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Alfalfa in Alabama.

By

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ALFALFA IN ALABAMA.

BY J. F. DUGGAR.

The present bulletin combines the results of experiments made by this station and the experience of a number of farmers who have begun to grow alfalfa in different parts of the State, as kindly furnished in correspondence with the writer. This is intended as a preliminary report. Extensive experiments on alfalfa in co-operation with the United States Department of Agriculture were undertaken by this station during the fall of 1903. It is the expectation to present those results, and others, in a future publication.

Alfalfa, or lucern, (*Medicago sativa*), belongs to the family of plants that normally bear enlargements or tubercles on their roots, through which these plants are able to take the introgen of the air. Alfalfa is a perennial, living for many years without reseeding. Great numbers of buds put out from the old root each year as soon as the coldest portion of the winter is past.

During the first few months of its life alfalfa may be regarded as a tender plant, both as regards cold and drought. After it has passed through its first summer, alfalfa is extremely resistant both to cold and to drought.

The name lucern, which also is properly applied to alfalfa, has led some men, unfamiliar with alfalfa and acquainted with sweet clover or melilotus, sometimes incorrectly called lucern, to confuse the two plants. These

are much alike when young. Alfalfa is a much smaller, fine stemmed plant, having purple blossoms and a coiled seed pod.

Alfalfa has, for many centuries, been an important plant, especially in the warmer portions of Europe. Above all other crops alfalfa may be credited with the foremost place in the development of the arid regions of the United States. 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 live stock industry will be based.

USES.

Alfalfa is useful for hay making, for feeding green (or soiling), for pasturage, and for the fertilization of the soil. Its most important use is as a hay plant. Alfalfa yields more hay per acre than any other leguminous forage plant. Indeed, in yield it has few superiors, sorghum perhaps being the only one of importance in Alabama, and this falling far behind alfalfa in nutritive value. Alfalfa hay is much more nearly a complete food than is the hay of Johnson grass, sorghum, crab grass, etc.

The following table gives the composition of green and cured alfalfa, and for comparison the composition of certain other forage plants, the chemical data being taken from Henry's "Feeds and Feeding" and from McBryde's tables:

Pounds of food material in 100 pounds of forage.

	Protein or muscle- formers.	Starch, sugar, etc.	Fat, wax, etc.	Woody fiber.	Ash.	Water.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Alfalfa hay	14	43	2	25	7	9
Cow pea hay	17	42	2	20	8	11
Johnson grass hay	7	46	2	29	6	10
Crab grass hay	7.8	45	2	28	8	9.2
Cured corn blades	6	36	1	22	5	30
Sorghum hay (verydry.)	4	37	3	24	4	28
Green alfalfa	5	12	1	7	3	72
Green rye	2.6	7	.6	12	2	75.8

The nutrients of most value are those in the first three columns. An *average* quality of cowpea and of sorghum hay is believed to be a little poorer, and corn blades (fodder) a little richer, than shown by the figures in the table.

From the above table it will be seen that alfalfa is about as rich as other hays and corn blades in starchy materials and sugar, and about twice as rich in muscle-forming material. Alfalfa hay is about equal in composition to the best grades of cow pea hay, but is not so coarse. Alfalfa hay is suitable for horses, cattle of all ages, and sheep. It is sometimes used in the Southwest as the exclusive food for farm teams, but it is generally advisable for working animals to have some corn in addition to alfalfa. However, the use of alfalfa hay greatly reduces the amount of corn necessary to keep working

teams in condition. For six weeks last summer Capt. J. C. Webb, of Demopolis, Ala., fed all the mules on one of his plantations on alfalfa alone. Although they were at work they kept in satisfactory condition. Alfalfa hay has also been successfully used as part of the winter ration for hogs. Alfalfa hay is similar to melilotus hay in composition, but much more palatable. It is less coarse, makes a better appearance, and, unlike melilotus hay, it is salable.

As a soiling plant, alfalfa may be utilized throughout every portion of Alabama, since the small area needed for this purpose will enable the soil to be suitably manured or limed or otherwise brought into condition for its successful growth. The especial advantage of alfalfa for soiling is the early date at which it is available, rye being the only other practicable crop which may be cut as early in the season. Alfalfa remains green throughout the year except in December, January, and February. In Central Alabama, alfalfa has been cut for food for horses as early as March 11. In nutritive qualities, green alfalfa is decidedly superior to green rye, and is eaten with relish by all farm stock and poultry.

Alfalfa is sometimes used as a pasture plant on soils to which it is well adapted, but is too valuable for hay or soiling to justify its general use for pasturage, until the acreage in alfalfa is greater than is needed for hay making and soiling. Pasturage shortens the life of the alfalfa plant by enabling weeds to outgrow it, and by packing the soil too closely around the crown and roots, and also by the injury resulting from very close continuous grazing. Stock should never run on an alfalfa field when the ground is wet or frozen, nor during the first year after the seed are sown. Cattle and sheep are subject to bloat when grazing on alfalfa. It is safer in this respect for horses, and perfectly safe for hogs. No one

can afford to graze cattle or sheep on alfalfa unless thoroughly informed in regard to all possible precautions for decreasing the amount of bloat and unless he has a surplus of alfalfa over and above that which he can use for hay and soiling. The principal precautions against bloat are (1) feeding dry food before cattle or sheep are first turned on alfalfa; (2) gradually lengthening the daily grazing period; (3) allowing stock grazing on alfalfa to have access at the same time to a pasture containing palatable grass.

Alfalfa makes an unrivaled pasture for hogs. One may conservatively estimate an acre of good alfalfa pasture as capable of supporting a sufficient number of hogs to weigh at least 1,000 pounds. This record has been greatly exceeded. F. D. Coburn says: "Ten young hogs per acre will not damage alfalfa, and should make 1,000 pounds of gain in a season, under ordinary conditions, without grain." While hogs make satisfactory and economical growth on green alfalfa alone, they more completely utilize this crop when a little corn is fed. Alfalfa used as a hog pasture, should be mowed whenever it becomes tall or coarse, to promote fresh tender growth. Rings in the hogs' noses are advisable to prevent destruction of alfalfa pastures by rooting. The young shoots on alfalfa remain green practically all winter in central Alabama.

Alfalfa has been made into silage with varying success. In our climate where we have frequent rains, the silo might prove a profitable means of utilizing cuttings of alfalfa too much injured by rains to make good hay, but still succulent.

In Alabama alfalfa should be used for soil-improvement only after it has outlived its usefulness as a food plant. Alfalfa greatly enriches the soil in nitrogen gathered from the air.

YIELDS OF ALFALFA HAY.

The following estimates of their yields of alfalfa hay obtained are reported in correspondence by the parties named below:

Total no. tons, per acre.	No. cuttings.	Reported by	County.	Date 1st cutting.
3 unmanured	4 to 7	J. C. Webb.....	Marengo.....	
5 to 6 manured	4 to 5	J. I. Thornton.....	Greene.....	May 1.
4 to 5				
1½ medium land	4	Dr. W. J. McCain.....	Sumter.....	May ..
5 on bottoms				
½ to 2½	3	P. G. Lightfoot.....	Greene.....	May 10
.....	3 or 4	E. F. Bouchelle.....	Greene..	April 20, '03
1 to 5	3 or 4	J. O. Hays..	Greene.....	May 10
2 to 4	4 to 6	S. Selden	Greene.....	April
1½ prairie	}	J. McKee Gould, Jr....	Greene.....	May 10
1 post oak				
0 sandy land				
.....	4	W. M. Hill.....	Hale.....	May 1
.....	4 or 5	B. B. Rudolph.....	Lowndes....	May 10
3.....	3	M. H. Traylor.....	Lowndes	{ Fall sowing May Spring sowing June
1 to 3.....	4	J. A. Dillard .....			Montgomery..	Mch 24
3.....	3	Judge W. H. Tayloe...	Marengo	
.....	4	Cobb & Macmillan	Sumter.....	April
2½.....	3	E. H. Allison.....	Morgan.....	

