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TECHNICAL BULLETIN No. 419 APRIL, 1934

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FORAGE-CROP FIELD EXPERIMENTS AT WEST POINT, MISS.

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The Bureau of Plant Industry in Cooperation with the Mississippi Agricultural College and Experiment Station

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INTRODUCTION

The suitability of the limestone soils of the prairie belt of Alabama and Mississippi for alfalfa has been recognized for many years, and the acreage devoted to the crop increased rapidly between 1909 and 1915. About 1919, however, complaints were received to the effect that alfalfa was much less productive and shorter-lived than formerly. The demands for assistance in determining the cause of the so-called "alfalfa failures" culminated in a congressional appropriation which enabled the inauguration in 1925 of experiments to ascertain the causes of the difficulty and to suggest remedial measures. The purpose of this bulletin is to summarize results to date of the field experiments conducted by the Division of Forage Crops and Diseases 5 miles east of West Point, Miss., in cooperation with the Mississippi Agricultural Experiment Station. The experiments have not been of sufficient duration to give conclusive results, but it is quite evident that the decline in yields and in longevity of stands is associated with the lack of available phosphorus, humus deficiency, and poor cultural practices. Tests with other forage crops that appear promising for this section have been carried on more or less incidentally to the alfalfa experiments.

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DESCRIPTION OF THE SOIL

The prairie limestone belt of Alabama and Mississippi is a crescent-shaped strip of land having an approximate average width of 30 miles and extending from Lee County, Miss., on the north in a southeasterly direction to Butler County, Ala., where it turns east, terminating in Bullock County, Ala. While soft limestone is the predominant underlying rock, the area is interspersed with other geological formations. The leading counties in the prairie limestone belt have a combined area of approximately 6,500,000 acres, of which less than 1,000,000 are derived from limestone and therefore regarded as potential alfalfa lands. The limestone soils of this section have been classed in the Houston, Bell, Sumter, Catalpa, and Eutaw series. Most of the alfalfa has been and is being grown on Houston, Sumter, and Bell clays.

The experiments at West Point are located mainly on the Houston clay, but with a small acreage on Bell and Sumter clays. The

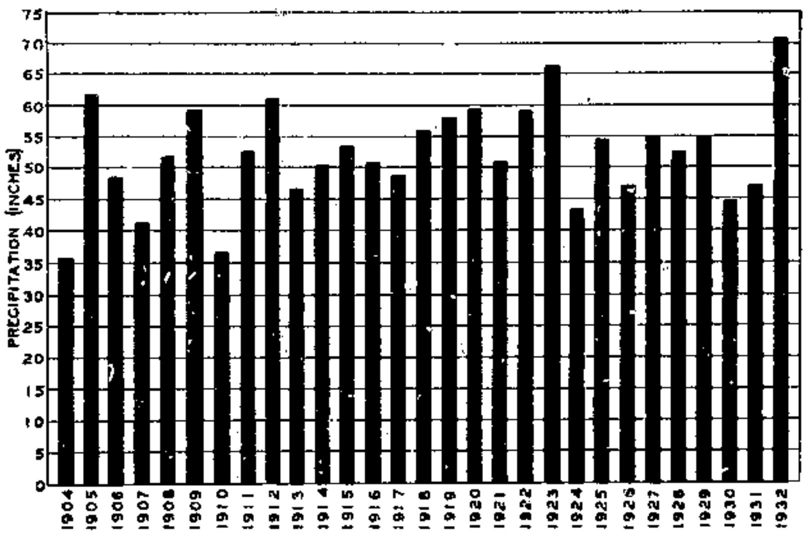

FIGURE 1.—Annual precipitation at Columbus, Miss., 1904–32 (U.S. Weather Bureau records).

Houston and Sumter soils have resulted from the decomposition, in place, of a rather soft shaly limestone that was deposited in the deep waters of the Gulf of Mexico when it covered this section, while Bell clay largely represents wash from adjoining areas of Sumter and Houston clays. These soils are compact, sticky, and tenacious when wet, but upon plowing break readily into a granular structure, due probably to the lime content. In dry periods the soil cracks badly, but with more favorable moisture conditions the cracks fill up readily. The general contour favors good surface drainage but the water table is often relatively high, especially during wet periods.

The practice of continuous cropping mainly to cotton for many years has reduced the organic-matter content and the productivity of these soils, and as they erode readily they should be in sod or some other cover crop during the winter months, when rain is usually most abundant.

CLIMATE

The average annual precipitation at Columbus, Miss., the nearest weather reporting station, amounted to 54.06 inches during the 33-year period 1888–1920 and 53.34 inches for the years 1925–32. As shown in table 1, the amount and distribution is generally adequate for crop production. The variation in annual precipitation is presented clearly in figure 1. During the summer months the precipitation is often local, while general rains occur during the winter months. Rains are most frequent from the middle of December to late in March. Since evaporation takes place much more slowly in winter, and since the water table is relatively high, it is seldom possible to work the soil during this period. The frost-free period for the past 8 years is given in table 2. The average frost-free period for these years extends from March 24 to November 6. As shown in table 3, the lowest temperatures have occurred in January, but there is little difference in the mean of December, January, and February. July normally is the hottest month. The most abrupt changes occur during February. The prevailing direction of the wind is from the southeast. The most agreeable months are October and November.

TABLE 1.—*Monthly and annual precipitation at Columbus and West Point, Miss., 1888–1932* [1]

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In*	*In.*	*In.*
1921	3.33	5.04	8.44	10.18	2.45	2.38	3.95	3.90	5.47	0.58	1.99	3.23	51.00
1922	5.91	5.81	12.19	3.78	3.71	1.12	4.94	4.03	2.29	1.62	5.49	8.16	58.96
1923	5.97	6.09	6.11	6.56	6.79	2.81	6.78	0.82	.50	7.35	5.01	5.63	60.40
1924	7.47	3.58	6.02	6.07	5.47	2.57	7.38	1.89	1.44	.31	[2] T	6.18	43.38
1925	11.53	3.22	4.34	1.21	4.68	2.32	6.04	1.22	4.17	8.04	4.11	3.03	54.51
1926	4.78	3.15	4.29	2.06	4.62	2.16	2.81	0.73	.52	1.61	5.54	8.54	47.41
1927	2.39	7.10	8.06	1.58	7.42	5.32	2.28	.08	1.23	3.33	7.07	8.22	55.07
1928	2.14	3.72	7.11	12.62	2.83	7.04	4.80	3.61	1.28	2.32	2.84	1.18	52.16
1929	5.35	4.34	10.04	3.71	4.35	3.32	1.99	1.24	3.18	3.80	10.09	3.52	54.93
1930	2.80	2.83	4.97	2.04	12.41	.22	2.05	4.20	1.58	3.11	5.19	3.27	44.65
1931	2.50	4.37	4.28	1.71	3.10	2.00	5.53	4.30	1.90	2.44	5.53	9.44	47.22
1932	0.81	7.92	3.76	1.44	2.36	2.01	9.15	4.05	10.55	9.40	3.64	9.65	70.74
Mean, 1888–1920	5.07	5.53	6.17	5.34	3.94	4.12	4.71	4.34	3.09	2.44	4.19	5.12	54.06
Mean, 1925–32	4.79	4.59	5.86	3.37	5.23	3.12	4.34	3.30	3.05	4.26	5.50	5.93	53.34

[1] Instruments for recording weather data were installed near West Point, Feb. 10, 1929. All other data are from the records of the nearest U.S. Weather Bureau station, at Columbus, Miss.
[2] T = trace.

