

LIME FOR THE LAND*

THE use of various forms of lime as a land dressing dates back to the beginnings of our agriculture. While the importance of liming is recognized in a general way by all agriculturists, even the lime subsidy has not succeeded in ensuring its complete re-establishment as a normal agricultural practice. Over large areas of the country, lime dressings are as important as the use of farmyard manure. Lime deficiency is widespread, and is actually limiting agricultural production.

It is not the purpose of the present article to discuss at length the reasons for applying lime to the soil. Indeed, there is some difference of opinion as to the precise function of lime. It is commonly supposed that it acts by correcting acidity: but satisfactory crop growth may be obtained on soils that are moderately acid, provided that there is a sufficient supply of available lime present. The divergence of views on the function of lime in soil has resulted in a great variety of analytical methods for assessing the needs of the soil for lime dressings. The present writer probably represents a minority of opinion in preferring to regard lime as a fertilizer and to assess the lime status of the soil by the amount of available (or exchangeable) lime actually present in the soil.

Whatever theories are held as to the action of lime, it is generally agreed that for the satisfactory growth of crops a soil must have an adequate supply of lime. It is true that some crops, notably potatoes, oats, and rye, can succeed in soils with relatively low lime status, but the establishment of satisfactory grass land with nutritious herbage requires the presence of as much lime in the soil as would be needed for crops, such as barley and sugar-beet known to be sensitive to lime deficiency.

“ EXCHANGEABLE ” LIME. In order that the action of lime on the soil may be understood, it may be helpful to give a brief outline of the chemical aspect of the subject. Lime occurs in the soil in three main categories, namely, (1) calcium carbonate; (2) exchangeable lime, *i.e.*, lime combined with the clay and humus of the soil; and (3) lime present in unweathered minerals. The lime of the third category, although ultimately of significance as a reserve supply, is not immediately of use to plants and, for practical purposes, may be ignored. All soils are potentially acid. In a soil containing no calcium carbonate and no exchangeable lime, the clay and humus behave as weak

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insoluble acids. Such a soil would, of course, be very infertile. Soils of heaths and many of our mountain and moorland soils approximate to this condition.

If we were to start with a soil containing no exchangeable or carbonate lime, and add increasing quantities of lime to it, allowing equilibrium to be reached after each addition, we should at first be adding to the exchangeable lime category. Eventually, however, the capacity of the clay and humus to combine lime in exchangeable form would be satisfied and the soil would be termed "base-saturated". Any lime over and above the amount required for base-saturation would remain in the soil as free calcium carbonate.

The presence of free calcium carbonate in the soil is generally an indication that the soil is base-saturated, *i.e.*, that it contains its maximum complement of exchangeable lime. This is not always strictly true. Sometimes the calcium carbonate may be present as comparatively large fragments and the mass of the soil may still be base-unsaturated. Also, where lime or limestone have been added to the soil, some time may elapse before equilibrium is attained.

For satisfactory plant growth it is not generally necessary to have excess of calcium carbonate in the soil. *What is needed is a sufficiency of exchangeable lime.* The proportion will vary for different soils, and for different systems of agriculture. For light sandy soils a figure of 0·2 per cent. may be sufficient, while for heavy soils 0·4 or 0·5 per cent. may be necessary. Higher proportions may be needed for peaty soils.

Where Lime is most Needed.—Given that for satisfactory performance soil must contain a sufficiency of lime, what is the general position of our agricultural soils? We note at once that there are certain kinds of soil naturally containing an abundance of lime. Such, for example, are the Chalk and most Lias soils. It should be added, however, that a sufficiency of lime in the soil cannot be taken for granted merely because the underlying formation is chalk or limestone. Many soils overlying Carboniferous Limestone are actually deficient in lime. But allowing for this, there are considerable areas, mainly in the south and east, where the need for liming does not exist. Over the greater part of our country, particularly in the west and north-west, soils are naturally deficient in lime and depend for their lime on dressings added by the farmer. Successful agriculture has been possible on such soils only because of such dressings. In past generations liming was a normal practice and considerable reserves of lime accumulated in the soil. It is owing to the presence of these lime reserves that satisfactory performance was possible long after the discontinuance of the practice of liming.

In the humid climate of Britain there is a steady loss of lime from the soil in drainage. The richer the soil is in lime, the more rapid is this loss. At Rothamsted, where the soil contains a relatively high proportion of lime, the annual loss may amount to the equivalent of about 5 cwt. of lime per acre. On soils with less lime, such as those in Wales, the loss may be only 1–2 cwt. per acre. Wastage is always taking place, however, and every soil will eventually come to the point at which its lime content is inadequate for satisfactory performance. There is ample evidence that, in Wales, the area

of lime-deficient soil is rapidly increasing, and the same is probably true of many other parts of the country. Much of the observed deterioration in grass land must be attributed to the fall in the lime status of soils. Unless it is remedied, widespread failures are likely with all crops except oats and potatoes, and when the recently ploughed-up grass is again seeded down. As oats is the crop most usually taken after ploughing up old grass, the effects of lime deficiency are not likely to be evident in the first year except in very extreme cases. But it may be expected that a very considerable proportion of the grass land ploughed up in 1939–40 will prove unsatisfactory for the succeeding crops of 1941 unless the lime status is put right.

The lime subsidy has led to a considerable increase in the use of lime dressings; but in Wales, at least, only a fraction of the lime needed has actually been applied, and over most of the country deterioration through loss of lime goes on unchecked. It is important that this should be realized and that liming should be greatly increased. Liming must, in fact, be restored as a normal practice over the greater part of our agricultural area.