The yields estimated by the above named alfalfa growers as the average production under their conditions indicate that after the first season alfalfa can be cut three to six times (usually 4 times), and that the yield of hay on good land is three or six tons per acre. Land producing less than two tons per acre may yield a profit, but should not be selected for alfalfa without first being fertilized with some legume, with manure, or with fertilizers.

The most usual date for the first cutting as found by the above named growers is about the first of May or earlier. When sown in the spring one would expect no cutting of consequence for a month later, and much less than a normal yield the first season of growth. On poor lands with unfavorable seasons no cuttings worth raking are obtained during the first season from spring sowing.

The following extract from Bulletin No. 20 of the Alabama Canebrake Experiment Station, at Uniontown, prepared by the writer, illustrates the possibility of obtaining from prairie soils large yields of alfalfa the first season, even from spring sowing.

"A tract of dark pebbly hillside of medium fertility was plowed and harrowed, and alfalfa seed was sown broadcast on March 20, 1903. The stand was so thick that weeds were not troublesome until the growth of alfalfa was checked by drought, which prevailed almost continuously from about the middle of August until November.

"Up to that time alfalfa made rapid growth and afforded three cuttings by September 3. Because of continuous dry weather, growth after that date was too slow for another cutting to be obtained, though with the ordinary rainfall of September and October a fourth cutting would doubtless have been secured.

"This alfalfa occupied all of 'Cut 23' except 1-20th of an acre, used for another forage plant. The area of this plot, according to a survey made by Mr. T. M. Cocoran, was 55-100 of an acre. Mr. Cocoran's survey is made the basis of the calculated yield per acre in the following table.

"Each cutting of hay required only one day in curing. It was then regarded by Mr. Richeson as dry enough to store in the barn, where it kept without molding.

"The yields of hay thus cured were as follows:

	Lbs. per plot.	Lbs. per acre.
June 16	1,030	1,871
July 15	1,682	3,058
Sept. 3	1,922	3,495
	<hr/>	<hr/>
Total	4,634	8,424

"This shows a yield of more than four tons of hay per acre when stored. It would probably not be safe to regard this as thoroughly cured hay, suitable for storing in large masses. If, to be thoroughly conservative, we assume that a further drying out to the extent of 25 per cent. after being placed in the barn would be necessary before we could regard this as thoroughly cured hay, we should still have a yield of more than three tons per acre. This is an unusually large yield for spring sown alfalfa in its first season of growth, and is probably as much as can *ordinarily* be expected from very young alfalfa, even when sown in the fall. The conditions producing this large yield were a thick stand, abundant rains from March to August, thorough surface drainage, and a supply of root tubercles.

"To emphasize the statement that this was upland prairie land of a fair degree of fertility, the following facts are mentioned: Corn without fertilizer and without any special treatment, averaged in the two cuts which bordered the alfalfa area 21 bushels per acre. The land sown to alfalfa in March, 1903, was in 1902 in cotton, without fertilizer; and in 1901 it had borne a crop of corn without cowpeas. No stable manure had been applied in very recent years, and it is not known that any manure had ever been applied."

The following is another instance showing the possibility of getting good yields from alfalfa the first season, even when sown in spring.

Mr. W. L. Ennis, Livingston, Ala., reports as follows: "Sowed 23 pounds of alfalfa seed, inoculated with earth from a bur clover field, on March 20, 1903, on the best land we had, about one acre. Yields of baled hay were as follows:

"First cutting, 21 bales; second cutting, 40 bales; third cutting, 17 bales. Total, 97 bales. Average weight of bales 104 1-2 pounds." This is about 5 tons per acre.

PRICES AND PROFITS.

Those Alabama alfalfa growers who have sold alfalfa report that the price in recent years has been not less than \$13 to \$15 per ton. Even if we assume a minimum yield of 4 tons of hay per acre on land to which alfalfa is adapted, and a minimum price of \$10 per ton, there would still be larger profits in growing alfalfa than most other field crops. Captain John C. Webb, of Demopolis, Ala., writes: "It has paid me better than any other crop I ever planted."

Mr. W. L. Foster is reported in Louisiana Bulletin No. 72 as follows in regard to alfalfa in the bottoms of the Red River, near Shreveport: "It costs an average of \$1.25 to \$2.00 per ton to put [alfalfa hay] in shape for the market."

The books of another alfalfa grower in the same region showed a cost of \$1.90 per ton to cut, cure, market, and bale a crop of this hay.

The same publication contains this significant paragraph as to the profits of alfalfa in that region:

"When the land is seeded to alfalfa by the owner and rented out, he gets fifteen dollars an acre, and the renter furnishes his own harvesting tools, or he gets eighteen dollars rent and furnishes the harvesting tools. This is on land that rents for five dollars an acre for cotton."

SOILS FOR ALFALFA.

At present the most important question in connection with alfalfa in Alabama is the determination of soils on which it can be made a profitable crop. In determining the best soils for alfalfa we shall be helped by bearing in mind that this plant needs a soil (1) well supplied with moisture, (2) well drained, (3) having an abundance of lime, (4) rich in other plant food.

Alfalfa is at its best when grown under irrigation, which fact indicates its response to large amounts of water judiciously applied. In humid regions alfalfa is pre-eminently a crop for valleys, because on these low levels there is a relative abundance of moisture even during dry seasons. On the other hand, the roots of alfalfa in congenial, well drained, permeable soils, penetrate to great depths in search of moisture. But with the poor drainage in a large part of the south this habit of alfalfa is not fully utilized. The need for ample supplies of moisture can be better understood by the statement that ordinarily hay plants must pass through their leaves about 400 tons of water for every ton of hay produced, or 1,600 tons of water per acre for every crop of four tons.

Drainage, important for most ordinary farm crops because of the need of the roots for air, and because of the deeper growth of roots in drained soil, is doubly important for any leguminous or soil-improving plant like alfalfa. For not only do the roots of such plants need water, but the nitrogen-fixing bacteria in the root tubercles must have thorough soil ventilation in order to perform their work of transforming the valueless nitrogen of the air into the valuable nitrogen of plant food. Whatever may be thought by some of the sufficiency of shallow ditches and levees for draining prairie land sufficiently for cotton and corn, it is certain that such mere surface drainage is insufficient for alfalfa, as, indeed, we believe it to be for the maximum results with other crops. Deeper ditches are needed for alfalfa.

No argument is needed to show the greater convenience and saving of land and work if some of these ditches could be converted into underground drains, whether box drains of plank, pole drains, or whether tile be the material employed. If tile drainage in Alabama can be shown to be cheap enough and continuously

effective for any field crop, that crop will be alfalfa. While few farmers owning land valued only at \$15 or \$25 per acre will be found at present willing to make the large expenditure necessary for tile drainage, this investment will doubtless be found feasible on certain stiff bottom lands, otherwise peculiarly adapted to alfalfa, especially as these lands advance in price because of their suitability to alfalfa. The establishment of tile factories in the south, or the co-operative purchase of tile machines would so greatly cheapen the cost of tile drainage as to make it practicable for alfalfa fields and other land farmed intensively.

Alfalfa should endure for many years. One of our correspondents has alfalfa plants seventeen years old growing on prairie land. If a field of alfalfa, free from disease and from excessive growth of weeds, begins to fail when only a few years old, deficient drainage may be suspected. Alfalfa is usually spoken of as needing an open soil. While permeability is desirable, yet in Alabama the soils to which it has thus far proved best adapted are lime soils of close texture.

PRAIRIE SOILS.