TABLE 2.—*Frost-free period at West Point, Miss., 1925–32*

Year	Killing frost		Frost-free period (days)	Year	Killing frost		Frost-free period (days)
	Last in spring	First in fall			Last in spring	First in fall	
1925	Mar. 15	Oct. 20	219	1929	Mar. 10	Nov. 5	240
1926	Apr. 1	Oct. 25	207	1930	Mar. 31	Oct. 31	214
1927	Mar. 23	Nov. 18	240	1931	Mar. 18	Nov. 7	234
1928	Apr. 16	Nov. 11	209	1932	Mar. 15	Nov. 12	242

TABLE 3.—*Mean maximum, mean minimum, mean, absolute maximum, and absolute minimum temperatures (° F.) at Columbus, Miss., for 30 years*

Item	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mean maximum	55.0	55.0	67.0	74.7	83.6	91.1	92.3	92.2	89.1	77.8	66.2	54.9	74.9
Mean minimum	33.5	33.2	43.4	50.4	59.3	67.1	70.2	69.0	63.5	50.6	40.0	32.9	51.2
Mean	44.2	44.1	55.2	62.6	71.4	79.1	81.2	81.0	76.3	64.2	53.1	43.9	63.0
Absolute maximum	81.0	87.0	93.0	95.0	100.0	108.0	113.0	106.0	110.0	100.0	88.0	82.0	------
Absolute minimum	−2.0	0	18.0	27.0	38.0	47.0	54.0	52.0	40.0	24.0	14.0	8.0	------

ALFALFA

From available data it appears that alfalfa was first grown in the prairie limestone belt about 1890. According to the United States census, the acreage increased more than 70 percent during the 10-year period 1909–19 (table 4). The advent of the bollweevil turned the attention of farmers to other cash crops as substitutes for cotton, and because of the success with alfalfa much interest developed in it. No data are available as to the acreage in 1915, but it is probable that the peak was reached near that time. Beginning about 1919 many complaints were received of alfalfa failures, and the decline in acreage over the 5-year period 1919–24 amounted to more than 77 percent. The purpose of inaugurating the alfalfa investigations at this station was to determine, if possible, the causes of alfalfa failures and to find remedial measures. The first experimental seeding was made in September 1925, and additional tests have been sown each spring and fall since that time. The results so far indicate that the alfalfa troubles are not due to any single factor, and that the crop may be profitably grown provided certain practices are followed consistently.

TABLE 4.—*Alfalfa acreages in the prairie limestone counties of Mississippi and Alabama* [1]

Mississippi counties	1909	1919	1924	1929	Alabama counties	1909	1919	1924	1929
Chickasaw	328	343	41	90	Autauga	5	3	6	3
Clarke	99	8	6	------	Bullock	1	147	------	------
Clay	1,632	2,820	23	181	Butler	2	------	5	------
Jasper	10	11	21	------	Dallas	290	89	189	115
Lee	745	1,905	484	839	Greene	2,496	988	101	------
Lowndes	1,268	2,504	585	566	Hale	500	2,577	757	553
Monroe	1,183	5,154	337	769	Lowndes	474	127	1	20
Newton	3	9	6	18	Macon	3	------	2	6
Noxubee	1,018	808	230	63	Marengo	264	1,169	597	305
Oktibbeha	204	65	6	38	Montgomery	360	380	600	440
Pontotoc	45	330	73	38	Perry	400	1,231	736	618
Prentiss	44	175	195	229	Pickens	445	844	4	22
Rankin	3	5	------	------	Sumter	1,013	439	90	73
Scott	5	6	20	89	Wilcox	142	130	------	------
Union	3	91	120	26	Total	6,400	8,124	2,098	2,161
Total	6,696	14,324	2,147	2,945					

[1] Figures taken from United States census report.

VARIETAL TRIALS

The varietal trials of alfalfa conducted during these investigations have included most of the important domestic varieties and strains, as well as several from foreign sources. Depending on ability to survive cold, these alfalfas are placed in three groups as follows: Nonhardy, medium hardy, and hardy. The nonhardy alfalfas, of which Hairy Peruvian is an example, recover rapidly after cutting, and under favorable conditions produce a greater tonnage of hay than most other sorts. None of the alfalfas in this group is sufficiently cold-resistant to be considered dependable for this section. The medium-hardy group is made up mainly of regional strains of common alfalfa that have developed where rather low winter temperatures are of frequent occurrence, thus resulting in strains that are intermediate in cold resistance. Kansas, Utah, and Dakota Common alfalfas are among the best-known strains in this group. The hardy or variegated alfalfas, of which Grimm is a representative, are cold-resistant but recover slowly after cutting and generally are less productive than alfalfas of the medium-hardy group where winter conditions favor the latter. Both the hardy and medium-hardy alfalfas tend to become dormant with the advent of shorter days and cooler weather.

The results of the varietal trials sown in the fall of 1925 and the spring of 1927 are given in tables 5 and 6, respectively. No fertilizers

FIGURE 2.—Alfalfa variety plots photographed in October 1927. Note the late growth of Arizona Common alfalfa just to the left of the center, as compared with the growth of Turkistan alfalfa in the adjoining plots on the right.

were applied to these plots until the spring of 1929, when those sown in 1925 were top dressed with 16 percent superphosphate, at the rate of 500 pounds per acre. The plots sown in 1927 have not been fertilized. As shown by these tables, the nonhardy alfalfas are less productive, especially after the first year, than the hardier sorts, due to a gradual thinning out. The fact that they continue to grow late in the fall (fig. 2) and often make considerable growth during warm periods in the winter has resulted in the plants becoming infected with Sacketts disease and also injured by cold, with a corresponding loss of stand. Some reduction in stand has also been noted during the summer, especially before the plants become well established.

The hardy alfalfas produced a good quality of hay and survived satisfactorily until the severe winter of 1929–30, when they appeared to suffer more injury than the medium-hardy alfalfas. The average annual yield of air-dry hay of the hardy alfalfas has been almost appreciably less than that of the medium-hardy alfalfas, and about the same as that of the nonhardy alfalfas. However, owing to better stands, the quality of hay produced by the hardy alfalfas in most cases has been superior to that obtained from the nonhardy sorts. Turkistan alfalfa, which is decidedly cold-resistant, has proved to be one of the most unsatisfactory varieties, both as regards productivity and survival. The rapid deterioration in stands of this alfalfa seems to be due in part to its susceptibility to leaf-spot disease under humid conditions. Since the hardy alfalfas yield less than the medium-hardy alfalfas, and since they have not shown a greater tendency to survive, they are not recommended for this section. From the data available it is evident that seed of common alfalfa from Kansas and Utah is as satisfactory as any alfalfa for the prairie limestone belt. Argentine alfalfa, seed of which is sometimes imported in considerable quantity, has given about as good yields as Kansas and Utah alfalfas.

