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Alfalfa Production in Alabama

AGRICULTURAL EXPERIMENT STATION
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ALFALFA PRODUCTION
in Alabama

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ALFALFA WAS FIRST GROWN successfully in Alabama on lime soils of the Black Belt. Experiments with alfalfa by the Agricultural Experiment Station of the Alabama Polytechnic Institute date back to 1889, when a per acre yield of 3,440 pounds of hay was reported at the Canebrake Station at Uniontown.

At this same location on Sumter clay soil, a stage-of-cutting test was begun in 1924, and variety and fertilizer tests in 1925. Although results from other experiments were reported occasionally, only a few tests were conducted until 1930 when experiments were begun at the Black Belt Substation, Main Station, and the Lafayette and Alexandria experiment fields. Since that time, alfalfa research has been expanded to include other areas of the State. Results of all known experiments relating to alfalfa in Alabama are summarized in this bulletin.

The value of alfalfa in Alabama was recognized early. In 1904, J. F. Duggar, then director of the Experiment Station, wrote, "at no distant day it will doubtless assume important proportions in the agriculture of Alabama. On all soils suitable to it in this State, it will doubtless become one of the principal foundations on which the livestock industry will be based." This prophecy has never been fulfilled, although alfalfa still appears to be the best crop for producing large yields of high quality forage.

An ideal forage crop is one that (1) is easily established, (2) grows throughout the year, (3) conserves soils, (4) requires little cultivation and hand labor, (5) produces a highly nutritious and palatable feed, (6) cures easily, (7) withstands grazing, (8) fits into a desirable rotation, and (9) yields economical returns of a useful product. Alfalfa meets most of these requirements.

The question as to why alfalfa has not been grown more extensively in Alabama is difficult to answer. Many past failures have been because of insufficient plant nutrients, particularly calcium, potassium, and boron. Diseases also may have been a factor. In some cases the use of non-hardy varieties has caused failures. Results of studies in various sections of Alabama show that good yields can be produced if the nutrient requirements are met; if planted on well-drained, fertile soils; if recommended varieties are planted; and if the proper cultural methods are used.

VARIETIES

Until recent years most alfalfa varieties in commercial production in the United States were introduced varieties that have become adapted to local conditions. Often the seed are sold under a variety name applied to some section in which the seed are grown. Thus, there are such varieties as Kansas Common, Texas Common, Arizona Common, and others. In some cases, the name is that of the country from which the seed were imported, namely, Argentine and Peruvian.

Alfalfa breeders in the United States have developed several new varieties with specific characteristics that make them desirable under certain conditions.

Qualities Needed in a Variety

Yield, quality of hay, and longevity are the most important characteristics in a variety. The yield may be affected as much or more by the ratio of stems to leaves as by height of plant. Thus, a tall-growing, coarse-stemmed plant may yield no more than a short, fine-stemmed one. Furthermore, the quality of the hay would be inferior to that from the fine-stemmed plants. A number of the newer varieties have fine stems and are very leafy. Some of these are more disease resistant than other varieties; as a result they produce high yields of good quality hay over a long period.

Winter hardiness is an important characteristic of varieties suitable to Alabama. In several instances, varieties that were not cold resistant have been killed or stands have been thinned by low temperatures, Figure 1.

Bacterial wilt has not been recognized as an important factor in alfalfa production in Alabama. However, if production is expanded, it seems reasonable to expect that the disease will be

Figure 1. Left—Williamsburg, a hardy variety, withstands cold weather; right—Indian, a non hardy variety, has poor stand because of thinning by cold.

more prevalent and the use of resistant varieties will be important.

Variety Characteristics

For this report, varieties are divided into winter-hardy and non-hardy groups.

HARDY GROUP. Varieties in the hardy group have never been winterkilled nor have the stands been seriously thinned by cold in any test in Alabama.

Atlantic, developed in New Jersey, is becoming a popular variety throughout the eastern United States. It has performed well in Alabama tests and is recommended for planting in this State.

Argentine appeared to be similar to Kansas Common in Alabama tests. Since the amount of seed imported at present is small, only a few are usually offered for sale to farmers.

Buffalo is a bacterial wilt-resistant variety of alfalfa developed by the Kansas Agricultural Experiment Station from Kansas Common parentage. In Alabama its performance is similar to that of Kansas Common. Certified seed of Buffalo are available, and, where seed of known origin and quality are desired, it is a preferred variety.

Du Puits, developed in France, is being widely acclaimed in the East-Central States. It is claimed to have the cold tolerance of northern strains and the rapid recovery of non-hardy strains.

In tests in Alabama, it outyielded all other varieties the first year or two; however, production thereafter declined, going below that of Kansas Common. The plants are very large and coarse; hence, the hay is not of as good quality as that from other varieties.

Kansas Common, Oklahoma Common, and Texas Common were the same in appearance and performance in the Alabama tests. They are winter-hardy, drouth-resistant, high-yielding varieties that produce good quality hay. They have always produced well in Alabama and are the standard varieties for this State. No variety has been found superior to these when all factors are considered. If bacterial wilt should spread in Alabama, Buffalo variety might be preferred.

Narragansett, developed by the Rhode Island Experiment Station, is a dark-green, leafy, fine-stemmed variety. It does not grow as tall as Kansas Common, but it has more and finer stems, is leafier, and, therefore, yields as well as Kansas Common. It produces a superior quality hay and might be preferred by dairymen and others where quality is so important. It is not resistant to bacterial wilt.

Nomad, developed in Oregon, and Rhizoma, developed in Canada, are creeping types of alfalfa. It has been claimed that they are superior for grazing. They have not been tested for grazing in Alabama, but they are decidedly inferior for hay production. In Alabama they have never shown any tendency to spread by rhizomes. They are hardy varieties and are not killed by cold.

Ranger, developed by the Nebraska Agricultural Experiment Station, although resistant to bacterial wilt, was inferior to Buffalo and Kansas Common in Alabama tests, and was more susceptible to the disease complex.

Vernal, developed by the Wisconsin Agricultural Experiment Station, is a bacterial wilt-resistant variety similar in all characteristics to Narragansett.

Talent, a variety developed by the Oregon Agricultural Experiment Station, has not shown any superior characteristics under Alabama conditions. In tests it yielded about 97 per cent as much hay as Kansas Common.

Williamsburg, a variety developed in Virginia, has produced about 2 per cent higher yields than Kansas Common and has been more resistant to certain diseases. It is not resistant to bacterial wilt. Williamsburg is an excellent variety for use in Alabama.

NON-HARDY GROUP. Varieties in the non-hardy group at some time or in some place have been seriously damaged by cold in Alabama.

African and Indian varieties are similar. They do not possess true winter dormancy characteristics. New growth is begun with each warm period, and with the next hard freeze they are killed back. As a result, the plants are in a weakened condition by spring. Even in southern Alabama, plantings made in the fall of 1950 were killed by abnormally low temperatures in November. In northern Alabama these varieties are often winterkilled. They are quite susceptible to the disease complex and the stands rapidly become thin. The combination of thinning of the stand by disease and by cold makes these varieties unsuitable for use in Alabama where stand maintenance of 2 years or more is important.

If it were desired to maintain a stand only 1 year, these varieties might be useful for providing winter grazing in southern Alabama, since they do not become dormant and will grow during the warmer periods of the winter.

Caliverde, developed by the California Agricultural Experiment Station, is resistant to bacterial wilt, common leaf spot, and mildew. It appeared to be similar to Chilean, Chilean 21-5, Arizona Common, and California Common in winter hardiness. It has yielded better than these varieties, but it has not been tested long enough to determine if it will survive longer than others under Alabama conditions.

Chilean, Arizona Common, California Common, Chilean 21-5, and Peruvian appeared to be similar in growth characteristics in tests in Alabama. They have a short winter dormancy, consequently, they begin growth earlier in the spring and remain active later in the fall than does Kansas Common. The top growth is often killed by cold, and in severe winters the stand is destroyed. This is particularly true of plantings made in the fall and followed by a severe winter; older plants survive cold somewhat better than young plants. Since these varieties do not outyield Kansas Common and are not as winter hardy, they are not recommended, particularly for northern Alabama.

RESULTS OF VARIETY TESTS IN ALABAMA

This bulletin presents hay yields of most of the new varieties of alfalfa as well as yields from many of the old ones available in the United States. Results from tests of varieties in various locations in Alabama are given.

The first variety test of alfalfa was begun at Uniontown at the old Canebrake Station in the spring of 1925. Tests were begun

TABLE 1. RELATIVE YIELDS OF ALFALFA VARIETIES IN TESTS IN ALABAMA, 1925-54

Variety	Relative yield[1] Kansas Common=100[3]	Location, year tests[2]
	Per cent	*Number*
African	82.2	7
Argentine	97.9	16
Argentine—Bahia Blanca	98.4	14
Argentine—Buenos Aires	97.5	14
Argentine—Rio Negro	108.8	14
Argentine—La Pampa	99.5	14
Arizona Common	103.3	16
Atlantic	101.8	42
Australian (Pilca Butta)	67.2	2
Buffalo	98.3	49
Caliverde	103.4	10
Chilean	94.0	39
Chilean 21-5	93.1	12
Du Puits	106.3	15
French	95.6	3
Grimm	79.5	5
Idaho Common	96.2	3
Indian	89.0	7
Kansas Common	100.0	59
Narragansett	99.8	20
Nemastand	86.7	7
Nevada C	75.3	7
Nomad	70.7	9
Oklahoma Common	99.1	31
Peruvian (Hairy)	90.6	37
Peruvian (Smooth)	79.4	3
Ranger	91.5	53
Ranger Syn. 1 new	96.1	14
Ranger Syn. 2 new	93.2	14
Ranger 2nd. generation	99.0	14
Rhizoma	96.4	17
Talent	96.5	7
Texas Common	104.6	6
Uruguay-Clone 10	94.5	10
Vernal	99.7	7
Williamsburg	102.0	34

[1] The relative yield is figured from Kansas Common as 100. It is based on hay yield at 15 per cent moisture. The yield of the particular variety is always divided by the yield of Kansas Common in the same test for the same year for the same location.

[2] Location, year tests is one test at one location for one year.

[3] The average yield of all tests of Kansas Common was 7,250 pounds of hay per acre.

at the Sand Mountain Substation in 1942 and at the Main Station in 1943. Later, tests were begun at the Gulf Coast, Tennessee Valley, Upper Coastal Plain and Piedmont substations, and at the Monroeville Experiment Field. In all cases the land was fertilized and limed in accordance with what was considered to be good practice at that time. Results of the various tests are given in Appendix Tables 1 to 18. The relative yields of all varieties in all tests are presented in Table 1. In all tests where a variety was winterkilled, it was replanted as soon as possible. Many of the tests with non-hardy varieties were conducted during the 1952-54 period in which there was no winterkilling. Hence, the yields in Table 1 for these varieties may give the impression they should be grown in Alabama. Non-hardy varieties are high yielding when they survive, but anyone planting them should be aware of the risk of winterkilling. Since there are several hardy varieties that yield as well as the non-hardy types, the Experiment Station recommends only hardy varieties for planting in Alabama.

RECOMMENDED VARIETIES. Based on results of tests, the following varieties are recommended for planting in Alabama: (1) hardy common varieties, such as Kansas, Oklahoma, or Texas; (2) Buffalo; (3) Williamsburg; (4) Atlantic; (5) Vernal; and (6) Narragansett.

RATE OF SEEDING

Rates-of-seeding tests have been conducted at the Main Station and at the Monroeville Experiment Field. Results are presented in Tables 2, 3, and 4. They show a slight increase in yield as the seeding rate is increased from 10 to 25 pounds. There were no increases from rates above 25 pounds in any of the tests. The increases in yield from rates above 10 or 15 pounds were not sufficient to warrant use of higher rates. However, in all of these

TABLE 2. YIELD OF HAY FROM DIFFERENT RATES OF SEEDING ALFALFA, CHESTERFIELD SANDY LOAM, MAIN STATION, 1945-46

Rate of seeding per acre	Yield of hay per acre		
	1945	1946	2-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*
10	4,947	12,903	8,925
15	6,766	13,243	10,005
20	7,477	13,870	10,674
25	6,954	14,654	10,804
Number of cuttings	4	5	

TABLE 3. YIELD OF HAY FROM DIFFERENT RATES OF SEEDING ALFALFA, CHESTERFIELD SANDY LOAM, MAIN STATION, 1952-54

Rate of seeding per acre	Yield of hay per acre			
	1952	1953	1954	3-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
10	10,431	10,590	7,298	9,440
15	10,666	10,243	7,701	9,537
20	10,328	10,867	7,690	9,628
25	10,337	10,686	7,987	9,670
30	10,490	10,553	7,776	9,606
50	10,320	10,598	7,633	9,517
Number of cuttings	4	5	3	

TABLE 4. YIELD OF HAY FROM DIFFERENT RATES OF SEEDING ALFALFA, MONROEVILLE EXPERIMENT FIELD, 1951-54

Variety	Rate of seeding per acre	Yield of hay per acre				
		1951	1952	1953	1954	4-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Atlantic	15	4,560	9,096	7,967	5,950	6,893
	30	4,183	9,018	8,158	5,416	6,693
Oklahoma Common	15	5,122	9,760	8,979	6,411	7,568
	30	4,993	9,954	9,590	6,700	7,809
Narragansett	15	4,738	8,813	7,924	5,902	6,844
	30	4,802	8,887	8,814	5,819	7,081
Average of all varieties	15	4,807	9,223	8,290	6,088	7,000
	30	4,659	9,286	8,854	5,978	7,194
Number of cuttings		4	4	5	4	

tests, care was taken to distribute the seed uniformly over the area. If the seed could be uniformly distributed and carefully covered, it is probable that the seeding rate could be less than 10 pounds and still get a satisfactory stand. Alfalfa plants have a remarkable ability to put out more shoots when spaced widely and thus compensate in yield for the fewer plants at the wide spacing. A high rate of seeding tends to smother out weeds better than a low rate. Thus, the higher rate might be desirable from this standpoint. The Experiment Station recommends a seeding rate of 20 to 25 pounds under most Alabama conditions; under favorable conditions, the rate may be 10 to 15 pounds.

INOCULATION

Like all legumes, alfalfa must be inoculated. Inoculation is usually done by applying a culture of the proper organism to the seed. Sometimes it is accomplished by spreading soil in which alfalfa has been grown over the area to be inoculated. Most inoculation is done by using commercial cultures.

Studies and experience have shown that inoculation is essential, and alfalfa should never be planted without it.

HARVEST

Stage of Cutting

Canebrake Station. Kansas Common was planted in the spring of 1924 on Sumter soil (or possibly Houston). It was cut during the summers of 1924-27. The yields for 1924, 1926, and 1927 are reported in Table 5. The 1925 yield is not available.

It is evident that there was considerable variation in yields. In general, the results show that early and/or late cuttings reduced yields. On the average, best results were obtained from cutting in full-bloom stage.

Main Station. Tests to determine the effect of cutting alfalfa at different growth stages on yield, stand, and reserve food in the plants were made at Auburn in 1949. Kansas Common was sown in the fall of 1948 on Norfolk sandy loam soil. Root growth was determined by digging 30 plants from each replication and making the necessary determinations.