Taking up the different soils somewhat in the order of their proved or probable fitness for alfalfa we must deal first with the Central Prairie Region of Alabama, extending from Union Springs in a northwest direction past Montgomery, Selma, Uniontown, Demopolis, and Livingston, and into Mississippi. In this region a few very small patches of alfalfa were grown many years ago. So far as I can learn, Capt. J. C. Webb, of Demopolis, was the first one in that part of the State to grow alfalfa on any considerable scale. One of his earliest plantings was made on a shallow gray soil underlaid near the surface with white rotten limestone. This field lay next to the

Tombigbee bluffs, on the western edge of Demopolis, and hence was well drained. Steers had been fed here on cottonseed meal and hulls, and the growth of alfalfa was most satisfactory. Capt. Webb has since largely increased the area which he devotes to alfalfa. The principal part of the alfalfa area of Alabama is now in Greene and Sumter counties.

Prairie soils may be subdivided into quite a number of classes merging into each other by imperceptible gradations. Those prairie soils are best suited to this crop which are best drained and best supplied with vegetable matter.

Extensive inquiries were made of a number of growers of alfalfa in Alabama, and below follows a summary of their answers to the question as to the character of soil in the prairie region best suited to alfalfa.

All expressing an opinion preferred lime to sandy or clay soils. Black prairie is the choice of most of these correspondents, some of these expressly naming black bottoms or slough land, others fertile black upland soil. Those who prefer bottom land specify bottoms that are well drained. Two prefer "hammock" land, one of these describing his favorite alfalfa soil as "alluvial land overlaying stiff prairie." One chooses shelly prairie, two cedar "hammock," and one gray upland prairie and "hammock," and another yellow prairie. One correspondent has succeeded best in growing alfalfa on the mixed soil at the base of white marl hills.

On the farm of the Canebrake Experiment Station at Uniontown, alfalfa has done remarkably well during its first year's growth on upland of medium quality, and containing a small number of rough pebbles. We are far from recommending alfalfa for that grade of prairie soil that consists *largely* of these roughened pebbles and that is too poor to make fair crops of cotton. Alfalfa needs fertile soil.

Answering the question what soils are unfit for alfalfa, these correspondents are almost unanimous in naming sandy soils. Three (including one farmer who has a very large acreage in alfalfa) specify post oak, and one especially designates black post oak.

With the confessedly incomplete data now available the soils of the prairie region of Alabama may be tentatively ranked in about the following order as regards their suitability for alfalfa:

First class: Black bottoms, well drained, and drained alluvial lime bottoms containing a little sand.

Second class: Black uplands; shelly gray uplands, and rich chocolate uplands.

Third class: Poor gray to white prairie, and poor, stiff red or post oak land.

OTHER LIME SOILS.

As to the suitability to alfalfa of the soils of the remainder of the State, there is much less evidence available. From theoretical considerations there is every reason for expecting alfalfa to succeed in all the lime soils of the Tennessee Valley region, and in the narrow lime valleys in the northeastern part of the State.

Messrs. E. H. Allison and R. P. McEntire, of Decatur, write of their success with alfalfa in that part of the Tennessee Valley, and other instances of success in that part of the State have been heard of, but not confirmed by answers to our inquiries.

There is reason to expect the best red calcareous soils of Talladega, Calhoun, and counties north of these, to give satisfactory results with alfalfa. In a word, there is a prospect for the successful growth of alfalfa on rich, well drained lime soils in any part of the State where they occur.

Rich bottoms in every part of the State, if not subject

to long or otherwise injurious overflows, and not too wet or too sandy, are probably suitable for alfalfa. If they are deficient in lime it can be added with the probability of profit.

SANDY SOILS.

While it is possible that alfalfa can be grown under garden conditions, on almost any soils in Alabama, yet it is probable that it will not be a profitable sale crop on upland sandy or clay soils deficient in lime unless they are exceptionally rich. In order for it to be grown at all successfully, on these soils, great care will be required and in many cases heavy applications of stable manure or lime (the latter being supplemented by large amounts of commercial fertilizers) will be necessary. It then becomes a question whether it is more profitable on these sandy uplands thus to coddle alfalfa or to rely on hardier forage plants, as hairy vetch, cowpeas, soy beans, sorghum, etc. We are certainly not yet in a position to recommend alfalfa for non-calcareous upland soils except on a very small scale. However, the great value of the plant on congenial soil makes it worthy of trial in a small way on every class of soils.

LOCAL EXPERIMENTS IN PROGRESS.

To determine the suitability to alfalfa of each of the principal soils of the State, this station in co-operation with the United States Department of Agriculture, last fall arranged for an experiment with alfalfa in nearly every county in Alabama. The unusually dry fall, necessitating late planting, and the early occurrence of frost and freezes, destroyed the stand of alfalfa in many of the experiments referred to. It is planned to continue the work along this line.

FERTILIZERS FOR ALFALFA.

One ton of alfalfa hay contains approximately 44 lbs. of nitrogen, 10.2 lbs. of phosphoric acid, and 33.6 lbs. of potash. Hence a crop of four tons contains as much nitrogen as is found in 2,450 lbs. of cotton seed meal, as much phosphoric acid as is contained in 336 lbs. of high grade acid phosphate, and as much potash as is contained in 1,075 lbs. of kainit. It would cost, to buy all these amounts of plant food in the form of commercial fertilizers, approximately \$35.00. Fortunately not all of this is removed from the soil, the greater part being the value of the nitrogen, the largest proportion of which the alfalfa doubtless gets from the air. It would, however, require about \$8.75 worth of phosphate and kainit to replace the amount of phosphoric acid and potash which would be removed from the soil of an acre by a crop of four tons. Hence it is evident that even the richest prairie soils, if cropped for many years in alfalfa, will need to have their supplies of phosphoric acid and potash replenished by the application of manure or fertilizers. This will be especially true if Johnson grass hay has previously been removed from these soils for a number of years, thus making heavy drafts on the soil's supply of these two minerals.

According to Wolff, one ton of alfalfa hay contains 70 pounds of lime, or 280 pounds in a crop of four tons. In three experiments on the station farm at Auburn lime has proved highly beneficial to the growth, permanency and hardiness of alfalfa.

In the case of soils not rich in lime it will be necessary from the beginning to apply this material, as is clearly shown in the experiments on the station farm at Auburn. Not only do lime and phosphoric acid directly stimulate the growth of alfalfa on soils deficient in these min-

erals, but their presence is believed to favor the development of tubercles, on the abundance of which largely depends the thrift of the alfalfa plant. From 6 to 12 barrels, equal to $\frac{1}{2}$ to 1 ton of unslaked lime, or to at least $\frac{3}{4}$ to $1\frac{1}{2}$ tons after slaking, may be applied per acre. Liming (or the use of manure or wood ashes) will be indispensable for alfalfa on acid soils, of which there are large areas in Alabama. To test a soil for acidity, a strip of blue litmus paper should be kept in contact with the moist soil until damp. If the soil is acid the color of the paper will change to pink. On application to the writer litmus paper for this test will be furnished free.

Where there is no local experience to guide one in selecting fertilizer, the following formula (or stable manure), is suggested as a fertilizer for alfalfa, in regions where the use of commercial fertilizers is general:

400 pounds acid phosphate per acre and 50 pounds muriate of potash per acre.

The above is not intended to take the place of lime, where the soil is deficient in lime, but to supplement it. When lime and acid phosphate are both used for any crop they should be applied separately, and one should be worked into the soil before the other is applied. Tubercles on the roots of alfalfa should supply it with nitrogen. But if the roots are devoid of tubercles, nitrate of soda or cotton seed may be needed.

FERTILIZER EXPERIMENTS AT AUBURN.

On reddish sandy upland soil at Auburn, capable of producing only about 10 to 12 bushels of corn per acre, without fertilizer, ten plots of alfalfa were sown, October 29, 1900. The soil was not acid. All plots were at that time fertilized at the same rate per acre, namely, 320 pounds of acid phosphate and 80 pounds of sulphate

of potash. An effort was made to inoculate the seed, but this was not entirely successful.