TABLE 5.—*Annual and average yields of air-dry hay and estimated stand of several varieties and strains of alfalfa sown in the fall of 1925*

Variety or strain	Acre yield					Estimated stand in—	
	1926 [1]	1927	1928	1929	Average	Fall of 1929	Spring of 1930
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Percent*	*Percent*
Nonhardy group:							
Hairy Peruvian	1.20	3.61	2.08	3.21	2.52	30	4
Smooth Peruvian	1.13	3.44	1.94	3.26	2.44	44	7
Arizona Common	1.13	3.36	1.78	2.80	2.27	37	9
Spanish	1.06	2.67	1.59	2.57	1.97	54	4
Italian	1.20	3.84	2.13	3.60	2.69	60	13
South African	1.19	3.34	2.17	2.99	2.42	68	15
Medium-hardy group:							
Kansas Common	1.78	4.56	2.63	3.62	3.15	70	34
Utah Common	1.48	4.55	2.60	3.40	3.01	70	42
Argentine (Chubut)	1.51	4.39	2.71	3.05	3.06	65	37
Argentine	1.46	4.53	2.56	3.80	3.10	70	35
Dakota Common	1.23	3.47	2.17	3.33	2.55	79	20
Lebeau	1.09	3.57	2.37	3.00	2.53	70	10
Hardy group:							
Grimm	1.03	2.77	1.62	2.66	2.09	80	8
Ontario Variegated	1.00	2.85	1.66	3.03	2.13	72	15
Cossack	.99	3.31	2.21	3.03	2.38	72	10
Hardigan	.90	2.93	2.06	2.84	2.11	73	68
Turkistan	1.06	2.11	1.72	1.92	1.70	17	3

[1] First cutting not included.

TABLE 6.—*Annual and average yields of air-dry hay and estimated stand of several varieties and strains of alfalfa sown in the spring of 1927*

Variety or strain	Acre yield						Estimated stand in fall of 1931
	1927	1928 [1]	1929	1930 [2]	1931	Average	
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Percent*
Nonhardy group:							
Hairy Peruvian	1.83	1.44	3.02	0.71	2.21	1.85	15
Arizona Common	1.69	1.30	2.94	.79	2.35	1.81	27
Spanish	.84	.95	2.33	.56	2.07	1.35	30
Do	.87	.96	2.51	.57	2.23	1.43	30
Italian	1.14	1.43	3.15	.77	2.96	1.89	50
Medium-hardy group:							
Kansas Common	1.60	1.75	3.22	1.04	3.53	2.21	65
Utah Common	1.24	1.32	2.92	.95	2.96	1.88	57
Do	1.37	1.43	2.95	.94	2.86	1.91	60
Dakota Common	1.60	1.86	3.77	.98	3.71	2.40	55
Do	1.06	1.51	3.17	.94	3.42	2.02	52
Dakota No. 12	1.30	1.47	3.07	.84	3.18	1.97	58
Lebeau	1.22	1.45	3.05	.88	3.07	1.93	63
Hardy group:							
Grimm	1.07	1.16	2.90	.72	2.78	1.73	42
Do	1.02	1.24	2.91	.66	2.68	1.70	37
Ontario Variegated	1.19	1.47	2.69	.85	3.09	1.86	25
Cossack	1.24	1.63	3.45	.83	3.22	2.07	33
Turkistan	.87	1.16	2.39	.81	2.48	1.54	2

[1] Third cutting not included. [2] Low yields due to severe drought.

FERTILIZER EXPERIMENTS

In preliminary fertilizer tests the only appreciable increase in growth of alfalfa resulted on plots receiving stable manure or phosphorus (fig 3). Nitrogen and potash alone did not affect the growth materially, and when combined with phosphorus to make a complete fertilizer, increased the yield very little, if any, over phosphorus alone. This being the case, later experiments were designed to determine (1) the comparative value of manure and the three common sources of phosphorus—superphosphate, basic slag, and raw rock—alone and

FIGURE 3.—Harvesting a second cutting of alfalfa on the fertilizer plots.

in various combinations, (2) the most economical rates of application, and (3) the time and frequency of applying for best results.

The yields of hay from the fertilizer tests sown in 1926 and 1928 are given in tables 7 and 8, respectively. The basic slag used in the 1926 seeding was known as Duplex basic slag phosphate, the analysis tag showing 16 percent of available phosphoric acid. As this product is no longer manufactured, ground open-hearth basic slag was used in the later tests, applications being increased to correspond to 16 percent superphosphate.

TABLE 7.—*Annual and average acre yields of air-dry hay from fertilized plots of alfalfa, sown in the spring of 1926*

Fertilizer and rate of application	1926	1927	1928	1929	Average
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
No fertilizer	0.23	1.07	1.13	0.70	1.03
20 tons stable manure	.79	4.53	3.79	3.76	3.22
10 tons stable manure, 500 pounds superphosphate	.65	4.54	4.39	3.55	3.28
500 pounds superphosphate	.37	3.40	3.02	1.96	2.20
250 pounds superphosphate	.32	3.24	2.61	1.84	2.00
2 tons ground limestone	.40	2.63	1.62	1.29	1.49
1,000 pounds basic slag	.40	4.02	2.85	2.25	2.38

TABLE 8.—*Annual and average acre yields of air-dry alfalfa hay comparing the effect of manure and different sources of phosphorus alone and in combination, sown in the spring of 1928*

Fertilizer and rate of application	1928	1929	1930	1931	1932	Average
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
No fertilizer	0.90	1.89	0.99	2.16	2.23	1.63
20 tons stable manure	2.00	3.20	1.72	3.55	3.19	2.75
20 tons stable manure, 500 pounds superphosphate (16 percent)	2.63	3.25	1.91	3.95	3.78	2.98
20 tons stable manure, 250 pounds superphosphate	1.99	3.86	1.98	3.84	3.50	2.99
20 tons stable manure, 250 pounds superphosphate annually	2.19	3.65	1.92	4.07	3.72	3.11
20 tons stable manure, 500 pounds basic slag	2.19	3.84	1.89	4.21	3.77	3.18
20 tons stable manure, 1,000 pounds raw rock phosphate	2.07	3.62	1.82	3.71	3.27	2.90
10 tons stable manure	1.91	2.87	1.36	2.85	2.76	2.35
10 tons stable manure, 500 pounds superphosphate	1.93	3.26	1.48	3.60	3.30	2.73
10 tons stable manure, 250 pounds superphosphate	1.79	2.99	1.32	3.28	3.17	2.51
10 tons stable manure, 250 pounds superphosphate annually	1.71	3.18	1.32	3.78	3.40	2.68
10 tons stable manure, 500 pounds basic slag	1.75	3.10	1.34	3.37	3.20	2.56
10 tons stable manure, 1,000 pounds raw rock phosphate	1.44	2.60	1.15	2.59	2.72	2.10
1,000 pounds superphosphate	1.29	2.81	1.15	2.68	2.78	2.14
1,000 pounds basic slag	.83	2.60	1.09	2.50	2.70	1.94
1,000 pounds raw rock phosphate	.77	1.64	.88	1.89	1.95	1.43
500 pounds superphosphate (biennially)	1.05	1.94	1.17	3.09	2.79	2.01
500 pounds basic slag (biennially)	.63	1.44	.92	2.68	2.46	1.63
250 pounds superphosphate (annually)	1.17	2.37	1.44	3.29	2.85	2.22
250 pounds basic slag (annually)	.89	1.83	1.21	2.96	2.83	1.94

