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Co-operative Experiments with Alfalfa

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UNIVERSITY OF MISSOURI

COLLEGE OF AGRICULTURE

Agricultural Experiment Station

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(2) In the service of the U. S. Department of Agriculture.

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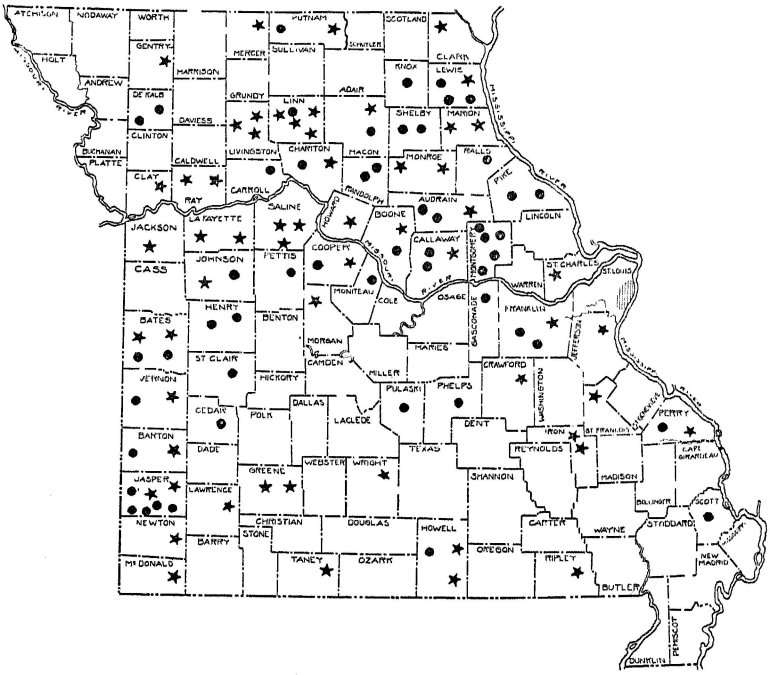


Map showing location of cooperative alfalfa experiments. Stars indicate experiments where alfalfa was grown successfully with one or another of the various soil treatments. Dots indicate experiments where none of the soil treatments were successful.

CO-OPERATIVE EXPERIMENTS WITH ALFALFA

M. F. MILLER AND C. B. HUTCHISON

Alfalfa is a crop that Missouri farmers are learning to grow. Its great value as a feed for farm animals and its renovating effect upon the soil make it a crop to be desired wherever it is possible to grow it. Where adapted in Missouri, alfalfa makes from three to six cuttings during a single season and produces from three to six tons of highly nutritious hay. The idea that it cannot be grown successfully in this State is partially due to not understanding the requirements of the plant. As these become better understood, there is no doubt that it will be grown to a greater or less extent in every county of the State. It is a crop, however, that one must learn to grow, and in many localities its production is still in an experimental state. It does not adapt itself to as wide a range of conditions, nor is it as easily grown as most forage crops with which Missouri farmers are familiar. In any case, if a farmer has had no experience with the crop, it is well to start with a small field and grow it experimentally until he learns more about the requirements of the plant and can be sure his soil is suited to its growth. If he is successful, he will be amply repaid for the time and effort spent in securing a stand, for where it is well adapted, it is without question one of the most profitable crops a man can grow.

In 1907 the Experiment Station began a number of co-operative alfalfa experiments with farmers throughout Missouri for the purpose of determining the best means of securing a profitable stand on the various soils of the State. From twenty to twenty-five experiments have been added each year since that time and data have been secured from all of these experiments in as many localities, representing 74 of the 114 counties of the State. These experiments have been confined chiefly to the upland soils, since but little difficulty is experienced in growing alfalfa on bottom lands where they are well drained and where proper precautions are taken in land preparation and seeding.

PLAN OF EXPERIMENTS.

In starting these experiments, the co-operators were instructed to select an acre of land representative of the average lands of their

community, uniform in fertility, well drained and not foul with weeds. Where possible, a representative of the Station visited the co-operator and assisted in selecting the land and in laying out the experiment, but this was not done in many cases. This acre was divided into four plots of equal size, as shown in the accompanying diagram.

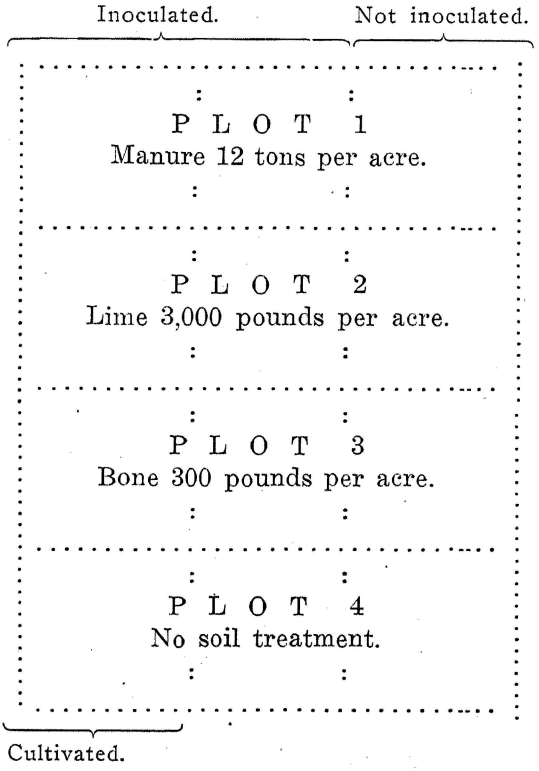


Diagram showing manner of laying out alfalfa experiment plots.