The results are reported in Table 6. Cutting in the bud stage

Table 5. Yields of Hay from Alfalfa Cut in Different Stages of Growth at Canebrake Experiment Station, 1924, 1926, and 1927

Stage of cutting	Yield of hay per acre			
	1924	1926	1927	3-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*
One-tenth bloom	2,912	7,940	3,620	4,824
Full bloom	5,072	6,560	3,740	5,124
Pod	2,624	6,620	5,040	4,761

Table 6. Effect of Cutting Alfalfa at Different Stages of Growth on Yield, Stand, and Root Reserves, Main Station, 1949[1]

Stage of cutting	Hay yield per acre in 1949	Plants per sq. ft. Nov. 10, 1949	Reserve food per acre[2] Nov. 10, 1949
	Pounds	*Number*	*Pounds*
Bud	3,720	5	64
One-tenth bloom	4,020	10	170
Full bloom	5,160	18	248
Full bloom one cutting, bud next cutting	4,300	11	160

[1] Alfalfa planted September 14, 1948, on Norfolk sandy loam soil; cut 4 times in 1949.

[2] Reserve food is total organic reserves and represents protein, carbohydrates, and fat.

reduced the yield, and greatly reduced the stand and reserve food in the plants. Cutting in full-bloom was most favorable for the alfalfa, but the quality of hay was not as good as that cut earlier. Alternate cutting at full-bloom and bud stage gave about the same results as cutting at one-tenth bloom. If alfalfa is cut early to get a high quality feed, the plants should be allowed to go to at least full-bloom before the next cutting in order to replenish the reserve food supply. If this is not done, the stand will soon diminish to the point that the alfalfa will have to be replanted.

It is recommended that alfalfa be cut between the one-tenth bloom and full-bloom stage.

WINTER GRAZING

Alfalfa is one of the best crops to furnish grazing in the late fall and winter. In order to determine the effect of grazing on the next year's yield, a fall and winter grazing experiment was conducted.

Kansas Common was planted in the fall of 1945. Four cuttings of hay were made in the summer of 1946. Alfalfa was allowed to grow from the last cutting until grazing was begun in late November (after a hard frost). An area was fenced and grazed during the winter until growth started in the spring. Cattle were then removed. A comparable area was not grazed. Yields were taken by clipping from four randomized 10- × 10-foot plots on each area. The results are presented in Table 7.

It is noted that the yield was reduced some the first year and about three-fourths ton the second year. The average was about one-half ton per acre. The amount of forage removed by grazing is not known. From these results it is evident that alfalfa stands can be reduced by overgrazing.

TABLE 7. YIELD OF HAY FROM ALFALFA GRAZED AND UNGRAZED IN THE WINTER, MAIN STATION, 1947-48

Treatment	Hay yield (15% moisture)		
	1947	1948	Average
	Pounds	*Pounds*	*Pounds*
Grazed in winter until growth began in spring	7,242	7,524	7,383
Ungrazed	7,624	9,290	8,457

Simulated Winter Grazing

In order to ascertain how much forage was removed during the winter and what effect it would have on yield the succeeding year, a test was begun in the fall of 1948 in which alfalfa was clipped during the winter to simulate grazing. Plots were selected in old alfalfa (planted in fall of 1942) and young alfalfa (planted in fall of 1948). In both cases Kansas Common variety was used. Two sets of plots were clipped every 2 weeks, one beginning December 4 and the other January 29. A lawn mower set to cut 2 inches high was used. Clipping stopped in all cases on March 26. At this time, unclipped old alfalfa was beginning its spring growth.

During the summer of 1949, the alfalfa was cut four times in the one-tenth bloom stage.

Results of this test for the year are given in Table 8. Clipping during the winter reduced the yield the following summer in all cases. The earlier the clipping began the greater was the yield reduction. In the case of the old alfalfa, the amount removed during the winter was about equal to the yield reduction the next year. However, this was not true for the young alfalfa. Thus, it appears that, with old established alfalfa, it is a case of deciding whether the forage in the winter is worth more than that the next summer.

The yields by clippings during the winter are presented in Table 9. It is evident that young alfalfa affords little grazing until March. Removal of the growth greatly affects the yield during the summer. From these results, grazing young alfalfa during the first winter's growth is not recommended.

Table 8. Effect of Clipping Alfalfa in Winter of 1948-49 on Yield of Hay During Winter and Yield of Hay the Following Year[1]

Date clipping began	Old alfalfa[2] — Yield of hay per acre			Young alfalfa[3] — Yield of hay per acre		
	During winter	During summer	Total for year	During winter	During summer	Total for year
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Dec. 4, 1948	2,652	2,800	5,452	357	2,700	3,057
Jan. 29, 1949	1,965	3,040	5,005	633	2,940	3,574
Not clipped	----	4,980	4,980	----	4,020	4,020

[1] Clipped every 2 weeks with lawn mower set to cut 2 inches high. Dates as follows: December 4, 17, January 15, 29, February 12, 26, March 12, 26. After March 26 cut in one-tenth bloom for four cuttings.
[2] Planted in fall of 1942.
[3] Planted September 14, 1948.

TABLE 9. EFFECT OF AGE OF ALFALFA AND DATE OF CLIPPING DURING WINTER ON PRODUCTION OF FORAGE IN WINTER OF 1948-49, MAIN STATION

Clipping Date	Old alfalfa[1]		Young alfalfa[2]	
	Date clipping began		Date clipping began	
	Yield of hay per acre		Yield of hay per acre	
	Dec. 4	Jan. 29	Dec. 4	Jan. 29
	Pounds	*Pounds*	*Pounds*	*Pounds*
December 4	1,624	----	47	----
December 17	107	----	15	----
January 1	53	----	4	----
January 15	150	----	16	----
January 29	330	1,333	60	333
Total to this date	2,264	1,333	142	333
February 12	39	102	8	16
February 26	139	248	30	69
March 12	35	60	24	36
March 26	175	222	153	179
Total Feb. 12 to March 26	388	632	215	300
Grand total	2,652	1,965	357	633

[1] Planted in fall of 1942.
[2] Planted September 14, 1948.

Old alfalfa produced considerable forage during the winter. In this experiment, about 1 ton of hay per acre was produced. However, most of this growth was made in the fall before cold weather dormancy. For grazing during the winter, it is necessary to allow sufficient time between the last cutting in the summer and the first cold weather in the fall to permit the alfalfa to grow.

TABLE 10. EFFECT OF CLIPPING ALFALFA IN WINTER OF 1948-49 ON RESERVE FOOD[1] IN ROOTS, MAIN STATION

Date of determining reserve food	Percentage of reserve food		
	Clipping began		
	Dec. 4	Jan. 29	Not clipped
	Per cent	*Per cent*	*Per cent*
		Old alfalfa	
December 4	68.3	68.3	68.3
March 24	56.7	57.8	67.8
May 6	61.3	61.0	68.5
June 18	62.8	62.5	62.6
		Young alfalfa	
December 4	76.3	76.3	76.3
March 24	73.6	73.1	79.1
May 6	73.3	75.6	76.5
May 20	75.7	76.0	77.4

[1] Reserve food is total organic reserves and represents protein, carbohydrates, and fat.

EFFECT OF WINTER CLIPPING ON RESERVE FOOD SUPPLY

Alfalfa roots were analyzed at frequent intervals during the winter and summer to determine the reserve food supply. Samples were taken from plants in the clipping tests, Figure 2. The analytical results are presented in Table 10.

The data show that clipping resulted in a reduction of reserve food in both the old and new alfalfa. It was sometime during the summer before the reserve food supply in the clipped alfalfa equalled that in the unclipped. This may explain the reduction in yield of hay in the summer following winter clipping or grazing.

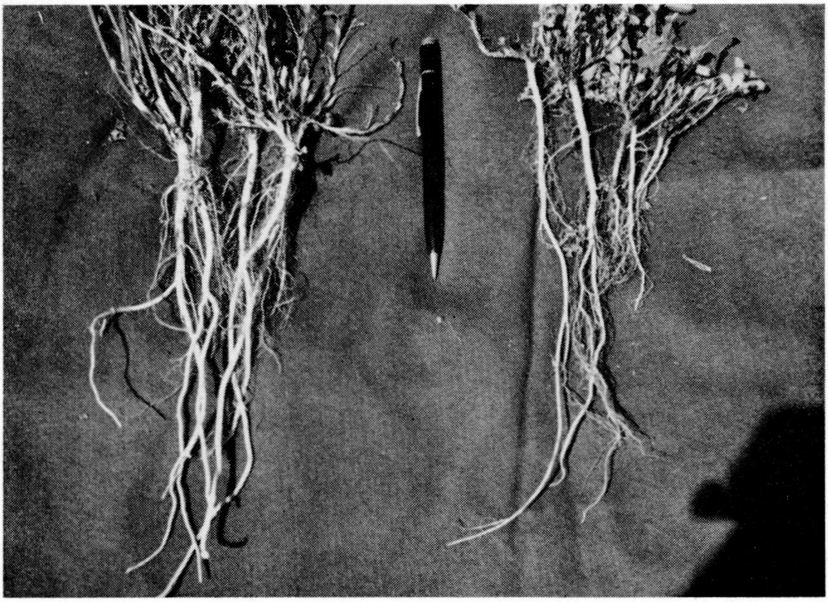

Figure 2. Left—roots from plants unclipped during winter; right—results of clipping every 2 weeks from December 4 to March 26. Photo made April 8.

CHOICE OF LAND

Alfalfa is suited only to well-drained soils. It will not stand a water-logged condition. If the proper fertilizer and lime treatment is followed, alfalfa can be grown on most well-drained soils in Alabama. Like most crops, the yield will be larger on more fertile areas than on poor land. It is preferred that the area be free of such perennial plants as Johnsongrass and Bermudagrass. If the land is fallowed for about 2 months in the summer (July and August), a stand of alfalfa can be obtained and maintained for a few years on land heavily infested with such plants. Nevertheless, such perennials will usually crowd out the alfalfa in about 3 years.

It has been difficult to grow alfalfa on the extremely heavy acid soils of the Black Belt and surrounding areas. Such soils as Eutaw, Vaiden, and Susquehanna do not appear to be suitable for alfalfa. Until more information is obtained, planting alfalfa on these soils is not recommended.

LAND PREPARATION

Alfalfa needs a well-prepared, firm seedbed. Preparation begins far enough ahead of planting to allow time for breaking, harrowing, and firming the land. Also, time should be allowed for sufficient rain to wet the soil and settle the seedbed. Best results have been obtained from turning under the lime several months ahead of planting to allow time for it to react with the soil. If the land is turned in early summer and fallowed for a few weeks, many weed seeds will germinate and be killed. This also allows moisture to accumulate. It is not recommended that alfalfa follow clover, vetch, or oats that have been allowed to produce seed. Even when combined, these crops will volunteer and crowd the alfalfa.

In some cases a crop of early corn has been grown ahead of alfalfa. The corn is harvested and the land is prepared for alfalfa. If sufficient rain falls in September to wet the soil thoroughly, good stands of alfalfa will result. However, a dry September may result in failure.

The most certain method is to fallow the land for about 1 or 2 months before planting, and thus accumulate sufficient subsoil moisture for the alfalfa.

The seed are sown on a firm seedbed and covered lightly, not over ¼ to ½ inch deep. A corrugated roller seeder is an excellent implement for covering the seed. If one is not available, a weeder or rotary hoe, or drag-harrow will cover the seed lightly. After using one of these tools, it is desirable to pack the soil with a roller or plank-drag.

TIME OF PLANTING

Time of planting studies in Alabama have shown that planting early in September is preferable in northern and central Alabama. In southern Alabama, October and November plantings produced just as good results as September plantings. Yield is reduced as planting is delayed. Danger of winterkilling is much greater with late planting. Spring plantings have produced poor results in Alabama because of serious competition from crabgrass and other weeds and because the weather often is dry. First year yields usually have been at least 3 times larger for fall-planted alfalfa than for spring-planted.

LIME AND FERTILIZER REQUIREMENTS

One of the first fertilizer tests conducted with alfalfa was established in 1925 at the Canebrake Station at Uniontown, Alabama, on Sumter clay. Three-year average yields of just under 4 tons per acre were reported where a heavy application of superphosphate was applied.

Results from experiments started at the Tennessee Valley Substation on Decatur clay loam in 1930 showed a need for lime as well as phosphate on acid soils. In both cases the response from potash was small compared to that from lime and phosphorus.

In a test begun at the Sand Mountain Substation on Hartsells fine sandy loam in 1939, the stand of alfalfa was maintained only 2 years on plots to which 160 pounds of K_2O per acre was applied before planting and none thereafter. On the plot getting 60 pounds of K_2O each year in addition to the initial application, the stand was maintained for 7 years and produced almost 3 tons of hay per acre the last year. The need for potash was also shown in a test begun in 1941 at the Main Station. Thus, tests at the various locations had established that lime, phosphorus, and potash were all important in alfalfa production. Deficiencies of these elements became evident sooner on some soils than on others, depending upon how well the soil was supplied with each at the beginning of the experiment.

In 1941, alfalfa grown on Norfolk sandy loam at Auburn showed a yellowed condition that was corrected by applying borax. Thus, boron was added to the list of elements important in maintaining stands of good-quality alfalfa forage. Since 1941 a large number of fertilizer and lime experiments have been conducted with alfalfa in order to have data available for a large number of the major soils of the State. Over 30 of these experiments have been conducted at more than 15 locations. The duration of the various experiments has ranged from 1 to 12 years.

Rates of Lime

Alfalfa probably has one of the highest requirements for lime of any crop grown in Alabama. It is significant that the first area where it was grown successfully was on the high-lime soils of the Black Belt. In a test started at the Tennessee Valley Substation in 1930, alfalfa showed good response to lime on Decatur clay loam. Results of this test are given in Table 11. Following this work, alfalfa response to lime was tested at many locations. The results from several of these tests are presented in Table 12. These data show an increase up to 3 tons of lime per acre at all locations where that rate was included. In some cases a need for 4 tons is indicated. On Susquehanna soil at Tuskegee, 8 tons of lime resulted in an increase of 830 pounds of hay per acre per year over that from the 4-ton rate. The data indicate that 3 to 4 tons of lime is the economical rate for most soils where it is desired to maintain an alfalfa stand for 3 or more years, Figure 3. It is recommended that the soil be tested for lime requirement before seeding alfalfa. To be certain that sufficient calcium is available, experience has indicated that lime should be applied and plowed into the soil at least 2 to 3 months prior to seeding alfalfa.

TABLE 11. EFFECTS OF VARIOUS RATES OF LIME ON YIELDS OF ALFALFA GROWN ON DECATUR CLAY LOAM, TENNESSEE VALLEY SUBSTATION

Lime per acre	First planting 1931-36[3]		Second planting 1937-41[4]	
	Annual yield	Yield increase per acre due to lime	Annual yield	Yield increase per acre due to lime
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
None	2,363	----	2,723	----
3,000[1 5]	3,317	954	4,701	1,978
6,000[1 5]	3,852	1,489	5,700	2,977
12,000[2 5]	----	----	6,637	3,914

[1] Applied in fall of 1930.
[2] Applied in fall of 1936.
[3] Planted in fall of 1930.
[4] The alfalfa was plowed up in summer of 1936 and replanted in fall of 1936.
[5] In some cases lime alone was used and in other cases phosphate and potash were applied in addition to lime. In all cases the increase is calculated when lime was the only variable.