The applications of phosphates alone on the 1928 seedings were so planned that at the end of 4 years each plot would have received the equivalent of 1,000 pounds of superphosphate with the exception of the raw rock, which was applied in the beginning at the rate of 1,000 pounds per acre, no analysis of the available phosphoric acid being at hand. The low yields in 1928 from the spring seeding of that year are due to the fact that the plants had not had an opportunity to become well established, and the low yields in 1930 are due to a drought so severe that little hay was obtained from the second cutting. In both of these tests the highest average yields were obtained from the plot receiving stable manure in combination with 16 percent superphosphate or basic slag, though the combination usually has had only a slight advantage over the same amount of manure applied alone.

Basic slag and 16 percent superphosphate alone increased the yields to some extent, but the raw rock phosphate apparently had noe ffect. Annual applications of 16 percent superphosphate at the rate of 250 pounds per acre seemed to have some advantage over double this amount applied every other year, though the increase may not always justify the additional labor involved. That the beneficial effects from fertilizer applications carry over to subsequent crops is shown by the yields of corn given in the following tabulation. In this test the highest yields of corn were obtained from the plots that produced the greatest tonnage of alfalfa.

Acre rates and kind of fertilizer applied to alfalfa:	*Yield per acre (bushels)*
No fertilizer	29.98
20 tons stable manure	43.42
10 tons stable manure and 500 pounds superphosphate	45.32
500 pounds superphosphate	38.69
250 pounds superphosphate	38.07
2 tons ground limestone	29.76
1,000 pounds basic slag	35.99

GREEN-MANURING EXPERIMENT

Since previous tests had shown the beneficial effects on alfalfa from liberal applications of barnyard manure, an experiment was inaugurated to determine whether green manures would serve a similar purpose. Table 9 gives the yields of alfalfa obtained after plowing under soybeans, velvetbeans, and cowpeas. Unfortunately, this test did not include an untreated check plot, but by comparing the yields obtained from the checks in table 8, covering the same period, it is quite evident that the green manures were responsible for an appreciable increase in production of alfalfa. The differences in yields following the various legumes are not significant.

TABLE 9.—*Annual and average acre yields of air-dry alfalfa hay, showing effects of annual legumes turned under as green manure before seeding to alfalfa*

[Sown in September 1927]

Crop used as green manure	1928	1929	1930	1931	1932	Average
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Biloxi soybeans	2.27	4.03	1.12	4.00	3.56	3.00
Laredo soybeans	2.22	3.98	1.42	3.70	3.18	2.90
Otootan soybeans	2.17	4.00	1.23	3.65	3.38	2.89
Velvetbeans	2.37	4.12	1.33	3.67	3.30	2.96
Brabham cowpeas [1]	2.75	4.21	1.48	3.97	3.39	3.16

[1] The plots on which Brabham cowpeas were used as green manure had an application of 500 pounds of superphosphate per acre at time of seeding.

DATE OF SEEDING

For the purpose of obtaining specific information on the best seeding date, alfalfa has been sown at various times in the fall and spring each year since the experimental work was started in 1925. These tests have shown rather conclusively that with favorable moisture conditions fall seedings are preferable, as weeds are less troublesome and better yields are obtained the following season than when seeding is delayed until early spring. Unfortunately, the moisture is often so deficient in the fall that it becomes necessary to postpone seeding until spring. Fall seedings may be made any time between September 1 and October 15, when sufficient moisture is available to insure germination of the seeds. Soybeans leave the land in excellent condition for fall seedings, and the roots and stubble tend to protect the young alfalfa and to check erosion. Short-season varieties of soybeans will mature seed in time to permit fall seeding of alfalfa, but the late-maturing varieties should be harvested for hay when the crop is to be followed by fall-sown alfalfa. Land on which soybeans have been grown is easily prepared for alfalfa by disking and harrowing. Cotton picking is seldom completed early enough to permit proper preparation of the land for fall seeding. Unfortunately, the moisture is often so deficient in the fall that it becomes necessary to postpone seeding until spring. Cotton land that has been well cultivated is usually easily prepared for spring seedings, which should be made as soon after March 1 as the land can be worked. Weeds are usually a more serious factor in spring seedings, especially in late spring seedings, as they frequently choke out many of the young plants before they have become established.

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STAGE OF CUTTING

A test was outlined to determine the effect of cutting at various stages of growth upon the yields and survival of alfalfa, the results being given in table 10. Under humid conditions the alfalfa blooms so sparingly that it is frequently difficult to determine the stage of growth by the percentage of bloom. In this experiment, therefore, when the conditions were unfavorable to the development of flowers, the alfalfa has been cut at intervals which are believed to approximate the stages indicated in the table and varying from 3 weeks for the bud to 8 weeks for the seed-pod stage. The relatively thin stands of all the plots, as shown in the table, are due to the fact that they were 6 years old when these estimates were made and the only fertilizer treatment had been the application of 500 pounds of 16 percent superphosphate in the spring of 1929. The data show conclusively that cutting at an early stage has resulted in a reduced tonnage and rapid deterioration of stands. Cuttings made after the seed pods have formed, while not noticeably injurious to the stand, have resulted in a poor quality of hay and have been conducive to the growth of annual weeds. The long period between cuttings has given many of the weeds an opportunity to mature seed and thereby to increase in number from year to year. The less frequent cuttings also have tended to encourage Johnson grass. From the results of this test it appears that the most desirable stage of cutting alfalfa is when the plants are one half in bloom to full bloom, or, in the absence of flowers, when the basal shoots are well started.

