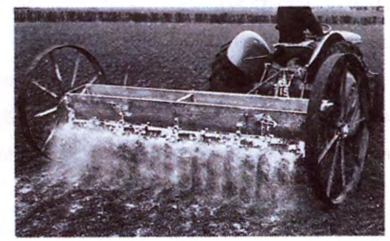
ala

agricultural lime

the natural solution

The Agricultural Lime Association is part of Mineral Products Association, the trade federation for the aggregate, coated materials and ready-mixed concrete industries.

AGRICULTURAL LIME THE NATURAL SOLUTION



Agricultural Lime Association

INTRODUCTION

Agricultural Liming is a fundamental aspect of soil husbandry which farmers throughout the world have recognised as playing a major role in overall profitability.

The decline in lime application has resulted in an increase in the proportion of soil samples exhibiting pH values below optimum in several regions in the UK. This means that the full agricultural potential for these soils has not been realised. In addition ALA believes that such soil acidification in catchment areas leads to adverse effects on water courses. The long term impact on the environment of agricultural liming by farmers has yet to be recognised. It is only now after several years of underliming in certain parts of the country that symptoms are being observed, such as fish loss and general decline in biological diversification of water courses, which may well be the result of changes in liming practice.

CONTENTS

Lime Losses 5

pH Value and Lime Requirements 7

Crop Requirements 9

Natural Liming Materials 11

Lime Effectiveness 14

Agricultural Liming 16

Fertiliser Utilisation 18

Liming for Profit 20

Lime and Upland Catchments 26

Liming in Forestry 28

Acknowledgements 30

Companies contributing to the production of this booklet. 31

Welcome to the revised edition of Agricultural Lime & The Environment.

agricultural lime the natural solution

The purpose of this booklet is to assist you, the user, by highlighting the benefits that the use of Natural Agricultural Lime will bring, both to your farming business and the environment.

The Agricultural Lime Association seeks to inform all users of the quality they should expect from all suppliers.

Agricultural Lime Association members have adopted a Quality Code of Practice and to this end all products sold by ALA members will conform to the current Fertilisers Regulations.

This booklet provides a number of reminders regarding the process to be followed when lime application is under consideration.
Two key messages are worth repeating:

Measurement of actual lime requirements of soil is a job to be carried out professionally.

Neutralising value, fineness and reactivity are the three factors which influence lime quality.

There are few improvements so easily and cheaply carried out which can have so fundamental an effect on the success or failure of crops and farming as the application of agricultural lime.

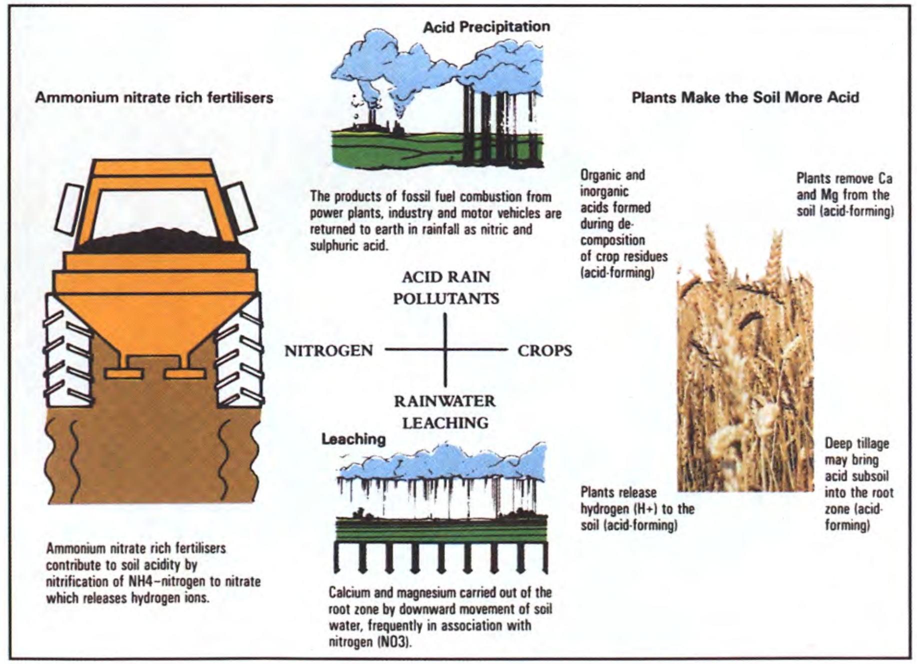
LIME LOSSES

Unless steps are taken to redress the balance of soils by applying a liming material there will be a natural reduction in the lime status of most soils. This results in a natural increase in acidity and in many cases a reduction in soil fertility.

Losses occur as a result of:–

- **LEACHING** The passage of water through the soil into the drainage system.
- **CROPPING** This loss varies with the type of crop and farming management.
- **FERTILISING** The use of concentrated fertilisers, particularly those with high ammonium nitrate contents accelerates lime loss.
- **POLLUTION** The effects of acid rain and various other pollutants.

LOSS MECHANISMS



The increased acidification of the natural environment by various pollutants including 'Acid Rain' raises issues of ecological significance not only for the Agricultural Industry, but also for Forestry and the Water Industry alike.

Acid soils in large areas of coniferous woodland give rise to acidic moorland streams and water courses which are unable to support fish and various algal species. This in turn has accelerated the increased acidification of fresh water lakes and reservoirs with the consequent change in their water chemistry.

The richness of our plant and animal ecology, the diversity in our fauna and flora, the health of our woodlands, and the quality and balanced chemistry of our water are all influenced by lime losses and soil acidity.