Table 12. Effects of Different Rates of Lime on Alfalfa Yields at Nine Locations in Alabama

Lime per acre[1]	Yield per acre								
	Crossville, Hartsells f.s.l.[2] 4-yr. av.	Alexandria, Decatur c.l.[2] 5-yr. av.	Winfield, Atwood f.s.l. 6-yr. av.	Camp Hill, Lloyd c.l. 4-yr. av.	Auburn, Madison c.l. 4-yr. av.	Tuskegee, Susque-hanna f.s.l. 4-yr. av.	Prattville, Greenville f.s.l. 5-yr. av.	Atmore, Orangeburg f.s.l. 5-yr. av.	Fairhope, Norfolk f.s.l. 3-yr. av.
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
2,000	----	----	----	----	----	----	----	6,600	8,143
4,000	7,806	6,396	5,367	5,216	7,041	4,048	6,137	7,658	7,712
6,000	8,473	6,738	6,609	----	----	----	9,287	----	----
8,000	6,815	6,355	7,432	5,559	8,584	4,371	8,419	8,555	7,695
16,000	----	----	----	5,546	8,283	5,201	----	8,738	8,310

[1] Lime was applied prior to seeding and none thereafter. Adequate amounts of phosphorus, potash, and borax were applied each year.

[2] F.s.l. = fine sandy loam; c.l. = clay loam.

Figure 3. Alfalfa at left received 1 ton of lime per acre. Plot at right had application of 4 tons per acre.

Sources of Lime

Experiments comparing calcitic and dolomitic sources of lime for alfalfa on Decatur clay loam at the Tennessee Valley Substation were conducted from 1933 through 1941. The yield data, Table 13, indicate no difference between the two sources of lime for this soil type. Although a no-lime plot was not included in this test to measure the response to lime, an adjacent test on the same soil had shown good response, Table 11.

Table 13. Comparative Yields of Alfalfa from Dolomitic and Calcitic Lime on Decatur Clay Loam, Tennessee Valley Substation

Kind of lime[1]	Average annual yield of hay per acre	
	1st planting 1933-37	2nd planting 1938-41
	Pounds	*Pounds*
Calcitic	5,217	4,556
Dolomitic	5,126	4,500

[1] Lime, superphosphate, and muriate of potash were applied at rates of 6,000, 2,000, and 400 pounds per acre, respectively, in the fall of 1932 and none thereafter. Although this test did not include a no-lime plot, an adjacent test had shown good response. (See Table 11.)

Rates of Phosphorus

Although the need for phosphorus was one of the first things shown by early field tests, it is probably not as often a limiting

TABLE 14. ALFALFA YIELDS IN POUNDS OF HAY PER ACRE WITH DIFFERENT RATES OF PHOSPHORUS

P_2O_5 per acre[1]	Yield per acre						
	Crossville, Hartsells f.s.l.[2] 4-yr. av.	Alexandria, Decatur c.l.[2] 5-yr. av.	Winfield, Atwood f.s.l. 6-yr. av.	Prattville, Greenville f.s.l. 4-yr. av.	Marion Junction, Sumter clay 7-yr. av.	Atmore, Orangeburg f.s.l. 5-yr. av.	Fairhope, Norfolk f.s.l. 3-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
36	----	----	----	----	----	6,828	7,764
50	7,383	6,909	5,296	4,948	9,353	----	----
72	----	----	----	----	----	7,612	7,571
100	7,716	7,111	6,369	6,209	9,045	----	----
144	----	----	----	----	----	7,658	7,712
150	8,473	6,738	6,609	6,137	9,632	----	----
200	8,386	7,203	6,816	7,187	9,907	----	----
216	----	----	----	----	----	8,546	7,473

[1] No phosphorus was applied during the last 2 years of the tests at Crossville, Alexandria, and Prattville. At Winfield, phosphorus was applied the first 2 years, omitted the second 2 years, and also the last 2 years, except for the 150-pound rate. All other areas received phosphorus annually at the designated rates. Lime, potash, and borax were supplied in adequate amounts.

[2] F.s.l. = fine sandy loam; c.l. = clay loam.

factor in alfalfa production as are lime, potash, and borax. The reasons are (1) alfalfa is generally grown on the better soils that are already well supplied with phosphorus, and (2) the applied phosphorus is not leached from the soil as are other elements.

Data showing response to phosphorus are presented in Table 14. Since phosphorus was omitted during the latter part of the experiment at several locations, the best annual rate per acre for the whole period of these experiments cannot be determined. Detailed data in the Appendix show a good response to 100 pounds of P_2O_5 per acre for the first 2 years in most cases, and to as much as 150 pounds the first year at some locations. Data from the Black Belt experiment do not indicate a need for more than 50 pounds of P_2O_5 per acre. This test was conducted on land that had been well fertilized with phosphorus for several years. Other data in Appendix Table 33 show response up to 120 pounds of P_2O_5 on the same soil type where phosphorus had not been applied previously. Thus, it is evident that the past phosphorus treatment of the soil has a great influence upon the amount of phosphorus needed for good yields. However, in field tests at 10 of 14 locations where phosphorus rates were included, good responses to 100 pounds or more P_2O_5 were obtained the first year. The present recommendation is 100 pounds of P_2O_5 per acre annually. Where it is suspected that less than this amount is needed, the soil should be tested for available phosphorus.

Time of Application of Phosphorus

Data obtained on Decatur clay loam and presented in Appendix Tables 21 and 22 do not show any difference in yield between spring and fall applications of superphosphate. Neither is there any differences between an initial application of 2,000 pounds of superphosphate and annual applications of 500 pounds where the duration of the experiment was 4 to 5 years.

Sources of Phosphorus

A considerable amount of data has been collected from the comparison of various sources of phosphorus for alfalfa. Some of these data are presented in Table 15. Triple superphosphate (with gypsum at a rate equivalent to 120 pounds of SO_3 per acre) gave yields as good as or better than regular superphosphate in most cases. Fused tri-calcium phosphate ground to a

TABLE 15. ALFALFA YIELDS IN POUNDS OF HAY PER ACRE WITH DIFFERENT SOURCES OF PHOSPHORUS

Phosphorus treatment[1]		Yield per acre						
Source	P_2O_5 per acre	Crossville, Hartsells f.s.l.[2] 4-yr. av.	Alexandria, Decatur c.l.[2] 5-yr. av.	Winfield, Atwood f.s.l. 6-yr. av.	Prattville, Greenville f.s.l. 4-yr. av.	Marion Junction, Sumter clay 7-yr. av.	Monroeville, Magnolia f.s.l. 2-yr. av.	Brewton, Kalmia f.s.l. 2-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Triple Super	50	7,383	6,909	5,296	4,948	----	4,190	5,166
------ do. ------	100	7,716	7,111	6,369	6,209	----	4,375	5,671
------ do. ------	150	8,473	6,738	6,609	6,137	----	4,724	5,473
------ do. ------	200	8,386	7,203	6,816	7,187	----	4,565	5,803
Superphosphate	150	7,187	5,846	6,276	8,047	9,632	3,947	5,320
FTCa phos. 10-M	150	5,781	6,335	6,396	9,579	----	4,323	5,153
------ do. ------ 40-M	150	7,404	6,992	6,537	7,706	8,835	4,571	5,288
Colloidal phos.	100	6,373	5,550	5,114	7,689	7,269	3,313	3,790
-------- do. --------	200	5,444	6,654	5,359	6,051	7,630	3,216	4,513
Rock phosphate	100	7,505	7,679	5,388	8,140	----	2,932	4,908
---------- do. ----------	200	6,230	6,431	4,831	6,544	----	3,183	3,931
Basic slag[3]	200	6,500	7,228	5,928	8,068	----	4,077	4,525
---- do. ----[4]	100	2,022	5,834	1,627	2,011	9,400	2,461	2,456
---- do. ----[4]	200	6,494	6,473	4,047	6,559	----	4,028	2,826

[1] Potash was applied annually at the rate of 240 pounds K_2O per acre. Lime rates per acre, except for the basic slag treatments, were: Crossville, 4 tons; Alexandria and Winfield, 3 tons; Prattville, Monroeville, and Brewton, 2 tons; and no lime on the Sumter clay at Marion Junction. All plots received borax. Where triple superphosphate was used, gypsum was applied annually at the rate of 120 pounds SO_3 per acre.

[2] F.s.l. = fine sandy loam; c.l. = clay loam.

[3] One ton of lime per acre applied.

[4] No lime applied.

fineness of 40-mesh proved to be as good a source as superphosphate at all locations with the possible exception of the lime-soil of the Black Belt. Both colloidal and rock phosphate were inferior sources at most locations even at rates that supplied 200 pounds of P_2O_5 per acre as compared with 50 pounds from concentrated superphosphate. Basic slag is a satisfactory source of phosphorus, but it will not meet the total lime requirement of most soils unless applied at rates in excess of those necessary to meet the phosphorus needs. It should not be expected to supply more than one-half of the total lime requirement for alfalfa.

Rates of Potash

On all soils of the State, potash is equally as important as lime in maintaining alfalfa stands, Figure 4. Without additional potash, stand failures before the end of the first season have occurred on sandy soils naturally low in K_2O. Alfalfa response to various rates of K_2O is shown in Table 16. At most locations, yields increased up to the 240-pound rate of K_2O. On soils that are well supplied with native potash, fair yields of alfalfa

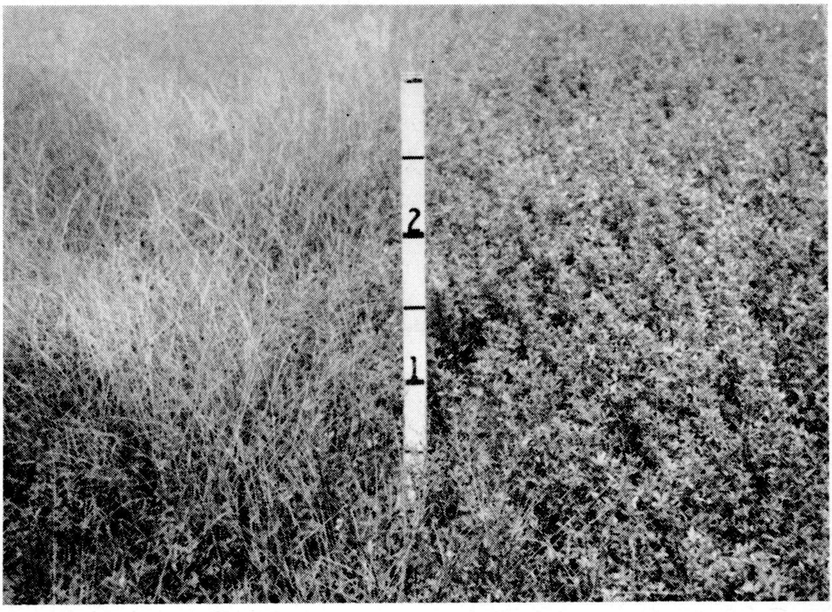

Figure 4. Plot at left received no potash, whereas adequate potash was applied to plot at right.

have been produced with rates of K_2O as low as 120 pounds per acre at seeding and 60 pounds applied annually. However, serious potash deficiencies have developed in crops that followed alfalfa. The Decatur soil is as well supplied with native potash as any soil in the State to which alfalfa is adapted; yet the data in Table 16 show a good response of alfalfa to an annual rate of 240 pounds of K_2O per acre for a 5-year period on this soil.

The data indicate that a rate of at least 200 pounds of K_2O per acre annually is needed to meet the requirements of alfalfa on most soils.

TABLE 16. ALFALFA YIELDS IN POUNDS OF HAY PER ACRE WITH DIFFERENT RATES OF POTASH

K_2O per acre[1]	Yield per acre			
	Crossville, Hartsells f.s.l.[2] 4-yr. av.	Alexandria, Decatur c.l.[2] 5-yr. av.	Winfield, Atwood f.s.l. 6-yr. av.	Auburn, Chesterfield s.l.[2] 7-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	5,556	----	4,963	1,959
60	----	----	----	5,379
120	6,860	5,961	6,360	6,852
240	8,473	6,738	6,609	7,434
360	8,187	7,331	6,466	----
	Prattville, Greenville f.s.l. 4-yr. av.	Marion Junction, Sumter clay 7-yr. av.	Atmore, Orangeburg f.s.l. 5-yr. av.	Fairhope, Norfolk f.s.l. 3-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	----	5,726	----	----
60	----	----	6,077	6,432
120	7,034	8,632	6,384	7,476
240	6,137	9,006	8,392	7,712
360	7,743	9,632	8,198	7,975

[1] Lime, phosphorus, and borax were supplied in adequate amounts.
[2] F.s.l. = fine sandy loam; c.l. = clay loam; s.l. = sandy loam.

RATES OF BORAX

Alfalfa has shown response to borax on all soils of Alabama where experiments have been conducted. Borax supplies the element, boron. Although it is needed in relatively small quantities, boron is important in maintaining stands as well as quality of the forage. Often a deficiency of boron in the soil causes some thinning of stand and yellowing of alfalfa before the yields show

Figure 5. Light color of alfalfa at right is result of boron deficiency. Plot at left was fertilized with borax.

much decrease, Figure 5. Thus, the effect of boron deficiency may occur so gradually that the alfalfa stand is seriously impaired before the grower realizes it. Even though applications of other elements, especially lime and potash, show more strik-

TABLE 17. ALFALFA YIELDS IN POUNDS OF HAY PER ACRE WITH DIFFERENT RATES OF BORAX

Borax per acre[1]	Yield per acre			
	Crossville, Hartsells f.s.l.[2] 4-yr. av.	Alexandria, Decatur c.l.[2] 5-yr. av.	Winfield, Atwood f.s.l. 6-yr. av.	Auburn, Chesterfield s.l.[2] 7-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	5,552	6,147	6,149	6,039
15	6,815	6,738	6,609	6,852
30	7,812	5,818	6,826	----
	Prattville, Greenville f.s.l. 4-yr. av.	Atmore, Orangeburg f.s.l. 5-yr. av.	Fairhope, Norfolk f.s.l. 3-yr. av.	Marion Junction, Sumter clay 7-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	5,055	7,047	----	8,886
15	6,137	8,392	7,712	9,789
30	9,575	7,449	8,282	9,632

[1] Lime, phosphorus, and potash were applied in adequate amounts.
[2] F.s.l. = fine sandy loam; c.l. = clay loam; s.l. = sandy loam.

ing results than borax application, boron is still important to the longevity of stand and quality of forage produced.

Data presented in Table 17 show the response of alfalfa to borax. In a majority of cases, yield increases did not result from an annual application of more than 15 pounds of borax per acre. However, since the quality of hay may decrease before any noticeable differences in yields occur and since yield responses up to 30 pounds of borax sometimes occur, the present recommendation is 20 to 25 pounds of borax per acre annually.