TABLE 10.—*Average and annual acre yields of air-dry hay and estimated stand of alfalfa cut at various stages of growth*

Stage of cutting	1927	1928	1929	1930	1931	Average	Stand in fall of 1931
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Percent*
Bud stage	1.89	1.63	1.01	0.58	1.26	1.30	23
1/10 bloom	2.09	1.87	2.20	.92	1.85	1.80	43
1/2 bloom	2.28	1.91	2.56	1.33	2.11	2.04	45
Full bloom	2.59	1.96	2.60	1.20	1.07	2.06	38
Seed pods formed	1.91	2.04	2.39	1.01	1.05	1.86	68
First cutting, bud stage; other cuttings, full bloom	2.74	1.82	2.76	1.03	1.08	2.01	23

CULTIVATION

A test to determine the effect of cultivation on yields and survival of alfalfa has been in progress 5 years. These plots were not fertilized until 1929, when they received 16 percent superphosphate at the rate of 500 pounds per acre. As originally planned, this experiment included an early spring cultivation, but due to the frequent rains at this time of the year and the tendency of the soil to dry slowly, it has been necessary to delay cultivation until after the first cutting. As shown in table 11, cultivation has not increased the yields of hay, though weeds have been less abundant in the cultivated plots, especially in the late cuttings. None of the treatments appears to have injured the alfalfa. The most desirable implement for cultivating alfalfa is the so-called alfalfa harrow, which is a modified form of the spring-tooth harrow. The disk harrow has a tendency to split the crowns and thus open the way for the entrance of various diseases. Cultivation of alfalfa is not advised until the plants are at least 1 year old.

TABLE 11.—*Annual and average acre yields of air-dry hay and estimated stand of uncultivated and cultivated plots of alfalfa*

Treatment	1927	1928	1929	1930	1931	Average	Stand in fall of 1931
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Percent*
Uncultivated	2.85	1.09	2.71	0.77	1.94	1.99	38
Disked after first cutting	2.04	1.61	2.56	.77	1.98	1.91	43
Spring-tooth harrow after first cutting	2.65	1.52	2.04	.77	2.10	1.94	53
Disked after each cutting	2.64	1.21	2.59	.72	2.44	1.92	68
Spring-tooth harrow after each cutting	2.69	1.27	2.62	.73	2.66	1.98	59

PROTEIN CONTENT OF ALFALFA VARIETIES

The protein content of each cutting of several varieties of alfalfa was determined during the season of 1929, the results being given in table 12. All alfalfas were harvested on the same date, when Kansas and Utah alfalfas had reached the stage of growth generally recommended for cutting. The slightly lower protein content of the rapid-growing alfalfas, such as Spanish, Arizona Common, and Hairy Peruvian, is doubtless due to the fact that they were more mature when harvested. The protein content of Grimm and Cossack alfalfa was somewhat higher than that of other alfalfas, probably because they recovered slowly after cutting and were therefore less mature.

TABLE 12.—*Protein content on a dry basis of different cuttings of alfalfa varieties in 1929* [1]

Variety or strain	First cutting	Second cutting	Third cutting	Fourth cutting	Average
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Italian	20.28	19.46	19.90	21.97	20.40
Spanish	21.38	18.68	20.27	19.35	19.92
Lebeau	20.65	19.49	21.96	22.69	21.20
Utah Common	21.74	19.90	21.31	23.03	21.65
Arizona Common	18.92	18.45	19.99	22.42	19.87
Turkistan	19.52	21.01	20.66	22.62	20.95
Ontario Variegated	22.13	20.30	20.71	23.06	21.65
Kansas Common	20.25	19.19	20.85	22.83	20.78
Hairy Peruvian	19.06	18.47	19.50	20.91	19.51
Dakota Common	20.51	19.55	21.81	22.02	20.97
Grimm	22.48	20.70	22.87	25.99	23.01
Cossack	21.17	20.82	22.23	25.53	22.44
Dakota No. 12	21.71	20.30	22.30	24.31	22.18

[1] Analyses made by W. F. Hand, Mississippi Agricultural Experiment Station.

DISEASES

Bacterial wilt (*Phytomonas insidiosum* (McC.) Bergey et al.) has not been observed in the experimental plots near West Point, but has been found in fields near Muldon and Shannon, Miss., though apparently not very serious. Fusarium wilt (*Fusarium oxysporum medicaginis* Weimer) was discovered in the experimental plots in 1926, but the disease does not appear to have increased rapidly, nor has it been particularly destructive. Crown wart (*Urophlyctis alfalfae* (Lagh.) Magn.) has been observed in several fields, but apparently it is not doing much damage. The presence of the disease is indicated by the warty growth around the crown of the alfalfa plant in early spring, usually disappearing by the middle of June. Where the disease is abundant it is advisable to rotate with other crops.

INSECTS

Of the several insects that injure alfalfa, the damage caused by the 3-cornered leaf hopper (*Stictocephala festina* Say) is generally most noticeable, being in evidence as a yellowing of the tops which results from a girdling of the stems by the insects. This type of damage is usually more prevalent in dry seasons. Measurement of girdled and ungirdled stems showed a difference in height of 20 percent in favor of the latter. As a rule, damage done by the insect is not sufficient to justify control measures.

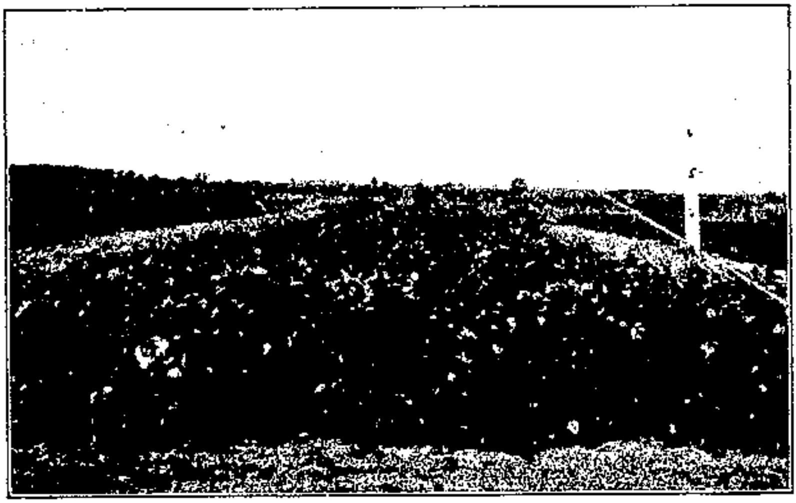

FIGURE 4.—Otootan soybeans in 3½-foot rows.

OTHER CROPS TESTED

SOYBEANS

The work with soybeans has included (1) comparative trials of some of the more common varieties for hay and seed production, (2) testing new introductions or selections, (3) inoculation and fertilizer experiments. Table 13 presents a 6-year summary of the air-dry hay yields of several varieties and selections sown broadcast and in rows and of seed yields from row plantings.

The Otootan (figs. 4 and 5), Laredo, Biloxi, and Mammoth Yellow are the varieties most commonly grown in this section. Otootan and Laredo are much finer stemmed than Biloxi or Mammoth Yellow and are therefore better suited for hay production. Laredo is grown more generally than Otootan, as it produces more seed, matures about 1 month earlier, and the seed is cheaper. Otootan yields somewhat more hay than Laredo, but usually it is not ready for harvest until early in October, when difficulty is often encountered in curing, due to the short days and less favorable weather. Mammoth Yellow and Biloxi are erect and so coarse that considerable loss results in feeding the hay. They are therefore used for grazing or soil improvement, either sown alone or in combination with corn or sorghum. Mammoth Yellow is ready for grazing or hay considerably earlier than Biloxi.