A good stand of plants was found on all plots the latter part of the following March and the early part of April, when different nitrogenous fertilizers were applied to these plots as shown in the next table.

Alfalfa made extremely poor growth in 1901 on the plots receiving no manure. On all plots, weeds, leaf rust, a sclerotial disease of the roots, and perhaps nitrogen starvation, killed the larger part of the plants. The lime and the stable manure plots suffered least and kept the best stands. No plot made a yield worth harvesting separately. October 7, 1901, without plowing, an additional amount of seed was disced in on all plots.

Again in the phenomenally dry summer of 1902, the alfalfa on *most* plots did not yield enough hay to justify raking it up. However, the plots were clipped four times in 1902—May 6, June 17, Sept. 13, and October 10. On the best plots, those to which stable manure had been applied about 15 months before, and which were now reduced by disease and dry weather to a mere fraction of a stand, the yield was only about one ton of hay for the entire season. The extreme drought of 1902, extending practically from the middle of April to August, will be recalled by most readers.

In the summer of 1902, the poorest plots of alfalfa were plowed up and planted in New Era cow peas in drills. These made slight growth, but were kept clean by late cultivation. The plots then plowed up as being the poorest were those which 18 months before had received per acre either 200 pounds of nitrate of soda or 500 pounds of cotton seed meal or no fertilizer.

September 13, 1902, inoculated alfalfa seed, 20 lbs. to the acre, were sown on these plots, first running a

disc harrow several times over the small growth of cow pea vines, a procedure that in ordinary seasons would not suffice to dispose of a crop of cow peas of the usual luxuriance, but which is sometimes a satisfactory treatment of cow pea stubble. On all these plots and nearly all other plots, 2,000 lbs. of slaked lime (equal to about 1,200 lbs. of unslaked lime) were harrowed in. Next March certain other plots where the stand had become very thin were plowed and sown in alfalfa.

The stand of alfalfa on other plots, (those which eighteen months before had been fertilized with either manure or lime), was thickened by drilling in with a grain drill a small amount of alfalfa seed, mixed with sand to make the distribution more uniform.

The yields of hay obtained in 1903 on each plot are shown in the following table:

Yields of alfalfa hay per acre in 1903, and fertilizers per acre previously used.

Plot.	When sown.	Fertilizer for 1901.	Fertilizer winter 1902-1903.	Lbs. hay per acre.			
				May 20.	July 26.	Sept. 25.	Total.
1	Sept. 13, 1902.....	{ 320 lbs. acid phosphate 80 lbs. sulphate potash.	{ 240 lbs. acid phos. 1 ton slaked lime.	.....	700	900	1600
2	Sept. 13, 1902..... Drilled.	{ 200 lbs. nitrate of soda. 80 lbs. sulphate potash. 320 lbs. acid phosphate.	{ 240 lbs. acid phos. 1 ton slaked lime.	.....	500	1000	1500
3	Sept. 13, 1902.....	{ 500 lbs. cotton seed meal. 320 lbs. acid phosphate. 80 lbs. sulphate potash.	1 ton slaked lime.	.....	1100	1200	2300
4	March 18, 1903.....	{ 320 lbs. acid phosphate 80 lbs. sulphate potash.	{ 6 tons horse manure. 1 ton slaked lime.	.....	1600	2000	3600
5	Oct. 29, 1900.....	{ 20 bbls. lime. 320 lbs. acid phosphate. 80 lbs. sulphate potash.	{ 240 lbs. acid phos. 1 ton slaked lime.	2300	2050	2300	6700
6	Oct. 29, 1900.....	{ 18.4 tons horse manure. 320 lbs. acid phosphate. 80 lbs. sulphate potash.	{ 240 lbs. acid phos. 1 ton slaked lime.	2400	2200	2200	6800
7	March 18, 1903.....	{ 80 lbs. sulphate potash. 320 lbs. acid phosphate. 22.2 tons cow manure.	{ 240 lbs. acid phos. 1 ton slaked lime.	.....	900	1600	2500
8	Oct. 29, 1900.....	{ 22.5 tons horse manure. 320 lbs. acid phosphate. 80 lbs. sulphate potash. 20 bbls. lime.	{ 240 lbs. acid phos. 1 ton slaked lime.	1400	1100	2000	4500
9	March 18, 1903.....	{ 320 lbs. acid phosphate 80 lbs. sulphate potash.	{ 80 lbs. nitrate of soda. 240 lbs. acid phos. 1 ton slaked lime.	.....	800	1000	1800
10	March 18, 1903.....	{ 6 tons rotten cowpea vines 320 lbs. acid phosphate. 80 lbs. sulphate potash.	{ 340 lbs. acid phos. 1 ton slaked lime.	.....	900	1300	2200

The results for 1903 shown in the above table may be summarized as follows:

(1)—Spring and fall sowing afforded practically the same yields, about one ton of hay per acre the first summer.

(2)—Nitrate of soda applied at the rate of 80 pounds per acre with the seed in spring failed to increase the yield.

(3)—Six tons of stable manure more than doubled the yield the first season when applied in February to fall sown young alfalfa plants.

(4)—Eighteen tons of stable manure enabled alfalfa to yield 3.4 tons of hay per acre the third season after the application.

(5)—Lime, at the rate of 20 barrels per acre, resulted the third year after application in a crop practically equal to that obtained by the use of 18 tons of stable manure at the same time.

(6)—The application of both lime and large amounts of stable manure together did not increase the yield the third year after application as compared with either applied alone.

The first cutting of hay was nearly pure alfalfa, the second contained considerable crabgrass, and the third cutting contained more crabgrass than alfalfa.

EFFECTS OF LIME AND INOCULATION COMBINED.

On October 3, 1902, three plots of sandy soil of fair quality on the Experiment Station farm at Auburn were sown with alfalfa. Phosphate and muriate of potash were used on all plots. Plot 3 had neither lime nor inoculation; plot 4 was not limed, but inoculated as follows: Soil from an old alfalfa field 100 yards distant,

was stirred into water, the seed dipped into this water, and then thirty bushels per acre of the same soil was sown broadcast and harrowed in promptly. Plot 5 was similarly inoculated and 1,000 pounds per acre of slaked lime was applied. Winter killing was severe on all plots, but much more severe on plots 3 and 4 than on the plot which was both limed and inoculated. Figure 1 shows in the lower part that on the plot both limed and inoculated the young plants had covered the ground; few and small were the plants surviving plants on plot 4, as shown in

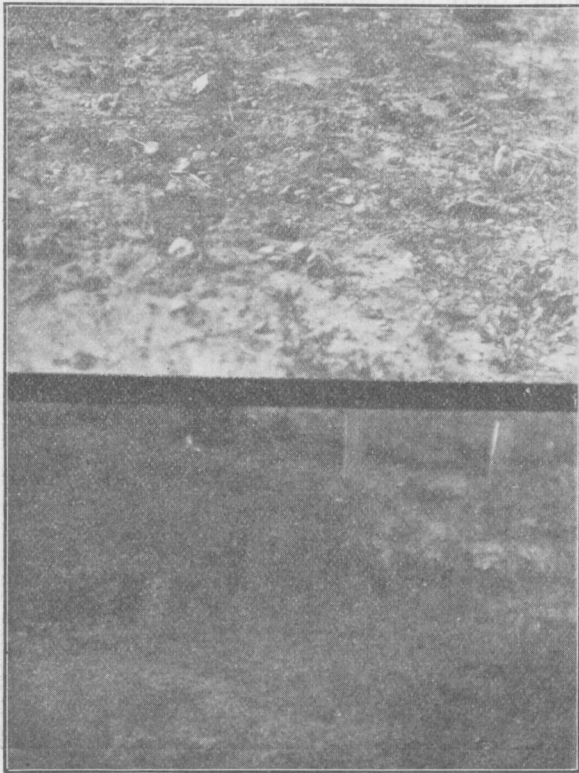


Fig. 1. Below, ground is covered with young plants, which have been inoculated and limed; above, lime omitted, and ground nearly bare.

the upper part of Figure 1. Figure 2 shows typical plants taken in April from each plot. Note the abundance of tubercles on the plants from the plot that was both limed and inoculated. The liming and inoculation seemed to make the young plants hardier and more resistant to cold. No one of these plots was a success, there being left at the end of winter only about half a stand on plot 5, and much less on the other two plots. The total yield for the season was 2,266 pounds per acre where liming and inoculation had been employed, while on the other plots there was not enough hay to be raked.