Recommendations

Based on data presented in the preceding sections, lime and fertilizer requirements for alfalfa can be met by (1) applying 3 to 4 tons of lime per acre 2 to 3 months before seeding, and (2) applying at seeding time 1,000 pounds of 0-10-20 fertilizer (containing 40 to 50 pounds of borax per ton) and annually thereafter in the spring. It is generally recommended that this annual application be applied before spring growth starts. In some areas such as the Black Belt where the soil is very wet in early spring, the annual application may be made in late fall or after the first cutting in the spring. Data obtained on Orangeburg fine sandy loam, Appendix Table 37, show that the best yield was obtained from plots fertilized prior to spring growth.

SPECIAL SOIL TREATMENTS

After several years of field experimentation and observations of farmers' success with alfalfa, it was apparent that good yields could be produced on most soils as long as stands could be maintained. However, in some cases stands disappeared after 2 or 3 years despite what appeared to be optimum lime and fertilizer treatments and optimum cutting management.

Since alfalfa is a very deep-rooted crop and has a high lime requirement, distribution of lime below the usual plow depth offered possibility of increasing yields and prolonging the life of stands.

Also, since stands were generally more difficult to maintain on sandy soils than on clay soils despite liberal fertilizer applications, and since nematodes are known to cause serious damage to some crops on sandy soils, soil fumigation also offered possibility for improving alfalfa production.

RATES OF LIME AND DEPTH OF PLACEMENT

In September, 1950, lime-placement field tests were established on Lloyd clay loam, Madison clay loam, and Susquehanna fine sandy loam soils. The original pH of the soils at various depths are given in Table 18.

TABLE 18. SOIL REACTION OF UNTREATED SOIL

Soil type	Soil pH at various depths		
	0-6 in.	6-12 in.	12-18 in.
Lloyd clay loam	5.77	5.47	5.37
Madison clay loam	4.90	4.97	5.10
Susquehanna fine sandy loam	4.87	4.75	4.67

The test on Lloyd soil was conducted on plots 5 × 25 feet in size, while those on Madison and Susquehanna soils were rim tests with each plot enclosed in a terra cotta rim 3 feet in diameter. All lime treatments were replicated 4 times. The deep applications of lime on the large plots were applied in plowed furrows, whereas for the rim tests the soil layers were dug and removed by hand and were replaced in proper order after the lime treatment was applied.

The yield data from the lime experiments are summarized in Table 19. Detailed tables of data are presented in Appendix

TABLE 19. EFFECTS OF RATES AND DEPTHS OF PLACEMENT OF LIME ON HAY YIELDS OF ALFALFA AT THREE LOCATIONS, 4-YEAR AVERAGE

Lime treatment per acre[1]	Depth	Average yield of hay per acre		
		Camp Hill, Lloyd c.l.	Auburn, Madison c.l.	Tuskegee, Susquehanna f.s.l.
Pounds	*Inches*	*Pounds*	*Pounds*	*Pounds*
4,000	0-6	5,216	7,041	4,048
4,000	0-12	5,099	5,954	3,256
8,000	0-6	5,559	8,584	4,371
8,000	0-6[2]	5,592	7,827	4,403
8,000	0-12	5,232	8,878	4,705
8,000	0-12[3]	----	----	4,384
8,000	0-18	----	9,065	4,469
16,000	0-6	5,546	8,283	5,201
16,000	0-12	5,744	9,320	5,585

[1] All plots received annual treatments of 200 pounds P_2O_5, 240 pounds K_2O, and 25 pounds borax per acre. Where lime was placed deeper than 6 inches at the Piedmont and Auburn locations, one-half was applied as a plowsole application and one-half worked into the top 6 inches. At Tuskegee, lime was incorporated with the entire soil layer indicated except as noted. (See footnote 3.)

[2] Subsoiled to depth of 12 inches.

[3] One-half of lime applied in plowsole at 12 inches and one-half mixed with top 6 inches.

Tables 39 to 41. On plots where lime was applied in the top 6 inches of soil, there was little increase in yields from more than 2 tons of lime per acre on Lloyd soil. Although the trend was toward an increase from deep placement on the more acid Madison and Susquehanna soils, it is doubtful that such increases would pay the extra cost of subsoil tillage. It is pointed out that the highest yields at all three locations were obtained from the 8-ton rate of lime applied to a depth of 12 inches.

No increase for subsoiling to 12 inches was obtained at any of the three locations.

Soil Fumigation

In March, 1951, a soil fumigant (Dowfume W-40) was applied to Norfolk sandy loam at the rates of 15 and 30 gallons per acre; the alfalfa was seeded 2 weeks after fumigation. Although spring seeding of alfalfa is not recommended, it was satisfactory for this experiment since the alfalfa could be hand-weeded until the stand was established.

Data for the first 4 years of the test are presented in Table 20. Yields have been highest from the fumigated plots each year. For the 4-year period, the 15-gallon rate of fumigant has shown an accumulated increase of 2,802 pounds of hay per acre over no treatment as compared with an accumulated increase of 3,949 pounds from the 30-gallon rate. The cost of the fumigant, not including application, was about $2 per gallon. If alfalfa hay is valued at $40 per ton, the 15-gallon rate showed a return over cost of material for the 4-year period of $26, and the 30-gallon rate a return of $19 per acre over the cost of fumigant. Although the 15- and 30-gallon rates gave comparable yields

TABLE 20. EFFECTS OF SOIL FUMIGATION ON HAY YIELDS OF ALFALFA GROWN ON NORFOLK LOAMY SAND, MAIN STATION, 1951-54

Treatment[1]	Yield of hay per acre (average of 4 replications)				4-yr. av.
	1951	1952	1953	1954	
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
None	1,176	7,093	6,977	3,808	4,764
Dowfume W-40, 15 gal. per acre	1,499	7,631	8,250	4,476	5,464
Dowfume W-40, 30 gal. per acre	1,470	7,607	8,674	5,252	5,751
Number of cuttings per year	3	2	5	2	

[1] All plots received 3 tons of dolomitic lime per acre initially and annual applications of 1,000 pounds 0-12-20 plus 25 pounds of borax per acre.

the first 2 years, the 30-gallon rate gave higher yields the last 2 years of the experiment.

Based on the results of this one test, it appears that soil fumigation definitely shows promise of increasing yields and prolonging the life of alfalfa stands on sandy soils of the Coastal Plains.

SUMMARY AND CONCLUSION

The data reported herein were obtained from alfalfa experiments at various locations in Alabama. Some 15 soil types were involved and studies extended nearly the full length and breadth of the State. Tests were made to determine adaptability of varieties and to determine lime and fertilizer requirements at the several locations. Grazing and mowing treatments were tested at the Main Station. Rates of seeding experiments were carried on at the Main Station and the Monroeville Experiment Field, and trials to determine stage of cutting were conducted at the Main Station and at the old Canebrake Station. The results are summarized as follows:

1. Of the commercial varieties tested, such hardy types as Kansas or Oklahoma common, Buffalo, Williamsburg, Atlantic, Narragansett, and Vernal are recommended for planting in Alabama.

2. Vernal and Narragansett have finer stems, are leafier, and are darker green than the other varieties. They are preferred varieties when quality of hay is important.

3. Caliverde, Chilean, Peruvian, and such non-hardy commons as Arizona winterkill under low temperatures. When winters are mild they are excellent varieties. They are not recommended because of the risk of winterkilling.

4. The non-hardy varieties, African and Indian, are not recommended for Alabama. If they are to be maintained for only 1 or 2 years and are to be grazed, they might have some merit in southern Alabama, since they do not have a winter dormancy period and grow well when the weather is not too cold. They are susceptible to cold and to disease.

5. The creeping or rhizomatic type (Nomad and Rhizoma) has not produced well when harvested for hay. Varieties of this type have not been tested for grazing. Under conditions in this State, they have not shown the creeping characteristics, and at present they are not recommended.

6. Fall planting is much better than spring planting. Seeding as early as possible is recommended. September 1 to 15 are preferred dates in central and northern Alabama. In southern Alabama, October or November plantings are satisfactory.

7. The recommended rate of seeding is 20 to 25 pounds. Under favorable conditions, 10 to 15 pounds of seed per acre will give just as large a yield as a higher rate.

8. For maximum yield, research results show that alfalfa should be cut in one-tenth to full-bloom stage. Although earlier cutting will produce better quality hay, the yield is less and the stand thins more rapidly than later cutting.

9. Grazing in the winter reduces yield the next year.

10. Grazing alfalfa during the first winter after planting seriously damages stands.

11. Alfalfa that is 2 years old or older may be grazed. The yield from winter grazing is about the same as the reduction in yield the following year.

12. Cutting alfalfa in early stages reduces the reserve food supply of roots, which results in reduction of growth and thinning of stand.

13. Grazing alfalfa produces the same effect on the subsequent growth as does mowing.

14. Except for lime soils of the Black Belt, results from field experiments indicate a need of 3 to 4 tons of lime per acre to maintain an alfalfa stand for 3 years or longer on most soils of the State.

15. A comparison of calcitic and dolomitic sources of lime for alfalfa on Decatur clay loam showed no difference between the two.

16. Unless the soil is known to be high in phosphorus, an annual application of 100 pounds of P_2O_5 per acre is recommended.

17. In a comparison of sources of phosphorus at several locations, concentrated superphosphate with gypsum added to supply sulfur resulted in alfalfa yields as high as those obtained from regular superphosphate. Fused tri-calcium phosphate ground to a fineness of 40-mesh was as good as superphosphate except on the lime soils of the Black Belt. Basic slag was also a satisfactory source of phosphorus. Both colloidal and rock phosphate were inferior at most locations even at rates that supplied 200 pounds of P_2O_5 per acre as compared with 50 pounds from concentrated superphosphate.

18. At least 200 pounds of K_2O per acre is recommended annually for alfalfa on all soils.

19. An annual rate of 20 to 25 pounds of borax per acre is recommended.

20. Results from studies involving the placement of lime below normal plow depth have not shown sufficient promise to recommend the practice.

21. Soil fumigation increased alfalfa yields on a Norfolk sandy loam at Auburn.

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In preparing this report the authors compiled results of many workers of this station.

Summarized are results from experiments at the Main Station carried on by J. F. Duggar[1], E. M. Evans, J. R. Langford, J. A. Naftel[2], D. G. Sturkie, and C. M. Wilson.

Studies at the experiment fields reported were conducted by H. R. Benford[2], F. E. Bertram, J. T. Cope, Fred Glaze, J. W. Richardson, J. T. Williamson[1], J. R. Taylor[2], and R. W. Taylor[2].

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Tests at Atmore Farm were conducted by D. G. Sturkie in cooperation with The Department of Corrections and Institutions of the State of Alabama.

[1] Deceased
[2] Resigned

APPENDIX TABLES

APPENDIX TABLE 1. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1948), ATWOOD FINE SANDY LOAM, UPPER COASTAL PLAIN SUBSTATION, 1949-54

Variety	Yield of hay per acre						
	1949	1950	1951	1952	1953	1954	6-yr. av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Arizona Chilean	7,335	5,722	6,598	3,544	8,393	5,226	6,136
Hairy Peruvian	7,173	5,612	6,659	3,857	7,683	5,051	6,006
Atlantic	7,941	5,433	6,883	3,919	9,097	4,866	6,357
Williamsburg	8,190	5,623	6,893	3,767	8,706	5,271	6,408
Ranger	7,550	5,516	7,535	4,551	8,997	5,852	6,666
Ranger Syn. #1	7,969	5,036	6,228	3,638	8,150	4,569	5,932
Ranger Syn. #2	8,017	5,233	6,466	3,859	8,402	4,978	6,159
Ranger 2nd generation	7,352	5,237	6,819	3,457	8,532	5,492	6,149
Buffalo	8,335	6,218	7,622	4,235	8,337	5,580	6,721
Argentine Rio Negro	9,140	5,857	8,150	3,542	9,084	4,185	6,660
Argentine Bahia Blanca	8,275	5,663	7,523	3,476	8,376	4,294	6,268
Argentine Buenos Aires	8,329	5,865	7,450	3,666	8,676	3,652	6,274
Argentine La Pampa	8,644	5,978	7,886	3,624	8,590	3,129	6,308
Kansas Common	8,246	5,810	6,802	3,634	8,601	4,803	6,316
Oklahoma Common	7,553	5,787	7,009	4,058	8,667	5,346	6,404
Number of cuttings per year	3	3	3	3	3	2	

APPENDIX TABLE 2. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1952), ATWOOD FINE SANDY LOAM, UPPER COASTAL PLAIN SUBSTATION, 1953-54

Variety	Yield of hay per acre		
	1953	1954	2-yr. av.
	Pounds	*Pounds*	*Pounds*
Arizona Common	6,972	6,215	6,594
Caliverde	6,371	5,796	6,084
Atlantic	7,240	6,388	6,814
Narragansett	5,917	5,488	5,702
Buffalo	6,071	5,520	5,796
Ranger	6,135	5,794	5,964
Williamsburg	7,176	6,378	6,777
Du Puits	7,449	6,701	7,075
Uruguay Clone 10	7,117	6,628	6,872
Rhizoma	7,471	5,701	6,586
Number of cuttings per year	3	2	

APPENDIX TABLE 3. HAY YIELDS OF DIFFERENT VARIETIES (PLANTED FALL, 1948), DECATUR CLAY LOAM, TENNESSEE VALLEY SUBSTATION, 1949-50

Variety	Yield of hay per acre		
	1949	1950	2-yr. av.
	Pounds	*Pounds*	*Pounds*
Arizona Chilean	3,480[1]	6,943	5,210
Hairy Peruvian	1,755[1]	8,765	5,261
Atlantic	6,758	8,873	7,816
Williamsburg	6,848	9,212	8,030
Ranger	6,338	10,642	8,490
Ranger Syn. 1 new	5,828	8,406	7,117
Ranger Syn. 2 new	6,000	7,002	6,500
Ranger 2nd generation	6,968	8,531	7,650
Buffalo	5,925	7,654	6,790
Argentine Rio Negro Province	7,500	8,442	7,971
Argentine Bahia Blanca	7,860	7,520	7,690
Argentine Buenos Aires	5,993	8,031	7,012
Argentine La Pampa	7,613	9,863	8,738
Kansas Common	6,518	10,533	8,525
Oklahoma Common	5,715	8,125	6,920
Australian	3,540[1]	7,969	5,729
Number of cuttings per year	2	3	

[1] Severely winterkilled in winter of 1948-49. Discontinued at end of 1950 due to severe killing of some varieties in winter of 1950.