To plot one was applied barnyard manure at the rate of 12 tons per acre; plot two received lime at the rate of 3,000 pounds per acre; plot three received steamed bone meal at the rate of 300 pounds per acre; plot four was given no soil treatment. The form of lime used in most cases was air or water slaked, but sometimes ground limestone was used. In addition to these treatments, two-thirds of the area was inoculated, as shown in the diagram, usually with soil from an old alfalfa field in order to introduce the alfalfa bacteria, and the other third was left without inoculation for com-

parison. Half of the inoculated strip was to be cultivated after each cutting with a disk or spring-tooth harrow to determine the value of cultivation in controlling the weeds and grass. This was done, however, in but few cases, and the data secured are not sufficient to determine definitely the value of cultivation on the various soils.

The land for these experiments was usually plowed early in July, the manure being plowed under. The bonemeal was either plowed under, or applied broadcast immediately after plowing and worked into the soil while preparing the seed bed, or it was drilled in with a fertilizer grain drill when the seed was sown. The lime was applied after plowing and worked into the soil while preparing the seed bed. The ground was given frequent and thorough cultivation until the latter part of August, when the seeding was done. Just before seeding, the inoculated soil was sown and harrowed in at once. In most cases the seed was sown broadcast at the rate of 20 pounds per acre and covered with a light harrowing.

RESULTS OF THE EXPERIMENTS.

For the purpose of summarizing the results of these experiments, the upland soils of the State are broadly divided into the six following groups:

I. Rolling Prairies of North Missouri.
II. Level Prairies of North Missouri.
III. Timber lands of North Missouri, including the brown loess.
IV. Ozark soils (Ozark border, Ozark center and Ozark plateau.)
V. Rolling prairies of West Central Missouri.
VI. Level prairies of Southwest Missouri.

The first of these groups includes the rolling prairies of the Northwest, the North, and the extreme Northeast section of the State, where the prairie soil is well drained, deep, rich, and underlaid with a fairly loose subsoil containing more or less glacial till, which provides fair under-drainage.

The second group embraces the so-called level prairies of the Northeast Section, lands that are level and rather poorly drained, with a soil about 9 to 10 inches in depth, underlaid with a very tight clay subsoil. The experiments, however, were all located on fairly rolling phases of these lands, and not on the flat areas with poor surface drainage.

The third group includes all lands at one time covered with timber north of the Missouri River, including the brown loess soil of

the Missouri River hills. The soils in most cases are loams or silt loams underlaid with fairly open subsoils, giving good drainage.

The fourth group includes all of the Ozark lands generally classed as Ozark Border, Ozark Plateau, and Ozark Center soils. On the Ozark Center and Plateau a number of the experiments were located on valley or creek bottom lands, since there are the chief cultivated soils of those regions.

The fifth group includes the rolling prairies of the West Central part of the State and covers a large part of the counties of Saline, Lafayette, Jackson, Cass, Johnson, and a smaller part of Pettis, Henry and Cooper. The soil, which is a phase of the loess, is a black or brownish loam, deep and rich, and unlaid with a fairly open clay subsoil.

The sixth group is that of the level prairies of Southwest Missouri. The soil here is a gray silt loam derived largely from alternating layers of limestone, sandstone and shale. It is 6 to 12 inches deep and underlaid with a heavy clay subsoil, close textured and poorly drained. On the level phases of these lands surface drainage is poor, but, as in the case of the Northeast Missouri prairies, these experiments were located on the more rolling lands, where surface drainage was good.

The results of each experiment on the various soils are presented in the following tables:

TABLE I.—RESULTS OF ALFALFA EXPERIMENTS ON THE ROLLING PRAIRIES OF NORTH MISSOURI.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Results of Treatments.
E. A. Cockefair.....	Unionville.....	Putnam.....	Black rolling prairie	Medium heavy Clay.	Manure beneficial.
W. R. Thompson....	Laddonia.....	Audrain.....	Rolling Prairie	Heavy clay.....	Manure, lime, and inoculation necessary. Bone meal beneficial
E. L. Newlon.....	Lewistown.....	Lewis.....	Rolling prairie. Feed lot but washed badly. Thin in spots.	Heavy clay.....	Rather uneven stand on account of dry weather Winter killed. Manure beneficial.
L. P. Chapman.....	Mendon.....	Chariton.....	Rolling, gray-black prairie loam, 10-11 in. deep.	Heavy clay.....	Manure necessary. Bone meal and inoculation beneficial.
R. L. Harbaugh.....	Liberty.....	Clay.....	Black rolling timber land, 8-18 in. deep	Medium heavy clay.	Manure and bone meal necessary. Good results.
V. S. Traughber.....	Carrollton.....	Carroll.....	Upland. Rolling sandy loam.....	Heavy clay.....	Manure beneficial.
Harry Mason.....	Brookfield.....	Linn.....	Black prairie loam. Rolling.....	Heavy clay.....	Manure and inoculation necessary. Finally winter killed.
R. C. Allen.....	Florida.....	Monroe.....	Black loam. Old garden. Very rich.....	Medium heavy clay.	Alfalfa did especially well. No effects of treatment on this rich soil.
F. R. Bergfield.....	Anabel.....	Macon.....	Black sandy loam.....	Medium heavy clay.	Sown late in fall. Too little growth to stand the winter.
C. S. Allen.....	Stanberry.....	Gentry.....	Black rolling prairie....	Medium heavy clay.	Manure especially beneficial. Bone meal beneficial.
R. S. Casebeer.....	Chula.....	Livingston.....	Rolling black prairie loam, 7 in. deep.....	Heavy clay.....	All except strip protected by snowdrift killed first winter. Reseeded. Fair success. No effects of treatment.

