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LIME AND SOIL PRODUCTIVENESS
DEALT WITH BY PROF. CUMMINGS

Following is the address delivered at the Rural Life Conference by Prof. M. S. Cummings, Principal of Nova Scotia College of Agriculture at Truro, N. S.

LIME AND SOIL PRODUCTIVENESS.

Liming of soils is a very old practice. It may be gathered from the writings of Pliny, a Roman writer, that progressive Roman farmers practised marling or liming more than two thousand years ago. It was a common practice in England more than two hundred and fifty years ago. In the epoch-making letters of Agricola published in Nova Scotia in 1818, the practice of liming was highly recommended. However, the practice generally grew into disfavor owing to the fact that it was overdone and no doubt also owing to the fact that the underlying principles were not thoroughly understood. Only in exceptional cases is lime of value as a direct plant food. In general its effect is to create favorable conditions for the setting free of plant food already existing in the soil. Hence, if means are not taken to keep up the supply of plant food, lime will ultimately deplete a soil of its store of plant food.

"Lime and lime without manure makes both farm and farmer poorer."

Whatever is said about lime applies equally to mussel mud, the valuable constituent of which is lime.

During the present century a widespread movement for the use of lime in agriculture has grown up and at the present time the judicious use of lime is being advocated by the leading agriculturists in nearly every state of the Union, in Eastern Canada and in parts of Europe also. However, the underlying principles are now understood and liming is being recommended only in so far as it is associated with the increase of humus in the soil. The crops which are most benefitted by lime are the clovers and modern practice has shown that where lime is used as a means of increasing clover production, it will not only stimulate the soil to which it is applied to give up its plant food but will actually lead to an increase in the amount of humus and nitrogen in the soil.

WHAT FORM OF LIME?

A twenty years test at the Pennsylvania Experiment Station, where lime was used at the rate of two tons per acre of burnt lime every four years or two tons of ground lime stone every two years, not only resulted in bigger crops but the plots to which lime stone was applied were at the conclusion of the experiment 375 lbs. per acre richer in nitrogen and contained 4.7 tons more humus than those to which burnt lime was applied. The lime stone produced all the results of the burnt lime but was milder in its action and did not use up the organic matter as did the burnt lime. Many similar experiments might be quoted to show the superiority of ground lime stone over burnt lime.

In line with the results of this last quoted experiment modern lime users are strongly recommending ground lime stone instead of burnt lime. The advantages in its favor are as follows:

1. It is milder in its action and not, therefore, likely to cause any injury. In other words, it is "Fool proof."
2. It can generally be produced cheaper.
3. It is much easier applied.

Lime stone consists of lime plus carbonic acid. When it is burnt, the carbonic acid is driven off and the lime left behind. One hundred pounds of limestone when burnt will yield fifty-six pounds of lime. Hence, in order to apply an equal quantity of active lime to the soil, one has to use practically two tons of limestone in comparison with one ton of burnt lime.

During the past three years, some hundreds of determinations of Nova Scotia soil have been made at the College at Truro and the significant fact has been determined that about 95 per cent. of Nova Scotia soils are more or less acid, which condition is not favorable to the optimum growth of most crops. A further significant fact is that the average amount of lime found in soils from different parts of the province was 25 per cent. whereas the average amount found in a good arable soil should be at least 3 per cent. and the average of two hundred very fertile United States soils is 2.16 per cent. of lime. Now, lime exists in the soil in several combinations, being united with carbonic acid, phosphoric acid, sulphuric acid, silicic acid as well as in combination with organic acids. The only one of these combinations which will help to correct acidity of the soil is the carbonate. Hence, the mere statement that a soil contains so much lime is not sufficient in itself to indicate the need of adding lime to it. But, when a soil is found to be below the average in lime content and to also be acid, experience has shown that the application of lime is likely to be attended with good results and since this is the case with most Maritime Province soils, one is lead to expect that, theoretically at least, lime should give excellent results. What are the facts?

On the College Farm at Truro, the soil of which is derived mainly from red sandstone, three plots of oats and three plots of wheat were treated with ground limestone by Prof. Trueman in the spring of 1914 at the rate of four tons per acre. Otherwise, this land was fertilized and cultivated in the usual manner. Corresponding plots were left without the limestone treatment.

No material difference was noticed in the yield of grain on

the limed and unlimed plots. As soon as the grain was cut, however, the clover on the limed portions of most of the plots was found to be considerably ahead of that where no lime had been used. This difference became increasingly noticeable right up to the time of the cutting of the clover in July 1915. The figures presented in the following table show the actual amount of hay cut on the respective plots:

No. of Plot	Size	Amount of Cured Hay	Yield per Acre
1	1 acre (1/2 unlimed)	2550	2.5 tons
	1/2 limed	3610	3.6 tons
2	1 acre (1/2 unlimed)	2570	2.6 tons
	1/2 limed	3090	3.2 tons
3	1/2 acre (1/2 unlimed)	1160	2.3 tons
	1/2 limed	1490	3.0 tons
4	1/2 acre (1/2 unlimed)	1150	2.3 tons
	1/2 limed	2010	4.0 tons
5	1/2 acre (1/2 unlimed)	8650	3.6 tons
	1/2 limed	8650	3.6 tons
6	1/2 acre (1/2 unlimed)	3050	3.1 tons
	1/2 limed	3050	3.1 tons

It will be seen that the gain from the use of lime stone was not uniform. On plot 1, the increase was a little over one ton per acre, while on plot 2, it was only a little over half a ton. On plot 3, the difference was 1320 lbs., while on plot 4, it was nearly one and three-quarters tons. On plots five and six, the yields were practically the same on the limed and unlimed areas. The only explanation we can offer for the lack of results on the last two plots is that the soil was in extra good condition and the clover grew well even without the use of lime.