APPENDIX TABLE 4. HAY YIELDS OF DIFFERENT VARIETIES (PLANTED FALL, 1952), DECATUR CLAY LOAM, TENNESSEE VALLEY SUBSTATION, 1953-54

Variety	Yield of hay per acre		
	1953	1954	2-yr. av.
	Pounds	*Pounds*	*Pounds*
Arizona Common	6,818	5,868	6,343
Caliverde	7,204	5,773	6,488
Atlantic	7,120	6,151	6,636
Narragansett	6,485	5,840	6,162
Buffalo	6,845	5,873	6,359
Ranger	7,446	5,300	6,373
Williamsburg	8,287	5,922	7,104
Du Puits	8,483	6,294	7,388
Uruguay Clone 10	7,081	5,709	6,395
Rhizoma	7,536	5,412	6,477
Number of cuttings per year	2	2	

APPENDIX TABLE 5. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1942), HARTSELLS FINE SANDY LOAM, SAND MOUNTAIN SUBSTATION, 1943-46

Variety	Yield of hay per acre				
	1943	1944	1945	1946	4-yr av.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Kansas Common	1,785	3,610	5,605	7,400	4,600
Ranger	1,550	3,053	5,523	6,803	4,232
Number of cuttings per year	2	2	3	4	

APPENDIX TABLE 6. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1952), HARTSELLS FINE SANDY LOAM, SAND MOUNTAIN SUBSTATION, 1953-54

Variety	Yield of hay per acre		
	1953	1954	2-yr. av.
	Pounds	*Pounds*	*Pounds*
Arizona Common	4,295	3,891	4,093
Caliverde	4,909	4,478	4,694
Atlantic	5,106	4,297	4,702
Narragansett	4,838	4,009	4,424
Buffalo	4,893	4,291	4,592
Ranger	4,701	3,873	4,287
Williamsburg	5,362	4,322	4,842
Du Puits	5,687	4,701	5,194
Uruguay Clone 10	4,528	4,505	4,516
Rhizoma	5,249	3,582	4,416
Number of cuttings per year	3	3	

APPENDIX TABLE 7. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1948), HARTSELLS FINE SANDY LOAM, SAND MOUNTAIN SUBSTATION, 1949-54

Variety	Yield of hay per acre						
	1949	1950	1951	1952	1953	1954	6-yr. av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Arizona Chilean	6,630	6,625	5,233	5,944	6,477	5,693	6,100
Hairy Peruvian	4,761	5,205	4,286	4,656	5,557	4,361	4,804
Atlantic	7,198	7,195	5,407	6,295	6,572	5,411	6,346
Williamsburg	5,497	5,301	4,896	5,150	5,443	4,324	5,102
Ranger	5,130	5,357	5,030	5,900	5,977	4,903	5,383
Ranger Syn. 1 new	6,705	6,628	5,779	5,962	6,652	5,449	6,196
Ranger Syn. 2 new	5,701	5,930	5,159	5,723	6,483	5,425	5,737
Ranger 2nd generation	6,401	6,664	4,996	5,745	6,974	5,636	6,069
Buffalo	7,040	6,190	6,042	6,232	6,320	5,438	6,210
Argentine Rio Negro Province	8,138	7,655	6,179	7,444	6,841	6,318	7,096
Argentine Bahia Blanca	6,937	6,409	5,143	5,971	6,558	5,065	6,014
Argentine Buenos Aires	6,952	6,746	5,283	6,073	6,490	5,084	6,105
Argentine La Pampa	6,623	6,552	4,667	5,517	6,345	5,051	5,793
Kansas Common	6,579	6,447	5,615	5,872	6,111	4,959	5,931
Oklahoma Common	6,534	6,783	5,529	5,751	6,156	5,064	5,970
Number of cuttings per year	4	4	3	3	3	3	

APPENDIX TABLE 8. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1946), HARTSELLS FINE SANDY LOAM, SAND MOUNTAIN SUBSTATION, 1947-49

Variety	Yield of hay per acre			
	1947	1948	1949	3-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*
Oklahoma Common	8,374	8,591	8,398	8,454
Kansas Common	7,777	8,397	8,416	8,197
Argentine	7,922	9,104	8,700	8,575
Ranger	7,948	7,364	8,136	5,104
Hairy Peruvian	5,822	7,678	7,493	6,998
Atlantic	7,448	7,978	7,678	7,702
Chilean	6,808	7,397	7,468	7,224
Buffalo	6,956	8,064	7,061	7,360
Number of cuttings per year	4	4	4	

APPENDIX TABLE 9. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1952), CECIL CLAY, PIEDMONT SUBSTATION, 1953-54

Variety	Yield of hay per acre		
	1953	1954	2-yr. av.
	Pounds	*Pounds*	*Pounds*
Arizona Common	7,721	8,070	7,896
Caliverde	7,140	7,273	7,207
Atlantic	7,466	8,658	8,062
Narragansett	7,150	7,660	7,405
Buffalo	7,086	7,531	7,309
Ranger	6,322	7,164	6,743
Williamsburg	7,835	9,205	8,520
Du Puits	7,924	8,412	8,168
Uruguay Clone 10	8,032	9,284	8,658
Rhizoma	7,403	8,422	7,913
Number of cuttings per year	3	4	

APPENDIX TABLE 10. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1943), CHESTERFIELD SANDY LOAM, MAIN STATION, 1944-48

Variety	Yield of hay per acre					
	1944	1945	1946	1947	1948	5-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Kansas Common	7,737	10,302	10,217	7,057	7,962	8,655
Buffalo	5,872	9,104	10,795	7,023	7,546	8,068
Ranger	4,966	7,234	9,860	6,612	7,176	7,170
Number of cuttings per year	4	4	5	4	4	

APPENDIX TABLE 11. YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1944), CHESTERFIELD SANDY LOAM, MAIN STATION, 1945-49

Variety	Yield of hay per acre					
	1945	1946	1947	1948	1949	5-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Oklahoma Common[1]	8,135	14,722	10,274	9,156	9,082	10,274
Oklahoma Common[1]	7,064	12,824	9,736	9,585	9,223	10,086
Kansas Common[1]	6,954	14,654	9,483	9,445	8,758	9,859
Kansas Common[1]	7,974	14,892	9,796	9,461	8,412	10,107
Argentine	8,194	14,314	9,100	9,103	8,584	9,859
Arizona Chilean	6,563	15,113	8,448	9,002	5,925	9,010
Hairy Peruvian	6,826	13,974	8,846	9,217	7,610	9,294
Ranger	5,228	12,614	9,628	9,243	7,762	8,895
Buffalo	8,730	13,366	8,792	9,277	7,450	9,523
Grimm	6,452	11,526	8,664	7,925	5,880	8,089
Number of cuttings per year	4	5	4	4	3	

[1] The two entries of Oklahoma and Kansas Common were from different seed sources.

APPENDIX TABLE 12. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1946), CHESTERFIELD SANDY LOAM, MAIN STATION, 1947-50

Variety	Yield of hay per acre				
	1947	1948	1949	1950	4-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Kansas Common	8,691	10,019	8,270	7,695	8,669
Oklahoma Common	8,202	9,561	8,201	7,451	8,354
Argentine	8,455	9,908	7,206	5,991	7,890
Ranger	8,310	9,498	8,346	7,897	8,513
Hairy Peruvian	6,928	8,184	8,329	8,288	7,932
Atlantic	8,719	10,426	8,924	7,710	8,945
Chilean	7,463	8,994	8,217	8,140	8,203
Buffalo	8,583	10,103	8,854	9,155	9,174
Number of cuttings per year	4	4	3	4	

APPENDIX TABLE 13. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1949), CHESTERFIELD SANDY LOAM, MAIN STATION, 1950-52

Variety	Yield of hay per acre			
	1950	1951	1952	3-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*
Arizona Chilean	4,561	6,995	10,489	7,349
Atlantic	3,853	7,464	11,054	7,457
Williamsburg	3,621	7,256	9,921	6,933
Narragansett	4,158	8,728	10,941	7,942
Chilean 21-5	3,336	5,785	8,039	5,720
Texas Common	4,063	7,588	10,629	7,427
Argentine	4,496	7,593	9,565	7,218
Kansas Common	3,371	7,120	10,174	6,917
Number of cuttings per year	4	4	4	

APPENDIX TABLE 14. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1951), CHESTERFIELD SANDY LOAM, MAIN STATION, 1952-54

Variety	Yield of hay per acre			
	1952	1953	1954	3-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*
Chilean 21-5	8,708	10,657	7,336	8,900
Hairy Peruvian	9,213	10,811	7,255	9,093
Atlantic	9,817	10,080	6,886	8,928
Narragansett	10,248	9,886	6,305	8,813
Ranger	9,182	10,160	6,789	8,710
Buffalo	9,868	9,780	6,810	8,819
Texas Common	9,750	10,284	7,046	9,027
Williamsburg	10,129	11,018	7,038	9,395
Du Puits	10,729	10,873	7,545	9,716
Nomad	9,129	8,269	4,962	7,453
Talent	9,626	9,718	6,942	8,762
Rhizoma	9,609	9,710	5,963	8,427
Arizona Common[1]	9,492	10,910	7,100	9,167
Arizona Common[1]	9,493	10,558	7,297	9,116
African	7,437	8,922	4,949	7,103
Indian	8,783	9,709	5,488	7,993
Nemastand	9,405	8,355	6,095	7,951
Wisconsin Syn. C	10,050	10,345	6,419	8,938
Nevada C	8,748	8,923	6,241	5,978
Number of cuttings per year	4	5	3	

[1] The two entries of Arizona Common were from different seed sources.

APPENDIX TABLE 15. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1952), CHESTERFIELD SANDY LOAM, MAIN STATION, 1953-54

Variety	Yield of hay per acre		
	1953	1954	2-yr. av.
	Pounds	*Pounds*	*Pounds*
Arizona Common	9,568	8,624	9,096
Caliverde	11,496	8,927	10,211
Atlantic	10,387	9,908	10,147
Narragansett	10,230	7,503	8,866
Buffalo	10,131	8,944	9,537
Ranger	9,304	7,673	8,488
Williamsburg	9,939	8,618	9,278
Nomad	7,764	5,522	6,643
Uruguay Clone 10	10,433	7,800	9,116
Rhizoma	9,389	6,719	8,054
California Chilean	10,139	8,507	9,323
Chilean 21-5	9,982	9,178	9,580
Number of cuttings per year	5	3	

APPENDIX TABLE 16. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1924), SUMTER CLAY, UNIONTOWN, 1925-27

Variety	Yield of hay per acre			
	1925	1926	1927	3-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*
Kansas Common	2,813	10,073	4,327	5,738
Chilean	3,180	10,300	4,000	5,827
Arizona Common	3,040	9,800	4,140	5,660
French	2,640	9,620	4,200	5,487
Idaho Common	2,760	10,000	3,800	5,520
Hairy Peruvian	4,020	10,960	4,580	6,520
Smooth Peruvian	3,480	10,840	4,560	6,293

NOTE: At the end of 1927, stands of Hairy Peruvian, Smooth Peruvian, and Arizona Common were much thinner than those of the other varieties. Kansas Common appeared to be the best variety at that time.

APPENDIX TABLE 17. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1950), MAGNOLIA FINE SANDY LOAM, MONROEVILLE EXPERIMENT FIELD, 1951-54

Variety	Yield of hay per acre				
	1951	1952	1953	1954	4-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
African	4,131	5,946	8,067	6,660	6,201
Atlantic	4,183	9,018	8,158	5,416	6,694
Wisconsin Synthetic	4,300	9,817	8,726	6,242	7,271
Buffalo	4,792	9,551	8,813	6,475	7,408
Chilean 21-5	3,950	7,285	8,523	6,543	6,575
Arizona Common[1]	3,659	6,275	8,372	5,794	6,025
Arizona Common[1]	4,072	9,360	8,551	6,850	7,208
Oklahoma Common	4,993	9,954	9,590	6,700	7,809
Indian	4,440	7,070	8,132	6,324	6,492
Narragansett	4,802	8,887	8,814	5,819	7,080
Nemastand	3,467	8,106	7,607	5,623	6,201
Nevada	3,344	7,243	7,995	5,716	6,074
Peruvian (Hairy)	3,921	8,299	8,521	6,099	6,710
Ranger	4,025	8,622	8,632	5,945	6,806
Williamsburg	5,086	9,988	9,876	7,054	8,001
Nomad	2,730	6,859	4,949	2,957	4,374
Chilean	4,122	8,304	8,961	6,962	7,087
Du Puits	5,164	8,950	8,197	3,614	6,481
Rhizoma	4,899	8,440	7,803	5,520	6,665
Talent	4,504	8,766	8,996	5,572	6,959
Number of cuttings per year	4	4	5	4	

[1] The two entries of Arizona Common were from different seed sources.

APPENDIX TABLE 18. HAY YIELDS OF DIFFERENT ALFALFA VARIETIES (PLANTED FALL, 1946), NORFOLK FINE SANDY LOAM, GULF COAST SUBSTATION, 1947

Variety	Yield of hay per acre 1947	Variety	Yield of hay per acre 1947
	Pounds		*Pounds*
Oklahoma Common	4,048	Hairy Peruvian	3,707
Kansas Common	4,130	Atlantic	4,033
Argentine	3,950	Chilean	4,196
Ranger	3,825	Buffalo	3,916
Number of cuttings per year	2[1]	Number of cuttings per year	2[1]

[1] First cutting not weighed because of weeds, but alfalfa was much larger than at second and third cuttings.

APPENDIX TABLE 19. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON DECATUR CLAY LOAM (FERT. EXPT. NO. 1), TENNESSEE VALLEY SUBSTATION, 1931-36

Treatment fall of 1930[1]	Yield of hay per acre						
	1931	1932	1933	1934	1935	1936	6-yr. av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
None[2]	1,410	4,875	3,868	2,040	2,040	370	2,434
3,000 lb. lime	1,370	4,290	4,230	2,520	3,640	720	2,795
3,000 lb. lime 1,000 lb. superphosphate	2,910	5,720	5,760	3,240	4,240	880	3,792
3,000 lb. lime 2,000 lb. superphosphate	4,032	7,670	7,260	4,440	6,440	1,360	5,201
6,000 lb. lime	2,256	6,630	6,180	4,240	5,680	1,080	4,345
6,000 lb. lime 1,000 lb. superphosphate	3,400	6,970	6,190	3,800	4,760	880	4,333
6,000 lb. lime 2,000 lb. superphosphate	4,154	8,000	7,720	5,000	7,400	1,400	5,613
6,000 lb. lime 2,000 lb. superphosphate 200 lb. muriate	3,558	7,140	7,100	4,360	6,000	1,120	4,880
2,000 lb. superphosphate 200 lb. muriate	1,706	5,970	5,800	2,600	2,440	360	3,146
3,000 lb. basic slag 200 lb. muriate	3,314	6,050	5,630	3,560	3,760	600	3,819
Number of cuttings per year	2	3	3	2	3	1	

[1] Treatments were not replicated and were applied in 1930 only.
[2] Yields are averages of 4 check plots.