TABLE I.—Continued.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Result of Treatment
J. S. Smith.....	Lawson.....	Ray.....	Rolling prairie. Black loam.....	Medium heavy clay.	Manure especially beneficial. Bone and inoculation beneficial.
J. B. Campbell.....	Unionville.....	Putnam.....	Rolling prairie. Black loam 2 to 3 feet deep...	Medium heavy clay.	Manure necessary. Inoculation beneficial.
B. F. Nall.....	Lewiston.....	Lewis.....	Rolling prairie. Black loam 2 to 3 feet deep...	Heavy clay.....	Two trials. Both winter killed. Manure and inoculation beneficial.

TABLE II.—RESULTS OF ALFALFA EXPERIMENTS ON THE LEVEL PRAIRIES OF NORTH MISSOURI. *

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Results of Treatment
Stanley Rollins.....	Jacksonville.....	Randolph.....	Level prairie. Gray loam.	Heavy clay.....	Winter killed.
Coleman Reed.....	Auxvasse.....	Callaway.....	Black prairie loam.....	Heavy clay.....	Winter killed.
J. W. Hunter.....	Jonesburg.....	Montgomery.....	Gray prairie loam.....	Heavy clay.....	Three trials. Manure and bone meal beneficial. Winter killed each trial.
Chris Fleahman.....	Jonesburg.....	Montgomery.....	Black prairie loam.....	Heavy clay.....	Winter killed.
Eugene Miller.....	Montgomery City....	Montgomery.....	Black prairie loam 8 in. deep	Heavy clay.....	Badly frozen out first winter. Manure beneficial.
H. D. Wilcox.....	Renick.....	Randolph.....	Black prairie. Feed lot...	Heavy clay.....	Winter killed.
W. W. Lewelling....	High Hill.....	Montgomery.....	Gray prairie loam.....	Heavy clay.....	Seeded 1907-08-09. Winter killed. New plot seeded 1910-11. Winter killed.
W. B. McPike.....	Bowling Green.....	Pike.....	Gray prairie loam.....	Heavy clay.....	Seeded 1907-08-09 and winter killed each year.
Ogle Heim.....	Gazette.....	Audrain.....	Black prairie loam 8 in deep	Heavy clay.....	Winter killed.
J. S. Clare.....	Montgomery City....	Montgomery.....	Black prairie loam 8-12 in deep...	Heavy clay.....	Bone and inoculation beneficial.
Byron McFarland...	Monroe City.....	Ralls.....	Gray prairie loam.....	Heavy clay.....	Seeded '05-06. Failed.
Frank Smith.....	Hurdland.....	Knox.....	Black level prairie loam..	Heavy clay.....	Seeded '07-08-09 and winter killed.
E. J. Waterstripe....	Clarence.....	Shelby.....	Gently rolling gray prairie loam 6 in. deep.....	Heavy, yellow clay..	None. Weather unfavorable. Poor stand. Failure.
Wencel Wasel.....	Auxvasse.....	Callaway.....	Rolling prairie.....		Manure and inoculation beneficial. Turned yellow and most of it died after first cutting.

TABLE II.—Continued.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Result of Treatment
C. G. Starr.....	Centralia.....	Boone.....	Black level prairie loam.	Heavy clay.....	Frozen out badly. Plowed up. Reseeded 1909. Similar results.
H. C. Craig.....	Cyrene.....	Pike.....	Rolling prairie gray colored.....	Heavy clay.....	Fair stand. Practically all destroyed by grasshoppers. Rest winter killed.

*All experiments on this soil type were located on land rolling enough to provide good surface drainage.

TABLE III.—RESULTS OF ALFALFA EXPERIMENTS ON THE TIMBERED LANDS OF NORTH MISSOURI.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Result of Treatment
H. C. Wiswall.....	Rocheport.....	Boone.....	Black upland, very rich Timber land. 24 in. deep	Medium heavy.....	Perfect stand where inoculated. Spotted stand where not inoculated Manure beneficial. Failure where not inoculated.
Wm. Wallace.....	Vandalia	Audrain.....	Timber ridge land.....	Gravelly clay.	Good stand, but badly frozen out first winter. Smothered out by weeds.
A. W. Sturham.....	La Grange.....	Lewis.....	Black Timber loam 8-10 in deep	Sandy clay.....	Manure, bone meal and inoc. beneficial. Poor stand. Finally choked out by grass and weeds.
Loyd Poteet.....	Paris.....	Monroe.....	Rolling timber land Brown loam 5-6 in. deep	Heavy clay.....	Manure necessary. Bone meal beneficial. Frozen out on other plots.
J. R. Hamann..	Canton.....	Lewis.....	Timber land	Medium heavy.....	Inoculation especially beneficial. Manure also beneficial. Untreated plot a failure.
E. E. Cline.....	Fulton.....	Callaway.....	Rolling timber. Black loam	Rather loose clay....	Manure beneficial. Other treatments not showing especially. Rich land.
J. W. Buck.....	Gregory's Landing..	Clark.....	Upland timber, well worn	Heavy clay.	First winter partly frozen out on lime and untreated plots. Only manured plots came thru second winter. Manure necessary. Bone beneficial.
H. A. Tomlin.....	Purdin.....	Linn.....	Black loam, slightly sandy. Timber land....	Heavy clay.....	Good success. Manure and bone meal especially beneficial.

