growing good stands of ALFALFA on low fertility soils

With . . .

1. *Adequate liming and fertilization.*
2. *Adapted varieties—winter hardy and wilt resistant.*
3. *Proper drainage and good management practices.*

. . . alfalfa stands can often be made productive for 9 or more years, extensive Wisconsin field trials have shown.

HOW long productive alfalfa stands will last is very important to many farmers in the northern half of the United States—especially to those living in areas where good yields of corn are not very certain due to early fall frosts of cool weather during the growing season.

In many areas, farmers normally expect alfalfa stands to thin out within two or three years and be replaced by timothy, bromegrass, or quackgrass.

Because of low yields or because the farmer wishes to maintain a relatively high proportion of cultivated crops in the rotation, alfalfa is often plowed under following the second or third year of hay.

Severe winter weather, disease, wet soil, poor seed, improper management, or competition from grasses cause loss

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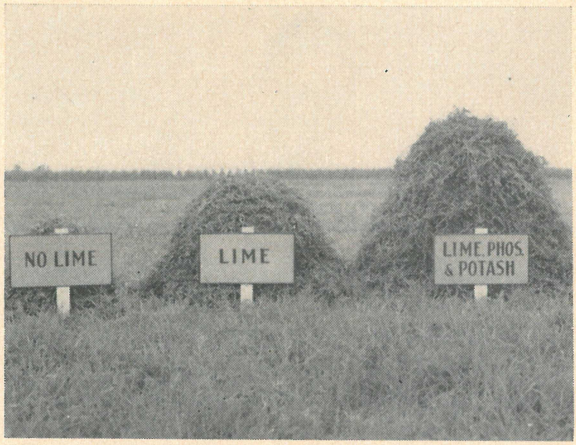

Here we see the influence of different fertilization on the yield from a second cutting of second year alfalfa hay. Alfalfa with no lime produced .07 ton; with 5 tons per acre of lime, .39 ton of hay; with 5 tons per acre of lime and 500 lbs. per acre of 0-13-30, *1.12 tons of hay.*

of alfalfa stands, *but frequently the main reason is starvation for lime, phosphate, or potash.*

Alfalfa often survives unfavorable conditions and remains productive for a surprising number of years when provided with a favorable soil reaction *and with adequate amounts of phosphorus and potassium in available form. Alfalfa may even become more productive with age.*

The problem of growing good alfalfa crops is very important on the Spencer silt loams and similar soils of the northern half of Wisconsin.

These soils—about three million acres of them—were developed on granitic glacial till overlain by several inches of loess. They are naturally very acid, low in available phosphorus and potassium, and usually have poor internal drainage. Unless properly limed and fertilized, they are unsuited for growing alfalfa. In some cases, it may be necessary to smooth the land and install terraces to provide satisfactory removal of surface water.

Experiments Started in 1942

Experiments were started on Spencer silt loam in 1942 to determine the levels of lime and available phosphorus and potassium for the most satisfactory crop yields.

The rotation used was corn, oats, and two years of alfalfa-timothy hay. The hay was cut twice each year. On going into corn, all plots received manure in proportion to their crop yields—one ton applied for each ton of dry matter harvested. In 1947, plans were modified in the case of the lime levels experiment and in 1948 in

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This stand of alfalfa is a striking example of the Wisconsin field trials. This alfalfa field has produced over 3½ tons of hay per acre annually for the past 9 years. Initial soil treatment included 5 tons of lime and 500 lbs. of 0-20-20 per acre, with 200 lbs. of 0-0-60 annually.

the case of the fertility levels experiment to allow the alfalfa to grow as long as the stands remained productive. So far, one block of plots in the lime levels experiment has remained in alfalfa for *nine years* of hay and one in the fertility levels experiment *for eight years.*

The plots which received adequate amounts of lime and high potash fertilizer have produced abundant yields of alfalfa during these periods, and apparently will continue to do so for several more years.