APPENDIX TABLE 20. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON DECATUR CLAY LOAM (FERT. EXPT. NO. 1, REVISED), TENNESSEE VALLEY SUBSTATION, 1937-41

Treatment fall of 1936[1]	Annual treatment in spring before growth began	Yield of hay per acre					
		1937	1938	1939	1940	1941	5-yr. av.
	Superphosphate	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
None[2]	None	4,360	2,900	3,210	2,180	950	2,720
200 lb. superphosphate 600 lb. muriate	200 lb.	6,690	4,560	5,960	4,000	1,240	4,490
200 lb. superphosphate 600 lb. muriate	200 lb.	7,400	4,400	5,320	3,720	1,360	4,440
200 lb. superphosphate 600 lb. muriate	200 lb.	9,300	5,120	6,280	4,200	1,760	5,332
200 lb. superphosphate 600 lb. muriate	200 lb.	8,550	6,280	7,880	6,200	2,600	6,302
200 lb. superphosphate 600 lb. muriate	200 lb.	8,760	5,680	7,000	5,080	2,160	5,736
200 lb. superphosphate 600 lb. muriate	200 lb.	9,730	6,440	8,280	6,200	2,520	6,634
400 lb. superphosphate 600 lb. muriate	400 lb.	9,380	5,840	7,470	5,640	2,160	6,098
12,000 lb. lime 400 lb. superphosphate 600 lb. muriate	400 lb.	9,590	6,440	9,240	7,040	2,840	7,040
10,500 lb. lime 200 lb. superphosphate 600 lb. muriate	200 lb.	8,380	5,800	7,040	5,360	2,280	5,772
Number of cuttings per year		4	3	3	3	1	

[1] In this revised experiment the treatments were superimposed on those applied in 1930 and shown in Appendix Table 19. Treatments were not replicated.

[2] Yields are averages of 4 check plots.

APPENDIX TABLE 21. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON DECATUR CLAY LOAM (FERT. EXPT. NO. 2), TENNESSEE VALLEY SUBSTATION, 1933-37

Treatment fall of 1932[1]	Yield of hay per acre					
	1933	1934	1935	1936	1937	5-yr. av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
None[2]	1,747	1,242	1,218	579	564	1,070
1,000 lb. basic slag	4,639	2,610	3,405	1,140	870	2,533
3,000 lb. basic slag	7,691	4,380	6,120	2,595	1,560	4,469
5,000 lb. basic slag	7,556	4,980	6,450	3,045	2,085	4,823
1,000 lb. basic slag 400 lb. muriate	4,035	2,055	2,445	975	660	2,034
3,000 lb. basic slag 400 lb. muriate	2,549	4,125	6,630	2,490	1,200	3,399
5,000 lb. basic slag 400 lb. muriate	7,624	4,995	6,915	2,985	1,710	4,846
2,000 lb. superphosphate 6,000 lb. dolomite	6,735	4,305	6,090	2,685	1,920	4,347
6,000 lb. dolomite 2,000 lb. superphosphate 400 lb. muriate	7,665	5,205	7,470	3,270	2,475	5,217
6,000 lb. calcitic lime 2,000 lb. superphosphate 400 lb. muriate	7,241	5,010	7,470	3,195	2,715	5,127
6,000 lb. dolomite 2,000 lb. superphosphate 400 lb. muriate	7,545	4,980	7,365	3,090	2,640	5,124
6,000 lb. dolomite 500 lb. superphosphate[3] 400 lb. muriate	5,989	4,995	7,710	3,540	2,880	5,023
2,500 lb. dolomite 2,800 lb. superphosphate 400 lb. muriate	7,335	4,590	7,260	2,985	2,040	4,842
Number of cuttings per year	3	2	3	2	1	

[1] Treatments were not replicated.
[2] Yields are averages of 5 check plots.
[3] Applied annually in the spring before growth began.

APPENDIX TABLE 22. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON DECATUR CLAY LOAM (FERT. EXPT. NO. 2, REVISED), TENNESSEE VALLEY SUBSTATION, 1938-41

Treatment fall of 1937[1]	Yield of hay per acre				
	1938	1939	1940	1941	4-yr. av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
None[2]	3,270	2,750	1,543	740	2,075
600 lb. muriate 1,000 lb. basic slag[3]	4,620	8,535	5,730	2,713	5,400
None	4,635	4,500	2,850	915	3,475
None	4,800	5,175	3,060	1,240	3,569
200 lb. muriate 188 lb. triple superphosphate[3]	3,960	4,560	4,725	2,093	3,835
None	4,575	4,320	2,910	1,178	3,246
None	5,280	5,640	3,615	1,581	4,029
None	4,995	5,205	3,150	1,364	3,679
None	5,775	6,480	4,305	1,721	4,570
None	5,835	6,075	4,380	1,767	4,514
2,000 lb. superphosphate	6,075	7,425	5,085	2,093	5,170
500 lb. superphosphate[3]	6,345	7,590	5,520	2,248	5,426
3,500 lb. dolomite 500 lb. superphosphate[4]	6,090	7,725	5,175	2,077	5,267
Number of cuttings per year	3	3	3	1	

[1] In this revised experiment the treatments were superimposed on those applied in 1932 and shown in Appendix Table 21. Treatments were not replicated.
[2] Yields are averages of 5 check plots.
[3] Also applied annually each spring.
[4] Also applied annually each fall.

Appendix Table 23. Effects of Lime and Fertilizers on Hay Yields of Alfalfa Grown on Hartsells Fine Sandy Loam, Sand Mountain Substation, 1940-48

Treatment per acre				Yield of hay per acre[4]								
P_2O_5[1]	K_2O[2]	Lime	Basic slag[3]	1940	1941	1942	1943	1944	1945	1946	1947	1948
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	0	0	0	2,650	4,330							
0	0	2,000	0	3,150	4,980							
54	0	2,000	0	3,060	5,030							
54	120	2,000	0	4,060	5,460							
*54	120	2,000	0	4,020	6,020	5,617	5,500	4,450	5,190	9,830	5,570	5,700
**54	120	2,000	0	4,160	5,810							
54	120	0	0	4,440	6,220							
48	120	0	600	4,110	5,450							
240	120	0	3,000	4,100	5,800							
Number of cuttings per year				2	3	3	3	2	3	4	3	4

[1] P_2O_5 was applied annually in the fall at the rates shown, except for plot (*) where it was applied annually in the spring and for last plot where the 3,000-pound rate of slag was applied only once. Where slag was used, the amount of P_2O_5 is calculated on the basis of 8 per cent.

[2] Only the initial application of K_2O was applied except for plot (**), which received the initial application of 120 pounds plus annual applications of 60 pounds per acre.

[3] The 600-pound rate of slag was applied annually and the 3,000-pound rate only once.

[4] The stand of alfalfa was lost after 2 years on all plots except one, where annual applications of potash were made.

APPENDIX TABLE 24. EFFECT OF BORAX ON HAY YIELDS OF ALFALFA GROWN ON HARTSELLS FINE SANDY LOAM, SAND MOUNTAIN SUBSTATION, 1942-47

Treatment per acre[1]			Yield of hay per acre						
P_2O_5	K_2O	Borax[2]	1942	1943	1944	1945	1946	1947	6-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
54	120	0	7,040	4,860	3,810	5,000	9,180	6,230	6,020
54	120	15	7,780	6,590	4,330	5,830	10,720	7,350	7,100
54	120	30	7,930	7,290	4,370	5,790	10,930	7,270	7,263
Number of cuttings per year			3	3	2	3	4	3	

[1] All plots received 1 ton of lime per acre; treatments were not replicated.
[2] Applied at these rates every other year.

APPENDIX TABLE 25. EFFECT OF BORAX ON HAY YIELDS OF ALFALFA GROWN ON HARTSELLS FINE SANDY LOAM, SAND MOUNTAIN SUBSTATION, 1943-47

Treatment per acre[1]		Yield of hay per acre					
Borax	Lime	1943	1944	1945	1946	1947	5-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	2,000	1,800	2,150	3,906	10,125	3,400	4,494
20[2]	2,000	3,175	3,425	4,950	10,825	5,050	5,594
20(10)[3]	2,000	3,550	3,575	5,550	10,550	5,500	5,806
20(10)[3]	4,000	3,750	4,300	6,700	11,550	6,875	6,575
Number of cuttings per year		2	2	3	4	3	

[1] Initial application of 72 pounds of P_2O_5 and 120 pounds of K_2O per acre was followed annually with 70 and 50 pounds, respectively. Treatments were not replicated.
[2] Initial application only.
[3] Initial application of 20 pounds; annual application of 10 pounds.

APPENDIX TABLE 26. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON HARTSELLS FINE SANDY LOAM, SAND MOUNTAIN SUBSTATION, 1949-52

Source of phosphorus[1]	Treatment per acre, pounds					Yield of hay per acre, pounds—average of 4 replications				
	P_2O_5	SO_3	K_2O	Lime	Other	1949	1950	1951	1952	4-yr. av.
Triple superphosphate	50	120	240	6,000	BX[2]	10,394	7,491	5,527	6,121	7,383
do.	100	120	240	6,000	do.	11,126	7,419	6,124	6,193	7,716
do.	150	120	240	6,000	do.	12,110	8,531	6,117	7,135	8,473
do.	200	120	240	6,000	do.	11,769	8,087	6,468	7,229	8,386
do.	150	0	240	6,000	do.	10,108	6,383	4,530	4,787	6,452
do.	150	30	240	6,000	do.	10,572	6,529	5,055	5,553	6,927
do.	150	60	240	6,000	do.	9,929	6,133	4,857	5,377	6,574
do.	150	120	120	6,000	do.	9,438	6,804	5,261	5,937	6,860
do.	150	120	360	6,000	do.	11,585	7,730	6,299	7,132	8,187
do.	150	120	240	4,000	do.	11,153	7,121	5,907	7,047	7,806
do.	150	120	240	8,000	do.	10,285	6,133	4,588	6,254	6,815
do.	150	120	240	8,000	X	7,667	6,047	3,777	4,716	5,552
do.	150	120	240	8,000	B_2X	11,143	7,266	6,058	6,779	7,812
do.	150	120	240	8,000	B	10,108	5,744	4,539	5,371	6,441
Superphosphate	150	0	240	8,000	BX	10,261	7,298	5,186	6,001	7,187
FTCa phosphate 10-M	150	120	240	8,000	do.	8,099	5,948	4,664	4,877	5,781
do. 40-M	150	120	240	8,000	do.	9,948	7,374	5,692	6,609	7,404
Colloidal phosphate	100	0	240	8,000	do.	8,314	6,510	4,977	5,689	6,373
do.	200	0	240	8,000	do.	6,928	5,714	4,384	4,751	5,444
Rock phosphate	100	0	240	8,000	do.	9,861	7,553	5,835	6,769	7,505
do.	200	0	240	8,000	do.	8,367	6,223	4,991	5,338	6,230
Basic slag	200	0	240	2,000	do.	10,314	6,153	4,764	4,767	6,500
do.	100	0	240	0	do.	5,187	2,316	344	239	2,022
do.	200	0	240	0	do.	9,434	5,511	4,506	6,524	6,494
Superphosphate	150	0	180	4,000	do.	9,291	7,880	6,108	6,059	7,335
do.	150	0	240	4,000	do.	9,982	7,675	6,094	6,388	7,535
do.	150	0	0	4,000	do.	8,728	5,127	3,685	4,683	5,556
Number of cuttings per year						4	4	3	3	

[1] No phosphorus was applied in 1951 and 1952 to the rates and source study. Where elements other than phosphorus were varied, phosphorus was applied annually.

[2] B = 15 pounds of borax per acre; X = 30 pounds of $MnSO_4$ and $ZnSO_4$ plus 10 pounds of $CuSO_4$ per acre.

APPENDIX TABLE 27. EFFECTS OF FERTILIZERS AND BORAX ON HAY YIELDS OF ALFALFA GROWN ON ATWOOD FINE SANDY LOAM, UPPER COASTAL PLAIN SUBSTATION, 1947

Treatment[1]			Yield of hay per acre				
P_2O_5	K_2O	Borax[2]	1st cutting	2nd cutting	3rd cutting	4th cutting	Total
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	180	25-15	2,325	1,600	2,350	700	6,975
72	180	25-15	2,775	2,024	2,200	1,075	8,074
108	180	25-15	2,750	2,474	2,775	1,225	9,224
72	0	25-15	2,700	1,924	1,625	875	7,124
72	120	25-15	3,024	2,224	2,075	850	8,173
72	180	25-15	3,050	1,950	2,275	925	8,200
72	180	0	2,675	1,850	1,825	850	7,200

[1] Two tons of lime, 108 pounds of P_2O_5, and 100 pounds of K_2O per acre applied in fall of 1945 just prior to seeding. In May, 1946, plots were laid out and fertilized as above, but no yields were recorded in 1946. Plots were again fertilized in March, 1947, and yields for that year recorded. Treatments were not replicated.

[2] Initial application of 25 pounds, annual application of 15 pounds.

APPENDIX TABLE 28. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON ATWOOD FINE SANDY LOAM, UPPER COASTAL PLAIN SUBSTATION, 1949-54

Source of phosphorus[1]	Treatment per acre, pounds					Yield of hay per acre, pounds—average of 4 replications						
	P_2O_5	SO_3	K_2O	Lime	Other	1949	1950	1951	1952	1953	1954	6-yr. av.
Triple superphosphate	50	120	240	6,000	BX[3]	8,209	6,843	6,681	2,891	4,820	2,329	5,296
do.	100	120	240	6,000	do.	9,166	7,961	7,403	3,749	6,817	3,116	6,369
do.	150	120	240	6,000	do.	9,101	7,502	7,005	3,721	7,965	4,361	6,609
do.	200	120	240	6,000	do.	9,536	7,832	7,476	3,783	8,096	4,174	6,816
do.	150	0	240	6,000	do.	9,249	7,988	8,143	4,141	9,346	4,905	7,325
do.	150	30	240	6,000	do.	8,382	7,219	7,305	3,658	8,500	4,321	6,564
do.	150	60	240	6,000	do.	9,247	8,220	7,447	3,630	7,932	3,795	6,702
do.	150	120	120	6,000	do.	8,333	7,237	6,699	3,523	7,845	4,524	6,360
do.	150	120	360	6,000	do.	9,127	7,450	7,236	3,375	8,012	3,598	6,466
do.	150	120	240	4,000	do.	8,266	6,719	6,355	2,959	5,960	1,942	5,367
do.	150	120	240	8,000	do.	9,210	7,754	8,074	4,308	9,441	5,804	7,432
do.	150	120	240	6,000	X	8,420	7,275	7,002	3,239	7,741	3,214	6,149
do.	150	120	240	6,000	B_2X	9,391	7,525	7,605	3,689	8,394	4,352	6,826
do.	150	120	240	6,000	B	9,107	7,427	7,584	3,709	7,646	3,198	6,445
Superphosphate	150	0	240	6,000	BX	9,176	7,986	7,377	3,198	6,707	3,214	6,276
FTCa phosphate 10-M	150	120	240	6,000	do.	8,464	7,262	7,377	3,877	7,333	4,098	6,396
do. 40-M	150	120	240	6,000	do.	9,107	7,726	8,040	4,250	7,528	2,577	6,537
Colloidal phosphate	100	0	240	6,000	do.	8,400	7,148	5,639	2,848	5,134	1,978	5,114
do.	200	0	240	6,000	do.	8,120	6,827	5,922	3,071	5,976	2,282	5,359
Rock phosphate	100	0	240	6,000	do.	8,256	6,975	5,657	2,984	6,056	2,834	5,388
do.	200	0	240	6,000	do.	7,590	6,201	5,064	2,950	5,200	1,982	4,831
Basic slag	200	0	240	2,000	do.	8,840	7,218	7,216	3,875	6,510	1,906	5,928
do.	100	0	240	0	do.	7,471	2,267	0	24	0	0	1,627
do.	200	0	240	0	do.	8,101	4,480	5,999	2,310	3,246	144	4,047
Superphosphate	150	0	0	6,000	0	8,080	6,100	5,821	2,654	6,017	1,107	4,963
do.	150	0	240[2]	6,000	B	8,436	5,955	6,088	3,434	6,906	3,127	5,658
do.	150	0	120	2,000	B	8,439	6,764	5,799	2,133	4,568	690	4,732
Number of cuttings per year						3	3	3	3	3	2	

[1] No phosphorus applied in the rates and source study for 1951 through 1954, except that the 150-pound rate was applied in 1953 and 1954. Where elements other than phosphorus were varied, phosphorus was applied each year.