TABLE III.—Continued.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Results of Treatment
M. F. Forbis.....	Chillicothe	Livingston.....	Timber land. Black sandy loam, 9 in. deep.....	Medium heavy clay	Manure and bone meal beneficial. Inoculation especially beneficial.
W. P. Brinkley.....	Linneus.....	Linn.....	Sandy loam, timber land.	Medium heavy clay with more or less gravel	Manure and inoculation necessary. Bone meal beneficial.
O. H. Harrington...	Bucklin.....	Linn.....	Timber land, black loam.	Medium heavy.....	Manure and bone meal beneficial.
B. L. Gash.....	Palmyra.....	Marion.....	Black loam, timber land 12 in. deep.....	Medium heavy clay. .	Manure and bone meal beneficial. Inoculation especially beneficial. Good stand.
E. L. Hughes.....	Glasow.....	Howard.....	Brownish black loam. Timber land.....	Fairly open clay.....	Fine success. Manure beneficial first year. No effects later. No treatment necessary.
W. M. Hutchison....	Chillicothe.....	Livingston.....	Black loam,timber land..	Medium heavy clay..	Manure beneficial, but very rich field. Good results.
Chas. Stephenson....	Elmira.....	Ray.....	Black rolling timber loam, 15 in. deep.....	Fairly loose.....	Inoculation very beneficial Lime and bone meal showed first season, but not afterwards.
W. M. Roberts.....	Maysville.....	DeKalb.....	Timber land, black loam 8-12 in. deep.	Fairly loose and open	Winter killed first winter.
Alvin Harwood.....	Amity.....	DeKalb.....	Rolling prairie, black loam.....	Medium heavy clay..	Winter killed first winter.
J. H. Somerville....	Mercer.....	Mercer.....	Rolling timber land. Light sandy loam.	Loose sandy loam....	Manure necessary. Bone meal and inoculation beneficial. Sussessful in good lands of locality.

TABLE III.—Continued.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Result of Treatment
Frank Sherwood ...	Shelbyville.....	Shelby.....	Black loam. Timbered land, 7-8 in. deep.....	Heavy clay.....	Lime, bone and manure beneficial. Frozen out late in winter of 1911 and 1912.
T. J. Park.....	Hannibal.....	Marion.....	Black loam. Timbered land.....	Heavy clay.....	Manure necessary. Bone meal beneficial. Frozen out badly.
A. H. Webbink.....	Augusta.....	St. Charles.....	Rolling timber land. Gray loam, 10 in. deep.	Heavy clay.....	Manure necessary. Bone and inoculation beneficial.
Karl Jones.....	Laclede.....	Linn.....	Black sandy loam. Timbered land.....	Medium heavy clay..	Seded 1907-1909-1910. First crop stood one year and died. Others froze out. Manure beneficial.
Ed Gates.....	Callao.....	Macon.....	Black timber land. Loam	Medium clay.....	Winter killed and reseeded 1910. Manure and inoculation beneficial.
P. W. Hawkins.....	Salisbury.....	Chariton.....	Black rolling timber land.	Medium heavy clay..	First trial killed by drought. Reseeded 1910 and winter killed.

TABLE IV.—RESULTS OF ALFALFA EXPERIMENTS ON THE OZARK SOILS.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Results of Treatment
G. R. Reynolds	Mountain View	Howell	Gravelly clay loam. Timber land	Heavy clay	Lime, inoculation, bone meal, and manure beneficial. Stood but one year.
W. J. Woodbridge	Granby	Newton	Bottom land, tiled	Loose and open	Inoculation beneficial first year.
F. C. Schmidt	Fulcom	Jefferson	Brown loam, timbered land, 3-8 in.	Heavy clay	Manure necessary. Bone meal beneficial. Slight favorable results with inoculation.
R. A. Mathis	Pineville	McDonald	Rolling timber land	Loose clay with gravel	Manure necessary. Inoculation favored first year.
S. O. Sherwin	Stockton	Cedar			Died out in summer of 1908. Inoculation beneficial.
A. J. Aberworthman	Berger	Franklin	Timber land. Upland clay loam	Medium heavy	Good stand, but nearly all winter killed.
John F. Mead	West Plains	Howell	Valley land	Loose and gravelly	Manure, inoculation and bone meal beneficial.
F. W. Evins	Lonedell	Franklin	Rolling timber land. Dark loam	Heavy clay red to yellow	Winter killed. Manure beneficial. An old feed lot seeded at same time did well.
Albert Thofern	Hermann	Gasconade	Timber land, black loam. 12 in. deep	Medium heavy clay	Badly winter killed second winter. Manure, bone meal and inoculation beneficial.
M. E. Martin	Sikeston	Scott	Sandy loam timber	Medium heavy clay	Badly winter killed. Manure and inoculation beneficial.

TABLE IV.—Continued.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Result of Treatment
M. McCauley.....	Doniphan.....	Ripley.....	Clay loam 5 in deep. Valley timber land.....	Gravelly clay. Good drainage	Lime and untreated plots winter killed badly. Bone meal and manure especially beneficial. Cultivation stimulated growth and checked weeds.
Rich Lucas	Mountain View.....	Howell.....	Rolling prairie, yellowish gray, 1-5 in. deep.....	Heavy clay with gravel	Killed by dry weather in fall and by first winter. Reseeded 1910 after cowpeas. Bone and manure necessary.
Geo. Geiger.....	Speed.....	Cooper.....	Rolling timber land. Light yellow. 8 in. deep.	Fairly open and gravelly clay	Manure and inoculation. especially beneficial. Bone and lime beneficial.
Elliott Tucker.....	Perryville.....	Perry.....	Brown loam 12 in. deep. Level timber land.....	Medium heavy clay..	Manure especially beneficial. Inoculation beneficial. Good success.
A. D. Poncot.....	Sarcoxie.....	Jasper.....	Rolling timber land. Red limestone soil.....	Medium heavy clay some gravel.....	Winter killed. Reseeded 1910. Underlaid with ledge of stone and dries out easily. Killed by drought.
C. S. Ladd.....	Oronogo.....	Jasper.....	Red limestone clay loam. somewhat gravelly.....	Heavy clay.....	Badly winter killed except on lime plots where the stand is good. Lime is necessary.
W. McCanse.....	Mt. Vernon.....	Lawrence.....	Red limestone clay loam (timber)	Medium heavy clay..	Winter killed and reseeded 1910 with whole plot manured. Good results.
H. D. Dilday.....	Cuba.....	Crawford.....	Second bottom land (Creek)	Gravelly	Good success. Manure and bone meal especially beneficial.

