) and arable land (including short-term rotation grass) to plough depth 20cm (8 in).

When sampling is done by spade, remove a slice of soil, about 2.5cm (1 in) thick, to sample depth, and collect in a clean plastic bucket. Further slices should be taken in the same way from different parts of the field, as illustrated in the diagram below, until about 20 have been collected. Mix the soil in the bucket thoroughly, and transfer a representative sample (1kg) to the marked bag.

When an auger is used, it should be twisted into the soil to sampling depth and then pulled out. All the soil adhering to it should be carefully transferred to the bucket. Further cores should be taken from different parts of the field, as illustrated in the diagram, until about 20 have been collected in the bucket and then thoroughly mixed before transferring to the sample bag.

Other sampling patterns may be preferred by the sampler. The net results should be the same, however, whichever route is followed, namely to produce a soil sample which is as representative as possible of the field being sampled. Remembering that 1kg of soil has to represent 2000 tonnes of topsoil per ha to a depth of 200mm.



Take at least 20 auger cores per sample. Ideally, 1 sample for every 4 hectares (10 acres)

CROPS & GRASSLAND

CROPS & CORRECTING LIMING

Lucerne, barley, sugar/fodder beet & peas are very sensitive to soil acidity. Beans, turnips, swedes & kale, wheat & clover are less sensitive while rye & oats can tolerate more acidity than other crops. Where there is a large lime requirement in excess of 8 tonnes/ha part can be ploughed down & the balance applied to the surface.

GRASSLAND

Serious shortages of lime on grassland encourages the formation of a matted layer of undecomposed grass on the soil surface. Under these conditions the better agricultural grasses die out and are replaced by inferior species like bent and Yorkshire Fog.

Clovers are usually absent in acid grassland although a few weak plants of wild white clover may survive. Red clover will not tolerate strongly acid conditions. Grassland may be limed at any time of year that will carry the weight of the spreader and full loads without damaging the sward, but stock should not be allowed access until rain has washed the lime off the herbage.

For improvement of acid grassland lime should be worked into the matted layer otherwise the mat is slow to decompose. The same applies to burning off an acidic sward with glyphosate, it takes time for the surface thatch to break down unless lime is worked in.

Because of the risk of over liming no more than 5 t/ha should be applied in one application where surface renovation is undertaken. On short-term grass leys where clovers are a key part of the mixture a moderate shortage of lime may cause poor growth by reducing the activity of the micro-organisms on the clover roots. Micro-organisms which fix atmospheric nitrogen to the benefit of clovers and associated grasses are very sensitive to soil acidity and it is essential that lime status of soil remains satisfactory if they are to function correctly. The target when setting out with these grass/clover leys is for an initial pH of at least 6.5 to get the vigorous stands of clover.



LIMING MATERIALS & NEUTRALISING VALUE

Liming materials should be purchased on the basis of the price relative to the neutralising value and fineness of the products on offer. The fineness will usually include the maximum size of particles and the amount passing a 150 micron sieve. The finer the grinding of the product the more rapid the rate at which neutralisation occurs, assuming the material does not blow away in the wind.

Neutralising value is a measure of the ability of the liming material to increase the soil pH value. Where products are similar in fineness they can be compared on the basis of cost per unit of neutralising value (% CaO). The cost of a unit of neutralising value is equal to the cost per tonne of lime (including delivery and spreading) divided by the neutralising value (% CaO)

As an example, currently a load of magnesium limestone delivered and spread in central Scotland is in the region of £37 per tonne. With a Neutralising Value of 48.0% = 0.77p per 1% of NV

For a comparison a sample of prilled calcifert lime in 600kg bags

is approximately £140 per tonne and spreading with a spinning disc spreader £25 per tonne. With a NV of 50.4% = £3.27 per 1% of NV

Forms of liming materials (with typical neutralising values from our independent 2022 analysis) in percent CaO include:

Ground Magnesian Limestone
(46.8%- 49.5%)

Ground Calcium Lime (Carboniferous)
(39.1% - 49.3%)

Ground Calcium Lime (Jurassic)
(43.5%- 50.4%)

Prilled Calcifert Lime (44.2% -50.7%)

Limex 70 (28%) Useful Amounts of P205 Sulphur.

Shell Sand (25-30%)

Fibrophos (14.5%)

Paper Sludge Crumble (2- 10%)

Gypsum (2.2%)

Haulage and distance from your lime source has become the single most significant factor in Scotland with a limited number of quarries particularly on the Eastern side of the country.