[2] Applied at planting and none thereafter.

[3] B = 15 pounds of borax; X = 30 pounds of $MnSO_4$ and $ZnSO_4$ plus 10 pounds of $CuSO_4$ per acre.

APPENDIX TABLE 29. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON DECATUR CLAY LOAM, ALEXANDRIA EXPERIMENT FIELD, 1948-52

Treatment						Yield of hay per acre—average of 3 replications					
Source of phosphorus[1]	Amount per acre										
	P_2O_5	SO_3	K_2O	Lime	Other	1948	1949	1950	1951	1952	5-yr. av.
	Lb.	*Lb.*	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Triple superphosphate	50	120	240	6,000	BX[2]	3,823	7,534	11,012	8,553	3,624	6,909
do.	100	120	240	6,000	do.	4,933	7,457	11,036	8,565	3,564	7,111
do.	150	120	240	6,000	do.	4,538	7,187	10,759	8,211	2,993	6,738
do.	200	120	240	6,000	do.	5,302	7,511	10,969	8,544	3,690	7,203
do.	150	0	240	6,000	do.	4,613	7,707	10,560	8,653	3,829	7,072
do.	150	30	240	6,000	do.	4,151	6,949	10,073	7,802	2,903	6,263
do.	150	60	240	6,000	do.	4,227	7,495	10,423	8,318	3,173	6,727
do.	150	120	120	6,000	do.	3,871	6,650	9,639	6,984	2,661	5,961
do.	150	120	360	6,000	do.	4,532	7,794	11,199	8,911	4,262	7,331
do.	150	120	240	4,000	do.	4,820	7,068	9,835	7,647	2,608	6,396
do.	150	120	240	8,000	do.	5,103	6,951	9,402	7,495	2,723	6,335
do.	150	120	240	6,000	X	4,232	6,731	10,034	7,632	2,106	6,147
do.	150	120	240	6,000	B_2X	3,852	6,548	9,150	7,061	2,477	5,818
do.	150	120	240	6,000	B	4,302	7,231	10,225	7,999	3,609	6,673
Superphosphate	150	0	240	6,000	BX	3,730	6,414	9,506	7,086	2,495	5,846
FTCa phosphate 10-M	150	120	240	6,000	do.	3,376	7,021	10,066	7,436	3,777	6,335
do. 40-M	150	120	240	6,000	do.	4,033	7,352	10,654	8,759	4,160	6,992
Colloidal phosphate	100	0	240	6,000	do.	2,749	6,336	9,243	6,938	2,484	5,550
do.	200	0	240	6,000	do.	3,129	7,297	10,685	8,465	3,692	6,654
Rock phosphate	100	0	240	6,000	do.	3,472	8,011	11,685	9,387	5,841	7,679
do.	200	0	240	6,000	do.	2,412	6,962	10,480	8,344	3,956	6,431
Basic slag	200	0	240	2,000	do.	3,685	7,780	11,015	8,919	4,740	7,228
do.	100	0	240	0	do.	1,817	8,246	8,958	7,724	2,427	5,834
do.	200	0	240	0	do.	2,574	7,869	10,013	8,435	3,476	6,473
Number of cuttings per year						4	3	4	4	3	

[1] No phosphorus was applied in 1951 and 1952 to the rates and source study. Where elements other than phosphorus were varied, phosphorus was applied annually.

[2] B = 15 pounds of borax; X = 30 pounds of $MnSO_4$ and $ZnSO_4$ plus 10 pounds of $CuSO_4$ per acre.

APPENDIX TABLE 30. EFFECTS OF FERTILIZERS, BORAX, ZINC SULFATE, AND MANURE ON HAY YIELDS OF ALFALFA GROWN ON CHESTERFIELD SANDY LOAM, MAIN STATION, 1943-49

Treatment[1] Amount per acre					Yield of hay per acre—average of 3 replications							
P_2O_5	K_2O	Borax	$ZnSO_4$	Manure	1943	1944	1945	1946	1947	1948	1949	7-yr. av.
Lb.	*Lb.*	*Lb.*	*Lb.*	*Tons*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
90	120	15	10	0	7,895	7,630	9,781	10,041	6,539	6,079	0	6,852
90	120	0	10	0	6,210	6,965	8,729	9,196	5,767	5,409	0	6,039
90	120	15	0	0	8,093	7,186	9,441	9,948	5,585	4,688	0	6,420
90	0	15	0	0	5,482	4,315	3,913	0	0	0	0	1,959
90	120[4]	15	0	0	7,168	8,049	10,012	11,282	6,710	4,763	0	6,855
90	60	15	0	0	6,181	6,802	8,120	8,121	4,641	3,789	0	5,379
90	240	15	0	0	6,535	7,721	9,807	9,938	7,238	6,048	4,748	7,434
90	120[5]	0	0	0	5,994	6,968	9,141	10,122	5,823	4,771	0	6,117
90	120	15	0	5	9,200	8,791	11,740	13,435	9,948	8,264	7,120	9,785
90[2]	120	15	0	0	7,588	7,350	9,601	9,819	6,274	5,675	0	6,615
90[3]	120	15	0	0	7,179	6,850	9,274	10,677	6,186	5,031	0	6,457
Number of cuttings per year					4	4	4	5	4	4	3	

[1] P_2O_5 and K_2O applied as 18 per cent superphosphate and 60 per cent muriate respectively, except as noted; 30 pounds of $MnSO_4$ and 10 pounds of $CuSO_4$ per acre were applied to all plots at time of planting. Borax and $MnSO_4$ were applied annually at the rate of 15 pounds per acre. Dolomitic lime was applied at the rate of 2 tons per acre to all plots prior to planting.

[2] P_2O_5 applied as Monsanto basic slag.

[3] P_2O_5 applied as colloidal phosphate.

[4] Forty pounds of K_2O applied before spring growth and repeated after first and second cuttings.

[5] Chemically pure potassium chloride used.

APPENDIX TABLE 31. EFFECTS OF RATES OF POTASH ON HAY YIELDS OF ALFALFA GROWN ON NORFOLK SANDY LOAM, MAIN STATION, 1944-47

K_2O treatment per acre[1]	Yield of hay per acre				
	1944	1945	1946	1947	4-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	1,436[3]	----	----	----	359
60	6,620	7,863	3,315[4]	----	4,450
120	7,144	9,928	8,517[5]	----	6,397
240	6,829	9,945	11,424	5,072	8,317
360	6,619	10,498	11,798	5,821	8,684
240[2]	8,101	12,870	15,399	5,841	10,552
Number of cuttings per year	4	4	5	4	

[1] Dolomite applied to all plots at rate of 2 tons per acre. P_2O_5 at the rate of 90 pounds per acre was applied as superphoshate annually; 30 pounds of borax per acre applied first year and 15 pounds per acre annually thereafter. Treatments were not replicated.

[2] Five tons of manure added annually.

[3] Failed at end of 2nd cutting.

[4] Failed at end of 4th cutting.

[5] Discontinued at end of 1946.

APPENDIX TABLE 32. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON GREENVILLE FINE SANDY LOAM, PRATTVILLE EXPERIMENT FIELD, 1949-52

Source of phosphorus[1]	Treatment: Amount per acre					Yield of hay per acre—average of 3 replications				
	P_2O_5	SO_3	K_2O	Lime	Other	1949	1950	1951	1952	4-yr. av.
	Lb.	*Lb.*	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Triple superphosphate	50	120	240	4,000	BX[2]	7,997	6,183	2,951	2,659	4,948
do.	100	120	240	4,000	do.	9,648	7,347	3,520	4,321	6,209
do.	150	120	240	4,000	do.	10,393	7,227	3,355	3,571	6,137
do.	200	120	240	4,000	do.	10,468	8,920	4,550	4,808	7,187
do.	150	0	240	4,000	do.	8,989	7,338	4,003	4,622	6,238
do.	150	30	240	4,000	do.	8,406	6,787	3,501	3,503	5,549
do.	150	60	240	4,000	do.	9,662	8,110	4,111	4,685	6,642
do.	150	120	120	4,000	do.	10,692	7,733	4,707	5,003	7,034
do.	150	120	360	4,000	do.	10,251	9,790	5,014	5,918	7,743
do.	150	120	240	6,000	do.	11,659	11,285	6,257	7,947	9,287
do.	150	120	240	8,000	do.	10,689	9,378	6,084	7,526	8,419
do.	150	120	240	4,000	X	9,474	4,429	2,999	3,317	5,055
do.	150	120	240	4,000	B_2X	13,313	11,527	6,268	7,191	9,575
do.	150	120	240	4,000	B	11,230	9,398	5,175	6,027	7,958
Superphosphate	150	0	240	4,000	BX	11,742	9,958	5,181	5,305	8,047
FTCa phosphate 10-M	150	120	240	4,000	do.	13,197	10,945	6,220	7,953	9,579
do. 40-M	150	120	240	4,000	do.	11,249	8,097	5,087	6,389	7,706
Colloidal phosphate	100	0	240	4,000	do.	11,332	8,560	5,198	5,665	7,689
do.	200	0	240	4,000	do.	9,067	6,863	3,878	4,396	6,051
Rock phosphate	100	0	240	4,000	do.	11,039	9,751	5,228	6,541	8,140
do.	200	0	240	4,000	do.	10,297	7,461	3,813	4,603	6,544
Basic slag	200	0	240	2,000	do.	10,704	9,027	5,725	6,816	8,068
do.	100	0	240	0	do.	3,565	1,472	1,363	1,643	2,011
do.	200	0	240	0	do.	9,200	6,651	4,590	5,796	6,559
Number of cuttings per year						4	4	4	4	

[1] No phosphorus was applied in 1951 and 1952 to the rates and source study. Where elements other than phosphorus were varied, phosphorus was applied annually.

[2] B = 15 pounds of borax; X = 30 pounds of $MnSO_4$ and $ZnSO_4$ plus 10 pounds of $CuSO_4$ per acre.

APPENDIX TABLE 33. EFFECTS OF RATES OF PHOSPHORUS AND POTASH ON HAY YIELDS OF ALFALFA GROWN ON SUMTER CLAY, BLACK BELT SUBSTATION, 1931-42

Treatment per acre[1]		Yield of hay per acre—average of 2 replications												
P_2O_5	K_2O	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	12-yr. av.
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	0	1,183	625	1,786	1,363	1,996	1,326	1,460	1,165	1,476	810	1,227	1,785	1,350
60	0	5,753	3,303	6,464	3,330	3,892	2,772	3,530	2,178	3,321	1,080	3,540	3,276	3,537
0	24	1,453	880	2,114	1,628	2,331	1,602	1,587	1,420	1,602	975	1,298	2,940	1,653
60	24	6,422	4,079	7,972	4782	4,909	3,316	4,726	3,641	3,982	1,800	5,659	4,530	4,652
120	24	9,024	4,773	8,842	4,995	5,680	3,541	5,430	3,987	4,178	1,485	5,865	6,240	5,337

[1] These data were acquired from plantings made in the fall of 1930, 1934, 1939, and 1941.

Appendix Table 34. Effects of Fertilizers on Hay Yields of Alfalfa Grown on Sumter Clay, Black Belt Substation, 1948-54

Source of phosphorus	Treatment: Amount per acre				Yield of hay per acre—average of 3 replications							
	P_2O_5	K_2O	Borax	Other[1]	1948	1949	1950	1951	1952	1953	1954	7-yr. av.
	Lb.	*Lb.*	*Lb.*		*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Superphosphate	50	360	30	X	8,698	11,184	9,387	4,725	11,836	11,958	7,682	9,353
do.	100	360	30	X	8,693	10,217	8,703	4,640	11,581	12,034	7,441	9,045
do.	150	360	30	X	8,679	11,013	9,448	5,216	12,465	12,848	7,967	9,632
do.	200	360	30	X	8,868	11,842	9,549	5,376	12,833	12,859	8,021	9,907
do.	150	0	30	X	7,737	8,869	7,533	3,413	4,457	4,423	3,653	5,726
do.	150	120	30	X	8,711	10,334	9,200	4,939	10,388	10,210	6,649	8,632
do.	150	240	30	X	8,660	10,072	8,781	4,789	11,485	11,836	7,424	9,006
do.	150	360	0	X	8,469	11,189	9,576	4,512	10,715	10,258	6,747	8,886
do.	150	360	15	X	9,209	11,538	9,755	5,088	12,355	12,738	8,192	9,789
do.	150	360	30	0	8,852	10,495	8,331	4,939	11,335	12,408	7,752	9,137
Basic slag	100	360	30	X	8,931	10,530	9,429	4,833	12,132	12,688	7,255	9,400
Colloidal phosphate	100	360	30	X	7,361	9,504	7,477	3,552	9,132	9,039	4,821	7,269
do.	200	360	30	X	7,986	9,474	8,005	3,776	8,927	10,028	5,212	7,630
FTCa phosphate 40-M	100	360	30	X	8,190	10,068	8,259	4,587	11,404	12,122	7,212	8,835
Superphosphate	150	360	0	100 lb. Mi-Min-Mix	8,754	11,031	9,485	5,003	12,377	12,401	7,878	9,561
Number of cuttings per year					3	4	2	1	4	4	4	

[1] X = 30 pounds of $MnSO_4$, 30 pounds of $ZnSO_4$, and 100 pounds of $MgSO_4$ per acre. Mi-Min-Mix is a commercial minor element mixture.