TABLE IV.—Continued.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Results of Treatment
Henry Wolff.....	Sullivan.....	Franklin.....	Sandy loam.....	Rather loose and open	Manure, bone and inoculation beneficial.
A. M. Howard.....	Brookline.....	Greene.....	Rolling timber land. Some surface stones.	Medium heavy clay with some gravel..	Manure especially beneficial. Bone and inoculation beneficial.
Ed. G. Napper.....	Billings.....	Greene.....	Timber land, brown loam	Red clay, more or less gravel	Manure necessary. Bone meal and inoculation beneficial.
Jacob Schmidtt.....	Wittenberg.....	Perry.....	Brown loam. Timber land	Medium heavy clay..	Winter killed after seeding in 1907. Also after seeding in 1908. Manure beneficial.
S. C. Redman.....	Tipton.....	Moniteau.....	Prairie loam.....	Heavy jointed clay. Hard pan	Practically all winter killed first winter. Reseeded and a complete failure.
S. J. Steinstra	Swedeborg.....	Pulaski.....	Black sandy loam, timber land.....	Heavy clay. Hardpan	Fair stand. Manure beneficial. Weeds and grass took it.
C. H. Menge.....	Farmington.....	St. Francois.....	Timber land. Rolling sandy loam. Thin.....	Light clay.....	Manure, bonemeal, and inoculation beneficial. Reseeded 1908, after being frozen out. Similar results again. Another plot reseeded with good results.
W. O. Huff.....	Chloride.....	Iron.....	Limestone clay loam. Timber land.....	Medium heavy clay..	Bone meal, manure and inoculation beneficial.
Geo. Stark.....	Arcadia.....	Iron.....	Silty clay loam. Timber land.....	Gravelly clay.....	Fair stand. Lime beneficial. Failed. Plot sown to cowpeas and reseeded 1910. Manure and bone meal beneficial second trial.

TABLE IV.—Continued.

Name of Co-operator.	Town	County	Character of Soil.	Subsoil. Character of	Results of Treatment
H. J. Phillips.....	Rill.....	Taney.....	Gravelly loam. Timber land, 6 in. deep.....	Yellowish clay loam..	Manure, bone, inoculation and lime beneficial.
Gustave Gutschke....	Mansfield.....	Wright.....	Brown clay loam. Timber land, 6 in. deep.....	Rather heavy gravelly clay loam.....	Manure necessary. Bone and inoculation beneficial. Cultivation aids.
A. J. Vogt.....	Versailles.....	Morgan.....	Black prairie loam, 10 in. deep.....	Medium heavy clay with gravel	Seeded 1909, but killed by potato bugs. Reseeded 1910 after cowpeas. Good stand. No effect of treatment, except plot with no treatment froze out more.
Levi Woodworth.....	St. James.....	Phelps.....	Gray brown prairie loam.	Heavy clay hardpan..	Seeded 1910. Froze out. Seeded 1911, froze out. Manure and lime beneficial

TABLE V.—RESULTS OF ALFALFA EXPERIMENTS ON THE ROLLING PRAIRIES OF WEST CENTRAL MISSOURI.

Name of Co-operator.	Town	County	Character of Soil.	Character of Subsoil.	Results of Treatment
L. W. Tieman.....	Aullville.....	Lafayette.....	Black prairie loam 18-30 in deep.....	Medium heavy clay..	Manure and inoculation necessary. Bone meal beneficial.
Hiram Howard.....	Marshall.....	Saline.....	Rolling timber land. Light clay loam.....	Loose clay.....	Manure and inoculation especially beneficial.
Otto Pinkepank.....	Sweet Springs.....	Saline.....	Black rolling prairie loam	Medium heavy clay..	Poor stand first year. Thickened up well second. Bone meal and manure beneficial.
Joe Mackler.....	Sweet Springs.....	Saline.....	Black prairie loam.....	Medium heavy clay..	Inoculation especially beneficial. Also cultivation.
Milton Uphaus.....	Concordia.....	Lafayette.....	Rolling timber land. Light sandy loam.....	Loose and open clay.	Bone meal, manure and inoculation beneficial.
H. P. Blodgett..... J. F. Livengood.....	Knobnoster.....	Johnson.....	Timber land. Dark clay loam.....	Sandy clay.....	Inoculation necessary. Manure especially beneficial. Lime beneficial.
H. C. Garman.....	Sedalia.....	Pettis.....	Gray prairie loam...	Heavy clay.....	Winter killed second winter. Failure. Inoculation beneficial.
R. J. Wilson.....	Centerview	Johnson.....	Mulatto level prairie, rather wet.....	Heavy clay.....	Spring sown. Manure and bone beneficial. Weeds and grass took it. Reseeded 1909 after cowpeas. Winter killed.
Chester Bailey.....	Greenwood.....	Jackson.....	Black prairie loam.....	Fairly loose and open	Bone meal and inoculation beneficial. Manure beneficial.
R. S. Harriman.....	Pilot Grove.....	Cooper.....	Bottom land.....	Fairly loose and open.	Winter killed.