There are almost no soils in the United Kingdom where the lime status is naturally retained without loss from the factors previously outlined. The exception arises where a significant movement of liming material takes place by ploughing—such as on some of the thin soils over chalk where the chalk is ploughed up in quantity.

Soils over limestone do not, by and large, achieve any benefit from the liming material lying below.

LOCH FLEET

pH Value & Lime Requirements

The degree of soil activity and soil alkalinity is measured by what is known as the pH scale.

A figure of pH 7 represents the neutral position. Figures below 7 indicate increasing acidity and above 7 increasing alkalinity.

The optimum for general cropping is between pH 6.8 and 7.0.

For permanent grassland the optimum pH is slightly lower.

There are several methods of testing the pH of soils and with some knowledge of the relationship between pH and lime requirement for various soil types the pH can be used as a guide to the lime requirement.

ALA LIME APPLICATION RECOMMENDATIONS (tonnes/hectare)*

Measured soil pH	Sand and loamy sands		Sandy loams and silt loams		Clay loams and clays		Organic soils (10-25% organic matter)		Peaty soils above 25% organic matter	
	Arable	Grass	Arable	Grass	Arable	Grass	Arable	Grass	Arable	Grass
7.0	0	–	0	–	0	–	–	–	–	–
6.9	2	–	2	–	2	–	–	–	–	–
6.8	2	–	2	–	2	–	–	–	–	–
6.7	2	–	2	–	2	–	0	–	–	–
6.6	2	–	3	–	3	–	2	–	–	–
6.5	3	0	4	0	4	0	2	–	–	–
6.4	4	2	4	2	5	2	3	–	–	–
6.3	4	2	5	2	6	2	4	–	0	–
6.2	5	2	6	2	6	2	5	0	2	–
6.1	5	2	6	2	7	2	6	2	3	–
6.0	6	2	7	3	8	3	7	2	5	–
5.9	7	3	8	3	9	4	8	2	6	–
5.8	7	3	8	4	10	4	9	3	8	0
5.7	8	4	9	4	10	5	10	4	10	2
5.6	8	4	10	5	11	5	11	5	11	2
5.5	9	5	11	5	12	6	12	5	13	4
5.4	10	5	11	6	12	7	13	6	14	5
5.3	10	5	12	6	13	7	14	7	16	6
5.2	11	6	13	7	14	7	15	7	18	7
5.1	11	6	13	7	15	7	16	7	19	7
5.0	12	7	14	7	16	7	17	7	21	7
4.9	13	7	15	7	16	7	18	7	22	7
4.8	13	7	15	7	17	7	19	7	24	7
4.7	14	7	16	7	18	7	20	7	26	7
4.6	14	7	17	7	19	7	21	7	27	7
4.5	15	7	17	7	20	7	22	7	29	7

Notes:

1. Recommendation based on soil depths of 200mm/8in (arable) and 150mm /6in (grassland). Greater depths of soil will require more lime.

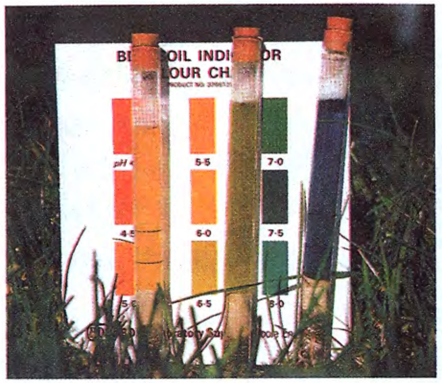
2. Maximum surface application for grass is 7 tonne/ha (3 tonne/acre). Minimum application rate: 2 tonne/ha (1 tonne/acre). Where application rates of over 10 tonnes/ha (4 tonnes/acre) are necessary on arable land the ALA lime should be applied as two dressings (first dressing ploughed in).

3. The application rates shown are based on material having a neutralising value of 54 and fineness of 40% passing 150 microns. When using other materials permitted under the Fertiliser Regulations the dressing should be adjusted accordingly. **Thus coarser materials and those having a lower neutralising value will also require a heavier dressing.**
See Lime Effectiveness (p.14).

*multiply by 0.4047 to obtain tonnes per acre.

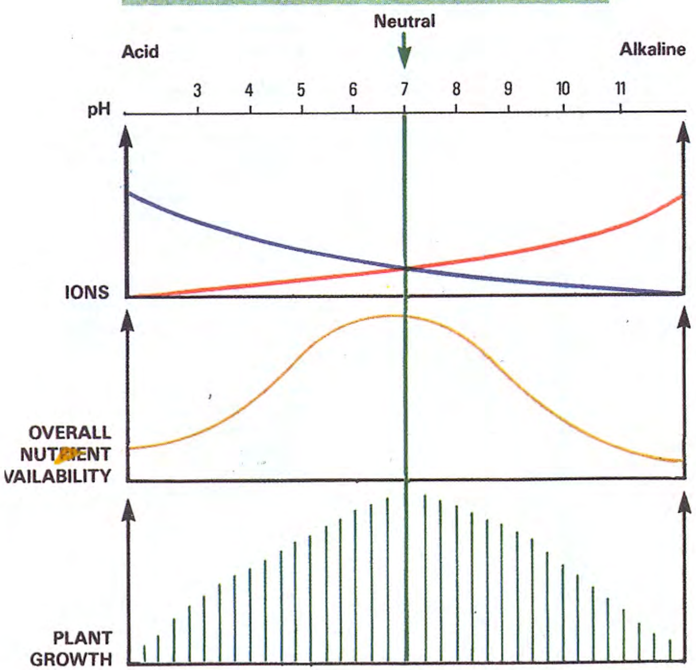
The above table is a guide to the lime requirement but the actual assessment should be undertaken professionally.

