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ALFALFA GROWING IN MISSOURI

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ALFALFA GROWING IN MISSOURI

M. F. Miller, Professor of Agronomy.

The interest that is being taken in alfalfa by Missouri farmers indicates that the crop is to become quite generally grown throughout the State. It has been but a few years since it was supposed that alfalfa could not be grown successfully except in the dry soils of the West, but it is now being grown in parts of every state in the Union. It should not be inferred from the preceding statement that alfalfa will ever come to be profitable on every type of soil in Missouri, but a better knowledge of how to grow and handle the crop by the farmers of the State will mean a much wider adaptation than is generally conceded. It is now being grown commercially and with much profit in several localities, the most important areas being those of the Mississippi bottoms in southeast Missouri, and in the Missouri river bottoms of the northwest. Many men are growing it with success in various other parts of the State, both on upland and lowland soils, and its further extension seems only a matter of learning the peculiarities of the plant. It usually requires some experience or knowledge of the habits of the crop to grow it successfully on soils to which it is not well adapted and the large number of failures which have been reported by farmers can be attributed to this cause. It is with the idea of calling attention to the more important principles underlying the successful culture of alfalfa that this bulletin is published.

Note.—Credit is given to R. E. Hyslop, who held a fellowship in Agronomy in 1905-6, for aid in collecting data for this publication.

CHARACTER OF THE ALFALFA PLANT.

The alfalfa plant belongs to the general order of legumes, and is closely related in character to the clovers. It is characterized by a very long tap root and an upright stem, which in time, especially under the influence of cutting, is multiplied into many stems arising from a crown just above the ground. The leaves have three leaflets as in the clovers, but are more narrow and of an even green color. The blossoms are of a purple color varying somewhat in shade, and are in the form of rather loose heads borne at the ends of the stems and branches. The seeds are borne in spiral pods and while they resemble red clover in general shape they are large, somewhat more kidney-shaped, and are of a greenish yellow when threshed, changing to a brownish color with age and exposure to light. The plant bears quite a strong resemblance to what is commonly known as sweet clover or bee clover (*melilotus alba*) but that plant is distinguished from alfalfa by its much larger, coarser growth, by its rank odor and its light-colored blossoms. The leaves of the sweet clover are also more thickened and somewhat more deeply notched.

The most striking characteristic of alfalfa is undoubtedly its long, straight tap root which often reaches depths of six feet or more, many instances having been recorded of roots going over ten feet in loose well-drained soil. Such a root is able to draw on the water stored in the lower soil layers and it is to this character that the plant owes its remarkable drought resistance when once well established. Many fibrous roots are thrown off from this tap root, especially in the upper two feet of soil, which penetrate laterally and bear the tubercles so important to the successful growth of the plant on ordinary soils (see cut). Another striking character of the plant is its ability to stool or send

up new stems after each cutting. In fact the cutting of alfalfa when young seems rather to invigorate than weaken the plant and one of the essentials to successful alfalfa culture is the frequent clipping of the plants during the first season of growth. The cutting back gives a more stocky character to the plant, widens the crown and seems to aid in the permanent setting of the roots in the soil. If the clipping is not done, the plants grow up tall and spindling, and on the poorer soils especially, they are almost certain to turn yellow and die.

THE VALUE OF ALFALFA TO THE FARMER.

The value of alfalfa as a farm crop is not generally recognized by the farmer. It will give from three to five cuttings annually, yielding from one-half to one and one-half tons per acre for each cutting, depending upon the richness of the soil, thickness of the stand and character of the season. An average yield when the plants are well set on soils to which the crop is well adapted is one ton for each cutting, giving an annual yield of about four tons. Many farmers exceed this yield on good soils, some even doubling it, but the figures given are conservative for good alfalfa soil. On thin lands the yield may drop to one-half ton per cutting, or even less, but such soils are not adapted to alfalfa unless barnyard manure is liberally applied.

Reports received from eight farmers growing alfalfa in Holt county give an average yield of six and one-half tons per acre, and from fifteen farmers reporting from Pemiscot county, the average is approximately five tons per acre. These farmers are growing alfalfa on the bottom lands to which the crop is well adapted. On the uplands of Cass county ten farmers out of fifteen reporting, give a yield above three tons, while seven of these report yields of four and one-half tons or over. One report gives six tons:

The five farmers whose yields are not given were not successful in growing the crop.

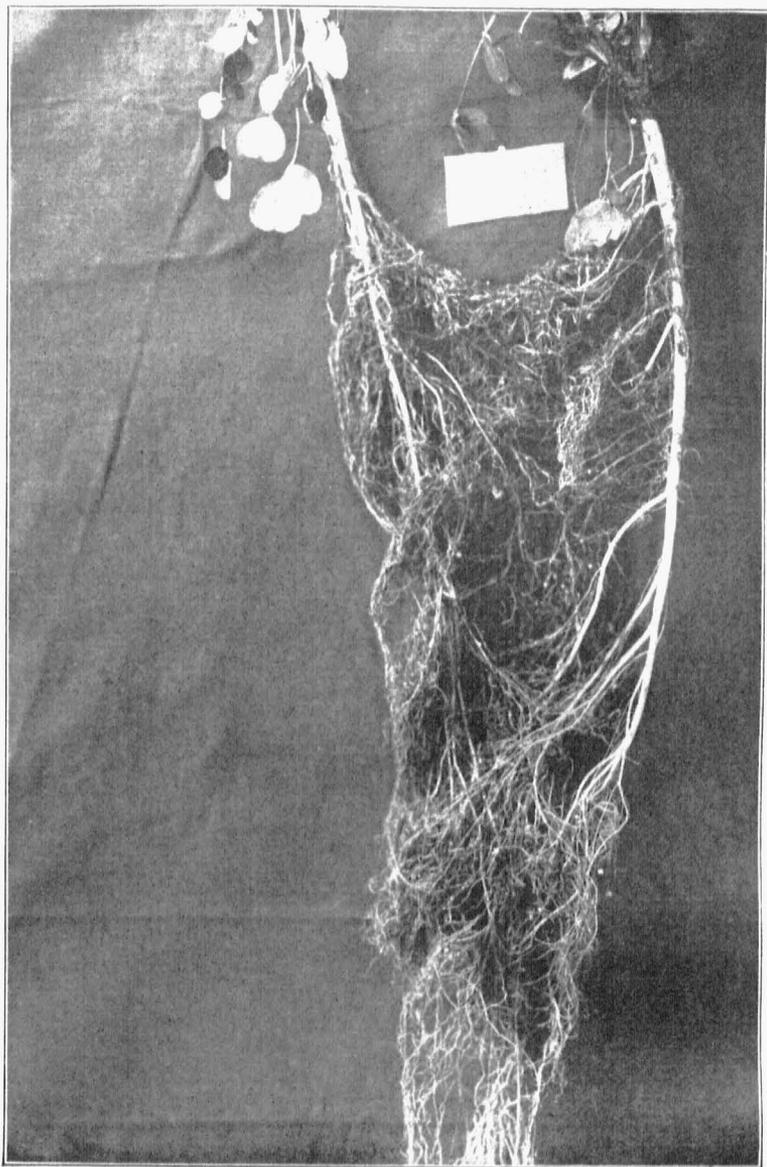
A farmer from Atchison county reports: "On a field of six acres, the first cutting made two and one-half tons per acre, the second cutting six bushels of seed and one and one-half tons of straw, the third cutting one and one-half tons of hay. The seed sold for six dollars per bushel and the hay baled at home, at \$7.50 per ton."

A farmer from Holt county makes this statement: "I have an account of a twelve-acre field of alfalfa for last year. The first cutting made thirty-six tons, at ten dollars per ton. The second cutting yielded 2,400 pounds of seed selling at ten dollars per hundred. I fed out the threshed hay and also the third crop, which was about the same as the first. I pastured the field some in the fall."

A Jackson county farmer writes: "Alfalfa will make an average yield of four tons per acre of good dry hay which on the farm is worth twenty dollars per acre."

The above statements are given to indicate the possibilities of alfalfa growing as stated by men who have made a success of the crop in Missouri. They undoubtedly represent the maximum as to yields and profits but many other farmers can do as well with a proper handling of the crop.

Alfalfa as a Feed.—As a dry feed alfalfa cannot be surpassed for dairy cows or fattening animals, and for horses it is as good as timothy. Its special value lies in the large amount of digestible protein it contains and in its palatability. The usual difficulty in feeding on the average farm is to secure a feed at a moderate price which will contain sufficient protein. A carbonaceous food like corn must be fed with a hay containing considerable protein, as clover, or a nitrogenous feed must be purchased if a balanced ration is to be obtained. Alfalfa hay is much superior to clover for this purpose.



ALFALFA ROOTS. Notice the long tap-roots and the lateral roots bearing the tubercles. These plants were grown in tall pots and the soil carefully removed from the roots by washing.

The following table, taken from Minnesota Bulletin No. 80, shows the feeding value of alfalfa as compared with other common feeding stuffs:

PERCENTAGE OF DIGESTIBLE NUTRIMENT IN DRY MATTER.