Highly Profitable Use

Yields for nine successive years of hay in the lime levels experiment are given in Table I. Note that total acre yields of hay for the nine years ranged from about 13 tons (mostly timothy and quackgrass) for the unlimed and unfertilized plot to about 35 tons of alfalfa for the plot receiving 10 tons of lime plus fertilizer. The average acre increase for this period due to liming alone was about 15 tons.

Profit on the lime and fertilizer investment may be calculated by contrasting the cost of the lime and fertilizer and the value of increased yield it produced. Using current prices, the acre costs for the lime and fertilizer applied on treatment 4 are as follows:

5 tons ground limestone spread at $4 per ton $20.00
1000 lbs. 0-20-20 (500 lbs. in

Table I. Yields of nine successive crops of alfalfa in the lime levels experiment on Spencer silt loam in Barron County, 1948–1956, inclusive.

Treatment number	Tons/A limestone	Approx. pH of soil (1953)	Lbs./A 0–20–20 in 1947	Lbs./A muritate of potash (60%) topdressed each fall starting in 1950	Tons per acre hay*			
					Total	Annual average	Increase over check	
							Total	Annual average
1	0	5.2	0	0	12.72	1.41	.....	.....
2	0	5.2	500	200	19.14	2.23	6.42	0.82
3	3	6.0	500	200	30.28	3.36	17.56	1.95
4	5	6.5	500	200	30.88	3.43	18.16	2.02
5	7	6.8	500	200	32.25	3.58	19.53	2.17
6	10	7.1	500	200	34.62	3.85	21.90	2.44

* No lime treatments mostly timothy and quackgrass, other treatments mostly alfalfa.

1947 and 500 lbs. charged against original application in 1942) at $65 per ton 32.50

1200 lbs. muriate of potash (60% K_2O) at $60 per ton .. 36.00

TOTAL $88.50

The value of the increase in yield for this treatment may be calculated as follows:

31 tons of alfalfa hay at $20 per ton $620.00

Less 13 tons of mostly timothy and quackgrass at $12 per ton 156.00

DIFFERENCE (OR PROFIT) $464.00

Divide the increased yield value ($464) by the lime and fertilizer cost ($88.50) and you get a *$5.00 return on each dollar invested in lime and fertilizer.* This figure is probably conservative since manure would normally be topdressed on alfalfa, reducing topdressing fertilizer cost about 50%.

Also other benefits, such as an increase in the organic matter content of the soil and improved soil structure, were not taken into account.

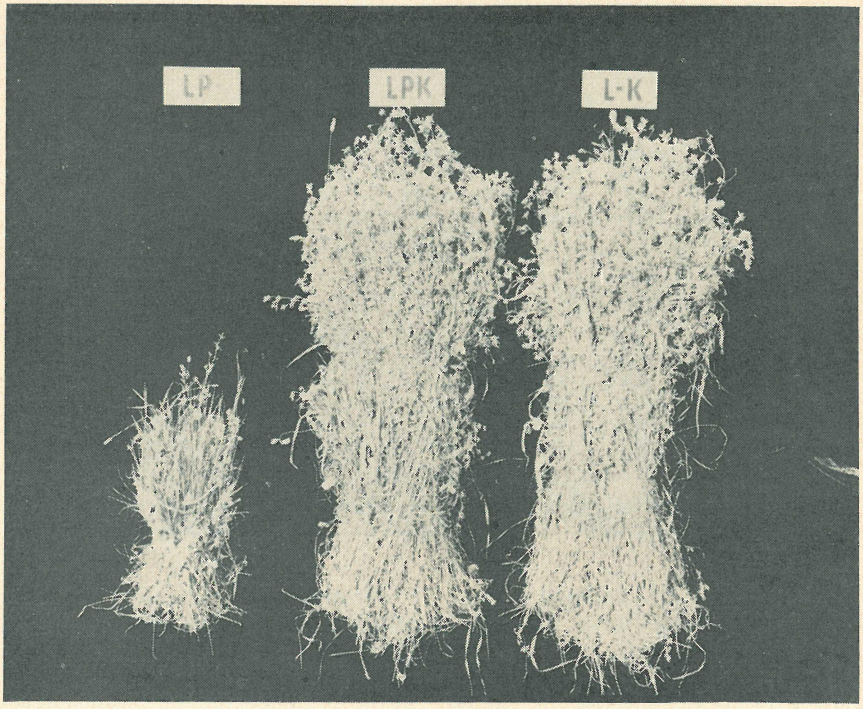
We now know that, due to increased availability of soil phosphorus from applications of limestone to these soils, more phosphate fertilizer was applied in the beginning (1942) than was actually needed. Many excellent stands of alfalfa have been established on these soils with an average acre application of about 5 tons of ground limestone and 500 to 1000 pounds of 0-10-30 fertilizer.