TABLE VI.—RESULTS OF ALFALFA EXPERIMENTS ON THE LEVEL PRAIRIES OF SOUTHWEST MISSOURI.*

Name of Co-operator	Town	County	Character of Soil.	Character of Subsoil.	Results of Treatment
S. Swingle	Reeds	Jasper	Red limestone soil. Timber land	Fairly loose and open.	Badly winter killed.
W. W. Whitaker	Reeds	Jasper	Gray prairie	Heavy clay	Winter killed first winter.
Thos. West	Carthage	Jasper	Gray prairie	Heavy clay, some gravel	Good stand. Winter killed Reseeded 1910 after cow-peas. Similar results.
J. F. Hoffmeister	Golden City	Barton	Gray prairie loam	Medium, heavy clay, somewhat gravelly.	Manure especially beneficial. Bone meal beneficial.
John Parker	Carthage	Jasper	Red limestone land	Medium heavy	Seeded 1909, winter killed. Reseeded 1910 with good results. Manure necessary. Bone, lime and inoculation beneficial.
J. S. Beamer	Lamar	Barton	Gray prairie loam	Heavy clay	Manure and lime beneficial. Failed. Three trials.
V. N. Wright	Walker	Vernon	Black prairie. Sandy loam	Heavy clay	Fine stand, but badly heaved first winter. Manure necessary. Bone-meal beneficial. Finally all but manured plot winter killed.
L. A. Spangler	Clinton	Henry	Gray prairie loam	Medium heavy clay.	Winter killed.
G F. Dunning	Clinton	Henry	Gray prairie loam	Medium heavy clay.	Died after first cutting.
L. B. Burk	Butler	Bates	Black prairie loam	Heavy clay	Poor stand. Winter killed first winter.
E. F. Burk	Butler	Bates	Dark gray	Heavy clay	Winter killed. Reseeded 1910. Manure, bone meal, lime and inoculation beneficial.

TABLE VI.—Continued.

Name of Co-operator	Town	County	Character of Soil.	Character of Subsoil.	Results of Treatment
Howard Hackedorn..	Schell City.....	Vernon.....	Sandy, loam prairie.....	Heavy reddish clay underlaid with sandstone	Smothered by weeds and winter killed second winter. Manure and bone beneficial.
J. M. Bailey.....	Rich Hill.....	Bates	Black loam.....	Heavy clay.....	Good stand. Lime and inoc. necessary. Good success on this land but failure on sandy soil.
J. A. Doerflinger....	Appleton City.....	St. Clair.....	Rolling prairie loam.....	Heavy clay.....	Winter killed.
J. C. Watkins.....	Joplin.....	Jasper.....	Rather level timber land. Light clay.....	Heavy clay.....	Manure beneficial. Failed 2nd year.
W. G. Goodenough..	Foster.....	Bates.....	Sandy loam prairie soil...	Heavy clay.....	Spring sown. Complete failure on account of weeds and grass.

*All experiments on this soil type were located on land rolling enough to provide good surface drainage.

TABLE VII. — NUMBER AND PERCENT OF SUCCESSFUL AND NON-SUCCESSFUL TRIALS OF ALFALFA ON THE VARIOUS SOILS OF THE STATE.

Soil.	Total No. of trials.	Total No.* of successful trials.	Total No. of failures.	Percent of successful trials.	Percent of failures.
Rolling Prairies West Central Missouri	10	7	3	70	30
Level Prairies Southwest Missouri ...	16	5	11	31.25	68.75
Rolling Prairies North Missouri	14	9	5	64.29	35.71
Level Prairies North Missouri	16	0	16	0.	100.
Ozark Soils	31	20	11	64.52	35.48
Timber land of North Missouri	24	17	7	70.83	29.17
Grand Total	111	58	53	52.25	47.75

*Experiments were termed successful where the alfalfa on any part of the plot stood at least two years, or where it was clearly demonstrated that by certain soil treatments alfalfa could be grown successfully on that soil.

It will be seen from the results of these experiments that all Missouri soils are not well suited to alfalfa. Of 111 trials, only 58, or 52 per cent, gave evidence that it could be made a successful crop there, even if the proper soil treatment was given, while 53 trials, or 48 per cent, of all of the experiments, failed entirely from various causes. It should be noted, however, that in a few instances failures were due to weather and other seasonal conditions, and in those cases the failures should not be taken as conclusive evidence that alfalfa can not be grown there successfully. In a large number of failures the alfalfa was frozen out the first winter, a fact due not only to the soil, but to the season as well, and which, in some cases, may be remedied. In severe winters alfalfa often freezes out badly in placese where it would have succeeded in a milder season, and occasionally there is insufficient rainfall after seeding

to enable the plants to become firmly enough established in the soil to survive the winter freezes. This was the case with the plot on the Jasper County Experiment Station field seeded for the first time in the fall of 1909, and which was practically all frozen out that winter. It was reseeded in August, 1910, after cowpeas, with good results. Similar cases occurred with some co-operators, and a second seeding was made before a stand was obtained. On the other hand, several co-operators made a second, and in some cases a third and fourth attempt before ceasing their efforts to grow alfalfa, and apparently definitely established the fact that it could not be grown economically on their farms.

Of the various upland soil types in Missouri, the rolling prairies of the West Central part of the State and the timbered lands of North Missouri, particularly the brown loess soil, seem best suited to the production of alfalfa. In each case 70 per cent of the trials were successful. On the former soils 7 out of 10 trials and on the latter 17 out of 24 trials succeeded. These soils are of a loamy texture, well drained, and underlaid in most cases with a fairly open subsoil, which provides fair drainage. Where the soil fertility has been kept up by proper soil management, or where it can be improved by certain soil treatments, these lands grow alfalfa very well.