	Crude Protein.	Ether Extract. (Fat.)	Fiber.	Nitrogen—free extract. (Carbohydrates.)	Ash.
Alfalfa	13.13	1.46	19.64	26.61	4.30
Red Clover	7.52	1.80	14.53	32.13	2.28
Timothy	3.40	1.30	16.20	27.20	
Corn Fodder. . . .	3.90	2.20	14.10	37.10	
Barley	9.10	1.80	2.40	56.60	
Corn Meal	9.00	2.80	1.00	66.40	
Wheat Bran . . .	12.50	3.60	3.60	38.50	

It will be noticed from this table that as compared with clover hay the digestible protein in alfalfa is much higher, being in fact the highest of all the feeds given, while the 'ash,' which is such a valuable constituent of a food for growing animals, is also much higher than in clover. On the whole the analysis shows the alfalfa to be very similar to wheat bran in actual feeding value.

Alfalfa as a Pasture.—As a pasture alfalfa has many disadvantages. The crop makes a most excellent pasture for all classes of animals but great precaution must be taken in pasturing it. The difficulties arise from the injury to the plants which close cropping may cause and to the fact that in cattle and sheep it is liable to cause bloat. According to reports received from farmers over the State, those who have attempted to make a continuous pasture of it have failed. After the plants are well established it will stand much closer pasturing than when plants are young, but care

must always be taken to prevent too close cropping, especially with sheep, and the number of animals allowed on a field should therefore be limited to several less than might be supported. Excessive tramping, especially on young fields or in wet weather, is very injurious and the crop should therefore not be pastured in early spring. Late fall pasturing is also harmful if the plants are not allowed time to recuperate before winter. The usual result of continuous pasturing seems to be the killing out of the alfalfa and the coming in of blue grass. The best method seems to be that of intermittent rather than continuous pasturing, and then for only such time as will prevent its being cropped too closely. The danger from bloat may be lessened, if not entirely removed, by using care to turn the animals on for only short periods at first and then allowing them free access to a good bluegrass pasture.

Effect of Alfalfa Growing on the Soil.—The effect of alfalfa growing on the soil is much the same as that of red clover. It has the same power of gathering the free nitrogen from the air and fixing it in its roots, thus increasing the supply of this element in the soil, but as several crops are removed each year the crop is exhaustive on certain mineral elements such as lime, phosphorus and potassium. As it feeds so deeply however, this exhaustion is not so strongly felt as it would be otherwise and the effect on crops following is much like that of red clover. Since alfalfa is a legume taking its nitrogen supply from the air it is often said that it will grow upon poor soils, and while this is generally true, if the soil is well drained and not foul, it rarely gives sufficient yield on such soils to be profitable. The effect of the plant upon the physical condition of the soil is beneficial because of the deep tap roots penetrating the soil and thus opening it up for air and drainage.

Exact experiments as to the value of this mechanical effect have not been made however, although it is probable that not a little benefit to future crops is due to this action.

A word should be said regarding the limitations of this crop since it has several disadvantages. In the first place it is not well adapted to a short rotation. It takes two or three years for alfalfa to reach its greatest efficiency, and should usually be allowed to run not less than five or six years for best results. It may of course run much longer than this under favorable conditions. It is a crop which should be seeded on land that can be thrown out of a short rotation, or that can be used for a rotation covering several years. Another disadvantage is in the difficulty with which an alfalfa field is plowed after the plants are once well seeded, as it usually requires four horses to an ordinary twelve or fourteen inch plow. There is no difficulty in eradicating the plant when plowing is done thoroughly and the land is put into a cultivated crop like corn, but poor plowing may result in many plants persisting to come up for a series of years. Another important disadvantage in handling the crop in this State is in curing the first cutting. This comes along in May when the weather is inclined to be showery and very often great difficulty is experienced in handling this cutting. Later cuttings are not so apt to be injured by rain and can usually be harvested without difficulty.

ADAPTATION OF ALFALFA TO MISSOURI CONDITIONS.

Investigations by this Station regarding the adaptation of alfalfa to the various soils of the State have been in progress for some time. They were systematically begun in 1902 by Dr. G. M. Tucker, who was at that time a member of the Experiment Station staff. In 1903 the aid of the

United States Department of Agriculture was secured in this work and the investigations were continued until the fall of 1904, when Dr. Tucker severed his connection with the Experiment Station. The work was again taken up in the fall of 1905 by Mr. R. E. Hyslop, who at that time held a Fellowship in Agronomy at the College of Agriculture, and to whom credit is due for much of the data here given regarding the adaptation of this plant to Missouri conditions. The Experiment Station has also conducted experiments upon the Station grounds for a number of years with this crop, the results of which are partly included in this publication.

• The investigations of Dr. Tucker consisted of chemical and physical analysis of the soils of the State, greenhouse pot experiments on various soil types and of field tests over the State in which several treatments were given the soil in an effort to find the best means of securing a permanent stand. Dr. Tucker also made personal visits to many localities in pursuance of these investigations.

The work of Mr. Hyslop has been that of gathering statements from the farmers over the State who have been experimenting with alfalfa, either under the direction of Dr. Tucker or independently, and the summaries represent the experience of 340 men from whom reports were received.

Climate.—The climate in Missouri is not perfectly adapted to alfalfa growing. The hay is often difficult to cure owing to wet weather and for the same reason seed does not seem to be produced so readily as in the irrigated regions. The crop seems particularly adapted to a dry, hot, sunny climate like that of our western country where it is grown under irrigation. The indirect effects of a humid climate, such as the heavy soils resulting from our heavy rainfall, and the tendency to sourness which such

soils often show, are additional disadvantages. The plant grows here as thriftily as in the semi-arid regions, however, providing the soil is rich and other conditions favorable.

On account of the uncertain weather in May, attempts have been made to use the crop for silage with fair results. Attempts have also been made to pasture the first crop, but this is not to be advised unless great precautions are taken.

Soils.—Alfalfa is not well adapted to all Missouri soils. The natural habitat of the plant seems to be the dry, loose soils of the semi-arid regions. These soils are usually deep and contain a greater or less amount of soluble alkali salts, which in the lesser amounts at least, seem to be favorable to the plant's development. The deep-root system is not hindered in its downward growth by such loose soils and the development of the root system overcomes to quite an extent the lack of moisture. Where irrigation can be practiced on such soils, the plant seems to reach the ideal development. Missouri soils are generally compact in the subsoils, and in the northern part of the State are usually lacking in drainage, so that the growing of alfalfa on such soils requires a thorough knowledge of the nature of the plant. The deep tap root is hindered in its downward growth by the heavy clay soil and often by the presence of water standing near the surface. Moreover, such soils are inclined to be sour, which condition is detrimental to the growth of the plant because it prevents the normal development of the bacteria which inhabit the tubercles. Again, many of the soils of the State are lacking in fertility, and for this reason are not adapted to the profitable production of the crop. All of these conditions can be remedied, at least to some extent, or alfalfa may be grown in spite of many of them when properly handled, but the presence of these un-

favorable conditions necessitates a thorough knowledge of the character of the plant and the proper method of handling to secure a profitable stand.

According to reports received from farmers and from observations made in connection with these investigations, the subsoil seems to be the controlling factor in the successful growing of alfalfa in Missouri. It appears that any soil that is moderately fertile, that is sweet and well drained and that is underlaid with a loose subsoil, will produce alfalfa successfully if ordinary care is taken in handling the crop. But on a soil underlaid with a stiff, compact subsoil the matter of securing a permanent stand is much more difficult. It should not be inferred that it cannot be grown by proper management, but for the farmer who is unacquainted with the handling of the crop, the heavy subsoil is a sufficient cause of failure. The following tables compiled by Mr. Hyslop from reports received from eighty counties of the State show very well the character of the subsoil as it affects the successful growth of the crop. It will be observed from these tables and the accompanying map that the largest number of successful alfalfa stands reported are along the Mississippi and Missouri River bottoms and in the regions of the better uplands especially those with the less compact subsoils. The thin lands of the higher Ozark country around Reynolds and Iron Counties and the prairies of the north which are underlaid by a compact subsoil show few successful reports.

RELATION OF STIFF SUBSOILS TO SUCCESS OBTAINED IN
GROWING ALFALFA.

County.	Total No. Reporting.	Total No. who succeeded.	No. who succeeded on stiff subsoil.	No. who succeeded on medium stiff subsoil.	No. who did not men- tion type of subsoil.
Andrew	4	4	1	2	1
Atchison	6	6	..	1	1
Audrain	2	1	..	..	..
Barry	5	2	..	..	1
Barton	2	1	..	..	1
Bates	10	3	..	..	1
Benton	8	7	..	..	..
Bollinger .....	..	..	..	..	..
Buchanan	1	1	..	..	1
Caldwell	5	3	2	1	..
Callaway	9	6	..	1	1
Camden	4	3	..	..	1
Cape Girardeau	2	1	..	..	4
Carroll	2	2	1	..	..
Cass	16	15	5	..	..
Cedar	1	..	..	..	..
Chariton	10	7	1	..	3
Clay	14	12	..	1	6
Clinton	2	1	..	..	..
Cooper	2	1	..	..	..
Crawford	3	1	..	..	1
Dade	1	..	..	..	..
Dallas	5	4	..	1	..
Daviess	1	..	..	..	..
DeKalb	6	5	..	1	4
Douglass	2	2	..	..	2
Dunklin	3	1	..	..	..
Franklin	8	7	2	..	1
Gasconade	1	..	..	..	..

RELATION OF STIFF SUBSOIL TO SUCCESS OBTAINED IN
GROWING ALFALFA.—Continued.