Soil samples should be taken methodically from a number of places in the field and tested individually since acidity frequently occurs in patches in the field. Test results should be plotted on a field map so that any lime required may be applied in the right place and at the correct and most economic rate. Although poor and patchy crop performance and the presence of acid loving weed species are rough indications of lime deficiency, the acid reaction to indicator solution or pH meter is the only reliable method of assessing lime requirements.



Reports based on bulk field samples are rarely reliable for lime status as they average out variations across fields and fail to identify deficient areas.

SOIL pH, NUTRIENT AVAILABILITY AND PLANT GROWTH



Acidity in the soil is the result of a build up of positively charged hydrogen ions. This build up is registered on the logarithmic pH scale (blue). The increase in calcium and/or magnesium ions as a result of liming is shown in red.

This has a definite effect on overall plant nutrient availability, the maximum availability to the plant being very near neutrality–pH7.

Plant growth follows very much the same pattern especially where a 'Lime Sensitive' crop is grown.

Crop Requirements

The replacement of calcium lost from the soil by leaching and crop uptake is essential to maximise production and profits from cereal crops. The growth of cereals of high protein content depends on stability of pH during the growing cycle; barley is an example. where sensitivity to soil pH is particularly apparent. Sugar beet also takes up nutrients most effectively in soils with a pH 6.5–7.0. Increasing acidity results in stunted plants and fangy roots.

The diagram overleaf provides a guide to the optimum pH levels for some important crops. If the soil pH is lower than the bottom of the indicated range, then crop yields will begin to suffer severely due to the crops' inability to tolerate that level of acidity.

Those crops which are tolerant to acidity would be more profitable at higher pH values. At a pH of 4.9 one is not getting as good a response from the fertilisers applied to maximise the potato crop as at the optimum pH.

Grassland (Derbyshire) growing on acid soil and displaying a predominance of Bent grasses and Yorkshire Fog in contrast (above) with Devon grassland established for three years on a soil at ph 6.0.

General view of part of a barley crop showing an acutely acid patch in which the majority of young plants had died out.

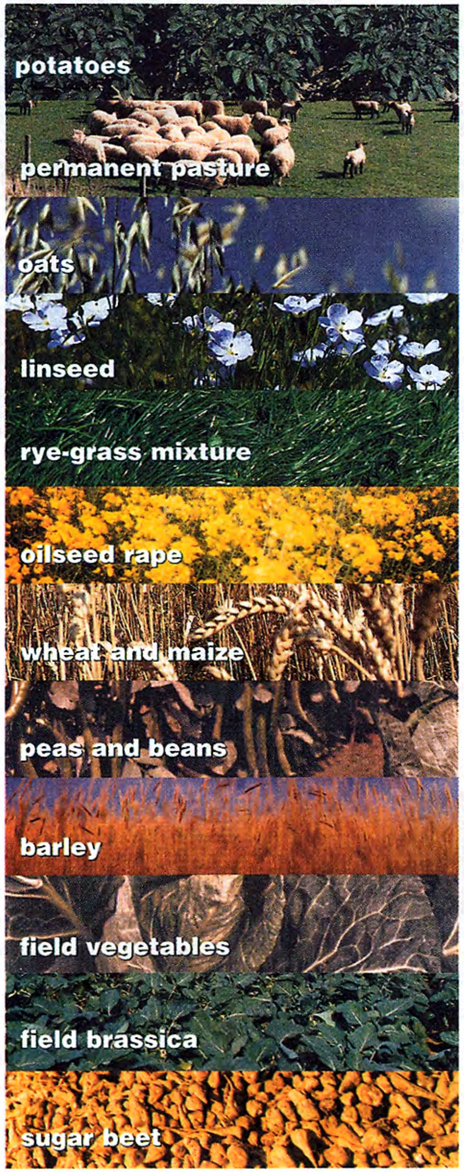
Below: The three central roots of sugar beet showing fanginess and poor root development attributed to acidity. The two outer roots were taken from better areas of the field.

Lime also aids soil fertility in grassland and ensures that added fertilisers are utilised to maximum effectiveness and helps to increase crop yield either as hay, silage, or grazing.

It is particularly important to adjust soil pH well in advance for sensitive crops such as oilseed rape, sugar beet, barley and peas. Spreading should be even, accurate, and cause little disruption to the soil structure.

The accurate measurement of the actual lime requirements of a soil should be carried out professionally.

OPTIMUM pH FOR CROP GROWTH



potatoes	5.5 - 6.5
permanent pasture	5.6 - 6.8
oats	5.5 - 7.0
linseed	6.0 - 7.0
rye-grass mixture	5.5 - 7.0
oilseed rape	6.0 - 7.5
wheat and maize	6.0 - 7.5
peas and beans	6.0 - 7.5
barley	6.5 - 7.5
field vegetables	6.5 - 7.5
field brassica	6.5 - 7.5
sugar beet	6.5 - 8.0

NATURAL LIMING MATERIALS

All ALA members supply agricultural lime in accordance with the current Fertiliser Regulations and the 'Statutory Statement' is provided to the initial purchaser.

The UK has a good spread of deposits of natural chalk and limestone suitable for this purpose, though Scotland is short of limestone and relies on imports to a large extent from the North of England.

The Fertiliser Regulations control the sale of agricultural liming materials. Quarry-produced materials can be sold under a number of permitted names (the term 'Agricultural Lime' alone is insufficient), each name has a precise meaning and associated declarations, which are required by law.

