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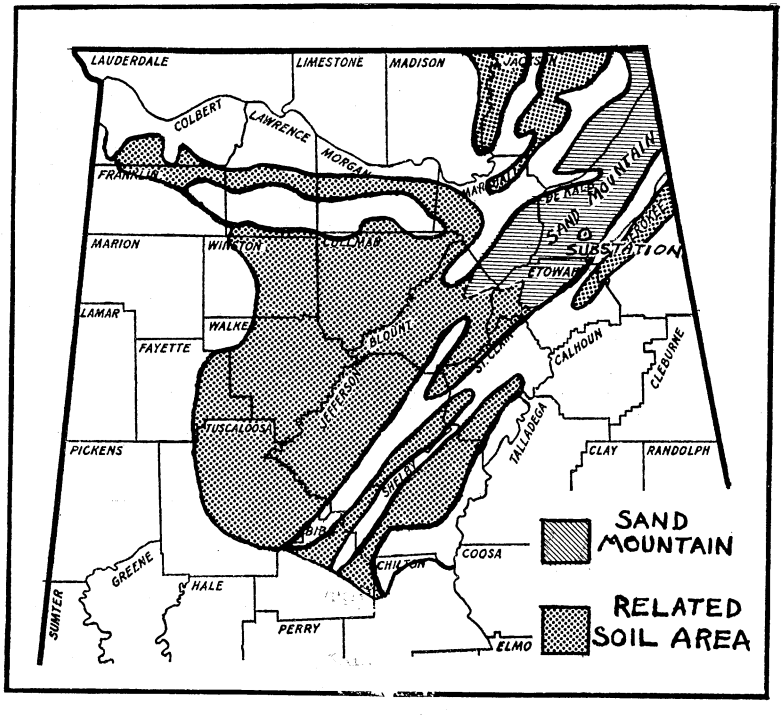
The Value of Lime in a Two-Year Rotation on Sand Mountain

A PROGRESS REPORT



THE RESULTS HEREIN REPORTED ARE APPLICABLE TO THE AREA SHOWN ABOVE

AGRICULTURAL EXPERIMENT STATION
OF THE
ALABAMA POLYTECHNIC INSTITUTE

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Contents

The Value of Lime in a Two-Year Rotation On Sand Mountain[1]

A PROGRESS REPORT

SHOULD lime be used in growing cotton and corn with legumes in a two-year rotation on the Sand Mountain section and on the related soil areas of Alabama? In order to answer this question, field tests with lime were begun at the Sand Mountain Substation in 1930, and it is the purpose of this paper to report the value of lime during the six-year period, 1930-1935. The results reported herein are intended for the soils of the area shown on the cover.

The most practical type of farming for this section, from the standpoint of profitable operation and the maintenance of soil fertility, is that by which soil improvement crops are grown in a rotation with cotton and corn. Thus a two-year rotation of cotton, vetch, corn and soybeans has been the cropping system used to determine the value of lime. Previous results showed that the profit from cotton and corn production on Sand Mountain was increased by the use of proper commercial fertilizers[2] and, as will be shown below, the **profits may be further increased by the use of lime in a two-year rotation.**

It is generally known that lime is necessary for plant food and as a preventive and corrective of soil acidity. The lime content of the sandstone soils of the Sand Mountain section is extremely low and becomes lower each year through losses by leaching and crop removal. Legumes grown in the two-year rotation feed heavily on lime and make their best growth on non-acid soils. The fact that non-acid-forming fertilizers do not increase the acidity of the soil does not remove the need for lime on these soils.

HOW MUCH LIME TO USE PER ACRE

Outline of Tests.—In order to determine the amount of lime to apply, two methods of liming were used. Small additions of 200, 400, and 600 pounds per acre applied every other year in the drill were compared with larger applications of 1,000, 2,000, and 3,000 pounds per acre broadcast once in ten years. Unlimed plots were used for checks and all plots received 600 pounds of 6-10-4 fertilizer per acre during the two-year rotation

[1]Acknowledgment: The tests reported herein were outlined by Director M. J. Funchess and conducted by R. C. Christopher, superintendent of the Sand Mountain Substation, Crossville, Alabama, on Hartsells fine sandy loam. The manuscript was prepared by James A. Naftel.

[2]Alabama Agricultural Experiment Station Circular 70.

of which none was applied to the corn. Vetch and soybeans were grown as soil improvement crops and dolomitic limestone was used in these tests.