County.	Total No. Reporting.	Total No. who succeeded	No. who succeeded on stiff subsoil.	No. who succeeded on medium stiff subsoil.	No. who did not men- tion type of subsoil.
Henry	9	3	2	..	..
Hickory	1	1	..	..	..
Howard	2	2	..	..	..
Holt	7	7	..	..	..
Howell	7	2	..	..	..
Iron	1	..	..	..	..
Jackson	6	5	1	..	2
Jasper	5	3	..	..	1
Johnson	9	7	..	1	3
Jefferson . . . . .	..	..	..	..	..
Laclede	4	2	1	..	1
Lafayette	2	2	..	..	2
Lawrence	2	2	..	1	..
Lewis	3	3	..	..	2
Lincoln	1	1	..	..	1
Linn	9	4	2	..	1
McDonald	4	1	1	..	..
Madison	1	1	..	..	..
Miller	3	1	..	..	1
Moniteau	6	2	..	..	2
Montgomery	1	..	..	..	..
New Madrid	9	9	1	..	2
Newton	1	1	..	..	1
Nodaway	2	2	1	..	1
Osage	4	1	..	..	..
Ozark	1	..	..	..	1
Pemiscot	18	18	..	..	..
Perry	6	5	1	2	..
Pettis	8	6	..	..	3

RELATION OF STIFF SUBSOIL TO SUCCESS OBTAINED IN
GROWING ALFALFA.—Continued.

County.	Total No. Reporting.	Total No. who succeeded	No who succeeded on stiff subsoil.	No. who succeeded on medium stiff subsoil.	No. who did not men- tion type of subsoil.
Phelps	1	..	..	..	..
Pike	2	2	1	..	..
Platte	3	3	1	1	..
Polk	2	1	..	..	..
Pulaski	3	2	..	..	..
Putnam	1	1	..	..	1
Randolph	3	1	..	..	..
Ripley	1	..	..	..	..
Saline	12	10	1	2	2
Schuyler	1	1	..	1	..
Shannon	2	2	1	..	..
St. Charles	11	7	..	1	5
St. Clair	5	5	1	..	1
St. Francois	2	..	..	..	..
St. Genevieve	2	1	..	..	..
St. Louis	1	..	..	..	..
Sullivan	1	..	..	..	..
Taney	4	3	..	..	2
Texas	6	6	1	..	..
Vernon	4	1	..	..	1
Warren	1	1	..	..	..
Webster	3	2	..	1	..
Wright	1	1	..	1	..
Total	341	239	27	20	65

RELATION OF CHARACTER OF SUBSOIL TO FAILURES.

County.	Total No. Reporting.	Total No. Failures.	Failures on Stiff Subsoil.	Failures on Medium Stiff Subsoil.	Failures on Loose Subsoil.	Character of Subsoil Not Reported.
Andrew	4	..	..	..	..	..
Atchison	6	..	..	..	..	..
Audrain	2	1	..	..	..	1
Barton	5	3	2	..	..	1
Barry	2	1	..	..	..	1
Bates	10	7	6	..	..	..
Benton	8	1	1	..	..	..
Buchanan	1	..	..	..	..	..
Caldwell	5	2	..	..	1	1
Callaway	9	3	2	..	..	1
Camden	4	1	1	..	..	..
Cape Girardeau	2	1	..	..	..	..
Carroll	3	1	1	..	..	..
Cass	16	1	1	..	..	..
Cedar	1	1	1	..	..	..
Chariton	10	3	..	..	1	2
Clay	14	2	1	..	..	1
Clinton	2	1	..	..	1	1
Cooper	2	1	..	..	..	..
Crawford	3	2	1	..	..	1
Dade	1	1	..	..	..	1
Dallas	5	1	..	..	1	..
Davies	1	1	..	..	..	..
DeKalb	6	..	1	..	..	..
Douglas	2	..	..	..	..	..
Dunklin	3	2	1	..	1	..
Franklin	8	1	..	..	1	..
Gasconade	1	1	..	..	..	1
Henry	9	6	6	..	..	1

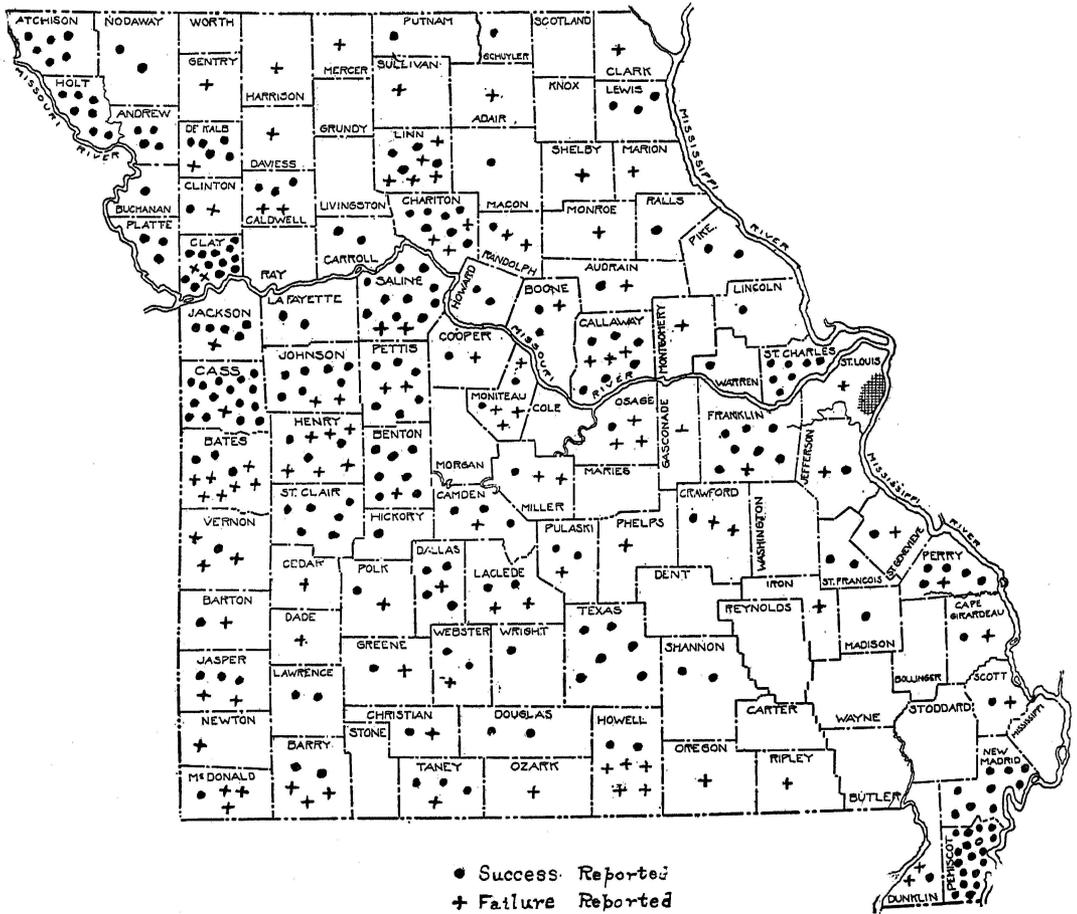
RELATION OF CHARACTER OF SUBSOIL TO FAILURES.

County.	Total No. Reporting.	Total No. Failures.	Failures on Stiff Subsoil.	Failures on Medium Stiff Subsoil.	Failures on Loose Subsoil.	Character of Subsoil Not Reported.
Hickory	1	..	..	..	..	..
Howard	2	..	..	..	..	..
Holt	7	..	..	..	..	..
Howell	7	5	3	..	1	1
Iron	1	..	..	..	..	1
Jackson	6	1	1	..	..	..
Jasper	5	2	1	..	1	..
Johnson	9	2	1	..	..	1
Jefferson . . . . .	..	..	..	..	..	..
Laclede	4	2	..	..	1	1
Lafayette	2	1	1	..	..	..
Lawrence	2	..	..	..	..	..
Lincoln	1	..	..	..	..	..
Linn	9	5	2	..	..	3
McDonald	4	3	1	..	2	..
Madison	1	..	..	..	..	..
Miller	3	2	2	..	..	1
Moniteau	6	4	3	..	..	1
Montgomery	1	..	..	..	..	..
New Madrid	9	..	..	..	..	..
Newton	1	..	..	..	..	..
Nodaway	2	..	..	..	..	..
Osage	4	3	..	..	2	1
Ozark	1	..	..	..	..	..
Pemiscot	18	..	..	..	..	..
Perry	6	1	1	..	..	..
Pettis	8	..	2	..	..	..
Phelps	1	1	1	..	..	..
Pike	2	..	..	..	..	..

RELATION OF CHARACTER OF SUBSOIL TO FAILURES.

County.	Total No. Reporting.	Total No. Failures.	Failures on Stiff Subsoil.	Failures on Medium Stiff Subsoil.	Failures on Loose Subsoil.	Character of Subsoil Not Reported.
Platte	3	..	..	..	..	..
Polk	2	1	1	..	..	..
Pulaski	3	1	1	..	..	..
Putnam	1	1	..	..	..	1
Randolph	2	2	..	..	1	1
Ripley	1	1	1	..	..	..
Saline	12	2	1	1	..	..
Schuyler	2	..	..	..	..	..
Shannon	2	..	..	..	..	..
St. Charles	11	3	1	1	..	1
St. Clair	5	1	..	..	..	1
St. Francois	1	1	..	..	..	..
St. Genevieve	2	1	..	..	1	..
St. Louis	1	1	..	..	..	..
Sullivan	1	1	..	..	..	..
Taney	4	1	..	..	..	1
Texas	6	..	..	..	..	..
Vernon	4	3	3	..	..	..
Warren	1	..	..	..	..	..
Webster	3	1	..	..	..	..
Wright	1	..	..	..	..	..
Total	342	103	53	4	15	31

Note.—Most of the failures reported on loose subsoils were due to floods.