Farmers should ensure that such information is available to them at the time of delivery (as required by law) and that the lime quality is clearly identified at the time of quotation.

Name, meaning and declarations of some quarry-produced liming materials complying with The Fertiliser Regulations 1991

Name of material	Meaning	Declarations (see Note)
Ground limestone	Sedimentary rock consisting largely of calcium carbonate and containing not more than 15% of magnesium expressed as Mg0 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
Screened limestone **Limestone dust**	Sedimentary rock consisting largely of calcium carbonate and containing not more than 15% of magnesium expressed as Mg0 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
Coarse screened limestone **Coarse limestone dust**	Sedimentary rock consisting largely of calcium carbonate and containing not more than 15% of magnesium expressed as Mg0 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% 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 ground limestone	Sedimentary rock consisting largely of calcium and magnesium carbonates and containing not less than 15% of magnesium expressed as Mg0 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 containing not less than 15% of magnesium expressed as Mg0 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
Coarse magnesian screened limestone **Coarse magnesian limestone dust**	Sedimentary rock consisting largely of calcium and magnesium carbonates and containing not less than 15% of magnesium expressed as Mg0 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% 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
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 Mg0 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 Mg0 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 Mg0	Neutralising value
Magnesian ground burnt lime	Commercial oxide obtained from magnesian limestone containing more than 27% magnesium expressed as Mg0 and of which 100% will pass through a sieve of 6.3 mm	Neutralising value
Magnesian kibbled burnt lime	Commercial oxide obtained from magnesian limestone containing more than 27% magnesium expressed as Mg0 and of which 100% will pass through a sieve of 45 mm	Neutralising value
Magnesian burnt lime	Commercial oxide obtained from magnesian limestone containing more than 27% magnesium as Mg0	Neutralising value
Hydrated lime	Product obtained by slaking burnt lime or magnesium burnt lime of which not less than 95% will pass through a 150 micron sieve	Neutralising value
Mixed lime	A product resulting from mixing two or more forms of liming material specified in this schedule not being materials for which there is no minimum standard laid down in column 3 of this schedule, or material produced during the manufacture of commercial burnt lime or hydrated lime	Neutralising value Amount of material as a percentage by weight that will pass through a sieve with a mesh of 6.3 mm

Note The limits of variation (absolute value in percentage by weight) shall be 5.0% of the amount stated for all declarations.

This table has been extracted from The Fertiliser Regulations 1991 (SI No 2197).

LIME EFFECTIVENESS

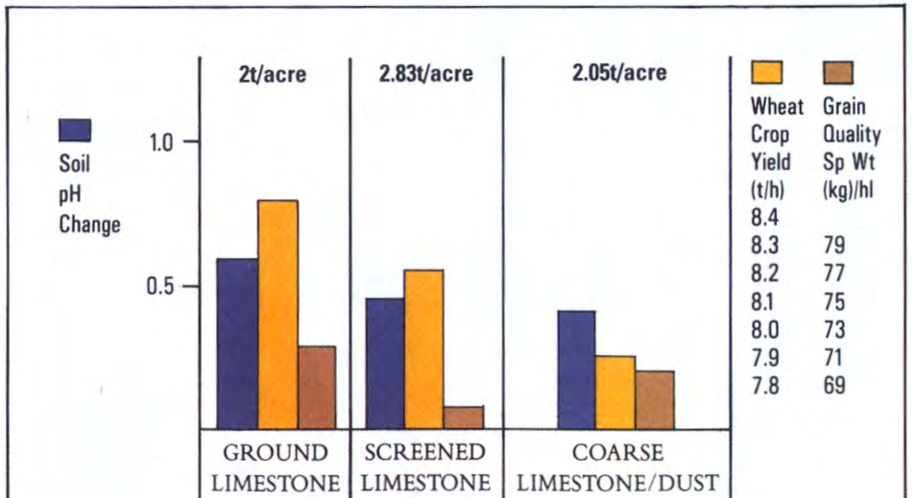
The effectiveness of a liming material is dependent upon its neutralising value, the fineness of grinding, reactivity and the relative hardness of the parent rock.

The neutralising value of a liming material is expressed in terms of the percentage of calcium oxide equivalent. Thus, 100 kg of a liming material with a neutralising value of 52% will have the same neutralising value as 52 kg of pure calcium oxide (Ca0). Neutralising value is determined in the laboratory and is calculated from the results of the chemical reaction with known strength hydrochloric acid, and always refers to the sample 'as received' rather than on a dry matter basis.

The effectiveness and speed of reaction of a liming material can be quantified in the laboratory using the "Reactivity Test". The results obtained from this test may be used to estimate the behaviour of a liming material in the soil. These results bear a good correlation with results obtained from long term pot trials.

The Reactivity Test involves the decomposition of the liming material in hydrochloric acid under stable pH conditions. The acid consumption during a given time is a direct criterion for the reaction time of the liming material being tested. The results of the test are expressed as a percentage, and they compare the speed and effectiveness of the sample with pure precipitated calcium carbonate.

ADAS FINENESS OF GRINDING TRIALS



	GROUND LIMESTONE	SCREENED LIMESTONE	COARSE LIMESTONE/DUST
Neutralising Value	53.6	37.9	52.2
Passing 150 Micron Sieve (%)	40.0	19.8	17.9

Sample of ground limestone undergoing testing at an ALA members' laboratory.

For maximum effectiveness, the harder and less porous the parent rock, the finer the liming material must be ground. An indication of the importance of the fineness of grinding can be seen from the field trial results shown on the previous page.