Field Results from Small Additions of Limestone in the Drill.—It was found that 200 pounds of limestone per acre in the drill was not sufficient to obtain the greatest profit, that 600 pounds was too much lime, but that **400 pounds gave the greatest profit from cotton and corn.** The figures for the six-year period are given in Table 1. The increase per acre from the 400-pound addition of lime in the drill was approximately 150 pounds of seed cotton and 7 bushels of corn. This increase from lime gave an average annual profit of $6.16 per acre (average of cotton and corn) after the cost of lime was deducted. The profits were based on seed cotton at 4 cents per pound, corn at $1 per bushel, and limestone at $5 per ton. The average yearly profits are more clearly shown in Figure 1. It may be seen from this information that when this method is used 1 ton of lime is sufficient for 5 acres in the two-year rotation. How the additions of small amounts of limestone in the drill compare with the larger ten-year broadcast application is important and is shown below.

Field Results from Ten-Year Applications of Limestone Applied Broadcast.—Similar to the case with small additions of limestone, the lowest ten-year application of 1,000 pounds per acre was too low for the greatest profit and the highest rate, 3,000 pounds per acre, was too high as compared with the intermediate amount of **2,000 pounds.** The 2,000 pound rate gave an average annual increase per acre over the unlimed plot of approximately 130 pounds of seed cotton and 8 bushels of corn as shown in Table 1. The profit from this treatment on cotton and corn amounted to $6.32 per acre annually. This is clearly shown in Figure 1. Should the farmer add 400 pounds of limestone in the drill every other year or apply 1 ton

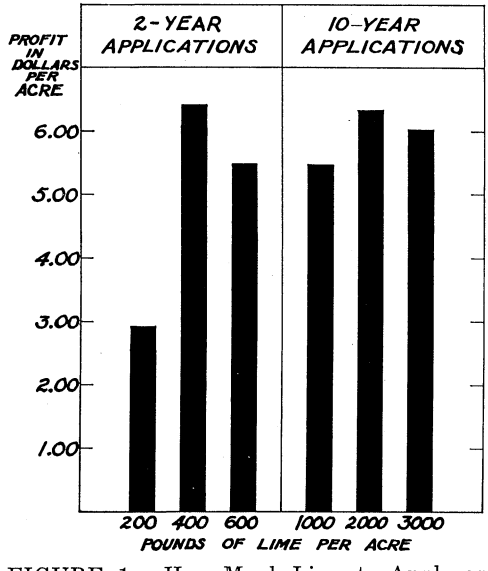

FIGURE 1.—How Much Lime to Apply as Shown by the Profit from Cotton and Corn in a Two-Year Rotation.

TABLE 1.—Results from Different Amounts and Methods of Applying Lime in a Two-Year Rotation on the Sand Mountain Substation.

Amount of lime per acre	Annual cost of lime per acre	Average annual results per acre for the 6-year period 1930-1935												Average annual profit from corn and cotton[3]
		Seed Cotton				Corn				Vetch[1]		Soybeans[1 2]		
		Yield	Increase from lime	Value of increase	Profit[3]	Yield	Increase from lime	Value of increase	Profit[3]	Yield	Increase from lime	Yield	Increase from lime	
Lbs.	$	Lbs.	Lbs.	$	$	Bus.	Bus.	$	$	Lbs.	Lbs.	Lbs.	Lbs.	$
Small 2-year applications of lime														
0	0	1,419	------	------	------	25.7	------	------	------	4,185		4,101	------	------
200	0.25	1,464	45	1.80	1.55	30.0	4.3	4.30	4.05	5,788	1,603	4,142	41	2.80
400	0.50	1,572	153	6.12	5.62	32.9	7.2	7.20	6.70	7,187	3,002	5,216	1,115	6.16
600	0.75	1,544	125	5.00	4.25	32.4	6.7	6.70	5.95	7,700	3,515	5,349	1,248	5.10
Large 10-year applications of lime														
0	0	1,419	------	------	------	25.7	------	------	------	4,185	------	4,101	------	------
1,000	0.25	1,525	106	4.24	3.99	32.9	7.2	7.20	6.95	6,674	2,489	4,815	714	5.47
2,000	0.50	1,550	131	5.24	4.74	34.1	8.4	8.40	7.90	8,117	3,932	5,388	1,287	6.32
3,000	0.75	1,500	81	3.24	2.49	35.9	10.2	10.20	9.45	8,282	4,097	5,858	1,757	5.97

[1]Pounds green weight per acre.
[2]5-Year average.
[3]Profit based on lime at $5 per ton, seed-cotton at 4 cents per pound, and corn at $1 per bushel.

broadcast once in ten years to increase the profits from the two-year rotation? This is discussed below.