Map showing the successes and failures in growing Alfalfa, reported by Missouri farmers.

It will be noticed that over half the failures reported were on soils underlaid by stiff subsoils. If the other thirty-one had reported the character the subsoil, this number would doubtless have been increased. On the other hand, while much of the larger number of successes were on loose subsoils, twenty-seven report successful stands on heavy subsoils, which demonstrates the fact that it is not impossible to grow the crop under such conditions.

It is undoubtedly unwise to draw conclusions from reports of this nature without making due allowance for the variation in judgment of such a large number of individuals as to what constitutes a stiff subsoil, but there would seem to be little reason to doubt the general accuracy of their reports. The methods of handling the crop on soils having stiff subsoils are becoming better understood and the future will doubtless see the extension of successful alfalfa culture to some of the most impervious subsoils in the State. The experiments and methods reported in the following pages will throw some light upon this problem.

INVESTIGATIONS OF THE EXPERIMENT STATION.

The investigations of the Station regarding the best methods of growing alfalfa include such matters as the treatment of the soil, time and manner of sowing, methods of curing and handling the hay and the general subject of adaptability of the crop to Missouri conditions.

Inoculation.—The alfalfa plant, in common with all legumes, bears upon its roots the nodules inhabited by a class of bacteria which have the power of fixing within their bodies the free gaseous nitrogen of the air, in a form available to plants. On soils poorly supplied with this element (that is, those containing an insufficient amount of decaying vegetable matter) these bacteria seem to be essential to the

proper development of the plant. If the soil is rich in nitrogen, so that the alfalfa plant can secure a sufficient quantity from this source these bacteria do not seem to be essential. Since most soils do not contain a sufficient amount of this element, however, the presence of these particular bacteria is important, and as a result much has been written regarding the value and necessity of inoculating soils on which alfalfa is to be grown.

The matter of inoculating is merely the introduction into the soil of the bacteria of the particular kind that are adapted to the legume which one wishes to grow. It may be accomplished in different ways. One method is by taking soil from a field already successfully growing this particular legume and scattering on to the field which it is desired to inoculate. The bacteria are thus transferred from one field to another in the soil. Another method is by what is known as a "pure culture" of the bacteria in which case they are taken from the nodules of healthy plants, developed into very large numbers in some suitable medium and then transferred either to the seed before planting or they are mixed with soil which is then scattered over the field to be inoculated. Various methods have been devised for transporting these cultures long distances, but the one most practical seems to be that of transferring the bacteria in a dormant form from the laboratories to the man who wishes to use them and allowing him to grow them to large numbers in a solution which is readily prepared from material sent with the bacteria. This solution is then either sprinkled over the seeds so as to moisten all of them or it is sprinkled on a small amount (about 100 pounds) of soil which is then mixed with a larger amount and scattered over the field.

These methods of inoculation have been tried at the

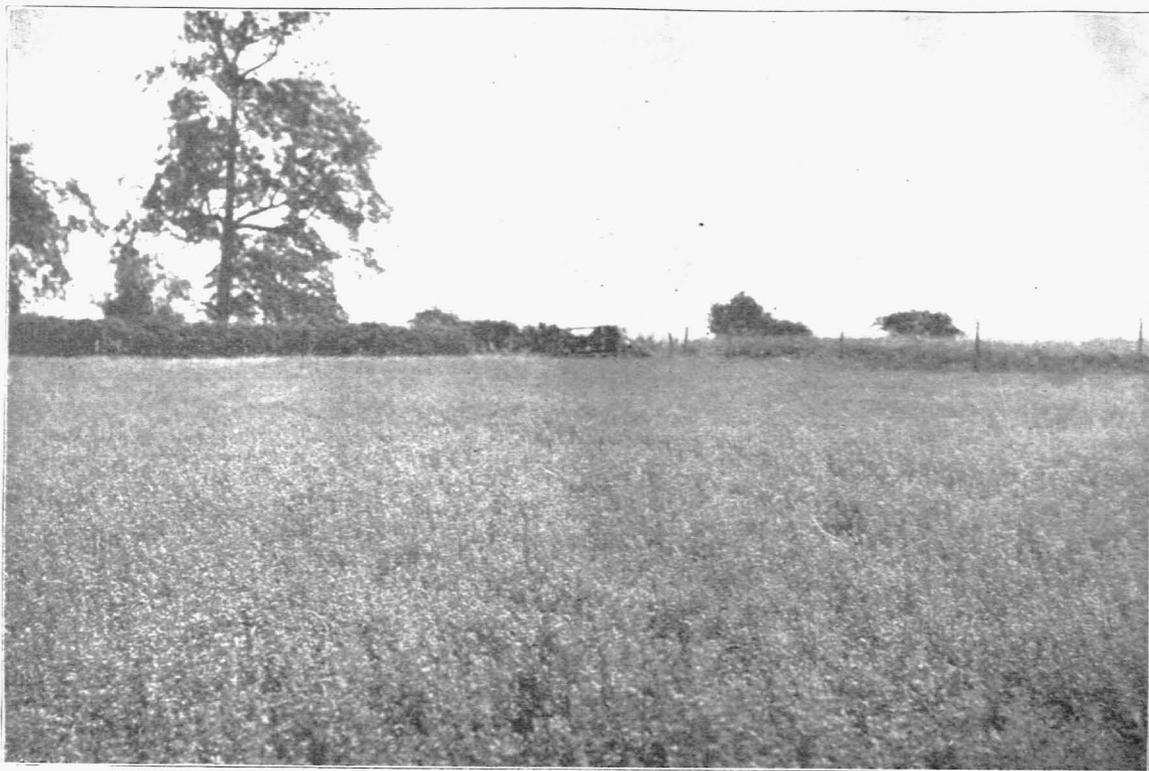
Experiment Station with varying results. In general, however, it has been found that on the soil of the Station fields the proper inoculation is accompanied by a marked benefit in the early growth of the plants, although as they develop further, less benefit is noticeable. This may be due to the fact that alfalfa has been grown at various times in the past on parts of this land and occasional plants still persist along the roadways and fences. This would of course mean that the soil is at least sparsely supplied with these bacteria and that after the plants have been growing on a block for a year or more they develop and spread in sufficient numbers to inoculate the whole. That this is possible seems well shown in several instances that have come under our notice. The experience of a grower in Dunklin county, who was experimenting under the Station's direction, is interesting in this connection. He writes May, 1904, as follows:

"This plot was sown June, 1903. The soil, seed and method of growing were the same and the seed was sown on the same day. All came up well and little difference was noticeable in the fall. It was all cut once. In the spring all came up equally well, but for the last month or five weeks, that inoculated has continued to grow well. Some of it is blooming and is about ready to cut. That which was not inoculated is turning yellow and beginning to die except in occasional bunches which seem to be doing better than the rest. I think this part will all die in a short time."

In a later report received April, 1906, this man states that the inoculated plot improved, seemingly from the distribution of the bacteria through the soil, and that a permanent stand had been secured. In this case the bacteria which inoculated the scattering plants were undoubtedly transferred to the soil on the seed, since in the ordinary process of curing alfalfa for seed it is very probable that

some bacteria are thus carried from the field. This accounts for the fact frequently noticed that a field sown to alfalfa or other legume a second time after one crop has failed will often make a successful growth. The bacteria introduced on the seed of the first sowing produce tubercles on the roots of a part of the plants and develop in sufficient numbers to gradually inoculate the whole field.

In the case of soils that are rich and contain plenty of available nitrogen, the plants may find sufficient of this element present to grow and thrive for a time even in the absence of bacteria. What usually happens, however, is that some bacteria are introduced as above indicated, and as the soil is depleted in its nitrogen, they gradually develop until it is thoroughly supplied. In the case of rich soils, therefore, it will be seen that inoculation may not be necessary. Experiments have pretty conclusively shown that the plant known as sweet clover (*melilotus alba*), sometimes called bee clover or Bokhara clover, has the same type of bacteria growing upon its roots as are found on alfalfa roots, so that in regions where this plant is common the soil is usually well supplied with the proper bacteria. The bacteria producing the nodules on other legumes are entirely different from those on alfalfa, in fact almost every legume has a distinct type of organism. Soils usually contain those found on the more common legumes, from the fact that they have long been grown in most sections of the State. Since these will not grow on the alfalfa roots, however, the growing of clover or cowpeas preceding a crop of alfalfa does not mean that the soil will be supplied with the bacteria for alfalfa. Bottom lands subject to overflow or washing from uplands, are usually supplied with alfalfa bacteria, probably from the drainage from areas where either alfalfa or sweet clover is growing, and as a consequence rarely need



Alfalfa on the Experiment Station grounds at Columbia. Photo taken June, 1906, before second cutting. Sown in August, 1903.

inoculation. Experiments indicate, however, that the average upland, in regions where both of these plants are unknown, usually needs inoculation to secure a permanent stand unless the soil is sufficiently rich to carry the young plants along until the scattering bacteria introduced on the seed have had time to develop.