THE FERTILISER REGULATIONS & LIME

Liming materials in the UK are regulated under the 1991 Fertiliser Regulations which list 24 recognised materials including natural quarried limes.

Name of Material	Meaning	Declarations See notes below
Ground Limestone	Sedimentary rock consisting largely of calcium carbonate and not more than 15% of magnesium expressed as MgO and of which 100% will pass through a sieve of 5 mm, not less than 95% will pass through a sieve of 3.35mm and not less than 40% will pass through a 150 micron sieve	Neutralising value Any amount of material as a percentage by weight that will pass through a 150 micron sieve
Screened Limestone	Sedimentary rock consisting largely of calcium carbonate and not more than 15% of magnesium expressed as MgO and of which 100% will pass through a sieve of 5 mm, not less than 95% will pass through a sieve of 3.35 mm and not less than 20% will pass through a 150 micron sieve	Neutralising value Any amount of material as a percentage by weight that will pass through a 150 micron sieve
Limestone Dust		
Coarse Screened Limestone	Sedimentary rock consisting largely of calcium carbonate and not more than 15% of magnesium expressed as MgO and of which 100% will pass through a sieve of 5 mm, not less than 95% will pass through a sieve of 3.35 mm and not less than 15% will pass through a 150 micron sieve	Neutralising value Amount of material as a percentage by weight that will pass through a 150 micron sieve
Coarse Limestone Dust		
Magnesian Ground Limestone	Sedimentary rock consisting largely of calcium and magnesium carbonates and not less than 15% of magnesium expressed as MgO and of which 100% will pass through a sieve of 5 mm, not less than 95% will pass through a sieve of 3.35 mm and not less than 40% will pass through a 150 micron sieve	Neutralising value Amount of material as a percentage by weight that will pass through a 150 micron sieve
Magnesian Screened Limestone	Sedimentary rock consisting largely of calcium and magnesium carbonates and not less than 15% of magnesium expressed as MgO and of which 100% will pass through a sieve of 5 mm, not less than 95% will pass through a sieve of 3.35 mm and not less than 20% will pass through a 150 micron sieve	Neutralising value Amount of material as a percentage by weight that will pass through a 150 micron sieve
Name of Material	Meaning	Declarations See notes below
Course Magnesian Screened Limestone	Sedimentary rock consisting largely of calcium and magnesium carbonates and not less than 15% of magnesium expressed as MgO and of which 100% will pass through a sieve of 5 mm, not less than 90% will pass through a sieve of 3.35 mm and not less than 15%	Neutralising value Amount of material as a percentage by weight that will pass through a 150 micron sieve.
Course Magnesian Screened Limestone Dust		
Chalk	Cretaceous limestone	Neutralising value
Ground Chalk	Cretaceous limestone of which 98% will pass through a sieve of 6.3 mm	Neutralising value
Screened Chalk	Cretaceous limestone of which 98% will pass through a sieve of 45 mm	Neutralising value
Ground Burnt Lime	Commercial calcium oxide containing not more than 27% magnesium as MgO and of which 100% will pass through a sieve of 6.3 mm	Neutralising value
Kibbled Burnt Lime	Commercial calcium oxide containing not more than 27% magnesium as MgO and of which 100% will pass through a sieve of 45 mm	Neutralising value
Burnt Lime	Commercial calcium oxide containing not more than 27% magnesium as MgO	Neutralising value
Magnesian Ground Burnt Lime	Commercial oxide obtained from magnesian limestone containing more than 27% magnesium as MgO and of which 100% will pass through a sieve of 6.3mm	Neutralising value

SOIL ACIDITY & LIMING

Not correcting soil acidity can cause large yield losses, but overuse of lime is wasteful and costly, can create problems with the availability of some micro-nutrients.

TABLE 1.1: OPTIMUM SOIL pH^a *

CROPPING SYSTEM	MINERAL SOILS	PEATY SOILS	ORGANIC	SUBSOIL
Continuous arable cropping	6.5 ^b	5.8	6.0	6.3
Grass with an occasional barley crop	6.2	5.5	5.7	6.0
Grass with an occasional wheat or oat crop	6.0	5.3	5.5	5.8
Continuous grass or grass-clover swards	6.0	5.3	5.5	5.8

- a. The optimum pH is based on soil that has been correctly sampled. In some soil samples containing fragments of free lime, analysis of the ground-soil sample in the laboratory can give a misleading high value for pH.
- b. In arable rotations, maintaining soil pH between 6.5 & 7.0 is justified if you are growing acid-sensitive crops such as sugar beet.