These field trials were carried out over a number of years. In the short term, the effect of the finer liming materials was even more marked.

Where lime is applied to an acid soil, there is a well proven relationship between the fineness of grinding and the crop yield response.

There is a considerable reduction in the effectiveness of liming materials containing particles above 600 microns (0.60mm, 60 mesh) unless the material is easily broken down.

Consequently, fineness is slightly less important in respect of:

a) Burnt lime which breaks down to a fine powder as a result of chemical reaction with water.

b) Soft, porous chalks which break down easily in the soil from the action of frost or the passage of cultivating implements.

The particle sizes of many waste limes such as sugar beet sludge are very fine, the moisture content can be high and the effectiveness of these materials can be impaired by the difficulty of obtaining an accurate and even spread. **Uneven spreading may result in over or under liming.**

Effective, economic liming will rely, not only upon the quality and suitability of the liming materials, but also upon having a soundly managed liming policy. The aim should be to maintain the lime status of the soil on a rotational basis. The cycle of the rotation will depend upon the locality, the type of soil, and the style of management. The rate of lime loss will need to be established from regular soil pH testing by ADAS or a reputable lime supplier. Annual lime losses vary considerably over the British Isles and a liming rotation cannot be established by guesswork.

The ultimate objective is to maintain the soil for arable crops at pH 7 and pH 6.5 for grassland. (Peaty soils should be maintained at pH 6.5 and pH 6 respectively).

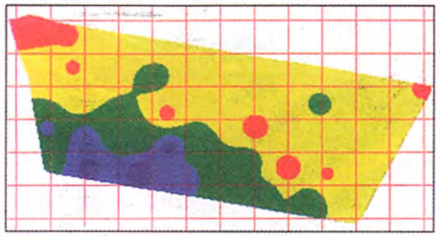
Neutralising value, fineness and reactivity are the three factors which influence lime quality.

AGRICULTURAL LIMING

The application of natural lime is, compared with the application of fertilisers, a long-term benefit. However, despite taking longer to be effective, natural lime makes a tremendous difference to the productive potential of arable and grassland, both in real terms and in economic terms.

Precision Field Mapping. *(photo courtesy of: Lindum Mapping Services)*

Typical Field Map.



ALA members use skilled operators and modern well maintained machinery suitable for the land and type of lime being spread. Spreading should be even, accurate and cause little disruption to the soil structure. The operation should be carried out in accordance with the liming recommendations made at the time of sale and with due regard for the surrounding land and property.

If you are concerned about scheduling your lime operation into an already tight work programme– talk to your ALA supplier about possible work options.

Lime spread carefully, with precision and accuracy, will enable maximum benefit to be obtained from every application. With ever increasing need to control and reduce inputs and maximise yields, the use of D.G.P.S. (Digital Global Positioning System) in producing soil maps combined with pH soil sampling must represent essential investment for the future.

The answer to the questions 'How often should I lime?' is, in general, 'As often as necessary to maintain a pH as near enough 7.0 on arable, with permanent grassland at 6.5'. To achieve these soil pH values during the growing cycle, ALA recommends liming to Target pH values shown below:

ALA Target pH	Arable	Permanent Grassland
Sands and loamy sands	7.0	6.5
Sandy loams and silt loams	7.0	6.5
Clay loams and clays	7.0	6.5
Organic soils (10-25% organic matter)	6.7	6.2
Peaty soils (above 25% organic matter)	6.3	5.8

Liming may be carried out at any time when ground conditions are suitable.

For arable land, lime is usually applied when the land is available after cropping. It is important to allow sufficient time for the soil to adjust to the correct pH before sowing. This can take several weeks, depending on the quality of lime used. It is particularly important to adjust soil pH well in advance of sensitive crops such as sugar beet, barley and peas.

Depth of Penetration

When agricultural lime is applied as a top dressing it will affect the surface layers. With time, rain will gradually wash the material to lower soil layers. When a soil is very acid throughout its depth, or when the lower soil layers are significantly more acid than the surface layers, it is advisable to plough in half the lime dressing and spread the remaining half on the ploughed surface. If such soils are only surface dressed there is a likelihood that the roots of acid sensitive crops will reach the acid layers of the soil and result in the crops exhibiting stress symptoms due to calcium deficiency.

Fertiliser Utilisation

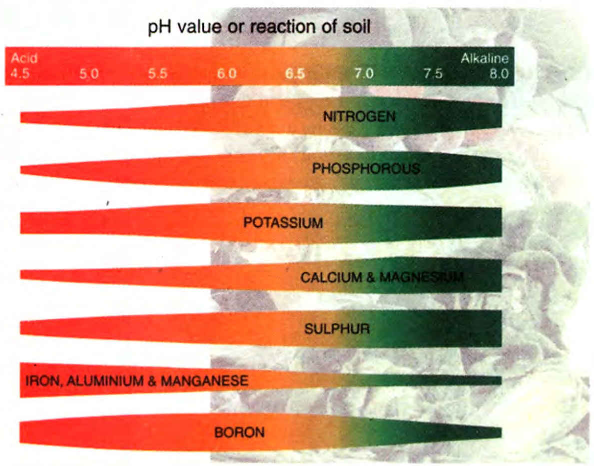
The availability of plant nutrients is affected by the pH of soil. The major plant nutrients nitrogen (N) phosphorus (P) and potash (K) as well as calcium and magnesium show a marked reduction in availability in acid conditions.