The rolling prairies of North Missouri, where the drainage is good, the soil deep and fertile, and the subsoil fairly loose, as well as the valley lands of the Ozarks, seem fairly well adapted for alfalfa growing, provided the proper soil treatments be given.

The level prairies of the State evidently constitute the poorest alfalfa lands in Missouri, since the fewest number of successes is reported on these soils. A glance at the map giving the location of these experiments will show that those sections have been especially well covered in these investigations. This has been due to the fact that more farmers are growing alfalfa successfully in the other sections, and, hence, fewer requests for these experiments have come from those sections than from those regions in which it is not successfully grown. Of 16 trials on the level prairies of Southwest Missouri, only 5 proved successful, and of the same number of trials on the Northeast prairies all were failures, although located on rolling phases of these prairies, where the surface drainage was good. On the Southwest Missouri prairies, most of the successses were located on the red limestone land, which it would be expected would be better suited for alfalfa than the gray silt loam prairies of the same regions. On the soil investigational fields conducted by the Experiment Station at Lamar, on the Southwest

Missouri prairies, and at High Hill, Bowling Green and Hurdland, on the Northeast Missouri prairies, all attempts to grow alfalfa have failed, although it has been sown from three to five times on each field. While this is perhaps insufficient data to definitely establish the fact that alfalfa cannot be grown on these lands, it at least indicates that it cannot be grown there with ordinary soil treatments, and that its economic production under such conditions is very doubtful.

RELATION OF SUBSOIL TO ALFALFA GROWING.

The character of the subsoil seems to be one of the great controlling factors in the successful growing of alfalfa in Missouri, and is without doubt of even more importance than the fertility of the soil. In most cases the fertility may be increased with little difficulty, but it is practically impossible to change the character of the subsoil where it is not suited to alfalfa growing. Alfalfa thrives best on a deep, loose and well drained soil, underlaid with a fairly open and porous subsoil, conditions that are not found in all sections of the state. From the tables it will be seen that the largest percentage of failures has occurred on the level prairies, most of which are underlaid with a very tight clay subsoil providing poor under drainage and offering difficulty to the penetration of the alfalfa roots. There is, in fact, a very close relation between the character of the subsoil and success with alfalfa on all of the various soil types, the most successes being noted on those soils with the most loose and open subsoils. Most upland soils in Missouri are underlaid with a fairly tight subsoil, but this character is more marked on the level prairies than elsewhere. Even on the most rolling phases along the breaks of small streams and branches, where the land slopes sufficiently to afford good surface drainage, the subsoil is so heavy that most attempts to grow alfalfa have resulted in failures. It is probably the excessive amount of water held in a soil underlaid by a very tight clay, that is responsible for the heaving out of the plants on such lands during the early spring freezes. Oftentimes, however, where sown in the fall the plants do not become deeply enough rooted and are consequently heaved out for this reason. Were it not for the grasses and weeds that always come in, earlier seeding would be advisable, for that would enable the roots to become more deeply set before winter. Grass and weeds, however, grow faster than alfalfa and smother it out so that spring and early summer seedings usually fail on this account.

TABLE VIII.—SOIL TREATMENTS NECESSARY OR BENEFICIAL IN SECURING A PROFITABLE STAND IN 58 SUCCESSFUL TRIALS ON THE VARIOUS SOILS OF THE STATE.

Soil	Number of cases where soil treatment was necessary or beneficial.*				Per cent of cases where soil treatment was necessary or beneficial.			
	Manure	Bone Meal	Lime	Inoculation	Manure	Bone Meal	Lime	Inoculation
Rolling Prairies West Central Missouri	6	4	1	6	85.5	55.5	14.3	85.5
Level Prairies Southwest Missouri	4	4	3	3	80.0	80.0	60.0	60.0
Rolling Prairies North Missouri	7	5	1	5	77.8	55.6	11.1	55.6
Level Prairies North Missouri	0	0	0	0	00.0	00.0	00.0	00.0
Ozark Soils	17	14	4	13	85.0	70.0	20.0	65.0
Timber lands of North Missouri	16	11	1	9	94.1	64.7	5.4	52.9
Total for State	50	38	10	36	86.2	65.5	17.2	62.1

*Treatments were termed necessary where the plot receiving no soil treatment failed, and where the treated plots succeeded; beneficial where a treated plot gave an increased yield over the untreated ones.