APPENDIX TABLE 35. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON MAGNOLIA FINE SANDY LOAM, MONROEVILLE EXPERIMENT FIELD, 1948-49

Treatment						Yield of hay per acre—average of 3 replications		
Source of phosphorus	Amount per acre							
	P_2O_5	SO_3	K_2O	Lime	Other[1]	1948	1949	2-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*
Triple superphosphate	50	120	240	4,000	BX	3,353	5,037	4,190
do.	100	120	240	4,000	do.	3,496	5,254	4,375
do.	150	120	240	4,000	do.	3,704	5,744	4,724
do.	200	120	240	4,000	do.	3,355	5,774	4,565
do.	150	0	240	4,000	do.	2,865	4,435	3,650
do.	150	30	240	4,000	do.	2,858	4,792	3,825
do.	150	60	240	4,000	do.	3,025	4,879	3,952
do.	150	120	120	4,000	do.	2,565	3,086	2,826
do.	150	120	360	4,000	do.	2,631	4,297	3,464
do.	150	120	240	6,000	do.	4,130	6,291	4,986
do.	150	120	240	8,000	do.	2,930	4,448	3,689
do.	150	120	240	4,000	X	2,149	2,292	2,221
do.	150	120	240	4,000	B_2X	3,107	5,418	4,263
do.	150	120	240	4,000	B	3,645	5,099	4,372
Superphosphate	150	0	240	4,000	BX	2,803	5,091	3,947
FTCa phosphate 10-M	150	120	240	4,000	do.	3,555	5,090	4,323
do. 40-M	150	120	240	4,000	do.	3,738	5,404	4,571
Colloidal phosphate	100	0	240	4,000	do.	2,443	4,182	3,313
do.	200	0	240	4,000	do.	2,430	4,001	3,216
Rock phosphate	100	0	240	4,000	do.	2,247	3,617	2,932
do.	200	0	240	4,000	do.	2,488	3,878	3,183
Basic slag	200	0	240	2,000	do.	3,258	4,895	4,077
do.	100	0	240	0	do.	2,610	2,312	2,461
do.	200	0	240	0	do.	3,411	4,644	4,028
Number of cuttings per year						4	3	

[1] B = 15 pounds of borax; X = 30 pounds of $MnSO_4$ and $ZnSO_4$ plus 10 pounds of $CuSO_4$ per acre.

APPENDIX TABLE 36. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON KALMIA FINE SANDY LOAM, BREWTON EXPERIMENT FIELD, 1948-49

Source of phosphorus	Treatment: Amount per acre					Yield of hay per acre—average of 3 replications		
	P_2O_5	SO_3	K_2O	Lime	Other[1]	1948	1949	2-yr. av.
	Pounds	*Pounds*	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*
Triple superphosphate	50	120	240	4,000	BX	5,472	4,859	5,166
do.	100	120	240	4,000	do.	5,844	5,498	5,671
do.	150	120	240	4,000	do.	5,786	5,160	5,473
do.	200	120	240	4,000	do.	6,246	5,360	5,803
do.	150	0	240	4,000	do.	5,958	4,973	5,466
do.	150	30	240	4,000	do.	5,264	4,707	4,986
do.	150	60	240	4,000	do.	6,461	5,432	5,947
do.	150	120	120	4,000	do.	4,155	2,788	3,472
do.	150	120	360	4,000	do.	5,530	6,143	5,837
do.	150	120	240	6,000	do.	6,382	6,151	6,267
do.	150	120	240	8,000	do.	6,033	5,667	5,850
do.	150	120	240	4,000	X	5,211	2,343	3,777
do.	150	120	240	4,000	B_2X	5,943	3,970	4,957
do.	150	120	240	4,000	B	5,463	5,300	5,382
Superphosphate	150	0	240	4,000	BX	5,521	5,119	5,320
FTCa phosphate 10-M	150	120	240	4,000	do.	5,530	4,775	5,153
do. 40-M	150	120	240	4,000	do.	5,761	4,814	5,288
Colloidal phosphate	100	0	240	4,000	do.	4,488	3,091	3,790
do.	200	0	240	4,000	do.	5,388	3,637	4,513
Rock phosphate	100	0	240	4,000	do.	5,875	3,941	4,908
do.	200	0	240	4,000	do.	4,733	3,129	3,931
Basic slag	200	0	240	2,000	do.	4,610	4,440	4,525
do.	100	0	240	0	do.	3,675	1,237	2,456
do.	200	0	240	0	do.	3,485	2,167	2,826
Number of cuttings per year						4	3	

[1] B = 15 pounds of borax; X = 30 pounds of $MnSO_4$, 30 pounds of $ZnSO_4$, and 10 pounds of $CuSO_4$ per acre.

APPENDIX TABLE 37. EFFECTS OF LIME AND RATES AND TIME OF APPLICATION OF FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON ORANGEBURG FINE SANDY LOAM, ATMORE PRISON FARM, 1945-49

Treatment[1]					Yield of hay per acre—average of 3 replications					
Amount per acre										
P_2O_5	K_2O	Lime	Borax	Other	1945	1946	1947	1948	1949	5-yr. av.
Lb.	*Lb.*	*Lb.*	*Lb.*		*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
36	240	4,000	15	0	4,810	8,830	8,201	7,266	5,031	6,828
72	240	4,000	15	0	5,740	9,446	8,777	7,717	6,379	7,612
144	240	4,000	15[2]	0	5,917	9,291	8,606	7,821	6,654	7,658
216	240	4,000	15	0	6,610	10,278	8,817	8,621	8,405	8,546
144	60	4,000	15	0	6,274	9,035	6,387	5,612	3,078	6,077
144	120	4,000	15	0	5,423	9,296	7,823	6,240	3,139	6,384
144	360	4,000	15	0	6,305	9,812	8,721	8,282	7,872	8,198
144	360	4,000	0	0	5,470	9,253	7,852	7,673	4,985	7,047
144	240	4,000	30	0	5,472	9,478	8,603	7,521	6,173	7,449
144	360	4,000	30	0	5,836	9,647	8,837	7,225	7,504	7,810
144	360	4,000	0[3]	0	6,229	10,184	9,327	8,525	9,362	8,725
144	240	4,000	15	0	5,846	10,316	9,382	8,592	7,825	8,392
144	240	4,000	15	X[4]	6,699	10,556	9,444	8,754	7,717	8,634
144	240	4,000	15	6 tons manure	7,961	11,350	10,753	10,817	12,666	10,709
144	240	4,000	15	200 lb. nitrate of soda	5,619	9,972	9,040	7,773	8,686	8,218
144	240	4,000	15	400 lb. nitrate of soda	6,659	10,325	9,260	8,757	10,266	9,053
144	240	4,000	15	[5]	5,916	9,285	8,714	8,234	6,820	7,794
144	240	2,000	15	0	5,859	9,133	7,472	6,614	3,924	6,600

(Continued)

APPENDIX TABLE 37 *(Continued)*. EFFECTS OF LIME AND RATES AND TIME OF APPLICATION OF FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON ORANGEBURG FINE SANDY LOAM, ATMORE PRISON FARM, 1945-49

Treatment[1]					Yield of hay per acre—average of 3 replications					
Amount per acre										
P_2O_5	K_2O	Lime	Borax	Other	1945	1946	1947	1948	1949	5-yr. av.
Lb.	*Lb.*	*Lb.*	*Lb.*		*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
144	240	8,000	15	0	5,965	9,772	8,884	8,424	9,730	8,555
144	240	16,000	15	0	5,945	10,020	9,270	8,478	9,978	8,738
144	240	4,000	15	800 lb. dolomite	5,236	9,450	8,380	6,843	6,666	7,315
0	240	4,000	15	1,600 lb. basic slag	5,892	10,115	8,981	8,206	9,898	8,618
0	240	0	15	1,600 lb. basic slag	6,365	9,597	8,643	8,006	8,463	8,215
0	240	0	15	800 lb. basic slag	4,478	8,559	6,935	4,817	3,958	5,749
144	240	4,000	15	[6]	5,345	9,652	8,597	8,077	8,715	8,077
144	240	4,000	15	[7]	5,579	9,820	8,902	7,640	8,056	7,999
144	240	4,000	15	0	5,998	10,918	9,222	8,330	9,862	8,866
144	240	4,000	15	3 tons manure	7,460	10,937	10,064	9,713	11,807	9,996
Number of cuttings per year					4	4	4	4	4	

[1] All treatments except lime were applied annually prior to spring growth except as noted.
[2] Fertilized after first cutting.
[3] Thirty pounds of borax prior to planting and none thereafter.
[4] Thirty pounds of $MnSO_4$, 10 pounds of $ZnSO_4$, and 10 pounds of $CuSO_4$ per acre.
[5] One-third of fertilizer before spring growth and one-third after first and second cuttings.
[6] Fertilized after second cutting.
[7] Fertilized after third cutting.

APPENDIX TABLE 38. EFFECTS OF LIME AND FERTILIZERS ON HAY YIELDS OF ALFALFA GROWN ON NORFOLK FINE SANDY LOAM, GULF COAST SUBSTATION, 1945-47

Treatment per acre				Yield of hay per acre—average of 3 replications			
P_2O_5	K_2O	Lime	Borax[1]	1945[5]	1946	1947	3-yr. av.
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
36	240	4,000	30	3,939	10,263	9,090	7,764
72	240	4,000	30	4,209	9,664	8,840	7,571
144	240	4,000	30	5,132	10,193	7,812	7,712
216	240	4,000	30	4,573	10,221	7,626	7,473
144	60	4,000	30	3,224	9,502	6,569	6,432
144	120	4,000	30	3,643	9,972	8,811	7,476
144	360	4,000	30	4,339	10,058	9,530	7,975
144	360	4,000	0	4,835	11,301	10,420	8,852
144	240	4,000	30 lb. borax annually	4,512	10,727	9,607	8,282
144	360	4,000	30 lb. borax annually	4,086	10,512	10,315	8,304
144	360	4,000	No borax after 1st yr.	3,947	10,917	8,781	7,900
144	240	4,000	30[2]	5,550	10,379	7,331	7,753
144	240	4,000	30[3]	3,354	11,345	10,071	8,257
144	240	4,000	30[4]	3,929	9,932	10,385	8,082
144	240	2,000	30	4,566	10,368	9,496	8,143
144	240	8,000	30	4,408	9,274	9,403	7,695
144	240	16,000	30	4,486	10,112	10,333	8,310
Number of cuttings per year				2	4	3	

[1] Borax applied at 30 pounds per acre initially and 15 pounds per acre annually thereafter except as noted.
[2] Thirty pounds of $MnSO_4$, 10 pounds of $ZnSO_4$, and 10 pounds of $CuSO_4$ per acre also added.
[3] Six tons of manure first year and 3 tons per acre annually.
[4] One-third of fertilizer after each of three cuttings.
[5] Seeded first in fall of 1944. Lost stand in July, 1945, and reseeded in fall of 1945.

APPENDIX TABLE 39. EFFECTS OF RATES AND DEPTHS OF PLACEMENT OF LIME ON HAY YIELDS OF ALFALFA GROWN ON LLOYD CLAY LOAM, PIEDMONT SUBSTATION, 1951-54

Lime treatment[1]		Yield of hay per acre—average of 4 replications				
Rate per acre	Depth	1951	1952	1953	1954	4-yr. av.
Pounds	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
4,000	0-6	3,336	6,480	7,238	3,810	5,216
4,000	0-12	3,088	6,137	6,981	4,190	5,099
8,000	0-6	3,426	6,574	7,672	4,565	5,559
8,000	0-6[2]	3,301	6,604	7,561	4,900	5,592
8,000	0-12	2,987	6,203	7,220	4,516	5,232
16,000	0-6	3,293	6,618	7,537	4,735	5,546
16,000	0-12	3,318	6,785	7,663	5,211	5,744
8,000	0-12[3]	3,223	6,626	8,162	5,064	5,769
Number of cuttings per year		2	4	4	3	

[1] All plots received annual treatments of 200 pounds of P_2O_5, 240 pounds of K_2O, and 25 pounds of borax except as noted. In the 0- to 6-inch treatments, lime was worked into top 4 to 6 inches of soil. In 0- to 12-inch treatments, one-half of the lime was applied as a plowsole application at a depth of 12 inches and one-half worked into top 4 to 6 inches.

[2] Subsoiled to depth of 12 inches.

[3] Initial applications of 100 pounds of P_2O_5 and 120 pounds of K_2O applied as plowsole application at a depth of 12 inches in addition to standard application of P_2O_5 and K_2O applied to topsoil.

APPENDIX TABLE 40. EFFECTS OF RATES AND DEPTH OF PLACEMENT OF LIME ON HAY YIELDS OF ALFALFA GROWN ON MADISON CLAY LOAM, MAIN STATION, 1951-54

Lime treatment[1]		Yield of hay per acre—average of 4 replications				
Rate per acre	Depth	1951	1952	1953	1954	4-yr. av.
Pounds	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
4,000	0-6	6,018	8,505	10,562	3,077	7,041
4,000	0-12	6,063	8,835	7,864	1,053	5,954
8,000	0-6	6,647	9,928	12,184	5,576	8,584
8,000	0-6[2]	5,736	9,405	11,475	4,693	7,827
8,000	0-12	6,718	10,700	13,326	4,767	8,878
8,000	0-18	6,929	11,154	13,506	4,672	9,065
16,000	0-6	5,914	9,463	12,620	5,136	8,283
16,000	0-12	7,269	11,318	13,332	5,359	9,320
8,000	0-12[3]	6,372	10,750	12,748	4,543	8,603
8,000	0-12[4]	6,889	11,151	12,561	3,653	8,564
Number of cuttings per year		4	4	5	3	

[1] All plots received annual treatments of 200 pounds of P_2O_5, 240 pounds of K_2O, and 25 pounds of borax except as noted. In the 0- to 6-inch treatments, lime was mixed with entire soil layer. In 0- to 12-inch treatments, one-half of lime was mixed with top 6 inches and one-half applied in plowsole at 12 inches. In 0- to 18-inch treatments, 2 tons of lime were mixed with top 6 inches and 1 ton was applied in plowsole at 12 and 18 inches.

[2] Subsoiled to depth of 12 inches.

[3] Initial application of 120 pounds of K_2O in plowsole at 12 inches in addition to other fertilizer.

[4] Initial application of 100 pounds of P_2O_5 in plowsole at 12 inches in addition to other fertilizer.

APPENDIX TABLE 41. EFFECTS OF RATES AND DEPTHS OF PLACEMENT OF LIME ON HAY YIELDS OF ALFALFA GROWN ON SUSQUEHANNA FINE SANDY LOAM, TUSKEGEE EXPERIMENT FIELD, 1951-54

Lime treatment[1]		Yield of hay per acre—average of 4 replications				
Rate per acre	Depth	1951	1952	1953	1954	4-yr. av.
Pounds	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
4,000	0-6	1,967	5,737	6,423	2,064	4,048
4,000	0-12	1,756	5,370	4,614	1,282	3,256
8,000	0-6	1,832	6,120	7,065	2,466	4,371
8,000	0-6[2]	1,953	6,280	6,823	2,556	4,403
8,000	0-12	1,821	7,231	7,507	2,261	4,705
8,000	0-12[1]	1,871	6,328	7,049	2,288	4,384
8,000	0-18	1,902	6,787	7,018	2,168	4,469
16,000	0-6	1,950	7,513	8,492	2,849	5,201
16,000	0-12	2,208	8,243	8,424	3,463	5,585
8,000	0-12[3]	2,502	8,288	8,115	2,678	5,396
Number of cuttings per year		3	3	3	2	

[1] All plots received annual treatments of 200 pounds of P_2O_5, 240 pounds of K_2O, and 25 pounds of borax except as noted. All lime was incorporated with the entire soil layer indicated except in one 8,000-pound treatment, in which case one-half of the lime was applied in the plowsole at 12 inches. In the 0- to 18-inch treatments, 2 tons of lime were mixed with the top 6 inches and the remainder was mixed uniformly from 6 to 18 inches.

[2] Subsoiled to depth of 12 inches.

[3] Initial application of 100 pounds of P_2O_5 and 120 pounds of K_2O was incorporated with the 6- to 12-inch soil layer in addition to other fertilizer applied.