The most certain method of inoculation seems to be by means of soil. This is accomplished by taking soil from a field where alfalfa has been growing well for two or more years and scattering it over an area to be inoculated. The soil for this purpose should be taken to the depth of six or seven inches, scattered on with a shovel and harrowed in. This will necessitate the ground being in good condition at that time in order that the infected soil may be well worked in. It is necessary to do this at once after scattering, since a few hours exposure to the sun either kills the bacteria or so weakens them as to interfere with their proper growth. The amount of soil to use will vary from 300 to 1,000 pounds per acre, depending upon the manner of application. If it is simply scattered on with a shovel, the larger amounts are usually necessary in order to make the soil cover the acre evenly. If it is necessary to ship soil long distances, however, two or three hundred pounds may be mixed with a large amount of soil from the field to be inoculated and thus more easily made to cover an acre. A small amount of soil may also be used in this way by drying it away from the sun, sifting and putting it in with the fertilizer attachment of a grain drill.

Inoculation with soil has the disadvantage of being somewhat expensive where the soil must be transported a long distance and also of making possible the introduction of noxious weeds, but the method is sure and requires no particular skill or knowledge of bacteria to handle. Care

should be taken to secure soil from a field on which alfalfa has been grown successfully for two or more years so that there will be no doubt as to the presence of the bacteria in the soil. The tubercles of the alfalfa plant are often difficult to find owing to their location on the small roots branching out from the tap roots, since these are usually left in the soil in pulling up a plant. They are best found by digging up the plant and examining the dirt in handfuls,



Alfalfa on farm of Geo. W. Williams, Humansville, Mo. Second crop, 35 days after first cutting, two years from seeding. This crop made $1\frac{1}{2}$ tons of cured hay per acre.

when they may be seen as oblong, sometimes fan-shaped, flesh-colored bodies, about one-eighth of an inch in length. They are often arranged in clusters making a mass almost a quarter of an inch across.

Inoculation of the seed by means of "pure culture" has been practiced for some years, but has recently come into prominence through methods devised by the United States Department of Agriculture, and through extensive advertis-

ing which has been given the matter both by agriculture journals and by certain concerns that are manufacturing these cultures for sale. Experiments with these cultures show that when properly used a thorough inoculation is usually obtained although it must be said that they are not entirely satisfactory since they are still in the experimental stage.

The culture is a preparation containing myriads of the bacteria grown in the proper medium from bacteria taken from the nodules on alfalfa roots. The material used for inoculating the seed may be a quantity of this culture, or it may be cotton which has been dipped in the solution and slowly dried in the absence of light, in which case the bacteria on its surface are not killed but rendered dormant. When this cotton is placed in clean water to which have been added certain substances for the purpose of furnishing them nutriment and otherwise furthering their growth, the bacteria develop rapidly and the solution becomes filled with them. The seed are then spread out and sprinkled with this solution, with constant shoveling until all are moistened, after which they are dried in a shady place and are ready for sowing. Usually seed inoculated in this way should be sown within a few weeks as the bacteria dried upon their surfaces gradually weaken with age. Seed thus treated must be worked into the soil at once to prevent injury to the bacteria from the sun.

Another form of this culture consists of a small vial of the original culture solution which is added to clean water and the bacteria developed in the same way as with the cotton. This latter method is the one now in use by the United States Department of Agriculture.*

*The Department of Agriculture has been sending this material free of charge in quantities sufficient for inoculating one bushel of seed to those who will agree to use it according to directions and report results carefully. It may be obtained while the supply lasts by addressing the Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

Experiments at the Station have included the seeding of alfalfa on both bottom land and upland. The bottom land was found to be well adapted to the crop without inoculation, but on the upland which has a heavy subsoil, and and is of only moderate fertility, the securing of a permanent stand has been very much more difficult. The benefit of both inoculation and lime in the early growth of the plant is indicated by an experiment begun in the spring of 1903 in which four plots were sown to alfalfa with the following treatments:

Plot 1 was sown without treatment.

Plot 2 was sown with inoculated seed.

Plot 3 was sown with inoculated seed and 1 ton lime per acre.

Plot 4 was sown with soil inoculation and 1 ton lime per acre.

These plots passed the summer of 1903 and the following winter in good condition and in May of 1904 gave the following yields of hay not perfectly cured:

Plot 1, 1300 pounds per acre.

Plot 2 2000 pounds per acre.

Plot 3 3800 pounds per acre.

Plot 4 4100 pounds per acre.

These results indicate a benefit from both inoculation and lime, the soil inoculation appearing to be the most efficient. As the season advanced, however, the grass took possession of the ground so that no further weights were taken.

The plots were allowed to run until the season of 1906 during which time the alfalfa has persisted in a fairly good stand in spite of the grass, on all plots except No. 1, which has finally succumbed. It should be noted, however, that this plot was on soil that seemed a trifle poorer than the

rest and somewhat more inclined to be wet and "spouty." This may account for the failure.

Other experiments on the upland soil have indicated much the same results in the effect of inoculation. While it gives a benefit in the early growth of the plants, its effect is not so noticeable thereafter. It should be said that this soil is of only average fertility which accounts largely for the result secured with this crop, and while it is growing successfully on several plots, the soil is not sufficiently fertile to give very abundant returns. Experiments are now in progress for the purpose of determining the effect of liberal manuring on this upland soil and they are indicating some striking benefits.

On the whole, it may be said regarding inoculation that a rich soil seems more important than inoculation and that the only soils on which inoculation will give much benefit are those of medium or low fertility where alfalfa or sweet clover has never grown.

ALFALFA AND SOIL ACIDITY.

The investigations of Dr. Tucker, corroborated by those of Mr. Hyslop, indicate that alfalfa cannot be grown successfully on soils that are sour, or acid. These investigations include the testing of a wide number of soils on which alfalfa growing is practiced, or has been attempted, and the results are fairly conclusive. These tests have been made both by means of litmus paper* and by the Hopkins

*The litmus paper test for sourness, while not entirely accurate, gives a fair indication of the soil as regards acidity, especially if the acidity is marked. It consists of mixing to a stiff mud with clean rain water the soil to be tested and inserting part way into it a piece of blue litmus paper, obtainable at any drug store. If after an hour the paper where it was in contact with the soil has turned a pinkish red color the soil is acid. A slight discoloration often shows, due to moistening. To be acid a soil must turn the paper distinctly pink.

method of determining the lime requirements of soils so that there seems little reason to doubt their accuracy. Of all the tests made on soils throughout the State, alfalfa has been found growing successfully on acid soil only in one instance, and in this case the acidity was very slight. The success in this case was undoubtedly due to cultural conditions and a rich soil.

A great many Missouri soils have a tendency to sourness, usually due to lack of drainage, and it is to these soils that attention must be given before alfalfa can be made to succeed. Obviously, one of the means of overcoming this condition is drainage, but as this is not always possible, the use of lime or manure may be resorted to. The difficulty of growing alfalfa on sour soil arises from the fact that the bacteria in the tubercles do not develop properly under such conditions, and also because the soil is usually not well supplied with lime. Alfalfa is a heavy feeder on the lime content of the soil and for this reason also a good lime content is desirable. Liming, therefore, gives a striking benefit to the alfalfa crop when it is properly applied. Barnyard manure, when applied heavily, also tends to correct this condition, and unless the soil is strongly acid, liberal manuring will usually bring results. It is therefore not impossible, if drainage can be controlled, to so change the conditions of a sour soil as to make alfalfa growing profitable.

Experiments in Liming.—The experiments which have been conducted on the effect of liming for alfalfa both at this station and over the State have given varying results. The experiment mentioned under the head of "Inoculation" shows some benefit from the lime. In the fall of 1904 several plots were sown at Columbia some being limed at various rates and others receiving no lime. The result was a fair stand over the whole area but with no difference notice-

able in the limed and unlimed plots during 1905. In the spring of 1906 little difference was observed except in the case of two plots on land somewhat wet and spouty. In these places the limed land seems to have a somewhat thicker stand and they have made a better growth. An experiment was begun in the fall of 1903 on a tract of three acres which was divided into three plots, one being limed at the rate of 1000 pounds per acre, one inoculated, and the third left untreated. The limed plot was the only one that proved a profitable stand, the others becoming very thin in large areas so that they were finally plowed up in the spring of 1905. The limed plot still persists and gives fair returns, although the soil is not sufficiently fertile for heavy yields. The soil from these plots shows only a slight trace of acidity, however, and it is doubtful whether the seeming benefit is from lime. It is noticeable that the soil where this lime was applied is inclined to be slightly more sandy than the other plots which may account for at least a part of the difference.