Discussion of Small Two-Year Additions as Compared With Large Ten-Year Applications.—On the basis of a **5-acre field** in a two-year rotation, the lime cost would amount to $5 when 400 pounds per acre is added or $25 when 1 ton per acre is added; however, the 1-ton application is for a ten-year period, while the 400-pound rate is for only two years. Over a ten-year period the same amount of lime is applied with both methods of liming. It would be necessary to make five applications during the ten-year period when using the small amount in the drill, but this may be mixed directly with the fertilizer and applied. In this way the more frequent applications of the small amounts would cost very little more in labor than the 1-ton application once in ten years. The advantage of the 1-ton broadcast application of lime is that the liming for a ten-year period is done at one time and requires no further labor cost. It may be concluded that either method may be used depending on the individual circumstances of the farmer; perhaps more farmers could afford the cost of 400 pounds for a two-year period than the 1-ton application for a ten-year period.

RECOMMENDATIONS AS TO THE AMOUNT OF LIME TO ADD FOR THE TWO-YEAR ROTATION

Add 400 pounds of high-grade finely ground limestone every two years in the drill or broadcast 1 ton per acre of high-grade finely ground limestone (or its equivalent) once every ten years.

DOES LIME PAY WHEN FERTILIZERS ARE USED?

Plan of Tests.—The following fertilizers were compared with and without lime: 1, superphosphate alone, 2, superphosphate and muriate of potash, and 3, superphosphate, muriate of potash, and nitrate of soda. Plots which received no fertilizer were used for checks. Two tons per acre of high-calcium limestone was applied in October 1929 to the limed plots.

Results of Tests.—The results from these tests (Table 2) show that lime increased the yields of all four crops regardless of the fertilizers applied. It is seen that with cotton and corn the greatest profit from the **lime** applications was on the superphosphate-muriate of potash plots. However, the yields on the cotton plots receiving superphosphate, muriate of potash, and nitrogen are the most practical since the yields are much greater from the addition of the nitrate of soda. Two tons of lime per acre was applied in these tests which, as shown above,

TABLE 2.—The Effect of Lime on a Two-Year Rotation With Different Fertilizers at Sand Mountain[1].

Fertilizer[3]	Seed Cotton				Vetch[2]		Corn				Soybeans[2]	
	Yields per acre			Profit from lime	Yields		Yields per acre			Profit from lime	Yield	
	No lime	Limed	Increase from lime		No lime	Limed	No lime	Limed	Increase from lime		No lime	Limed
	Lbs.	Lbs.	Lbs.	$	Lbs.	Lbs.	Bus.	Bus.	Bus.	$	Bus.	Bus.
Check No Fertilizer	996	-------	------	------	4,996	----------	29.6	------	----	------	7,850	----------
600 lbs. Superphosphate	1,128	1,184	56	1.24	8,130	8,186	39.3	44.3	5.0	4.00	8,907	10,327
600 lbs. Superphosphate 75 lbs. Muriate	1,356	1,595	239	8.56	9,882	12,684	40.0	46.4	6.4	5.40	8,202	11,066
600 lbs. Superphosphate 75 lbs. Muriate 100 lbs. Nitrate of soda	1,692	1,885	193	6.72	11,289	12,629	47.4	48.5	1.1	0.10	10,037	12,150

[1]4,000 lbs. lime per acre applied every 10 years = $10 or $1 annual cost; seed-cotton figured at 4c per pound and corn at $1 per bushel.
[2]Pounds green weight per acre.
[3]Fertilizers applied as follows: ⅔ minerals applied in fall to vetch, and the remaining ⅓ applied to cotton. No fertilizer was applied to corn except nitrate of soda in the complete fertilizer plot.

was excessive and hence reduced the profit from lime as compared with a 1-ton application. **Lime is not a substitute for fertilizers, but the proper fertilizers should be used with the lime.**

DO LEGUMES PAY WHEN FERTILIZERS AND LIME ARE USED IN A TWO-YEAR ROTATION?

Outline of Tests.—Tests were made with cotton and corn where commercial fertilizers and lime were used with and without legumes in a two-year rotation. The fertilizers were applied to the cotton and none to the other crops with 4,000 pounds of calcareous limestone applied broadcast once each ten years.

This corn was grown on limed land following vetch in a two-year rotation where the cotton and vetch were fertilized; no fertilizer was applied to the corn. (See superphosphate-muriate plot of Table 2.)

Results.—The results from these tests on cotton and corn are shown in Table 3. It is seen that the legumes in the rotation gave an increase in seed cotton of 410 pounds. The profit on the cotton from the legumes was $16.40 per acre. It should be noted here that the cotton received only 100 pounds of nitrate of soda in the complete fertilizer and also lime in each case. Legumes in the rotation increased the corn yields from 25.6 bushels to 41.0 bushels or an increase of 15.4 bushels with a profit of $12.90 per acre. The average annual profit for the six-year period was $14.65 by growing legumes in the rotation when fertilizers and lime were used. Obviously it is wise and profitable to grow legumes in a two-year rotation when fertilizers and lime are used.