Alfalfa Needs High Potash Fertilizer

Yields for the eight successive years of hay in the fertility levels experiment are given in Table II. Note that total acre yields ranged from about 15 tons of mostly timothy and quackgrass in treatment 1 for lime only to nearly 31 tons of alfalfa in treatment 8 for phosphate and potash in addition to lime.

It is very important to note that potash application with lime in treatments 2 to 4 inclusive yielded about 24 to 27 tons per acre, or nearly as high as treatments with phosphate in addition to potash and lime.

But chemical analyses revealed that the phosphorus content of the alfalfa on the no-phosphate plots averaged



Benefits from adequate lime (L), phosphate (P), and potash (K) applications are shown by these year square samples from the second cutting of 6-year-old alfalfa. LP yielded .20 ton; LPK, 1.37 tons; and LK, 1.47 tons.

about 0.15% which, according to some livestock researchers, is too low for proper animal nutrition. It would therefore seem wise to fertilize with a high potash fertilizer containing some phosphate, such as 0-10-30 or supplement the livestock ration with phosphorus.

Lime and Potash Help Prevent Winterkilling

The great importance of lime and potash in reducing winterkilling of alfalfa is shown on page 15. The content of water soluble protein in the alfalfa crowns appears to be closely related to its resistance toward winterkilling.

Liming to pH 6.5 (5 tons lime) or higher and fertilizing to levels of 200 or more pounds per acre of exchangeable potassium seem to favor both the protein content and resistance qualities.

To maintain alfalfa stands over a period of years, it is usually necessary to topdress each year with 150 to 200 pounds per acre of muriate of potash or its equivalent in mixed fertilizer. Where these conditions were met (as in the lime levels experiment), good stands and good yields were maintained for the nine years the plots were in alfalfa. Also, the prospects are that the alfalfa on these plots will continue to withstand severe winter conditions and remain productive for several years.

Lime Increases Availability of Soil Phosphorus

In the beginning (1942) of these experiments, corn, oats, and alfalfa responded about as much to phosphate

Table II. Yields of eight successive crops of alfalfa hay in the fertility levels experiment on Spencer silt loam in Barron County, 1949–1956, inclusive. All plots limed to pH 6.5.

Treatment number	Approx. lbs. per acre available after initial fertilization (1943)*		Lbs. per acre 0–0–60 topdressed on alfalfa each fall beginning in 1950	Tons alfalfa hay per acre**			
	Phosphorus	Potassium		Total (1949–56)	Annual average	Increase over check	
						Total	Annual average
1	15 to 25 (check)	100 (check)	0	15.03	1.88	.....	.....
2		150	100	26.14	3.27	11.11	1.39
3		200	200	24.01	3.00	8.98	1.20
4		300	300	27.71	3.46	12.68	1.58
5	30 to 40	100 (check)	0	16.68	2.09	1.65	0.21
6		150	100	25.22	3.15	10.19	1.27
7		200	200	24.85	3.11	9.82	1.23
8		300	300	30.52	3.82	15.49	1.94
9	45 to 55	100 (check)	0	16.35	2.04	1.32	0.16
10		150	100	26.38	3.30	11.35	1.42
11		200	200	26.69	3.34	11.66	1.46
12		300	300	26.99	3.37	11.96	1.49
13	95 to 105	100 (check)	0	17.40	2.18	2.37	0.30
14		150	100	23.35	2.92	8.32	1.04
15		200	200	23.90	3.49	12.87	1.61
16		300	300	30.28	3.79	15.25	1.91
17	200 lbs. 0–20–20 on oats with grain fertilizer drill.		0	19.58	2.45	4.55	0.57