The Value of Ground Limestone.—The farmer has a considerable choice of liming materials. Probably to the majority of farmers liming means the spreading of quicklime slaked in heaps on the land. Calcium carbonate (carbonate of lime), if in a sufficient fine state of division as ground limestones or chalk, is equally effective. In past years, large areas in the south and east of England were limed by spreading soft chalk dug from pits, as at Rothamsted. In maritime districts shell sand has been used. Much time has also been applied in the form of marl. To most farmers, however, the choice is between lump lime, ground lime, and ground limestone or rough processed chalk.

Lump Lime is quicklime obtained by burning limestone in kilns. Before it can be spread, it must be slaked, and this is generally done in heaps in the field. Although this is the time-honoured method of applying lime, it is now generally regarded as wasteful and inefficient. Where this method has been in constant use one frequently sees remarkably even spreading, but more frequently the distribution is very irregular, so that some parts of the field get far more and others far less than is necessary. There is always the difficulty of getting proper slaking. In wet weather it is easy to get the slaked lime turning to a pastry mass which cannot be spread. The writer has frequently seen lump lime dumped in a field and left until it can no longer be handled.

Ground lime has the advantage that it can be spread evenly by means of a drill. It is, however, very unpleasant and even harmful to man and beast if blown about by the wind. Stored in buildings, it is dangerous owing to risk of fire from the heat developed in slaking during damp weather. It is unsuitable for spreading on grass as it tends to cake on the herbage, which is scorched by it.

Modern opinion is strongly in favour of *ground limestone**. In the United States, practically all lime is put on in this form. If sufficiently finely ground, it is as effective as quicklime, allowing for the fact that $1\frac{3}{4}$ times as much must be applied to give the same amount of lime, a fact which operates against its extended use where transport is costly. It has no burning action and does not

* The term limestone includes, of course, chalk.

deteriorate or change in storage. It can be applied to grass land at any time of the year without damage to herbage or stock, although it is preferable to apply it before or after the growing season.

One of the obstacles to the more general adoption of ground limestone has been the price. Since more of it must be used, it should be appreciably cheaper than lump lime or ground lime. The price at which ground limestone can be sold depends to a large extent on the fineness of grinding. There has been an impression that the finer the grinding the better is the material. It appears, however, that extreme fineness of grinding is unnecessary.

When ground limestone is incorporated with an acid soil, a reaction takes place whereby calcium combines with clay and humus. It is this combined or "exchangeable" lime that actually determines the lime status of the soil. Calcium carbonate in a very fine state of division, say less than 100 mesh, rapidly enters into combination and is immediately effective. Coarser material reacts more slowly, but it has been shown at Bangor that particles up to 1/8 in. diameter react and go into an available form within 2½ years. Provided that the dressing contains enough fine material for the immediate needs of the crop, the coarser material of value as a reserve for following years.

The writer would suggest the general adoption of a grade of ground limestone all passing the 20-mesh sieve and having about 45 per cent. of material finer than 100 mesh. Such a grade is similar to the "Agricultural Ground Limestone" commonly used in the U. S. A. According to American authorities, the efficiency of such a dressing over 4 years is over 90 per cent. of that of the finest grade product. Over a longer period the efficiency would approach 100 per cent. Thus, if a limestone dressing is planned to suffice for 8 or 10 years, the 20-mesh grade recommended would be practically equal in efficiency to a dressing of the immediately available finest grade material. There is reason to think, indeed, that it might be preferable, since losses by drainage in the first year or two would be less than where the finest grade material or quicklime is applied. Apart from its cheapness, a moderately coarsely ground limestone has the advantage of running more easily through the drill. It has been found possible to put on as much as 2 tons per acre with a single drilling using "20 mesh to dust" material.

A Liming Policy.—If the lime status of our soils were raised to a satisfactory level, it is safe to say that a very large increase in food production would ensure, particularly in the humid regions of the west where lime deficiency is so widespread. The writer ventures to outline the main points of a national liming policy :—

- (1) The requirements of all soils for lime should be ascertained. It is not possible to assess the needs of a soil for lime merely by inspection. A lime and phosphate survey, which is financed out of the Research Fund provided by the Government's Land Fertility Scheme, is actually being made and a considerable amount of information is already available.
- (2) The use of lime dressings should be established as a normal practice in all districts where soils are not naturally calcareous.

- (3) Except where local supplies of cheap material, such as soft chalk are available, the standard lime dressing should be a ground limestone similar to the Agricultural Ground Limestone used in the U. S. A.
- (4) To ensure a satisfactory margin, lime dressings should be applied in sufficient quantity to cover immediate needs and to leave a reserve sufficient for 8 or 10 years.
- (5) Where possible, ground limestone should be given during the arable break. Applied immediately after ploughing up a grass ley, it assists in rotting down the sod and becomes intimately mixed with the soil during subsequent cultivations. Where very poor grass land is destined for ploughing, it would probably be better to improve it beforehand by dressings of ground limestone and, possibly, slag.
- (6) Steps should be taken to organize supplies of ground limestone. It might be worth considering the possibility of dressing land by contract. There is need for economics in handling. A large proportion of the expense of getting ground limestone on to the land is represented by bags, an item that is likely to become more costly in future. The possibility of cutting out the bagging process and getting the ground limestone in bulk from the crushing plant to the field should be examined.

Agricultural production can be increased both by switching over from grass land to arable farming and by increasing the productivity of the land under crops and grass. There is no single step offering a more certain promise of increasing productivity than the restoration of our potentially fertile lime-deficient lands to a satisfactory condition by the widespread use of lime dressings.