This diagram shows the scale of availability. The diagram illustrates the risk of shortage of iron, manganese and boron in alkaline conditions which, if not monitored, can give rise to specific problems in fruit and some root crops. The most important and significant illustration, however, is the increasing unavailability of the major and most commonly applied plant nutrients, nitrogen, phosphate and potash (N, P, and K) with increasing acidity. Maintaining an adequate balance annually requires constant attention and necessitates regular crop inspection and field-walking practice.

The addition of lime helps to release soil nutrients. Fertilisers and manure cannot be fully effective if the land is short of lime. In addition water that leaches from acid soils may contain undesirable materials which can adversely effect the quality of surface and groundwaters.

Heightened environmental controls and regulations on the disposal of sewage and other industrial wastes to landfill or sea outfalls have led to an annually increasing volume of application to agricultural land. These products do bring beneficial residual fertiliser and organic value to the soil. However, problems do arise as these wastes also contain a number of metallic and other inorganic contaminants. With repeated applications these contaminants accumulate in the soil and can remain indefinitely, causing restrictions on plant growth, increased uptake of metals by animals and man via the food chain and reductions in soil microbial activity. Heavy metals become more available in acid soils and adverse effects will then increase. When sludge or waste is applied there will be a need to maintain alkaline pH values for an indefinite period thereby inhibiting the release of heavy metals, whilst gaining the manurial values of the material.

PLANT FOOD AVAILABILITY CHART



The coloured bands show how liming makes essential plant nutrients more available and toxic aluminium less available. A pH of 6.5 - 7.0 (just on the acid side of neutral) is the best level.

When straw is incorporated there is a need to encourage the activity of aerobic bacteria to accelerate decomposition. **Bacteria can only flourish when the lime status is maintained.**

With the fixed and other variable costs to add to the cost of fertilisers, to say nothing of rent, and return on capital, it is essential that the correct pH level for the crop to be grown is looked upon as good agricultural practice in the efficient management of any profitable operation.

Regular liming in order to maintain appropriate pH levels also helps in achieving the right balance between profitable farming and environmental protection.

Certainly there are few improvements so easily and cheaply carried out which can have so fundamental an effect on the success or failure of crops and farming.

Liming For Profit

Natural Agricultural lime is used to correct acidity and provide the right conditions in which plants and aquatic life can develop.

Natural lime in the form of calcium carbonate or magnesian limestone has a major influence on:

plant development

efficient use of fertilisers

bacterial activity in the soil

animal health

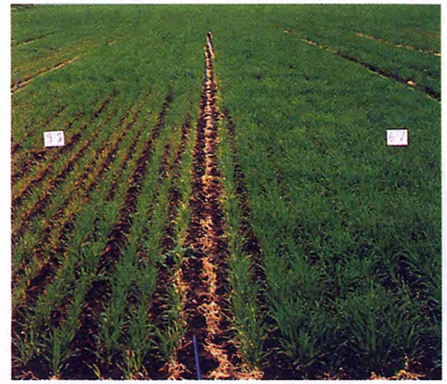
water quality in rivers and streams

development of woodland areas

soil structure

efficient use of some herbicides

The benefits of lime applications to arable crops were investigated by ADAS in an experiment sponsored by the Agricultural Lime Association. The trial site near Wetherby, North Yorkshire was on a sandy loam soil and had an initial pH value of 5.1 Lime requirement was 11t/ha (4.5t/acre).



The experiment assessed the effect of 0,5.5, 11 and 22 t/ha (0, 2.2, 4.5, and 9t/acre) of screened limestone applied during first winter.

Soil analysis results confirmed progressive increases in soil pH values with increasing rates of lime application. The highest soil pH values were achieved in the first or second year after lime application. After that the pH level began to decline.

At no stage did the recommended dressing of 11t/ha (4.5t/acre) achieve the target pH value of 6.7. **The results confirmed the reduced effectiveness of screened limestone compared with ground limestone.**

Four years after the initial lime treatments, further lime dressings were needed on plots receiving the 11t/ha (4.5t/acre) treatment. This is typical of the normal liming interval for light-textured soils in low rainfall areas.

The effects of the lime treatments on the growth and yield of sugar beet, spring barley and spring wheat were monitored for three years. Acidity symptoms were clearly visible in crops on the control plots which received no lime but there was no root or leaf damage on any of the limed plots. Crop growth was, however, more vigorous on the plots receiving the highest rate of lime, showing low soil pH can have an adverse effect on growth, even when no acidity symptoms are visible.

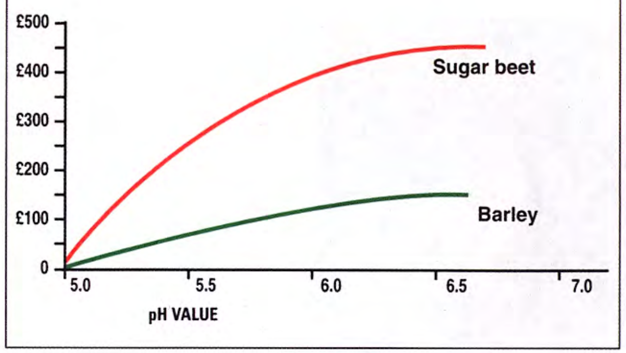
Crop growth was also closely related to soil pH value and consistent yield increases came with increasing soil pH in all four years of the experiment. The yield responses resulting from an increase of 1pH unit were 9.2t/ha (3.7t/acre) of sugar beet in the first year; 0.7t/ha (0.3t/acre) of spring barley in second year; 3.6t/ha (1.5t/acre) of sugar beet in third year; and 0.2t/ha (0.8t/acre) of spring wheat in fourth year.