* To establish the levels of P in treatments 5 to 8, 9 to 12, and 13 to 16, inclusive, 350, 700, and 1630 lbs., respectively of 43% superphosphate were applied; the 150, 200, and 300 lb. levels of K took 300, 600, and 1200 lbs., respectively, of 50% muriate of potash.

** Mostly timothy and quackgrass where no potash was applied and about 40 to 50% alfalfa on plots topdressed with 100 lbs. per acre of muriate of potash; other plots usually 60 to 80% alfalfa.

as potash. But when lime became more thoroughly worked into the land over a period of time, the crops, especially alfalfa, responded less and less to phosphate fertilizers.

Abundant evidence now indicates this was due largely to an increase in the availability of the phosphorus naturally present in the soil, especially that in the forms of organic matter and hydrated iron and aluminum phosphates.

Lime on acid soils increases the availability of the soil phosphorus, data in Table II shows. Some increase in acid soluble phosphorus occurred in treatments 5 and 6 but none in treatment 4. Any increase in the amount of acid soluble phosphorus due to the lime applied in this latter treatment was probably more than offset by the amounts of phosphorus removed by the larger yields which it produced.

Furthermore, during the 11-year period, liming caused a release of 26 to 68 pounds per acre of inorganic phosphorus (largely in all probability, from hydrated iron and aluminum phosphates) and 42 to 64 pounds per acre from the organic form. Thus, the total amount of phosphorus released from these two forms is about 100 pounds per acre, or about 9 pounds per acre per year for the 11-year period the

Table III. Influence of applications of limestone to Spencer silt loam in 1942 on the forms and amounts of soil phosphorus found after 11 years. All plots received 400 lbs. per acre P_2O_5 as 0–20–20.

Treatment number	pH of soil	Per cent organic matter	Pounds per acre phosphorus		
			Soluble in 0.002 N H_2SO_4	Alkali soluble	
				Inorganic	Organic
2	5.1	2.3	56	180	325
4	6.5	2.3	54	112	263
5	6.9	2.3	71	146	261
6	7.1	2.7	70	154	283

plots had been in operation at the time of sampling. This is equivalent to about 100 pounds per acre annually of 0-20-0 valued at about $2.00.

Similar data were obtained for a number of other acid soils. Except for the higher percentage of organic matter found in treatment 6, liming appeared not to affect appreciably the content of this soil constituent.

Boron Starvation Cuts Alfalfa Yields and Quality

Boron starvation in alfalfa—sometimes called "yellow top"—frequently occurs on sandy soils and on many other soils during drouth. Most of the available boron in soils comes from the breakdown of soil organic matter. When the soil is low in this constituent or when the plow layer dries out so the supply of available boron is greatly reduced, starvation symptoms often appear, with yield and quality being lowered.

Such symptoms did appear from time to time in the experiments just discussed, but they soon disappeared when about 30 pounds of borax were applied per acre. Such borax applications were made three times in 13 years of operating the plots.

In practice, it is usually more convenient to topdress the borax or fertilizer borate already mixed with the regular fertilizer. Frequently this mixture is 0-10-30B, the letter B indicating that borax has been added.