In the experiments conducted over the State, lime has given satisfactory results only on soils that tend to sourness. In these cases the liming has had the effect of either thickening the stand or of allowing it to persist in growth, while that on the untreated soil failed. Since sour soils are usually wet, however, the lime has not always resulted in growing a profitable stand. The drainage is as important as a neutral or alkaline soil for the growth of the roots, and while the correcting of the acidity by the lime may aid in promoting the growth of the plants, the soil must be reasonably well drained for a profitable stand. Undoubtedly lime will be found of much benefit on such soils, as it will remove one of the obstacles to successful alfalfa culture, but it must be used in connection with good cultural meth-

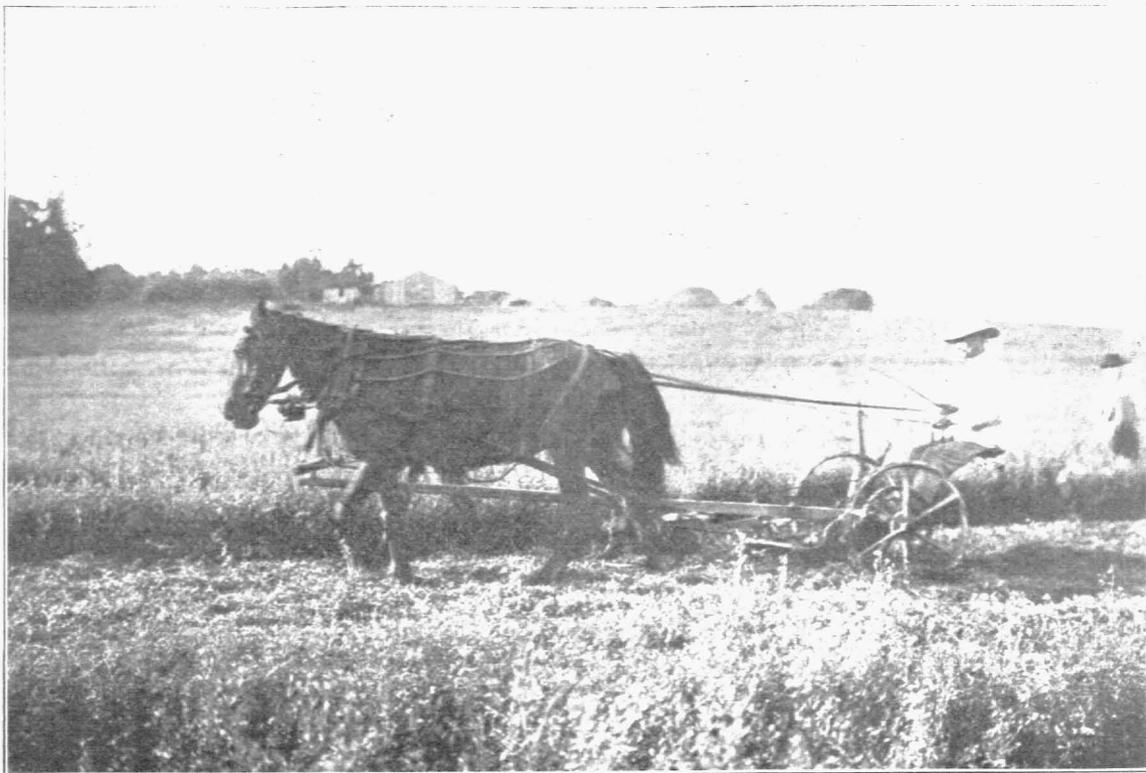
ods and a reasonable amount of drainage if a profit is to be secured.

How to Apply Lime.—The best form of lime to apply in any locality will depend upon the relative cost of each, and the means at hand for spreading. Air-slacked lime is most commonly used where one is near enough to a limekiln to get it cheaply as a waste product. Stone lime may be slacked by using just enough water to reduce it to a powder. The powdered limestone produced as a waste product at stone crushers is also used. It has the same composition as the air-slacked and when finely ground is practically as efficient. This material can now be secured of two or three concerns in the State, and unless a limekiln is convenient where the air-slacked lime can be secured, it is usually the cheapest form to apply. It also handles much better than the other forms as it is not so irritating to the mucous membranes in scattering.*

A pulverized form of caustic or stone lime is on the market and in some states it is used to considerable extent. It is crushed to small granules which are easily scattered by special devices made for the purpose, and when once in the soil soon slacks to a fine powder. It is difficult to prevent its partial slacking in shipment, however, thus making it rather hard to handle.

For correcting acidity, lime should be applied in amounts ranging from 500 to 4000 pounds, depending upon the degree of sourness of the soil. From one to two thousand pounds is a common application. It is best applied

*Firms handling this finely ground limestone for agricultural purposes are: The Crystal Carbonate Lime Co., of Elsberry, The Glenco Lime and Cement Co., of St. Louis, and the Western Crushed Stone Co., of Carthage. The price of this material is approximately \$1.00 per ton, F. O. B., in car lots.



Alfalfa on upland farm of Simon Baumgartner, Pierce City, Mo. Third cutting August 18. The three cuttings gave approximately $5\frac{1}{4}$ tons per acre.

just after plowing the land and thoroughly worked into the soil by disk and drag harrow. The thorough working in is important. It may be scattered with a shovel from a wagon or sled, or on a quiet day an end gate seeder may be used. The latter method is especially adapted to scattering the crushed limestone. A drill with fertilizer attachment may be used if it has sufficient capacity. The ordinary drill will not feed fast enough, however, and will require going over the land several times if the amount to be applied is large. If stone lime is to be used it may be placed in small piles over the field covered with moist dirt and allowed to slack, or it may be slacked by throwing a small amount of water on each pile. This puts the lime in position to be easily scattered with a shovel and is one of the simplest methods of application. Care should be taken to use only enough water to cause it to fall to a powder.

DIFFERENT DATES OF SEEDING.

The Station has made various tests as to the methods and times of sowing. The practice of spring sowing either alone or with a nurse crop such as is frequently done farther north, has as a rule proven unsatisfactory. On the whole, when spring sowing is done it seems best to sow without a nurse crop about the last of April or first of May. If the land is fall plowed, better results will usually be secured than where spring plowing is done. The difficulty with all spring sowing arises from the inability of the young plants to reach a sufficient size to withstand the weeds and grass of summer. Usually such sowing gives an early growth of fine dark green plants which later succumb to weeds and grass. This is not always true, however, especially if the land is rich and well adapted to alfalfa or if the season is favorable to its growth. Many

successful stands have been secured throughout the State by spring sowing, but the experience of the Station and of farmers who have tried sowing at both times gives strong preference to fall sowing.

A Clinton county farmer reports: "I sowed alfalfa in the spring two years. Each time I secured a good stand and as soon as it had made sufficient growth for the mower to clip I would cut it and leave it on the ground as a mulch and protection from the sun, but each year the foxtail came so thick that it smothered out the alfalfa and by fall there would be hardly any alfalfa left. The next year I sowed the first of September—got a good stand, made a very good growth that fall and the next spring got ahead of the foxtail. I cut some little hay from it that summer, but next year, which was last summer, I cut three crops of very good hay."

A Bates county farmer, who has sown both fall and spring, states that spring sowing has always resulted in failure, but fall sowing has been a success on his farm. As conditions in both these counties are unfavorable to alfalfa, such results would be expected. In Holt county and in counties of the southeast, where alfalfa is particularly adapted, very good results are obtained from spring sowing.

Spring sowing with a nurse crop is rarely practiced in this State, and at the Station has proven a failure. The nurse crop generally used is oats, sowing the oats thin, about five pecks per acre, and cutting for hay about the time they are in the milk. If left for seed they tend to dry the ground too much and then come off when the weather is hot. This sudden exposure of the young alfalfa plants to the sun and heat is usually fatal. Spring barley is also used in states farther north and is considered a better nurse crop than oats.

Fall sowing has the advantage over spring sowing in allowing the plants to get a good growth during the fall, thus giving them sufficient start to withstand the weeds and grass of the following summer. In this case the seed is sown without a nurse crop, sometime during the last half of August. Sowing as late as the middle of September will give good results some seasons, but is not to be recommended on account of the danger from winter killing. For average seasons, late August seeding is much to be preferred, especially on lands not particularly adapted to the crop. When fall sown, two to four crops can usually be harvested the next season if the soil is fertile, while in spring sowing the first year's crops are very light.

METHODS OF PREPARING SOIL.

The Station has made no experiments with the single idea of determining the best methods of soil preparation for alfalfa, although various experiments in which different methods were used indicate what appear to be proper and improper methods. In the first place it may be said that on soils well adapted to alfalfa the matter of soil preparation is not of so much importance as on those poorly adapted to the crop, so that it is to these latter soils that the most attention must be given. On such soils where fall sowing is practiced it is best to have the land plowed a considerable time before time to sow the seed in order that it may become well compacted in the under layers. A recently-plowed soil is not a proper seedbed for alfalfa, for like wheat it requires a loose surface soil with a compact soil beneath. Usually wheat land may be turned for alfalfa with good results if the wheat is gotten off sufficiently early, and providing the land is reasonably fertile to furnish plant food for a permanent stand. A crop that removes much moisture from

the soil, such as oats, cane or cowpeas is to be avoided unless they be removed early. Wheat, too, will dry the soil very much unless the summer is one of considerable rainfall. A moist fall will allow alfalfa to follow any of these crops with little difficulty as regards moisture, but a dry fall makes it very important that the water should not be so completely removed from the soil to begin with.

The surest method is to begin the preparation of the land in early summer and to harrow it whenever a crust forms or weeds start. This conserves the moisture and fertility and frees the land of weeds, so that when the alfalfa is put in, the land is clean and in good condition for its growth. Of course, the character of the land must determine largely just when this preparation shall be done, as care must be taken to prevent the serious washing of the surface such as usually occurs on bare uplands. A clover sod pastured down, liberally dressed with barnyard manure and turned under early in the summer gives one of the best seedbeds for alfalfa. Heavy blue grass or timothy sod should be turned under early in the spring if one wishes to sow such land to alfalfa. A loose porous layer, such as a heavy undecomposed sod will give, cannot be tolerated under ordinary conditions. The young alfalfa plants are very tender and require careful handling to secure a permanent foothold. It is for this reason that the ground must be so carefully prepared and as many of the weeds killed as is possible with the means at one's command.