Fig. 2. Small plants **not** inoculated; central plant, not limed; largest plant, inoculated and limed.

An adjacent plot was sown in crimson clover at the same time that the alfalfa was sown, and after the cutting of the crimson clover, the same plot was sown in June in broadcast sorghum. The yields obtained give an interesting illustration of the fact that under ordinary conditions on sandy land unsuited to alfalfa, other crops often furnish a far larger quantity of forage. The yield of crimson clover on this adjacent plot was 6,100 pounds per acre, and the amount of sorghum hay obtained at one cutting during the same season was 13,000 pounds per acre. These are exceptionally good yields of both crimson clover and sorghum. This is an extreme case where all conditions were highly favorable for crimson clover and sorghum, and exceedingly unfavorable for alfalfa.

FERTILIZER EXPERIMENTS ON PRAIRIE LAND.

A series of fertilizer experiments on 10 plots was begun in 1902 in co-operation with Mr. J. O. Hays, Sumter county, Ala., by whom the fertilizers were applied in accordance with the writer's plan. The seed were not sown until April 3, only a few weeks before the beginning of the memorable drought. In the absence of any considerable amount of rain until August 28, the fertilizers were without effect. No hay was raked, but Mr. Hays reports that this alfalfa, though sown late, "stood the drought better than any other forage plant, and is the only one that kept a good lively green color, while Bermuda grass was parched perfectly yellow, and sorghum was twisted and stopped growing."

It should be added that eight of the plots were inoculated with soil from an old alfalfa field.

In 1903 Mr. Hays again undertook a fertilizer experiment for this station. On June 13 he writes: "Plots 9 and 10, the ones most highly fertilized, are the best."

These both received per acre 200 pounds cotton seed meal, 240 pounds acid phosphate, and respectively 200 and 100 pounds of kainit.

MANURE.

For the prairie region it may be said that no fertilizer except stable manure has yet been sufficiently tested on alfalfa to determine its suitability. In numbers of instances stable manure has greatly increased the yield of alfalfa on prairie lands, and the most experienced growers of alfalfa use it so far as the limited supply permits. The benefit from the use of stable manure is a common experience in west Alabama, and the application of manure has immensely increased the yield of alfalfa on the lime land of Mr. J. A. Dillard near Montgomery, Ala., as the writer can testify from a personal inspection.

However, the question may well be raised whether alfalfa is the best crop on which to apply stable manure which is so scarce and so sure to largely increase the yield of any crop. So far as concerns the nitrogen of stable manure, alfalfa could well dispense with that. For alfalfa thoroughly inoculated and on land sufficiently well drained to insure fair soil ventilation, should be able to obtain through its root tubercles unlimited quantities of nitrogen from the air. On the other hand, sorghum or cotton, not having this means of securing nitrogen, would make good use of the nitrogen as well as of the other constituents of stable manure. In favor of the application of manure to alfalfa is the fact that this application in winter promotes early development of the plants, and forces the alfalfa to a sufficient height for cutting at a time when other forage is scarce. Moreover, if immense quantities of stable manure are used it will serve as a mulch, retaining the moisture in the soil

and alleviating the effects of drought. On the other band, surface application of manure without incorporation with the soil results in great loss of the valuable portions of the manure and is ordinarily a wasteful method of application.

INOCULATION.

Alfalfa belongs to that family of plants able to derive a large part of their nitrogen from the gaseous nitrogen of the air. This is done through the agency of enlargements on the roots, called tubercles or nodules. Within these tubercles dwell countless numbers of microscopic vegetable organisms, usually referred to as nitrogen-fixing bacteria or germs.

Root tubercles of alfalfa, clovers, vetches, cowpeas, velvet beans, and other legumes, are essentially fertilizer factories engaged in the manufacture of nitrogen. This is a fertilizer material, which, when bought in the form of cotton seed meal or nitrate of soda or ammoniated guano, costs about 15 cents per pound. The importance of the work of root tubercles may be realized from the fact that a crop of any one of these plants growing on an acre usually contains from 75 to 200 pounds of nitrogen in roots and tops taken together.

When the germs necessary for causing tubercles to develop on the roots of alfalfa are absent from the soil and from the seed, the roots of alfalfa have no tubercles. The proper germs, which we may designate as alfalfa germs, are usually absent from the sandy and non-calcareous soils of Alabama, and often from other soils. More frequently there are a few of the proper germs present either in the seed sown or in the soil, so that tubercles develop on a small proportion of the plants.

A leguminous plant without tubercles is a drone

that no farmer can afford to provide for. Such plants depend entirely upon fertilizers for their expensive nitrogen or draw it from the earth, thus impoverishing the soil.

The farmer has it in his power to cause tubercles to develop on the roots of his alfalfa, and thus to force the plants to provide their own nitrogenous food, and to enrich the land in nitrogen. When leguminous plants form their tubercles without aid from man we may speak of the process as natural inoculation. Experiments on a number of soils at Auburn and observations of young alfalfa plants in a number of other localities, lead us to conclude that the alfalfa germ is wanting or not present in sufficient numbers in most of the sandy and clay soils of Alabama that are deficient in lime. On such soils the necessary germs must be supplied by the process of inoculation, or more accurately, by artificial inoculation.

The material used for inoculating alfalfa may be soil from a field where alfalfa or bur clover (a plant of the same genus) has in recent years been well supplied with root tubercles, or it may be a concentrated patented material now being manufactured in the laboratories of the United States Department of Agriculture.

To inoculate with soil we have used the following methods, depending on convenience and on the amount of inoculating soil available.

(1) With small amounts of inoculating soil: To about a peck of soil from an old alfalfa or bur clover field add several gallons of water; stir well; allow a few minutes for settling and then moisten every alfalfa seed thoroughly with the muddy water, which contains the necessary germs. Then dry the seed by mixing with them more of the same inoculating earth in a dry condition and crushed as fine as possible. Cover seed promptly.

(2.) With large amounts of inoculating earth: Moisten the seed as above; dry as above, if convenient; sow broadcast per acre 20 to 30 bushels of the same earth in as fine a condition as possible, and harrow in seed and inoculating earth as promptly as possible. The method of inoculation and the amount of inoculating soil can be varied according to convenience.

Directions for use accompany the pure cultures sent from Washington. Dr. A. F. Woods, under whose direction this inoculating material is distributed, authorizes me to state that the Department will supply free inoculating material for alfalfa to any parties whose names I shall send in, and who will furnish their own seed. Applicants should state the number of acres that they will plant.

On prairie soil the writer has repeatedly observed that alfalfa plants are, when young, well stocked with tubercles. The cause for this is evident from the recent investigation of Dr. C. G. Hopkins, of the Illinois Experiment Station. Under date of February 2, 1904, he writes as follows with reference to his bulletin now in press, and gives permission for this use of his results: "The investigations reported in this bulletin prove conclusively that the bacteria of sweet clover are similar to the bacteria of alfalfa."

RESULTS OF INOCULATION OF ALFALFA ON SANDY LAND.