LIME RECOMMENDATIONS

For each field, the amount of lime to apply depends on the current soil pH, soil texture, soil organic matter and the target pH, which should be 0.2 pH points above optimum. Clay and organic soils need more lime than sandy soils to increase pH by one unit. A lime recommendation is usually for a 20cm depth of cultivated soil or a 15cm depth of grassland soil.

Table 1.2 gives examples of the recommended amounts of lime (t/ha) of ground limestone or chalk, neutralising value (NV 50-55) required to raise the pH of different soil types to achieve the target pH level shown in the footnotes.

TABLE 1.2: LIME RECOMMENDATIONS IN TERMS OF TONNES OF LIME (NV50) TO APPLY PER HECTARE *

SOIL TYPE		LIMING FACTOR	LIMING RECOMMENDATIONS (t/ha)			
			Initial soil pH 6.2	Initial soil pH 6.0	Initial soil pH 5.5	Initial soil pH 5.0
Sands & loamy sands	Arable	6	3	4	7	10
	Grass	4	0	0	3	5
Sandy loams & silt loams	Arable	7	4	5	8	12
	Grass	5	0	0	4	6
Clay loams & clays	Arable	8	4	6	10	14
	Grass	6	0	0	4	7
Organic soils ^a	Arable	8	4	6	10	14
	Grass	6	0	0	4	7
Peaty soils ^b	Arable	16	0	0	8	16
	Grass	12	0	0	0	6

- a. For mineral and organic soils, the target soil pH is 6.7 for continuous arable cropping and 6.2 for grass. Aim for 0.2 units above the optimum pH.
- b. For peaty soils, the target soil pH is 6.0 for continuous arable cropping and 5.5 for grass. Aim for 0.2 units above the optimum pH.

*These figures are from the latest RB209 recommendations

CALCIUM & MAGNESIUM

All plants need calcium, but some plants need more calcium than others. Legumes require larger amounts of calcium than magnesium.

Calcium is important in many cellular functions and no matter what the crop higher calcium levels improve root growth, disease resistance and crop quality. Calcium improves soil structure and helps bring other elements into line, it also stimulates beneficial soil organisms.

Magnesium lime has historically been used widely in the North of England and Scotland due to its availability as a competitively priced liming source with a low extraction cost. High magnesium levels are undesirable not only because they exclude calcium but also because in some soils higher magnesium tends to bind clay particles together leading to tight soils and poor soil structure. Ideally a calcium to magnesium ratio of 5:1 to 7:1 is desirable.

The reason basic slag was such a useful grassland fertiliser was its balance of 3.4% magnesium, phosphate levels of 7-22% (with good quality having 75% of the phosphate soluble in 2% citric acid), 32% calcium with its NV and a good range of trace elements.

Selecting your lime source to increase your calcium levels is crucial as under the regulations, calcium limestone can have up to 15% magnesium with a 5% tolerance. Top quality calcium lime will have up to 40% calcium with negligible magnesium, under 0.25%.

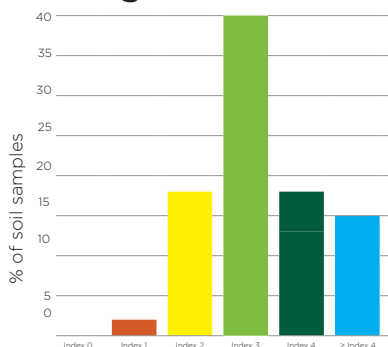
Other sources of calcium without the NV include gypsum at 22% and 0.35% magnesium.

SULPHUR

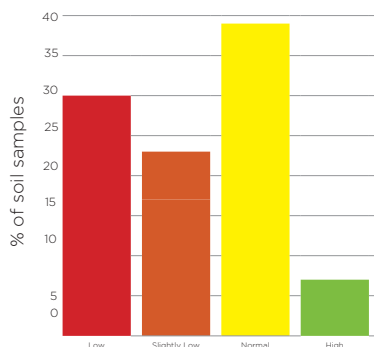
Sulphur was once a secondary element and was found in many fertilisers based on mined rocks and more came from air pollution. However, with the use of N-P-K fertilisers and lower sulphur from power station emissions, many crops are low or deficient.

Most crops take up as much sulphur as they do phosphate. In good biologically active soils 70/90% of the total sulphur is released each year from organic matter. About 55% of the sulphur in raw manure is released in the first year. Sulphur is necessary to produce quality, complete protein. It is needed for chlorophyll formation, root growth, and nitrogen-fixing root nodule bacteria. The balance between nitrogen and sulphur in the soil system is critical as to how much humus/OM is retained in a soil.