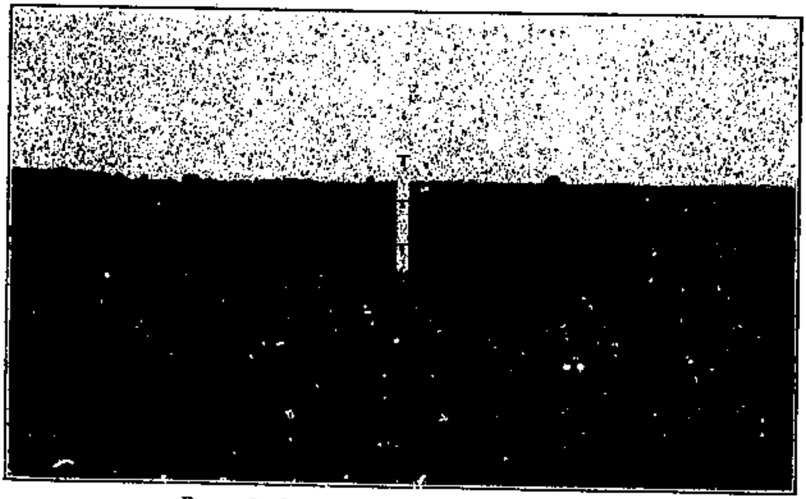

FIGURE 5.—Otootan soybeans sown broadcast for hay.

TABLE 13.—*Average acre hay and seed yield of varieties and selections of soybeans*

Variety	Air-dry hay: Seeded broadcast	Air-dry hay: Seeded in 3.3-foot rows	Seed from 3.3-foot rows
	Tons	*Tons*	*Bushels*
Otootan [1]	2.81	3.03	11.78
Laredo [2]	2.32	2.75	13.93
Mammoth Yellow [1]	1.60	2.30	13.90
George Washington [1]	1.81	------	11.53
Pine Dell Perfection [2]	1.68	------	11.43
Biloxi [2]	1.07	1.45	11.34
Selection no. 04886 [1]	2.13	1.65	13.80
Selection no. 04888-A [1]	1.80	1.14	12.47
F.P.I. selection no. 36900-A-7-11 [1]	1.77	1.22	15.13
F.P.I. selection no. 60175-F [1]	1.76	1.24	16.05
F.P.I. no. 60247 [2]	2.31	1.78	11.74

Variety	Air-dry hay: Seeded broadcast	Air-dry hay: Seeded in 3.3-foot rows	Seed from 3.3-foot rows
	Tons	*Tons*	*Bushels*
F.P.I. no. 60274 [1]	1.29	1.51	11.56
F.P.I. no. 60275 [1]	------	------	12.78
F.P.I. no. 60209 [1]	------	------	12.83
F.P.I. no. 62838 [1]	2.74	1.47	13.70
F.P.I. no. 62842 [1]	------	1.42	11.13
F.P.I. no. 62846 [3]	------	------	10.17
F.P.I. no. 71595 [3]	------	1.70	11.64
F.P.I. no. 71605 [3]	------	1.53	15.15
F.P.I. no. 71038 [3]	------	------	10.82
F.P.I. no. 71064 [3]	------	1.08	18.13
F.P.I. no. 71702 [3]	------	------	18.70
Selection no. 05458-1 [1]	1.63	1.67	11.10

[1] 5-year average. [2] 6-year average. [3] 4-year average.

The highest-yielding varieties of soybeans have not produced quite as much hay as the best alfalfas, and the cost of seeding broadcast or in close drills has been about the same. And since alfalfa produces satisfactorily for 4 years it is a more economical hay crop. Some of the limestone soils are not suited to alfalfa but do grow soybeans satisfactorily, giving a greater tonnage of hay of a higher feeding value than is obtained from three cuttings of Johnson grass, which is the crop commonly grown on such lands. In this section the best yields of hay and seed have been obtained from plantings made during April and May. June plantings generally are less productive, and July plantings are apt to be injured by cold weather before maturing. Plantings made in March, while usually successful, mature little if any sooner, nor are they any more productive than those made in April and May. They require more cultivation to keep the weeds, especially Johnson grass, under control.

Inoculation tests conducted during the season of 1926 showed no advantage from the use of cultures either in yield of hay or in number of nodules. Applications of 16 percent superphosphate at the rate of 300 pounds per acre in 1926 did not increase the yields of hay. However, this test was conducted on very productive soil where the air-dry hay from both fertilized and unfertilized plots amounted to more than 4 tons per acre.

Insects that at times cause considerable damage to soybeans are the corn earworm, the velvetbean caterpillar, the southern grass worm, grasshoppers, and blister beetles.

The only disease of any consequence has been the stem rot (*Sclerotium rolfsii* Sacc.), and no serious damage has been done by it, although the increase in the number of plants affected by the disease is noticeable where the soybeans have been grown continuously for a period of years. The disease may be controlled by practicing systematic crop rotation.

SOYBEANS AND CORN

Soybeans have been planted in various combinations with corn, the total yield per acre in each case being about the same. In all of the tests the yields of corn have been decreased by planting with soybeans, although the mixture is more valuable for feeding because of the high protein content of the soybeans. Moreover, the soybeans have a beneficial effect on the soil. Comparative yields of soybean hay and the grain yields of corn when grown alone and in combination are given in table 14. The production of corn stover has not been taken into account in these tests, but a considerable amount of valuable roughage is available from this source.

TABLE 14.—*Average acre yields of soybean hay and corn grown alone and in combination in rows 3.3 feet apart*

Method of planting	Air-dry soybean hay	Corn	Method of planting	Air-dry soybean hay	Corn
	Tons	*Bu.*		*Tons*	*Bu.*
Otootan soybeans alone [1]	2.25	------	Corn alone [1]	------	23.60
Otootan soybeans and corn [1]	1.36	16.68	Otootan soybeans and corn in alternate rows [2]	1.12	14.33
Laredo soybeans alone [1]	2.47	------	Laredo soybeans and corn in alternate rows [2]	1.06	13.39
Laredo soybeans and corn [1]	1.37	13.10	Biloxi soybeans and corn in alternate rows [2]	.41	16.55
Biloxi soybeans alone [2]	1.63	------	Mammoth Yellow soybeans alone [2]	.30	12.74
Biloxi soybeans and corn [2]	.79	17.96			
Mammoth Yellow soybeans alone [3]	1.28	------			
Mammoth Yellow soybeans and corn [3]	.48	12.98			

[1] 6-year average. [2] 5-year average. [3] 4-year average.

SORGHUMS

Sorghums are grown for hay, fodder, silage, and grain production and to a much less extent for the production of sirup. Grain sorghums do not appear promising for this section because of frequent injury by the sorghum midge and the favorable moisture conditions which usually insure better yields of grain from corn. During the 6 years of the test, grain sorghums produced sufficient seed for replanting in only one season, 1930. The low yields were due largely to the sorghum midge, which is most destructive during rainy seasons. Schrock and

FIGURE 6.—Honey sorgo.