In an inoculation experiment with alfalfa made by the writer in February, 1897, the yield of alfalfa at the first cutting was increased 336 per cent as the result of inoculation. The soil within the plots was from a sandy field near Auburn, and the inoculating material was the dust sifted out of bur clover seed and derived from the soil on which bur clover had grown. In several later

field experiments the use of bur clover earth has produced tubercles and greatly increased the yield of alfalfa.

Figure 2 shows typical alfalfa plants taken in April, 1903, from three plots at Auburn, sown the preceding October. The small plants on the right had been neither limed nor inoculated and were free from tubercles; those in the center had been inoculated, but not limed; the largest plant had been inoculated and limed, and here the supply of tubercles is abundant. Soil from an old alfalfa field was used in this experiment as inoculating material.

INOCULATION OF ALFALFA ON PRAIRIE SOILS.

In the light of Dr. Hopkins' demonstration we can now see why it is unnecessary to inoculate alfalfa on fields where melilotus (sweet clover) has recently grown, and produced tubercles, as it almost invariably does on prairie soil. It would still seem advisable, however, to inoculate alfalfa seed to be sown on such prairie land as has not recently grown melilotus. While these germs have probably been widely distributed by wind and water and otherwise, in the prairie region, we have no proof that they are present in all fields of prairie land in sufficient numbers for *best* immediate results with alfalfa.

Indeed the observation made by Mr. J. O. Hays in our fertilizer experiment on gray prairie land in Greene county, previously referred to, seems to indicate that there is an advantage, at least during the first few months of growth, in inoculating alfalfa on some lime land. In 1902, on land which had been used as a pasture for a number of years, he reports that on the six-months-old inoculated alfalfa plants tubercles were

abundant, while up to that time none had been found on the plots not inoculated.

Relative to a similar experiment in 1903, he writes under date of June 13, 1903, as follows: "I inoculated all plots except No. 8, which seems to be the poorest of any of them."

In view of Dr. Hopkins' conclusions, we can now recommend that earth from an old melilotus field be used for inoculating alfalfa, where this is decidedly more convenient than to use earth from alfalfa or bur clover fields or than the pure culture of the laboratory.

TIME TO SOW.

The following is a summary of results of sowing alfalfa on the station farm during the eight years that work has been under the writer's charge:

We have records of fall sowings on ten different dates. In every case when alfalfa was sown broadcast after November 1, the stand was ruined by cold. In one case alfalfa sown as early as October 7, (1901), was almost completely winter killed. Plants from seed sown as early as September 13 (1900), and as late as October 29 (1899) survived the winter, although in other years a considerable proportion of the sowings made in late October resulted disastrously.

We have records of eight dates of spring sowing of alfalfa on the station farm. These point to the first half of March as better than a later date.

In our co-operative experiments with alfalfa in 1903-1904, arranged for in nearly every county in the State, fall sowing was made unduly late by drought, and cold weather came on unusually early, and has been unusually continuous. Moreover, in most cases there was insufficient moisture to cause the young plants to grow

rapidly. Under these conditions, it is estimated from reports thus far received that in considerably more than half the experiments the stand of alfalfa was ruined. These reports afford an interesting comparison of the relative hardiness towards cold of the young plants of alfalfa, crimson clover and hairy vetch. The first two, when very young, are almost equally sensitive to cold, while hairy vetch is much hardier in this respect than either.

Alfalfa has been successfully sown in Alabama, both in the early fall and in the early spring. The principal advantages of fall sowing are the following:

- (1.) A larger yield of hay obtainable the first summer;
- (2.) Less danger of having the alfalfa overtaken and crowded out by crab grass and weeds;
- (3.) Use of teams in preparation for alfalfa in August and September, when they would not be employed in preparing for the usual crops.

The chief advantages of spring sowing are as follows:

- (1.) Freedom from risk of winter killing, to which fall sown alfalfa, especially that sown late, is liable.
- (2.) Opportunity to sow alfalfa after cotton, the best of the hoed crops to precede it;
- (3.) Usual better condition of the land for plowing in December and January than in August and September.

Each reader must contract these opposing advantages in the light of his own conditions. By far the larger proportion of alfalfa sown in Alabama on prairie soils is put in after Christmas, which suggests that this is

generally the most convenient time. Some years it is the only practicable time, the ground being too dry and hard in the early fall. Several extensive growers of alfalfa who sow chiefly in the spring, nevertheless express a preference for fall sowing when there is sufficient moisture for thorough preparation and for sowing *early* in the fall.

Fall sowing should occur at a date early enough to permit the roots to penetrate deeply before freezes begin, and thus to anchor the plants against heaving. Not only are young alfalfa plants easily heaved or lifted out of the soil by alternate freezes and thaws, but the very young plants are otherwise and more directly injured by severe cold following mild weather.

In Central Alabama we would recommend that fall sowing be done, if practicable, from September 15 to October 15, with the preference for the earlier part of this period. While a date as late as November 1 occasionally gives success, the risk of winter killing is then too great. If alfalfa cannot be sown before October 15 in central Alabama, we would recommend that sowing be postponed until March.

The safest period for spring sowing is from March 1 to 20. Some sow on prairie land as early as February 20, but from February sowing at least one instance of loss of stand from cold has come under our notice. While seed sown in April sometimes succeed, the success is less uniform than with March sowing. The more weedy the land the stronger the reason for fall sowing.

PREPARATION.

There is no field crop that pays better for thorough preparation than alfalfa. The man who is content to prepare land for alfalfa as he would for oats had best

leave this crop to some one else. The plowing for alfalfa should be deep and thorough and it is highly probable that subsoiling on prairie and other stiff land would be more profitable for alfalfa than for any other field crop. Harrowing must be done, not once, but from two to four or more times, according to the condition of the land. Usually two harrowings with a disc harrow and two with a tooth harrow (including the one given after sowing the seed) will suffice.

Harrowing for fall sowing will be most effective if done within a few hours after plowing. For spring sowing this is less imperative. It is important that between the time of plowing and the time of sowing a sufficient interval should elapse for rains to compact or settle the soil. If sufficient rain does not fall to settle the soil, this should be done by repeated use of roller or weighted drag. One of the most common causes of failure to secure a satisfactory stand in alfalfa growing consists in having the soil too loose at planting time. For fall sowing plowing should occur at least several weeks before the seed are to be sown. If alfalfa is to be sown about the first of March the plowing may be done in November or December, or January, more satisfactorily than just before planting. Land plowed before Christmas will only need to have the surface layer freshened with the harrow at the time of sowing. While the above statements embody the general experience, success sometimes attends the sowing of the seed immediately after plowing. A farmer in the north-eastern part of Texas who has many hundred acres of alfalfa, describes his method of preparation of black prairie for alfalfa as follows: "I use a disc plow with four good mules, run a subsoil plow drawn by six mules eighteen inches deep behind the disc. Then I follow with a disc harrow with four mules, then float

the land with an implement eight or nine feet long and five feet wide, made by 2x6's spiked together; six mules draw this. I can reverse the float, turn it over and use it to level the land in rough places. I am not yet ready to seed this land prepared in this way. I must have a rain on it that will settle it and take the air cells out. Then, with a light toothed harrow I break the surface, sow the seed with a wheelbarrow seeder and cover with a light harrow followed by a heavy steel roller. Good black land seeded in this way will return \$40 or \$50 per acre every year, at very little cost for labor."

One grower in West Alabama subsoiled his land for alfalfa last fall, but it is too early for the effects of subsoiling to become apparent.. One grower in the same neighborhood harrowed his land seven times, an extreme case. Others report satisfaction from one or two harrowings, a number often insufficient. It should be borne in mind that preparation for alfalfa is expected to suffice for from three to twenty years, and should therefore be thorough.

SOWING BROADCAST VERSUS IN WIDE DRILLS.

It is maintained by some parties that in the Gulf States drilling alfalfa, with such distance between rows as to permit of cultivation, will be more satisfactory than broadcast planting. In three experiments at Auburn and in one at Uniontown, drilling was unsatisfactory. On the station farm at Auburn it was found difficult in planting by hand in drills to avoid covering the seed too deep, and it was found that the amount of cultivation required to keep the grass and weeds subdued in drilled alfalfa was greater than it is practicable to give to a hay field.