Plowing for alfalfa should be deep and thorough, especially if done early in the summer. If done later, care should be taken to plow no deeper than can be well compacted by rolling and harrowing before time for sowing the seed. Subsoiling has often been recommended, and doubtless on soils with heavy clay subsoils it would be of

benefit, but the expense and difficulty of doing the work just in the proper manner usually makes the practice inadvisable. The Experiment Station has conducted no investigations on subsoiling on the heavy clays.

The final preparation of the seed bed should be thorough, although care should be taken not to have the land in such fine shape that the beating rains of the fall will pack it seriously or cause it to wash badly. In several instances at the Experiment Station stands have completely failed, due to the beating of heavy fall rains, which either washed the young plants out or compacted the soil so that they did no good.

The best time to sow is just after a good rain in late August if possible, but judgment must be used should a rain not come. If the land is properly prepared and a loose mulch has been kept on it by harrowing for some weeks, there is little to fear regarding the seeds germinating. Usually when the soil is moist the plants are up by the third day, and with a week or ten days of good weather following, without washing or beating rains, a stand is almost assured. These suggestions, of course, do not apply particularly to bottom lands, except in a general way.

SOWING THE SEED.

The seed should be broadcasted evenly by any means which will secure a very even distribution. An ordinary seed sower is good when properly regulated. It is found that a more even stand is possible by setting the seeder to sow one-half the amount necessary and then going over the land twice, walking say east and west the first time and north and south the second time. This will give a much more even distribution than can be gotten either by hand sowing or with a seed sower when it is put

on at one sowing. Broadcasting by hand should only be done when one is particularly experienced in sowing seed this way. The seed should be covered with a light harrow. A piece of brush drawn over the field is also recommended but usually leaves the soil too smooth. A harrow which will not cover the seed too deeply (from one-fourth to three-fourths of an inch) but that still leaves the land slightly ridged, seems to be the best. A grain drill may be used by placing the seed in the grass-seeder attachment and allowing the hoes to cover the seed lightly just as timothy is sown when drilling wheat. On ordinary soils the seed will need a little deeper covering than clover since they are larger and germinate more freely because of being sown at a warmer season of the year.

The amount of seed to sow will depend upon the quality, and the care with which the seed bed has been prepared. The amounts recommended by various growers vary from ten to thirty pounds per acre, but experiments indicate that from fifteen to twenty pounds of seed is about the proper amount. Fifteen pounds is sufficient with plump seed of strong vitality, properly put in on a well-prepared seedbed containing a reasonable amount of fertility. Twenty pounds will be necessary with poor seed or poor soil conditions. Where sown with a nurse crop in the spring, as oats or barley, the amount of alfalfa seed to be recommended remains the same as where sown without a nurse crop.

There is a great variation in the quality and in the general character of alfalfa seed, some strains of the plant appearing better adapted to certain soils or conditions than others, since the region in which the seed has been grown affects to considerable extent its use in any particular part of the country. Ordinarily the nearer the source of seed is to the region in which it is to be grown the better.



Alfalfa on the farm of T. J. Dowdy, Hayti, Mo. First cutting of second year. The field gave two cuttings the first year after spring sowing. Characteristic growth of alfalfa on the bottoms of Southeast Missouri.

There are some types of imported alfalfa which seem in some cases to have slightly better adaptation to particular soils or seasons than the home-grown plants, but ordinarily it is much better to secure seed grown just as nearly under the conditions to which the crop will be subjected as possible.

There is little alfalfa seed produced in Missouri, owing, first, to the fact that the crop is not yet widely grown, and, second, to the fact that our moist climate is not the best for seed production. Several farmers, however, have grown seed successfully and where this can be secured of good quality it is by far the best. Ordinarily Kansas or Nebraska grown seed is about the best that can be secured in the state, as seed from the irrigated regions does not seem to be well adapted to our humid climate.

Alfalfa seed is often contaminated with various weed seeds such as are found in clover seed. Among the common ones are lambs quarter, crab grass, foxtail and the plantains. It also sometimes contains seeds of dodder, a parasitic vine which twines around the alfalfa stalks, pushing its roots into the tissue of the stalks and ultimately killing the plants. It will be usually noticed in spots in the field as a yellowish red vine twining about the plants and slowly spreading. There is but one remedy if the alfalfa field is to be maintained, and that is to either remove all the plants from this area and burn or better still to burn hay or straw over the entire affected area, after which it may again be re-seeded to alfalfa. This pest has become quite common in some of the eastern alfalfa fields and one should not hesitate to take the most radical measures of exterminating it when it appears. The seeds of the dodder are very difficult to distinguish from the alfalfa seeds unless one is

very familiar with the two. They are somewhat more irregular in shape, usually not quite so large, and ordinarily somewhat greenish in appearance.

CARE OF THE CROP.

Clipping.—One of the most vital points in connection with the culture of alfalfa, especially on lands not particularly adapted to it, is frequent clipping during the first and sometimes during the second season. It is rarely possible, therefore, to harvest as large crops during the first season as thereafter, since the plants must not be allowed to grow too long. The young plants in their early development grow up very slender and if allowed to reach full blossom they usually turn yellow and appear to be weakened. In general the rule is to cut whenever the lower leaves begin to turn yellow. The cutting causes the plants to stool and throw up new stalks, thus widening the crown just above the surface of the soil. Such cutting, therefore, seems to make the plants more stocky and allows them to set their roots more deeply and firmly in the soil.

Experiments at the Station on clipping the crop frequently during the first and second years in comparison with clipping irregularly, have shown much advantage from the regular clipping, especially on the uplands not well adapted to the crop. An experiment made in the fall of 1904 to test the desirability of late fall clipping on plants

*Note.—There are several firms handling alfalfa seed in this State and Kansas that can be recommended as reliable. Those who handled Kansas-grown seed in 1906 were J. G. Peppard, 1101 W. 8th Street, Kansas City, Missouri, and Ross Brothers Seed Co., Wichita, Kansas. There are doubtless others in Kansas City and Omaha who handle this seed. St. Louis firms who deal in alfalfa seed and secure their seed from various sources are the D. I. Bushnell Seed Co., 105 North 2nd Street, the St. Louis Seed Co., 613-615 North 4th Street, W. R. Wilkinson & Son, 212 North Main Street, and Schisler and Cornelli, 813-715 North 4th Street.

sown in August indicated an advantage from the practice. This particular fall was well suited to the growth of alfalfa and plants sown in August made a growth twelve inches high before cold weather. One series of plots was clipped in October and another series allowed to stand over winter. The fall clipped plots came out in the spring with a better stand than the others, but as this is but a single experiment no definite conclusions can be drawn. Much evidently would depend upon the character of the winter and the size reached by the plants. Ordinarily it is undoubtedly much safer to defer this clipping until spring.

Harvesting the Crop.—As previously mentioned, one of the difficulties in handling alfalfa in this State is found in curing, this statement being especially true of the first crop when the weather is not suited to hay-making. The cutting of a ton or a ton and a half per acre cures very slowly when the stems are so full of water and the weather moist. In the dry air of western Kansas and eastern Colorado the hay cures so quickly that it goes into the stack almost as green as when first cut; but with a moist atmosphere and frequent rains it is practically impossible to harvest every crop without getting some of it badly bleached. The silo may be used for storing the first crop that cannot be field-cured if care is taken to either allow it to mature somewhat more than usual, or if it is allowed to lose some of its moisture after cutting. The young green plants make a silage that contains too much water, and since there is nothing with which the first cutting may be mixed, this later maturity or subsequent drying is usually necessary. Later cuttings may be mixed with corn in the silo with good results.

Much depends upon the weather as to best methods of handling, but it rarely happens in this State that al-

alfalfa can be properly cured in the swath. When thus cured the leaves drop off so much in raking that much of the feeding value is lost. It is usually better, therefore, to rake into light windrows when only partially cured and either allow to finish curing in the windrow, or put in shocks. If shocked, care should be taken to make the piles tall and narrow to shed water well and at the same time allow rapid curing. Sometimes it may be cured in light windrows and either be loaded by a loader or by hand if it is to be hauled to the barn, or where stacked, it may be pushed to the stack by a common bull rake. Showers when it is in the windrow usually necessitate turning it, but it seems better to do this than try to cure it in the swath. Judgment must be used as to the best method of handling at any particular time.

The best time to cut after the plants are once established is just as they are beginning to bloom, the general rule being to cut when one-tenth of the blossoms are out. Early in the growth of the crop earlier clipping may be necessary as already mentioned, but later cutting is rarely advisable unless it is to be cut for seed.

The stacking of alfalfa is not so common in this State as it is farther west owing to the fact that there is rather a heavy loss when put up this way. The stack cannot be made to turn water so well as timothy, and like clover should be topped with straw or hay. The ordinary plan is to put most of the hay in the barn where it is either fed out or baled. The large growers bale almost all the hay sold, especially where it is to be shipped. Care should be taken in baling to leave it perfectly dry and for this reason it is rarely baled out of the field unless the weather is very favorable.

Cutting for Seed.—Missouri conditions are not partic-

ularly suited for producing alfalfa seed, as the moisture is usually too abundant. The best seed is produced either in the dry regions of the west, or on dry season in the more humid parts of the country. Usually the second crop is left for seed, although in many cases the third crop is better, since the weather is usually driest during August. It is therefore best to be governed by the weather in the matter, since a short crop due to dry weather may often be more profitably turned into seed. The seed crop takes much longer to reach the cutting stage and so saps the vitality of the plant that it usually takes the place of two cuttings.