Magnesium Levels

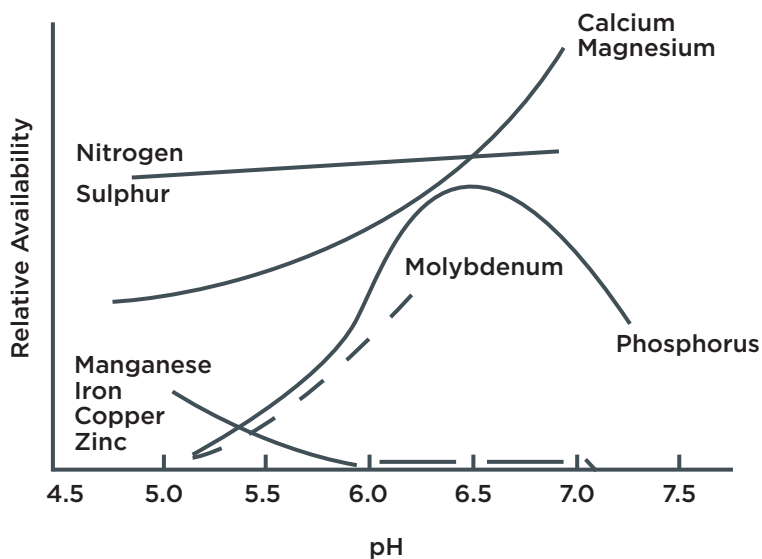
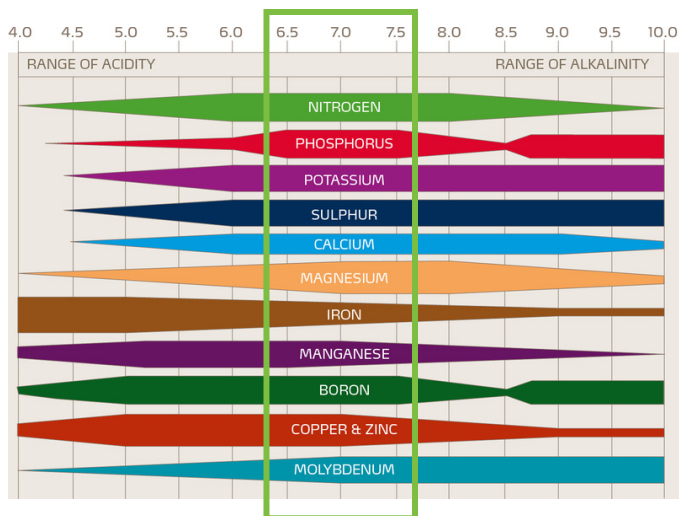


Calcium Levels





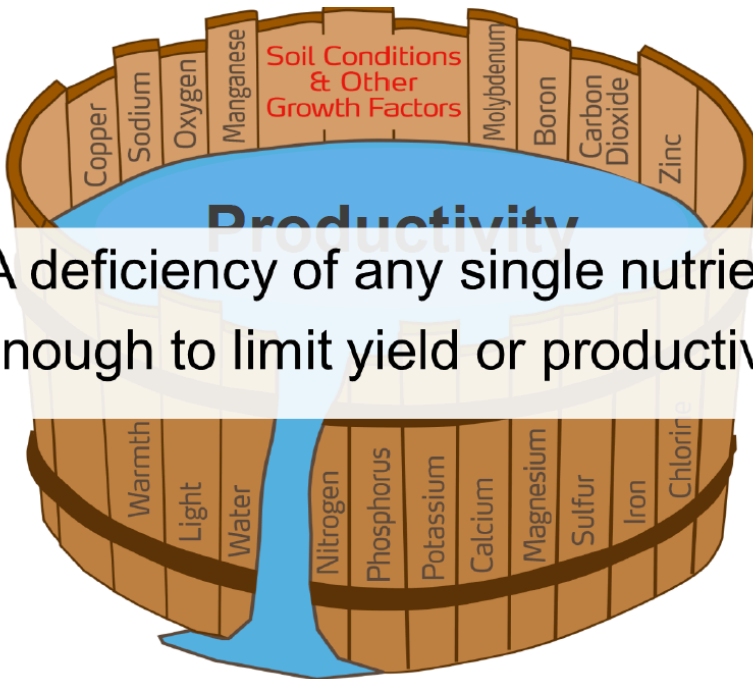
Soil pH impact on nutrient efficiency



The effects of soil pH on the relative availability of individual nutrients to plants.



GOING BEYOND THE BASICS



“A deficiency of any single nutrient is enough to limit yield or productivity.”



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