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LIMING THE LAND

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How Soils Lose Lime

It is common knowledge that some soils need, or are improved by lime. Nearly all natural waters contain lime dissolved out of the rocks or soil. In this way, the soil gradually loses its lime, which is usually carried out to the ocean, where it is deposited as limestone. Most of the limestone deposits now used in agriculture have originated in this way.

The amount of lime lost from the soil in the drainage waters is greatest under conditions of free drainage and high rainfall. Although the amounts of lime lost in this way under New Zealand conditions have not been measured, results from similar soils overseas under a 30 inch rainfall show that these losses would be equivalent to about 500 pounds of limestone per acre per year. On this basis approximately one ton of limestone per acre, or its equivalent in other forms of lime, will be needed every four years to make good the drainage loss of lime.

All agricultural crops absorb lime so that the soil is gradually depleted of this material by the growing of crops and grazing of animals. However, the amount of lime thus carried away is small compared with that lost in the drainage. Some fertilisers, such as nitrate of soda and sulphate of ammonia, tend to increase the loss of lime slightly whilst others such as basic slag, and blood and bone, tend to increase the supply.

Effects on the Soil

When lime is added to sour soils it brings about changes which result in an improvement of the soils and an increase in the yields of crops. These changes are physical, chemical, and biological.

Physical Effects.—Heavy clay soils are made more crumbly, easier to cultivate, less sticky, better drained, and more suitable for plant growth when heavy dressings of lime are applied. Lime is a soil improver, not a fertiliser. Therefore, the increased growth induced by lime will result in a heavier drain on the other soil materials. This should be balanced by the use of fertilisers.

Chemical Effects.—Apart from adding calcium, which is a plant food, liming brings about chemical changes which are commonly called "sweetening." Soil acids are neutralised and harmful conditions associated with these acids are avoided. Lime increases the efficiency of phosphatic fertilisers by fixing the phosphate in an available form; it makes potash and other minerals more available and promotes the breakdown of the soil's organic matter and the liberation of its nitrogen.

Biological.—The beneficial soil bacteria do more useful work in soils that contain lime, or in those that have a low acidity, either naturally or as a result of liming, than they do in rather sour soils. On the other hand, some undesirable organisms of the soil are favoured by plenty of lime. Such is the fungus which causes potato scab. This potato disease is much less injurious in an acid soil. Excessive lime encourages "root rot" of tobacco, but it reduces markedly the activity of the fungus of "club root" disease.

Soils that Need Lime

Soils deficient in lime are frequently called sour or acid. Sour clay soils are usually hard to cultivate, slow draining and sticky when wet, whilst the lighter stony soils which are sour are readily distinguished by the dominance of hair-grass, sweet vernal, and sorrel in the pastures. Careful observation of the kind and the condition of the vegetation often furnishes valuable

information on the lime status of the soil. Certain plants such as lucerne, red clover, mangolds, and barley, make thrifty growth only on soils that are well supplied with lime. White clover, wheat, and ryegrass make good growth on soils that contain insufficient lime for lucerne or red clover. Oats, potatoes, and lupins will grow fairly well on soils that are very low in lime and unsuitable for the crops already mentioned. Certain weeds, such as spurrey, sorrel, sweet vernal, hawkbit, and flat weeds are also tolerant of very sour conditions, but their presence in large numbers may also result from an impoverished condition of the soil.

In the classification below the crops which require most lime in the soil for thrifty growth are placed towards the head of each list. Those below have progressively greater tolerance of acidity, and those near the end of each list make good growth on sour soils.

It must be borne in mind that other factors in soil management and manuring affect fertility as well as soil acidity. Thus the ploughing under of green manure crops or liberal applications of farm manure and superphosphate may make good growth of clover possible on soils which, when untreated, are too sour to grow it well.

Forms of Lime

There are three different kinds or chemical forms of lime available for use on the soil. These are (1) Carbonates, i.e., limestone, shell lime, marl; (2) burned, caustic, or quicklime; and (3) slaked or hydrated lime. Ground limestone is by far the commonest form of these used in New Zealand as it is cheapest, easiest to handle and does not spoil when stored or wetted. The colour of limestone which varies from nearly white, to yellow, gray or deep brown, is due to impurities, and is unimportant.