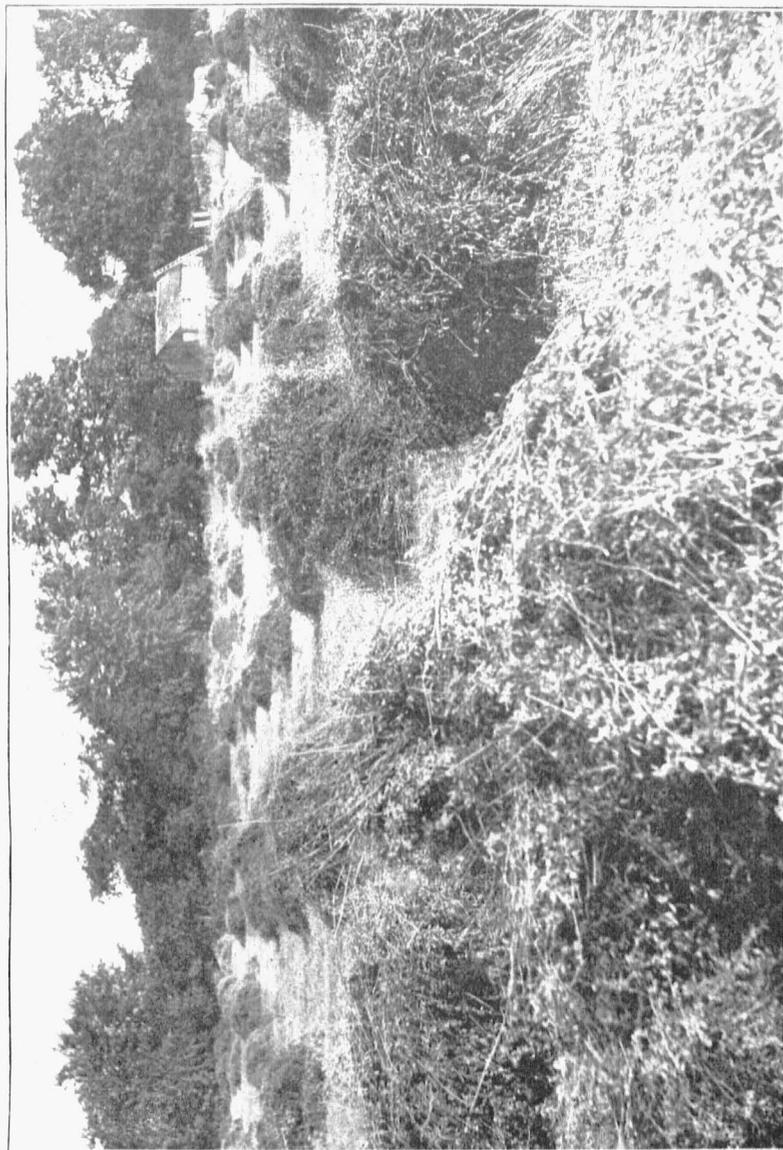
In cutting for seed it is impracticable to wait until all the seeds have ripened since new flowers may be in bloom when the more advanced seeds are ripe. It may be handled in various ways, the essentials being that it be well cured and that it be allowed to shatter as little as possible. A selfrake, a mower with a buncher attached to the cutter bar or a binder may be used, depending upon conditions. If the weather is particularly favorable it may be cut and cured the same as hay, threshing from the windrow, the shock, or even from the stack. The straw is usually fed, as it has something over half the feeding value of hay if it is cured under proper conditions. The yield of seed varies from one to ten bushels per acre, a yield of three to six bushels being considered good. It is doubtful whether the production of seed will ever be of much importance in this State.

Disking.—Disking alfalfa fields after cutting has been widely heralded as a means of keeping down grass and weeds on soils to which the plant is not well adapted. It is also sometimes done on old fields to split up the wide crowns of the plants and thus aid in making a more even stand. The Experiment Station has begun an investigation of the use of the disk for the first-named purpose, but thus

far results are inconclusive. They have shown that the amount of grass and weeds may be materially lessened, although it is not yet proven that this gain is enough to overcome the injury to the alfalfa. This injury does not appear to be great, as it is difficult to cut the tough alfalfa roots, and when the disk is run at an angle that is not too oblique, little is to be feared except a covering of some of the crowns. A light harrow following the disk seems also to be of advantage. Used with judgment after one or more cuttings on fields badly infested with grass or weeds, the use of this implement seems to have possibilities, although it is doubtful whether the method will give much profit. Evidently it is better to have the soil sufficiently rich that the alfalfa plants will not need such nursing, but under certain conditions much good may come from it. Many favorable reports have been received from farmers regarding the practice.

Manuring.—The key to successful alfalfa culture on lands poorly adapted to the crop is liberal manuring. Of course, manure will not make every soil an alfalfa soil, but the investigations of the Station indicate that most any soil on which alfalfa has repeatedly failed may be made to produce abundant returns by manuring. The stiff clay subsoils are of little importance where heavy manuring is practiced, providing reasonable drainage is secured, and the poorer, worn uplands may be made to yield abundantly when thus fertilized. About the only soils on which manure will not give a stand of alfalfa are those that are badly in need of drainage, so that the importance of liberal manuring cannot be too strongly emphasized.

The amount of manure to apply depends altogether upon the soil's character, but within reasonable limitations, the more the better. An old feed lot or garden spot gives



Alfalfa on farm of Geo. M. Kellogg, Pleasant Hill, Mo.

ideal conditions for alfalfa if it is not too foul with weeds, or if the ground is broken early and the weeds killed by frequent harrowing before sowing. Usually the average farmer will have no use for over five or ten acres of alfalfa, owing to its extensive yield and constant attention at harvest time so that with small areas heavy manuring may be practiced.

If manure is applied before sowing, it should be done before the land is plowed, and, as already mentioned, the turning under should be early enough to allow it to become thoroughly decomposed before time for seeding. It is never advisable to top dress immediately before sowing on account of the danger of introducing weed and grass seeds to choke out the plants. Top dressing after the plants are well set, however, has proven to be practical and profitable. In this case fine manure must be used, and while it may be put on after any crop, spring or fall applications are considered best. A Cass county farmer reports that manure increases his crop from one-third to one-half and others report similar benefits. The experiments at Columbia have not been carried far enough to give accurate data regarding the gain from manuring, but they seem to corroborate the experience of farmers and to indicate that manure can be applied to alfalfa with much profit where it can be obtained at reasonable cost.

The use of commercial fertilizers in securing a profitable stand and in bringing abundant yields has proven very successful at some of the eastern Stations. The New Jersey Experiment Station reports a yield of six and one-half tons in a single season with the aid of fertilizers, where without fertilization the yield was entirely unprofitable. This was of course on a soil that was badly worn. The Illinois Experiment Station has found great benefit from the use

of bone on soils particularly low in phosphorus. Recent experiments on the soils of Missouri indicate that many of them are strikingly deficient in this element also, and the use of such fertilizers as bone and rock phosphate will undoubtedly be of much benefit both in securing a permanent stand and in the after-yield of the crop. The addition of 150 to 200 pounds of bone, or double the quantity of rock phosphate applied with manure just before plowing for alfalfa, is to be recommended on poor soils, especially those lacking phosphorus. This will apply to most of the Missouri uplands that are now becoming thin.

CONCLUSIONS.

1. Alfalfa is being grown with success on various types of Missouri soil, although many soils are not well adapted to its growth.

2. A knowledge of the peculiarities of the plant will ultimately make it possible to extend its culture to most soil types of the State.

3. Liberal manuring is the key to successful alfalfa culture on the upland soils of the State. The manure may be applied before plowing and also as frequent top-dressings.

4. The value of the crop as a feed and its high yield where favorable conditions are supplied make it a particularly desirable crop to grow, at least in small areas, on farms where mixed farming or dairy farming is practiced.

5. While alfalfa makes a most nutritious pasture crop, it does not lend itself well to pasturing unless certain precautions are taken.

6. Where alfalfa is grown for hay difficulty is often experienced in harvesting the first, and sometimes other cuttings, on account of wet weather. The silo may be used in such cases.

7. The stiff subsoils of the State are responsible for most failures reported, because it requires some knowledge of the methods of handling the crop to make it succeed under such conditions.

8. Alfalfa is not adapted to soils that are sour, liming, manuring or drainage being necessary to prepare such soils for the crop.

9. Alfalfa sown on upland soils that have never grown alfalfa or sweet clover is benefited by inoculation. On bottom lands or lands that are very fertile, inoculation has little or no effect.

10. The surest and often the simplest means of inoculation is by means of inoculated soil. The cultures prepared for seed inoculation have in many cases given excellent results, but they are still in the experimental stage and some skill is required to handle them properly.

11. The best preparation of the seedbed is that which allows of an early plowing and the use of a harrow every time a crust forms or weeds start before time to sow the seed. The seedbed should be much like that for wheat—loose above but firm below.

12. The best time to sow in this State is between the middle of August and the middle of September, the last week in August usually giving best results.

13. The amount of seed to sow is between fifteen and twenty pounds, depending upon the quality and the character of the soil, and it is best sown without a nurse crop.

14. Alfalfa must be clipped frequently the first and sometimes the second season, especially on soils to which it is not well adapted. It should usually be cut when the lower leaves begin to turn yellow.

15. Disking occasionally after cutting, with the disks set at a moderate angle, is an aid in keeping out the weeds and grass, but its use is still somewhat experimental.