Summary

The Spencer silt loams are similar to many other acid, low fertility soils throughout the northern United States.

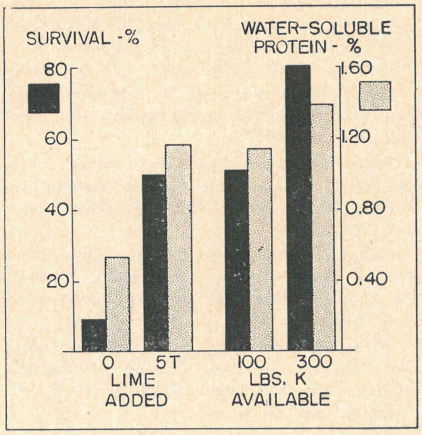
The results of the field trials reported here are convincing evidence that with (1) *adequate liming and fertilization,* (2) *use of adapted varieties (winter hardy and wilt resistant),* (3) *proper drainage and good management,* alfalfa stands may often be made productive for a period of 9 or more years.

The essential steps used in establishing and maintaining the alfalfa in the Surefire Program in Wisconsin are given as follows:

1. Select fields with good surface drainage or provide such drainage by suitable terracing, ditching, or land forming.

2. Take soil samples to determine the needs for lime and phosphate and potash fertilizers.

3. Apply the needed lime and fertilizer. If four or more tons of lime are needed, it is usually preferable to split



Here is shown the effect of lime and potassium on survival and content of water-soluble protein in alfalfa crowns sampled in November. (In lime comparison, the soil contained 10 lbs/A available P and 100 lbs/A available K. In the potassium comparison, the soil received 5 tons lime per acre and contained 10 lbs/AP.

the application and apply half before plowing and half after, with thorough working in each case. Favorable results usually result by applying 200 to 300 pounds per acre of fertilizer with the grain nurse crop and the balance broadcast and disced in before seeding.

4. Harvest the crop at the proper time. Usually each cutting should be taken soon after the first flowers appear. Several inches of growth should be left in the fall to hold the snow for winter cover.

5. Topdress with high potash fertilizer as needed, usually 200 to 400 pounds per acre 0-10-30 or 0-10-30B where boron starvation is indicated to maintain stands for several years.

6. Retest the soil about every four years or each rotation to determine needs for lime and fertilizer.

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"Surefire Program"

Getting farmers in northern Wisconsin to grow alfalfa was largely a financial problem—overcome by the teamwork between local bankers, official agricultural advisors, and progressive farmers.

This teamwork became known as the Surefire Alfalfa Program.

On the average, the initial application needed was 5 tons of lime and 1,000 pounds of 0-10-30 fertilizer—costing about $45.00 per acre. About $500 was needed to buy the lime, fertilizer, and seed necessary for establishing a 10-acre stand of good alfalfa—usually alfalfa-brome mixture.

Area meetings were set up to interest local bankers in arranging loans for the initial treatment. And when they saw the yields of alfalfa resulting from proper lime and fertilizer treatment, seven banks arranged for loans in 1950 to finance the program.

The banks asked the farmer to have his farm examined, the soil tested for its lime and fertilizer needs, and a 10-acre field with proper surface drainage selected for the alfalfa. The farmers agreed to treat the soil and put in the seedings as their official agricultural workers directed.

Following their county agents and University of Wisconsin Soils Department advisors, most of the farmers entering the program are now getting 3 and 4 tons of high quality alfalfa-hay per acre from land once unproductive.

Today, bankers throughout the area make two-to-three-year loans for lime and fertilizer purchases used on basic soil improvement.

One leading banker of the program, Mr. John Stauber of the Citizens National Bank at Marshfield, expressed the bankers' sentiments this way:

"A farmer doesn't have to go out and buy his livestock feed. He raises it himself and becomes more self-sufficient. Our bank is interested in financing his ability because we feel it makes a better farmer, a better citizen, and finally a better customer for our bank."