The effectiveness of ground limestone in correcting the acidity of soils is determined by its carbonate content, the hardness of the stone and the fineness of grinding. Of these, the percentage of total carbonates present is the most important. Usually only high quality deposits are used for crushing, but the commercial supplies at present available to farmers cover a wide range of carbonate contents. This is partly accounted for by the uneven nature of the deposits, but commercial samples which are consistently low in carbonate content should be supplied at a reduced cost. In general, ground limestones may be classified on the basis of carbonate content as:—Over 85% carbonate, high grade; 70-85% carbonate, medium grade; below 70% carbonate, low grade.

Generally speaking, a soft rock is more easily ground and is more readily soluble than is a hard rock, but differences in hardness (or softness) can very largely be overcome by the fineness of grinding. This is very important, for the finer the rock is ground the more evenly can it be distributed and the more rapidly will it go into solution. On the other hand a limestone that is too finely ground presents difficulties in its application and it is readily lost in the drainage water. Consequently a good commercial sample should contain at least 50 per cent. of fine flowery material which will produce a rapid action in the soil, together with sufficient of the coarser gritty fractions which will promote free sowing and by dissolving more slowly will continue to give some benefit over a period of several years.

Most limestones are of good quality and reasonably well ground, but in order to compare one limestone with another in so far as its probably effects on the soil are concerned, a statement of its carbonate content and fineness of grinding is desirable.

Burnt lime, or quick lime, is prepared by buring limestone with

RELATIVE LIME NEEDS OF GENERAL CROPS

	Legumes	Cereals	Roots	Grasses and Weeds
Sweet Soils	Lucerne	Barley	Sugar Beet	Ryegrass
	Red Clover	Maize	Swedes	Poas
	Alsike	Wheat	Mangolds	Fescues
	Sub. Clover	Oats	Turnips	Cocksfoot
	Vetches	Rye	Carrots	Spurrey
	Peas		Potatoes	Sweet Vernal
Sour Soils	Lupins			Sorrel

coal at red heat and the purity of the product depends mainly on the carbonate content of the limestone used. It is very caustic and disagreeable to handle and when not protected from moist air, slakes and slowly changes back to calcium carbonate which was its original form before burning. If the unpleasant nature of the burnt lime is not considered, then the choice of which form of lime to apply is largely determined by the costs of cartage and the purity of the sample. Since 1 ton of burnt lime is equal to 1½ to 1¾ tons of ground limestone, the cartage costs will be lower for burnt lime. The purity of the burnt limes available to farmers has been found to show a very wide variation and particular care must be taken when buying burnt lime to ensure that it is of good quality. Apart from the fact that burnt lime is caustic and cannot be used on growing crops or in fertiliser mixtures, it may be used for the same purposes as ground limestone. It tends to give a more rapid response than the ground stone and may be used effectively as a preventive for "club root." It does not burn away the organic matter unless applied as a heavy dressing to a dry field.

Slaked lime is made by adding to burnt lime about half of its weight of water. The action produces a very fine powder which is readily soluble. It is of little or no agricultural importance in New Zealand.

Quantity of Lime Needed

Although there are many laboratory methods of determining the lime requirement of a field it is essential that the method used should have been checked against field results on a similar soil and that the factors rainfall, management, kind of crop, fertilisation, etc., be taken into consideration before making recommendations based on the laboratory results. At best, all recommendations as to the quantity of lime to be applied to a field are approximations. In order to build up the lime status of a sour clay soil to a satisfactory level an initial application of from 1 to 2 tons per acre may be required, whilst the equivalent of about 1 ton every 4 to 5 years should be applied to maintain the lime status. On the lighter stony soils an initial dressing of from 10 cwt. to 1 ton should be adequate if followed by light annual applications of 2 or 3cwt. per annum or ½ton every 4 to 5 years. The common method of applying small dressings of from one to three cwt along with superphosphate to pasture is a very satisfactory method of maintaining the lime status of the soil, provided this has been preceded by a heavy initial dressing.