On the Canebroke experiment farm at Uniontown,

where the drills were about 24 inches apart and no cultivation given, crab grass and weeds crowded the alfalfa more than in the portion of the field sown broadcast.

However, for a small patch of alfalfa kept for feeding green, drilling and cultivation may be necessary and feasible, especially on highly fertilized sandy soils filled with the seeds of crab grass and weeds. Planting in very narrow drills by the use of grain drills is a favorite method in alfalfa-growing states. This of course does not permit of cultivation.

SOWING.

Most of the successful growers of alfalfa in Alabama have used about 20 pounds of seed per acre, and this is the amount that has invariably been used on the station farm at Auburn. Capt. John C. Webb uses 40 pounds. The excellent stand obtained in 1903 at the Canebrake station resulted from sowing a little more than 20 pounds per acre. One grower in Alabama reports the use of 30 pounds, or half a bushel of seed. Yet this grower is one who most emphasizes the presence of large amounts of crab grass and fox tail grass, indicating that sowing large amounts of seed is not always effective in crowding out weeds, though it has that tendency.

If ten or more acres are to be sown, it is best to use one of the ordinary patterns of seed sowers instead of sowing by hand. The Cahoon is the one used at this station, and this seems to be in most general use in this State. One grower makes use of the seed attachment to the disc grain drill, a method which is common and satisfactory in states where this machine is in general use. When alfalfa seed are sown by hand, the most even distribution is obtained by dividing the seed into two parts and going over the land twice.

In Alabama alfalfa should be sown alone and not with grain, which is so much used as a nurse crop for alfalfa, clover and grasses in the North and West.

In covering alfalfa the procedure must necessarily differ according to local conditions, the preparation of the land, and the state of the weather. The most common custom in Alabama is to cover with a spike tooth harrow, teeth inclined backward. An equally good or better way employed by a few growers is to cover the seed with a weeder, which affords a more shallow covering than any form of harrow. A carefully made brush drag can also be used, but either of the preceding implements is preferable. We have found it advantageous when the land is dry to use the roller immediately after sowing and then to use the harrow or weeder. This order could be reversed, but at the risk of having the rolled surface transformed into a dense crust, should a heavy rain fall occur before the seed germinate. Coburn, an authority on alfalfa, advises that when from any cause a crust has been formed prior to the appearance of young plants, that this crust should be broken with weeder or harrow, even at the risk of bringing some of the sprouting seed to the surface.

It pays to buy the best alfalfa seed, even though they should cost several cents more than inferior seed. Imported as well as old should be avoided. So far as this information can be obtained, it is desirable to purchase seed grown in regions where love vine (dodder) is not abundant. In any case it is advisable to buy seed that have been run through a machine that is claimed to be able to remove the seed of dodder. As indicating the need of buying the best alfalfa seed, even at an increased price, one of the farmers who is conducting one of our alfalfa experiments in Wilcox county, under the

writer's direction, reports as follows, under date of January 23, 1904: "All the seed sent from Washington came up readily to a good stand. * * * The seed we bought did not make a 15 per cent. stand."

To test the germinating power of alfalfa, dampen two small pieces of cloth; place 100 seed between the two pieces of cloth. Then put the whole thing in a plate or saucer, cover it, and leave it in a warm room, repeatedly moistening the cloth before it dries. Count the seed that sprout within ten days.

BEST CROPS TO PRECEDE ALFALFA.

A crop selected to get land in best condition for alfalfa should be one that either leaves the land clean and unusually free from weeds and weed seed, or one that adds vegetable matter, and hence enriches the soil. Cotton fulfills the first requirement, and cow peas or melilotus the second. The land that is to be sown in alfalfa next fall should be sown thickly in a running variety of cow peas in May, 1 1-2 to 2 bushels per acre. The vines should be cured for hay about a month or more before the time for planting alfalfa. On soil very deficient in vegetable matter it may be profitable to plow under the entire growth of cow peas. If the latter plan is followed, this mass of material should be plowed under in ample time for rotting to occur, or from 40 to 60 days before the date of planting. When green vegetation is plowed under at this season it is desirable to compact the soil with the roller or heavy drag, otherwise this vegetable matter before rotting will injuriously dry out the soil by preventing the rise of capillary moisture from the moist subsoil. On soils deficient in lime the lime necessary for alfalfa can be applied before

the green growth of cow peas is turned under, thus hastening rotting and obviating the souring effect that might otherwise occur. Melilotus furnishes vegetable matter and nitrogen for alfalfa, and also by means of the decay of its large and deeply penetrating roots assists in the drainage of prairie soils. It is advisable to let one carefully worked cotton crop, intervene between the turning under of the second years' growth of melilotus and the sowing of alfalfa seed. This interval permits the owner to free the land from any volunteer plants of melilotus and from weeds.

JOHNSON GRASS LAND FOR ALFALFA.

One of the important advantages of alfalfa is its ability to grow in land too thickly set with Johnson grass for the profitable cultivation of corn or even of cotton. By the introduction of alfalfa or hairy vetch into a Johnson grass meadow, the soil will be to some extent enriched in nitrogen, the nutritive quality of the hay improved, and the total yield of hay increased.

An effort was made by correspondence with leading growers, to learn whether the successful growth of alfalfa in Johnson grass meadows was conditional upon such preparation of the land as would kill a large part of the Johnson grass. The general experience is that alfalfa thrives in old Johnson grass meadows even when the preparation for alfalfa is such as would ordinarily improve the growth of Johnson grass. The verdict was almost unanimous that Johnson grass did not crowd out the alfalfa in the second or third year after the alfalfa was sown. Those with the longest experience were as emphatic as others in stating that alfalfa was quite equal to a contest with Johnson grass, and some growers even stated that the alfalfa was tending

to crowd out the Johnson grass. When alfalfa is sown in land stocked with Johnson grass, fall sowing gives the alfalfa an advantage over its competitor. A still further means of giving the ascendancy to alfalfa consists in breaking the Johnson grass land and sowing thickly with cow peas, cutting the cow peas and Johnson grass for hay, and turning under the stubble a month or more before sowing alfalfa seed.

PRINCIPAL ENEMIES OF ALFALFA.

Among these first rank must be given weeds and weedy grasses, chief among which is crab grass. Crab grass and absence of tubercles have been responsible for the majority of failures that have come under the writer's observation. Other weeds that have given trouble in alfalfa on the station farm are evening primrose, morning glories, pepper grass, and even lespedeza or Japan clover. Among weeds most troublesome in prairie regions are crab grass, Bermuda grass, *Sida spinosa*, (a rather low branched weed with small yellow flowers and solid leaves), morning glories, fox tail grass, prairie or wire grass, horse nettle, and cow itch vines.

The only method known for decreasing injury from weeds is one of prevention rather than cure. The injury from weeds is best prevented by growing just before alfalfa, cotton or some other crop requiring careful cultivation. The avoidance of manure made from feeding hay abounding in weed seeds is also advisable. Manure from cattle fed on cotton seed meal and hulls is the best kind for alfalfa. Fall sowing is one of the best means of enabling alfalfa to get a start and triumph over its many enemies among the weeds. Judicious use of the disc harrow and even the use of the weeder when crab grass has just appeared is sometimes helpful.

Dodder, which is often introduced in alfalfa seed, is a thread-like, yellow vine, feeding on and destroying alfalfa. Mowing and burning in place is the most convenient of several remedies.

The most successful method of combatting weeds consists in frequent mowing during the first year, even when the alfalfa plants have not attained sufficient height for hay making. Repeated clipping with the mower during the first summer will do much to repress weeds and to thicken the stand of alfalfa by making the plants throw out a greater number of stems.