The economic benefit from liming was assessed by calculating the cumulative value of the crop yield increases and comparing that with the cost of the liming (see graph and table overleaf). Returns were adjusted to first year values.

The benefits of liming vary but the greatest returns will be achieved by maintaining the soil pH in a narrow range within about 0.2 units of the optimum pH value.

When the cost of lime is related to the long-term benefits, it is one of the best investments you can make.

Additional Revenue per Hectare through raising pH



Crop Yield Increase with 11t/ha Lime Application in Winter.		
Year	**Crop**	**Yield increase (t/ha)**
First	sugar beet	9.2
Second	spring barley	0.7
Third	sugar beet	3.6
Fourth	spring wheat	0.2

Soil Structure

All plant and animal life has the best potential to grow and reach full maturity when in an environment best suited to its specific needs; similarly any restrictive condition will ultimately reduce its potential. Soils are the living environment, which provide the essential plant necessities of water, air and nutrients.

Good soil management requires three 'golden' basics; adequate drainage to prevent waterlogging, the correct level of compaction for root anchorage and the movement of air, and the correct pH level to allow the plant to grow and utilise optimally the available soil nutrients. Any imbalance of these basics will reduce a plant's ability to optimise it's potential, irrespective of any further 'cosmetic' treatments.

Soil is a medium which enables worms and micro organisms to live and carry out the function of breaking down animal and plant residues. This assists the cycle of further plant development, but in doing so produces acid soils which display significantly reduced bacteriological activity.

This build up reduces pH levels, creates 'stale' soils and places plants under stress which reduces their ability to make effective use of the nutrients and organic matter available to them.

Heavy soils, particularly clays, although benefiting from regular liming tend to maintain pH levels since they have greater ability to retain calcium/magnesium ions and displace hydrogen ions. In clay soils the soil particles are of denser construction and do not allow so easily the free movement of bacteria and micro organisms. The addition of lime modifies the characteristics of the clay particles so that they flocculate resulting in improved drainage and easier movement of all major ingredients in plant and life development.

Sandy soils have reduced capacity for holding liming materials and as a result of their free draining nature they require more frequent liming at lower dose rates. It is on these soils that troubles from acidity are most common and most acute, but easily remedied.

Farming today faces it's greatest challenge to optimise crop production in increasingly mono-culture or non-agronomic systems. The soil as the basic medium remains the same, but never before has the need to work and maintain the three 'golden' basics been greater. Correct pH levels are a must in any sustainable soil management.

"Never let your land know you're poor"

Sandy Soil
–poor structure

Sandy Soil
–good structure

(MAFF, ADAS Crown Copyright)

Stock Well-Being and Healthy Grassland

The benefits to stock of limed pastures are due mainly to increased intake from the more palatable and nutritious grasses (e.g. perennial rye grass) and clovers which being more lime sensitive are encouraged to replace the more acid loving, low calcium content, meadow foxtail, agrostis and other weed grasses. The contrast in limed and unlimed grassland plots is shown below with weed grasses clearly visible on the unlimed area.

Trials conducted by ADAS over the years show liming will increase the percentage of calcium within a plant and will also encourage and help to maintain a sward with the highest nutritional value.

Where the correct soil pH status is maintained the activity of micro-organisms on clover roots will fix atmospheric nitrogen to the benefit of them and associated grasses. When the pH is allowed to fall to a critical level the micro-organisms can die and may take many years to re-establish even if the lime status is corrected. Magnesian limestone is a helpful addition to the soils where their ADAS nutrient index is below one (25mg/1 Mg) and they are being used to establish grasslands.

Agro-Chemical Effectiveness

It has been shown that the efficiency of some pesticides, insecticides and residual herbicides applied to the soil can be affected by the degree of acidity of the soil. Soils deficient in lime absorb chemicals more strongly than well-limed soils and so the effectiveness of chemicals is reduced.

In neglecting to lime the correct pH level, usually 6.8 or above for arable crops, farmers may be risking inadequate weed pest control in addition to the adverse effects of soil acidity on the growing crop. At a soil pH of 6 which may be satisfactory for a crop like maize it should be remembered that the activity of some herbicides is one half or less of the activity on a well limed soil.

Natural Agricultural Lime Benefits the Environment

Lime & Upland Catchments

by Dr. W. A. Adams, The University of Wales, Aberystwyth.

Agricultural soils in the lowlands of the UK are limed on a regular basis to maintain a pH of 6 or higher depending upon the cropping system. This general situation of neutral or near neutral soils does not apply to extensive areas of hill and upland. Here the benefits to herbage production enabled by liming may only be economic on small areas of the farm. Historically the practice of liming has moved up and down the hills depending upon the profitability of the livestock sector.

Soils in most of the uplands have low natural reserves of calcium. High rainfall and 'acid rain' have resulted in the loss of bases by leaching and a fall in soil pH to values of 4 or lower. The upland areas of Wales are typical and in the very acidic soils, aluminium accounts for over 70% of the exchangeable cations and calcium a few per cent only. In limed soils, even when the pH is no higher than 5.5, there is no exchangeable aluminium and calcium is dominant. Exchangeable cations are the immediate source of these ions in the soil solution which are available to plants and liable to loss by leaching. Aluminium is negligible in the soil solution of limed soils but is toxic to many plants in acid soils. It is necessary to lime soils as part of upland pasture improvement to prevent aluminium toxicity in ryegrass and clover.

The way pasture improvement has progressed in the uplands has resulted in a mosaic of limed and unlimed areas on many catchments. The patchwork of improved and unimproved pasture has important consequences for the area as a whole and the impact of liming should not be viewed as affecting agricultural production alone.