TABLE 3.—The Value of Legumes With Fertilizer and Lime In a Two-Year Rotation of Cotton and Corn at The Sand Mountain Substation.

Crop of cotton with N P K L[1]				Crop of corn with residual NPKL				Average annual profit[2]
Seed cotton yields per acre		Increase from legumes		Yields per acre		Increase from legumes		
No legumes	With legumes	Yield	Profit[2]	No legumes	With legumes	Yield	Profit[2]	
Lbs.	Lbs.	Lbs.	$	Bus.	Bus.	Bus.	$	$
1,464	1,874	410	16.40	25.6	41.0	15.4	12.90	14.65

[1]All fertilizers applied were to cotton and were 600 pounds superphosphate, 75 pounds muriate, and 100 pounds nitrate of soda per acre. Two tons lime per acre was used.
[2]Profits were based on cost of vetch at $2.50 per acre and the value of corn at $1 per bushel and seed-cotton at 4 cents per pound; cost of vetch was charged to corn.

KINDS AND GRADES OF LIME TO USE

Kinds of Lime.—There are several kinds of liming materials which may be used for agricultural purposes but the tests reported here were made with **finely ground calcareous** and **dolomitic** limestones. Either of these forms may be used; however, there is some evidence that the dolomitic lime may be slightly more beneficial since it contains magnesium which is low in many of the soils. The grade and price of the lime should determine the kind of lime to use as will be seen below.

Grades of Lime.—The grade and value of any liming material is determined by two factors which are:

(1) Composition (total neutralizing power) or purity.
(2) Fineness (size of particles or screen test).

The composition of the lime is determined by chemical analyses and is reported on the basis of 100 for pure calcareous limestone. On this basis a pure dolomitic limestone may run as high as 108 since it contains magnesium in addition to calcium.

The fineness of the limestone is determined by sorting the particles into size groups by means of screens of different meshes or openings per linear inch. The coarser the particles the more slowly the lime becomes available, thus 10- to 20-mesh particles are very slowly available; 20- to 40-mesh, slowly available; 40- to 60-mesh particles, fairly available; and finer than 60-mesh particles, readily available within 1 to 3 years after applying to the soil.

All agricultural limestone is required by law to have a guaranteed analysis and the value of the particular liming material should be determined accordingly. **A high-grade finely ground limestone should be near 90 or above in total neutralizing power, and at least 60 per cent of the lime should be finer than 60-mesh.**

HOW TO LIME THE SOILS FOR TWO-YEAR ROTATIONS

Liming With Small Applications.—The 400-pound rate of calcareous or dolomitic limestone may be added in the drill at the same time the fertilizer is added. In the case where lime is to be added for the winter legume following cotton the drill should be close to the cotton stalks in order that the residue from the cotton fertilizers may be used by the legume crop. Similarly in the spring where the lime is added in the drill for cotton or corn the lime and fertilizer may be applied in one operation a week or ten days before planting.

Liming in the Fall With 1 Ton Per Acre on Cotton Land.—As soon as the cotton is picked, apply the lime evenly over the entire surface of the soil. Plant the vetch or other winter legume with the proper fertilizer and throw out the middles with a turn plow or "Middle Buster", thus working the lime into the soil and yet not disturbing the fertilizer residue at the cotton stalks; this gives the legumes the maximum effect of the residual fertilizer and the lime.

Liming in the Fall With 1 Ton Per Acre Where Cotton Was Not Grown.—On these fields there is usually no fertilizer residue, and the lime may be spread evenly over the field and then the land flat broken with a turn plow or disked. This works the lime into the soil to plow depth, and the land is ready for seeding and fertilizing the winter legume.

SUMMARY

A summary of this progress report on the value of lime in a two-year rotation of cotton, vetch, corn and soybeans on Sand Mountain is given below.

(1) The most profitable two-year addition of lime with proper fertilizers was the 400-pound per acre rate added in the drill; the profit has averaged $6.16 per acre annually during the past six years.

The 2,000-pound per acre rate applied once each ten years was the most profitable broadcast application; the average annual profit was $6.32 per acre.

(2) Lime increased the yields of all crops in the rotation regardless of the kind of fertilizers used, but was most practical where the cotton received the proper complete fertilizer and the corn received the residue from the superphosphate and muriate; the profit from the lime on the cotton and corn was $6.06 annually in this test.

(3) The most important and practical use of lime was obtained when legumes were grown in the rotation of cotton and

corn receiving proper fertilizers; the annual profit was $14.65 per acre for the last six years.

(4) The kind of lime to use is determined by the grade and price; the value of any liming material is determined by its analysis for total neutralizing power and fineness and these should be guaranteed to the farmer.

(5) The lime should be applied for the two-year rotation at the most convenient time, which is usually in the fall before the winter legumes are planted. The lime should be well worked into the soil.