Leaf rust on alfalfa, appearing in the form of small black spots on the leaves, has been very destructive to alfalfa on the station farm, especially during damp weather. When it becomes serious, the best thing to do is to mow the alfalfa, the new growth usually escaping injury for quite a while.

A more fatal disease occurring on alfalfa on the station farm is a sclerotial root disease, which, however, the writer has not observed in other alfalfa fields. Indeed this root disease has been the principal cause of failure of our most promising fields of alfalfa, a large proportion of the plants in certain fields being killed by it.

CLIPPING AND DISCING ALFALFA.

After the young plants appear the most effective aid that can be given them is to use the mower frequently. Clip young alfalfa whenever weeds crowd it, and whenever it rusts or turns yellow from any cause. If the growth is slight, leave the mown material on the ground as a mulch and fertilizer, provided it is of a kind that will not give trouble when hay is raked after a later cutting.

Old alfalfa, whose growth has been arrested, and which has become unthrifty, is often benefited by prompt mowing, even though the growth be too light for harvesting.

The next most important treatment usually recommended for alfalfa more than a year old is to run a disc harrow over it when needed. This is sometimes done after each cutting, but judgment is needed in this matter. The discs are set straight so as not to cut off the plants. Discing serves as a cultivation and to thicken the stand of old alfalfa. On sandy land at Auburn we have found the weeder useful in young alfalfa in killing very young grass and weeds just germinated.

At Auburn crimson clover sown early in October in old drilled alfalfa was ready for cutting at the same time as the alfalfa, and the combined yield was large. This combination is not advised except when the stand of alfalfa has become so thin that it is about time for it to be plowed under.

TOLERANCE OF ALFALFA TOWARD OVERFLOWS.

When excessive rains occur and poorly drained soil remains saturated for a long time, alfalfa sometimes take on a pale yellowish, sickly color. This plant is classed as among those least able to endure prolonged saturation of the soil. Yet the large yields obtained on bottom lands make it worth while to take some chances of injury from overflows, especially on soils so drained naturally or artificially that the ground soon dries after the waters subside.

An overflow does not necessarily mean the destruction of the alfalfa plants. Experience in other states indicates that alfalfa may pass safely through a submerg-

ence of several days if all conditions are favorable. Its endurance of overflow is greater when the water is moving than when it is stagnant, and greater during the cooler periods of the year than when the plant is in a more active stage of growth. The deposit of much sediment on the plant, and hot, fair weather immediately after the water passes off are conditions unfavorable to recovery. Rains, washing off the sediment, are favorable to recovery.

In a bulletin of the Texas Experiment Station are cited two instances in which alfalfa in the Brazos River bottoms was under water for five or six days in summer without the destruction of the stand, except where the deposit of sediment was great or on poorly drained areas. These are extreme cases, and refer to soil that was well drained. Mr. R. P. McEntire, of Decatur, Ala., gives his experience with overflow as follows: "In the fall of 1901 I sowed 3 acres October 15, and got a good stand. In January we had an overflow from the Tennessee River, which was out over the land for two weeks. In a few days we had a hard freeze. Then on February 15 we had another overflow, which lasted 10 days. As the water went off we had another freeze. When spring opened I had something like half a stand." It would seem that one might raise alfalfa on land naturally well drained and where the overflows occur chiefly in winter, and where it is unusual for the water to remain on the land as long as three or four days in winter or two days in the warmer part of the year.

HARVESTING ALFALFA.

A discussion of the methods of harvesting alfalfa and of the machinery and devices employed would unduly extend this bulletin. In brief, alfalfa should be cured with the shortest practicable exposure in the swath to the sun. The leaves are the richest portion of alfalfa, and if the hay is sunned too long the leaves drop off. The preferred time for cutting alfalfa is when about one-fourth in bloom, but this varies with the weather and with the thrift of the plants.

SUMMARY.

Alfalfa is a perennial leguminous plant, useful for hay, feeding green, pasturage, and for soil improvement. In nutritive qualities alfalfa stands in the front rank, and when fed to farm teams the ration of corn can be greatly diminished. On suitable soil the yield of hay exceeds that of any other hay plant. On prairie soils in Alabama yields of more than 3 tons per acre were in two instances obtained within seven months after sowing the seed, and the yield continues to increase for several years. Farmers report 3 to 5 tons per acre as the usual yield of hay per acre on prairie soil in Alabama, and in a number of instances these yields are greatly exceeded.

Alfalfa makes an unrivaled hog pasture, and is also recommended as a pasture plant for horses and mules. Cattle and sheep sometimes bloat when grazing on al-

falfa. Pasturing, especially during the first year, injures and sometimes kills alfalfa.

Soils for alfalfa should be rich, well drained, well supplied with lime and vegetable matter. Alfalfa has been repeatedly demonstrated to be a success on the best grades of prairie soil on both uplands and lowlands. There is reason to believe that alfalfa will thrive on the lime soils of the Tennessee Valley region and on other calcareous soil in Alabama, and on fertile, well drained, alluvial soils in nearly every part of the State.

A crop of 4 tons of alfalfa hay contains 176 pounds of nitrogen, 40.8 pounds of phosphoric acid (equal to that in 336 pounds of high grade acid phosphate), 134.4 pounds of potash (equal to that in 1,075 pounds of kainit, or in 269 pounds of muriate of potash, and 280 pounds of lime. To replace only the phosphoric acid and potash by commercial fertilizers an expenditure of about \$8.75 would be required.

The preparation of the land for alfalfa should be thorough, including plowing as deep as practicable, and repeated use of disc and spike tooth harrow. Generally it is best to plow a number of weeks before the seed are to be sown. A weeder or light harrow is the preferred mode of covering the seed, which are sown broadcast at the rate of 20 pounds or more per acre. Fall planting before October 15, when practicable, gives alfalfa a start ahead of weeds, but spring planting (early in March), is usually more convenient.

Alfalfa, especially that sown in the spring, requires land as free as possible from seeds of weeds, crab grass, etc. Repeated use of the mower during the first year is the preferred method of combatting weeds in alfalfa.

Planting alfalfa in drills and cultivating it may be

suitable for a small patch kept for feeding green, but this system was found impracticable for a hay field.

Usually the best crop to precede spring sown alfalfa is cotton, especially if cotton follows melilotus (sweet clover). The best crop to prepare the land for fall sown alfalfa is cow peas, sown very thick.

Numbers of farmers have found that alfalfa thrives when sown on Johnson grass meadows, holding its own, at least for the first few years, against this aggressive grass.

Dodder, a yellow thread-like growth, is a serious enemy of alfalfa. One of the remedies consists in mowing and burning. Seed merchants often pass alfalfa seed through a machine which is claimed to remove the dodder seed.

On sandy upland soils at Auburn alfalfa has not afforded very profitable yields. On such soils it requires heavy applications of lime or barnyard manure, and it is believed that more profitable use can be made of manure. At Auburn neither nitrate of soda nor cotton seed meal very greatly increase the yield of alfalfa that was properly stocked with root tubercles. Acid phosphate and potash fertilizers are considered indispensable here, and generally advisable on sandy or other soils not rich in lime.

Inoculation with soil from old fields of either alfalfa or bur clover greatly increase the yield of alfalfa growing on sandy land.

The germ that causes tubercles to develop on sweet clover (melilotus) also causes tubercles to develop on the roots of alfalfa. Hence artificial inoculation of alfalfa is not necessary when it is grown on prairie land that has recently borne a crop of melilotus. Artificial

inoculation of alfalfa is probably advisable even for prairie soils when it is uncertain whether either the melilotus or alfalfa germs are present in great numbers.

In regions in Alabama where neither alfalfa, melilotus, nor bur clover is extensively grown, inoculation of alfalfa is advisable. For this purpose one may use soil from old fields of either of these plants or inoculating material prepared in the laboratory.