Limed soils support not only the sown herbage species, typically perennial ryegrass and white clover, but also bentgrasses, fine fescues and herbaceous species which are intolerant of extreme acidity. Thus botanical diversity as a whole is increased. Earthworms which are a food source not only for many birds but also for animals, including badgers, cannot survive in unlimed soils.

Beneficial effects of liming are not restricted to the land itself because the water draining from limed soils is of higher quality than that from the natural, unlimed soils. Water draining from unlimed upland soils, especially those in coniferous woodland, are very acidic, high in aluminium and often low in bases. Biological diversity is restricted over a wide range of species ranging from algae to insects to fish and the birds and animals which depend upon them as a food source. A dramatic improvement in stream water quality is usually observed as streams originating in unlimed rough grazing or forest pass through improved pasture.

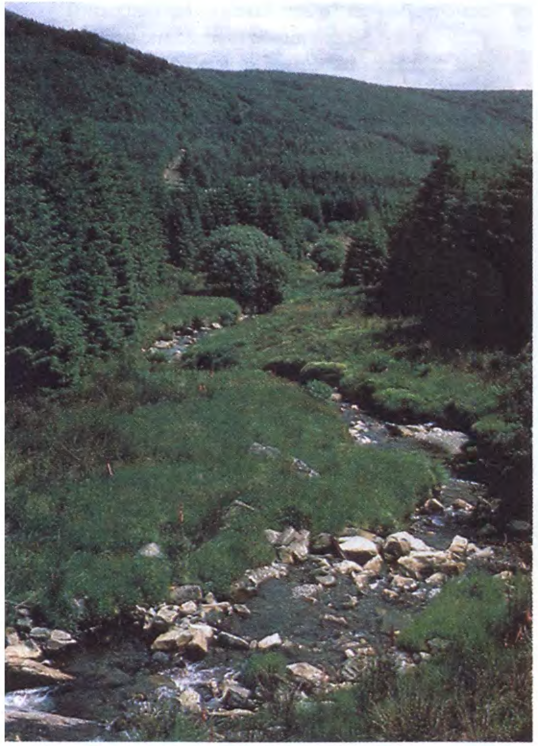
There is no need on agricultural grounds to increase the area of improved land in the uplands but the substantial contribution made to environmental quality by the current mosaic of limed and unlimed areas should be recognised. A strategy for liming in the uplands is needed to exploit its potential contribution to catchment management.

Liming in Forestry

by Dr. T. R. Nisbet. Forestry Authority Research Division

Trees, particularly conifer species, prefer acid soil conditions and can tolerate very low soil pH (pH<4.0). There is therefore no requirement to apply lime to forest soils for the purpose of improving tree growth. In those situations where soil acidity may be limiting to certain broad-leaved species, alternative 'tolerant' species are planted.

Liming is used in UK forestry solely as a treatment to ameliorate stream water acidity. Many forests are located within regions where there is a serious problem of acid waters e.g. parts of central and south-west Scotland, Cumbria, the Pennines and central and north Wales. These areas are underlain by acid, poorly buffered soils and rock and receive large inputs of acid pollutants from the atmosphere–the primary cause of surface water acidification. A century and a half of air pollution has resulted in the decline or complete loss of fish populations within affected waters.



Trees are able to filter out and capture more acid pollutants from the atmosphere than shorter crops due to the greater size and height of their canopies. Because this 'scavenging' effect could contribute to the further acidification of stream waters, the Forestry Authority recommend liming for new planting proposals within those areas at risk (see Forestry Commission's Forests and Water Guidelines (1991) published by The Stationery Office, London).

Although soil liming in combination with fertiliser is being used on a widespread scale in central Europe for ameliorating soil and groundwater acidification and revitalising forests damaged by air pollution, this treatment is not recommended in the UK. This is because UK forests have not been directly affected by the lower air pollutant concentrations in this country and the fact that acidified areas are drained mainly by surface waters rather than groundwaters. Research has also shown that liming of our generally nutrient poor forest soils can result in a decrease in tree growth, which may last for between 5 and 20 years. This growth reduction is believed to be due to the lime reducing the soil nitrogen supply to the forest crop.

Research studies have shown that the most effective way of ameliorating the acidity of surface waters is to apply a large amount of fine powdered limestone (50%< 10 micron) to the boggy, usually unplanted, source areas in the headwater regions of sensitive catchments. These are the areas through which much of the run-off passes from the surrounding land on route to the stream, particularly after sustained rainfall when most drainage is near to the soil surface and acidity levels are at their greatest. Fine powdered limestone must be used in order to achieve the rapid rate of neutralisation that is required under high flow conditions. The current recommendation is to treat these areas by hand or all-terrain vehicle at a rate of 15 tonnes per hectare. A helicopter will usually be required to deliver the lime to such remote sites.

A headwater liming treatment is expected to remain effective at ameliorating stream water acidity for a period of between 5 and 10 years. This is the time it takes for the surface applied limestone either to be exhausted or to move down the soil and become unavailable to neutralise surface run-off. Repeat applications will be required to be made until air pollutant emissions from industry and cars are sufficiently reduced to protect a given site from acidification.

The need for liming and the exact treatment details will be addressed by the Forestry Authority in consultation with an applicant and the water regulatory authority when a grant application is received for new planting. Because liming may adversely affect the conservation value of treated sites the appropriate national conservation agency will also be consulted. Liming will only be allowed in areas where there will be no detriment to the existing flora and fauna.

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