The total yield in favor of lime on the first four plots amounted to 1.4 tons, being from one and a half acres limed vs. one and one-half acres unlimed. That is a gain per acre of .93 tons, which at \$10.00 per ton would be worth \$9.30.

In order to get his results four tons of lime stone were applied so that the returns per ton of lime stone in the first crop of clover hay was \$2.32. There was nearly a corresponding difference in the second crop of clover, which was cut green the same season for feeding purposes, there being eight-tenths of a ton more clover on the limed than on the unlimed plots. This makes the total extra return in the two cuttings for the year 1.7 tons, worth approximately \$17.00, so that in this particular experiment we got back practically \$4.00 for every ton of ground lime stone applied. It must not, however, be forgotten that we got no returns worth speaking of from the lime applied to plots 5 and 6. Furthermore, smaller experiments carried on to determine the gain from the application of lime stone to poor soils, resulted in very small yields indeed. The inference is that on a whole area to which lime stone might be applied the returns will vary greatly, but assuming that the soil is in moderately good condition and that the results from Truro are reasonably typical, one should expect about \$2.00 extra clover crop for each ton of ground limestone applied up to four tons per acre, but do not forget that one has to wait two years for even this return.

The lime stone should continue to give results due to the extra heavy sod which will be plowed under in the limed area as compared with the unlimed area and also due to its own beneficial effect on succeeding crops. Hence, one should reasonably look for at least double the above return at the end of five years which is about the length of time that a four ton application will continue to give noticeable results.

It is valuable in this connection to record the results which have been obtained at other experiment stations. In bulletin 400, published by the New York Agricultural Experiment Station, it is stated that, in Ohio, in twelve years of testing on many plots, moderate applications of lime stone once in a crop rotation of five years on soils only moderately acid have given average net profits of \$15.00 an acre when used alone and of from \$2.00 to \$5.00 more than this when used with phosphorous, with barnyard manure, etc.

In the same bulletin it is stated that in New Jersey the value of the increase in general farm crops in five years after a two ton application of ground lime stone was placed at \$25.00 per acre and the value of the increase in vegetables at \$48.00 per acre. Other records of this kind will be found in an article on "Lime in Relation to Agriculture" by Harlow, appearing in the Annual Report of the Secretary for Agriculture, Province of Nova Scotia for 1915.

Further tests were tried at the College at Truro in 1915 on mangels and turnips. In the mangel experiment, an acre of land was divided in two parts, the whole acre was treated with barnyard manure and one thousand lbs. of acid phosphate per acre. On one-half of the acre marl, or limestone, was applied at the rate of four tons per acre and on the other half no marl was used. The yield on the marled half was at the rate of 98 bushels per acre extra.

In the turnip experiment, which was an exact duplication of the mangel experiment, the yield on the limed plot was at the rate of 20 bushels per acre extra, which extra yield is so small that it might be accounted for by natural difference in the areas upon which the turnips were grown.

Experiments with garden crops gave somewhat uncertain results. Certainly one could not infer from them any decided advantage from the application of lime. Our present experience at the College Farm leads us to advise farmers to use limestone largely for seeding down purposes and to expect to get their big returns from the growth of clover and the subsequent enrichment of the soil. It is our belief that if the land is left down to clover and subsequent hay for a number of years, the ultimate results will be very unsatisfactory, but if a short

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rotation is practised and clover sown once every four or five years, we expect that lime will prove the means of building up our soils.

CAN LIME RESTORE WORN OUT LAND TO ITS ORIGINAL FERTILITY?

No. Manure or some commercial fertilizer must also be used. The lime will correct the acidity, will improve the texture and generally make the soil more responsive to manure and fertilizer. On the other hand, manure or fertilizer cannot be used to correct the acidity. But the combination of the two, i. e., lime with manure or fertilizer and the subsequent clover and rotation of crops will pave the way for fertile fields and productive farms.

I cannot too strongly urge the point that while lime will assist in improving the productivity of soils, it is not a fertilizer and will not take the place of fertilizer. Used alone, on a fairly rich soil, it will give fairly satisfactory results for a year or two but on the average soil the results are bound to be disappointing unless one knows what to expect. Used, however, along with barnyard manure, or commercial fertilizer and a proper rotation of crops lime, preferably ground limestone, will, I am convinced, prove a most practical means of building up fertile soils in the Maritime Provinces.

HOW CAN A FARMER KNOW WHETHER THE APPLICATION OF LIME WILL PAY OR NOT?

Ans. Ask the soil. In other words try it. My advice is that each farmer who possibly can, should apply ground lime stone to small areas on several fields of his farm at the rate of about 4 tons per acre. Use it preferably on land which is being seeded down to clover. It will take two seasons before you will get results but then you will know. In the meantime I would strongly warn farmers not to expect limestone to take the place of fertilizers or manures which they have been using. It will not, all of which means that the farmer must get his limestone at a low price per ton.

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