An excess of lime in the soil is not desirable but the quantities which would have to be applied to most South Island soils before detrimental effects upon crops would result are so high that there is little danger of overliming. However, since some crops require a higher lime content in the soil than do others (see list above), it is best to lime for the particular crop to be grown. If a rotation is practised, the application should be made before sowing the particular crop which requires the highest lime content in the soil.

Application of Lime

Burnt lime or very heavy dressings of ground limestone should not be applied while any tender crop is growing. These dressings are best made during the final stages in the preparation of a seed bed for a cultivated crop so that the lime becomes thoroughly incorporated with the top layers of the soil. Application of crushed limestone to grassland may be made at any time of the year, when pressure of seasonal work will allow, when the turf is dry enough to carry a truck distributor, and when the pasture can be temporarily spelled from stock, and, except where the lime is applied with fertilisers, the time of application is not important.

During recent years the great expansion in the application of lime during the autumn has resulted in many orders for delivery being delayed. By spreading their demands for lime throughout the year, farmers could help to reduce congestion at the works.

Lime on Pastures

A large percentage of South Island pastures need lime to encourage the development of desirable grasses and clovers. Clovers are essential for low cost feed production, and the nitrogen which they fix in their roots under favourable soil conditions is required by all non-legume crops, cereals, root crops, and grasses. On sour soils, therefore, liming increases the subsequent production of the regular

rotation crops, wheat, oats, clovers and grasses, turnips, etc., Since clover builds up the fertility of the soil it is the most important of these crops, and lime helps to grow clover. The results of experiments conducted at Canterbury Agricultural College show that liming tends to stimulate the pastures most strongly during the summer and autumn periods that are normally of low production. Also they have shown that pastures grown on limed land are richer in both lime and phosphate than are similar pastures grown on unlimed land. The effects of adequate lime on lucerne are outstanding.

Use of Lime with Super

Any form of lime in a ready mixed fertiliser reacts with the soluble phosphoric acid present, causing it to revert or change from a quickly soluble form to a more slowly soluble form, thereby reducing the availability and quick action of the superphosphate used in the mixtures. Mixing limestone with super immediately before spreading has no disadvantages. The mixing of lime with super also counteracts the tendency of super to burn seeds sown in contact with it. Accordingly limestone-super mixtures are usually used when sowing swedes, turnips, and similar seeds.

If maximum returns and efficiency from super are desired it is essential that lime be applied to sour soils either with the phosphate or preferably some time before the phosphate is applied. If phosphate is added directly to sour soils a large amount of the soluble phosphate becomes fixed in a form unavailable to crops by combining with iron, aluminium, and other substances which are active in sour soils.

Experience has shown that the value of lime is usually increased by the use of fertilisers, and that fertilisers give the best results when lime is adequate.

Summary

Adequate liming is a basic step in building up and maintaining the fertility of most farming lands.

The quantity of lime applied to a soil depends upon the properties of the soil, its management and the crop to be grown. Soils which are deficient in lime should be given a heavy initial dressing of from 1 to 2 tons for heavy soils and ½ to 1 ton for light soils. Soils lose lime freely in the drainage, and the initial dressing should be followed by light annual maintenance dressings or heavy applications spaced at longer intervals.

The most generally suitable form is the ground limestone rock. Guaranteed standards of quality and fineness of grinding are desirable.

On cultivated land lime is most effectively applied during the final stages in the preparation of a seed bed for a lime-loving crop. On established pasture lime may be applied at any convenient period of the year. Farmers could help to ensure themselves of prompt deliveries from the works by ordering supplies throughout the year.

Lime tends to encourage clovers which build up the soil fertility. Pastures grown on well limed land are richer in both lime and phosphate.

To obtain the greatest value from fertilisers, the lime content of the soil should be adequate, and conversely, the greatest benefit from lime is received when the soil is well fertilised.

Copies of this Bulletin may be obtained from the Secretary, Canterbury Chamber of Commerce, P.O. Box 187, Christchurch.