Darso are the most promising varieties of grain sorghums. In forage production the sorgos, or sweet sorghums, have done well, the better strains producing a greater tonnage than corn. Honey sorgo (fig. 6), a late variety, has given the heaviest yields, but some of the earlier varieties, such as Sumac and Red Amber, while less productive, are easier to harvest. The Gooseneck sorgo is objectionable because of its tendency to lodge. Forage yields obtained from the varieties under test are shown in table 15.

TABLE 15.—*Annual and average acre yields of green and air-dry forage of several varieties of grain sorghum and of sorgo*

Variety	Green forage								Air-dry forage							
	1926	1927	1928	1929	1930	1931	Average		1926	1927	1928	1929	1930	1931	Average	
							1929–31	1926–31							1929–31	1926–31
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Schrock	5.78	7.50	4.06	6.01	9.03	12.54	9.19	7.50	2.60	3.21	1.91	2.70	2.78	3.39	2.96	2.78
Sagrain	6.47	7.30	4.35	5.48	9.35	11.73	8.85	7.40	2.84	3.21	1.97	2.52	2.98	4.09	3.20	2.94
Darso	----	----	----	5.38	5.20	10.73	7.10	----	----	----	----	2.57	2.53	3.33	2.81	----
Hegari	----	----	----	5.70	15.56	14.10	11.79	----	----	----	----	2.45	4.68	6.35	4.40	----
Straightneck milo	----	----	----	5.78	8.11	13.01	8.07	----	----	----	----	2.55	2.52	4.91	3.33	----
Blackhull kafir	----	----	----	5.07	9.20	11.56	8.61	----	----	----	----	2.17	2.55	4.01	3.11	----
Spur feterita	----	----	----	4.47	7.30	9.74	7.17	----	----	----	----	1.88	1.73	3.68	2.43	----
Orohoma	----	----	----	----	----	10.98	----	----	----	----	----	----	----	3.00	----	----
Red Amber	----	----	----	----	13.19	10.60	----	----	----	----	----	----	3.70	4.78	----	----
African millet	----	----	----	8.20	16.23	17.04	14.02	----	----	----	----	3.69	7.01	8.00	6.23	----
Sumac	7.89	8.20	5.65	8.38	12.65	10.21	13.41	10.33	3.53	3.33	2.99	4.61	3.27	6.79	4.69	4.04
Kansas Orange	8.70	8.65	5.40	10.47	12.66	10.44	14.19	10.90	4.64	4.04	2.85	4.60	5.18	8.95	6.24	5.04
Atlas	----	----	----	8.96	15.25	19.58	14.60	----	----	----	----	4.44	6.59	9.20	6.74	----
Sacaline	----	----	----	10.80	17.03	16.85	14.01	----	----	----	----	5.20	7.24	9.50	7.34	----
Honey	15.87	13.68	8.67	11.48	23.38	32.42	22.43	17.58	7.28	6.17	5.96	6.10	8.93	10.65	10.56	8.52
Gooseneck	----	----	----	----	----	25.61	----	----	----	----	----	----	----	13.21	----	----

JOHNSON GRASS

Johnson grass is the leading hay plant on the prairie limestone soils, and since so much of the hay contains mature seed there is comparatively little land on which Johnson grass is not a troublesome weed in cultivated crops. As the grass is widely distributed and has a high feeding value, information is needed regarding the methods of handling the crop to obtain the greatest possible revenue. Accordingly, tests have been conducted at this station for several years to determine the most desirable stage of harvesting the grass for hay and the cultural treatments essential to the largest yields. The plots have been cut at three stages of growth as follows: (1) Before bloom, (2) at bloom, and (3) after seed has matured. In these tests the yields have been slightly more from the grass which has formed seed before it was cut, but the quality of the hay was inferior. Such hay not only commands a lower price on the market but, because of its maturity, considerable waste results in feeding. Furthermore, manure carrying mature seed when spread on cultivated land tends to increase the weed problem. The yields obtained from Johnson grass harvested just before bloom and in full bloom have not differed appreciably, although the hay cut before blooming has been of a higher quality, and there is less waste in feeding. All results indicate that for the best quality of hay, Johnson grass should be harvested just before blooming, or, since Johnson grass blooms irregularly, as soon as a few scattering plants begin to bloom.

In the study of meadow management it has been rather definitely established that some kind of tillage is necessary to increase the vigor of Johnson grass and check the growth of wiregrass, which is especially troublesome on these soils. While the results of cultural treatments are not conclusive, uncultivated plots have contained over 50 percent of wiregrass in the earlier cuttings. Shallow plowing or heavy disking every 3 years has been of material assistance in improving the yield and quality of hay.

SUDAN GRASS

As indicated by preliminary tests, results of which are given in table 16, Sudan grass can often be used to advantage as an emergency hay and pasture crop where Johnson grass is not already well established.

TABLE 16.—*Annual and average acre yields of air-dry Sudan grass from rows and broadcast seedings*

Method of planting	1926	1927	1928	Average	
				1927–28	1926–28
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
Broadcast	1.84	3.19	1.46	2.33	2.16
3.3-foot rows	2.41	2.48	1.25	1.87	2.05
1.65-foot rows		2.93	1.51	2.22	

LESPEDEZA

In addition to common lespedeza (*Lespedeza striata*), two other annual lespedezas, Korean (*L. stipulacea*) and Kobe (*L. striata*), have been grown several years. Kobe lespedeza resembles the common sort in general appearance but has longer leaves and is more vigorous. Korean lespedeza is earlier maturing, coarser, and has broader and larger leaves than the common species. These annual lespedezas are not satisfactory hay crops on the heavy limestone soils, but may have a place in pasture mixtures. During the dry summer of 1930, Korean and Kobe lespedezas proved more drought resistant than common lespedeza. *L. sericea*, a perennial form, was sown in the spring of 1926 and the plants still survive. This lespedeza makes a growth of 6 to 8 inches the first season and 2½ to 3 feet subsequent seasons but does not appear promising on this soil. The seed has matured late in the season and very little volunteering has been observed. Both the annual and perennial forms would doubtless give more satisfactory results on the lighter-textured soils.

VELVETBEANS

Velvetbeans can be grown successfully in this section, and they afford valuable grazing during the late fall and early winter months. The bush or bunch and vine varieties have been tested over a period of 4 years. While the results have not been tabulated, observations indicate that the vining varieties are the most desirable. The pods of the bush velvetbean usually form on or near the ground and therefore are often damaged by rain before maturity. The vining varieties are usually grown in combination with corn (fig. 7), and as they are difficult to harvest they are usually grazed. As a seed crop velvetbeans offer no serious competition with other legumes, as they must be hand-picked and are difficult to thresh because of the hard seed pod.

SWEETCLOVER

The work with sweetclover has been confined largely to nursery seedings. Twenty varieties and strains have been tested, but none appear superior to the ordinary biennial white variety. Good results have been obtained from seedings made in early spring in winter oats, the oats being harvested for grain or hay, after which two crops of sweetclover hay are secured the first season. The following year the sweetclover is turned under when in full bloom as a soil-improvement crop. The biennial yellow strains of sweetclover being fine stemmed produce a better quality of hay, but the biennial white sweetclover is more vigorous and more desirable for general use. Tests are under way to determine the comparative value of these two types for pasture and green manuring.

CROTALARIAS

Nursery plantings have been made of most of the species of *Crotalaria* and indications are that they are less dependable for soil improvement than soybeans. Since there is a serious doubt as to their palatability

FIGURE 7.—Velvetbeans in corn.

for stock feed, there is no good reason for growing them on a soil where clovers, alfalfa, and soybeans are adapted.

PIGEONPEAS

More than 200 strains of pigeonpeas have been tested, but none has shown any special merit. The behavior of the different strains varies from year to year, and the time of maturity is also uncertain. Those tested cannot compete with soybeans in this section

WINTER LEGUMES

For several years tests have been conducted to determine the adaptability of certain winter legumes as cover crops and for soil improvement. Of the legumes tested, Austrian winter peas and hairy vetch have proved most dependable. Crimson clover is fairly satisfactory if sown early. Hungarian vetch is hardy but has been much less productive than hairy vetch. Monantha vetch grows rapidly in the early fall but has failed to survive even the mild winters. The so-called "Canadian winter peas" have not proved hardy. Difficulty has been experienced in obtaining uniform stands of bur-clover, and the growth has not been heavy. Tests are now under way to determine the comparative value of rye, crimson clover, hairy vetch, and Austrian winter peas as cover crops. Unfortunately, few of the winter legumes make growth sufficiently early to plow under for cotton, though they may be satisfactorily followed with corn, and have increased the yields of grain at the rate of 12 bushels per acre. Winter legumes should be sown in September or October, otherwise they may not become sufficiently established to survive the normal winters.

CORN

The corn variety test has been carried on for 5 years to determine the most desirable variety for general use. This experiment has been conducted continuously on a plot of fairly uniform soil without fertilizers, which is the usual method of growing corn in this locality. Early and late varieties have been planted at the same time and treated similarly. The yields for each variety, as given in table 17, are based on the actual weights and shelling percentages, as determined by sampling at the time the weights were taken. It will be noted that these yields are low as compared with yields following alfalfa (p. 8), especially on those plots that had previously been fertilized, indicating the need for fertilizers in growing corn on these soils.

TABLE 17.—*Average and annual acre yields of grain of several varieties of corn*

Variety	1927	1928	1929	1930	1931	Average
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Mosby's Station	29.90	15.19	21.65	18.86	11.52	19.42
Hasting's Prolific	31.69	16.65	23.43	22.04	16.17	21.98
Delta Prolific	29.11	18.30	28.31	21.50	17.01	22.97
Paymaster	24.60	18.45	24.95	20.74	11.00	19.97
Tennessee Red Cob					11.18	
Mexican June	31.79	21.97	27.36	23.53	17.29	24.39
Laguna	30.45	23.72	20.15	22.86	17.91	24.22
Goliad	28.54	20.72	22.37	27.45	15.75	22.97
Cocke's Prolific	30.24	17.57	25.29	23.30		24.12

WINTER CEREALS

The tests with winter cereals have included several strains or varieties of oats, barley, wheat, and rye to determine their value for grain and as winter cover crops. None of the oats or barleys tested has proved entirely winter-hardy. During 2 of the 6 winters all varieties winter-killed practically 100 percent. The oats tested included Fulghum, Red Rustproof, and Hastings 100 Bushel. Rye and wheat have withstood all winter conditions for the past 6 years, and while the yields of grain have not been sufficient to justify sowing for this purpose alone, these crops appear to have value as a winter cover, alone and in combination with winter legumes. Abruzzi rye and Fulcaster wheat appear best adapted to general use. French and South Georgia rye are almost as satisfactory as Abruzzi rye for winter-cover purposes. Rosen rye does not make as early a growth as is desired for turning under for cotton.

SUMMARY

The forage-crop field experiments near West Point, Miss., have been carried on in cooperation with the Mississippi Agricultural College and Experiment Station and were established primarily to determine causes of so-called "alfalfa failures" and if possible to find remedial measures.

The experiments are located on Houston or closely related soils.

The average annual rainfall over a period of 33 years amounted to 54.06 inches at Columbus, Miss., the nearest weather station with a continuous record.

The alfalfa acreage of the limestone prairie belt of Mississippi and Alabama increased more than 70 percent from 1909 to 1919 and decreased more than 77 percent from 1919 to 1924. The acreage since that time has remained fairly constant.

Strains of common alfalfa from Kansas, Utah, and the Dakotas have proved most satisfactory for this section. Alfalfas of the hardy group do not produce as much hay, and those of the nonhardy group are not sufficiently cold-resistant.

The best yields of alfalfa have been obtained from applications of stable manure alone or in combination with phosphatic fertilizers. Superphosphate and basic slag alone have also increased yields. Nitrogen and potash have not appeared to affect the growth.

Increased yields of corn have been obtained following alfalfa fertilized with phosphatic fertilizers and stable manures.

Alfalfa can be seeded either in spring or fall. Seeding should not be made later than April 15 in the spring or October 15 in the fall.

Too-frequent cutting has injured the stands of alfalfa. The safest stage of cutting in this section is when the new basal shoots appear.

Cultivation of alfalfa has not proved economically profitable, though no injury to the stands occurs when cultivated with a spring-tooth harrow with a modified type of tooth. The later cuttings contain less weeds.

No serious diseases are prevalent, but a few fields have been found to be affected with bacterial wilt, Fusarium wilt, and crown wart. Insect damage has been slight, the most common insect attacking alfalfa being the 3-cornered alfalfa leaf hopper.

Soybeans are well adapted to the prairie limestone belt and should be grown on areas not adapted to alfalfa. They are not so profitable as alfalfa for hay on the better types of limestone soil. Combinations of corn and soybeans have resulted in lower yields of corn, but they enable the grower to raise more feed on the same area.

The sorgos (sweet sorghums) are much more desirable than grain sorghums for forage.

Johnson grass should be cut for hay just before blooming or as soon as the first few blooms appear. Heavy disking or shallow plowing of the sod every 3 years increases the productivity.

Sudan grass sown broadcast is a good emergency hay crop where Johnson grass has not gained a foothold.

Sweetclover is adapted to about the same soils as alfalfa and will produce satisfactorily on soils of lower fertility.

Crotalarias, pigeonpeas, and velvetbeans are not so desirable as soybeans for annual summer legumes. Lespedezas do not make sufficient growth for hay on the heaviest soils.

Hairy vetch and Austrian winter peas are the two most promising winter legumes used.

Results of corn variety tests on land of medium fertility without fertilizer show very low yields.

Winter wheat and rye are useful as winter cover crops, alone or in combination with legumes. No dependable winter-hardy varieties of oats and barley have been found.

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