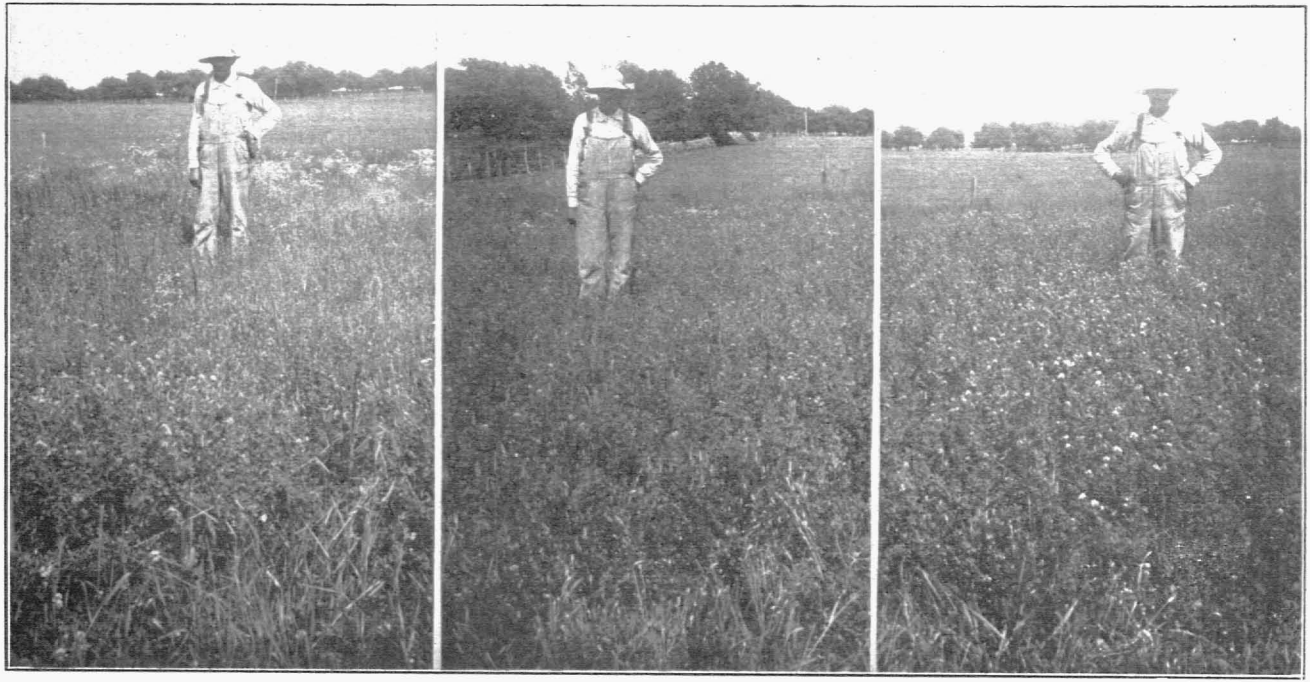
TABLE IX.—NUMBER OF CASES WHERE SOIL TREATMENTS HAVE SHOWN BENEFICIAL RESULTS IN 53 TRIALS CLASSED AS FAILURES ON THE VARIOUS SOILS OF THE STATE.

	Soil Treatment Beneficial			
	Manure	Bonemeal	Lime	Inoculation
Rolling Prairies West Central Missouri.	1	1	0	1
Level Prairies Southwest Missouri ...	4	1	1	0
Rolling Prairies North Missouri	4	0	0	0
Level Prairies North Missouri	3	2	0	2
Ozark Soils	7	2	2	4
Timber lands of North Missouri	3	2	1	1
Total for State.....	22	8	4	8
Percentage of Total....	41.5	15.4	15.4	7.7

THE RELATION OF SOIL TREATMENT TO ALFALFA GROWING.

A study of Table VIII will show that even on lands adapted to alfalfa certain soil treatments will aid very materially in getting a profitable stand. It was with the idea of determinng what effect manure, phosphorus, lime, and inoculation would have upon the stand and yield of alfalfa on the various soils of the State that these experiments were planned. It will be seen that manure, phosphorus and inoculation have proven beneficial in a majority of cases and may be said to be the key to successful alfalfa growing on most Missouri soils.

Effect of Manure: Barnyard manure is the first essential in the successful growing of alfalfa on most Missouri soils. While it will not make every soil grow alfalfa and will not offset the unfavorable conditions of a heavy clay subsoil, it will aid very materially, and in many cases is necessary, in getting a profitable stand. Alfalfa thrives best in a rich soil, and if the land is thin, it is prac-



No soil treatment. Short alfalfa and much grass and weeds. Average yield per acre, 2300 pounds.

Twelve tons of manure plowed under. Good clean alfalfa. Average yield, 3080 pounds per acre.

Twelve tons of manure and 300 pounds of steamed bonemeal. Very good, clean alfalfa. Average yield, 3985 lbs. per acre.

Results of soil treatment for alfalfa at the Billings Experiment Field, Christian County.

tically always necessary to use manure before it can be made a profitable crop. Even on the better lands, where alfalfa grows fairly well without soil treatment, its use will be found of considerable benefit. Table VIII shows that in more than 86 per cent of all successful trials throughout the state manure was either necessary or beneficial. It did not overcome the effects of the subsoil on the Northeast Missouri prairies, although a good showing was made on those of the Southwest section. It should be remembered, however, that there were only five successful trials on the Southwest prairies, and most of them on the best part of these lands. Of these, four, or 80 per cent, have been benefited by the use of barnyard manure.

In applying manure to land for alfalfa, it is best used with some crop the previous year so that the weeds and grass seed it contains will have had an opportunity to germinate and be killed, and also that the manure may be better decomposed, and hence, more beneficial to the alfalfa plants when starting. If one wishes to get alfalfa started sooner than this, then the manure is best applied early in the season, preferably with a spreader and plowed under. The amount of manure necessary depends upon the soil, but usually the application should be fairly heavy. An old feed lot or garden plot will usually be found an ideal location for the alfalfa field, provided it is not foul with weeds, as such soils are always very fertile. Since a man will want only a comparatively small area devoted to alfalfa on account of its yield and the attention necessary at harvest time, heavy manuring will usually be possible. From 12 to 15 tons per acre may often be used with good results. It is also a good plan to double disc the ground thoroughly before plowing, which will chop up the manure and work it into the soil so that it will decompose more rapidly than if plowed under without discing. Top dressing old alfalfa fields at the rate of 4 to 8 loads per acre in early winter is also a good practice, provided clean manure, that is as free of weed seeds as possible, be used, and precautions taken to keep down the grass by cultivation. The benefits of such treatment have been shown by the experiments at Columbia.

Effect of Phosphorus: Most Missouri soils that have been farmed for some time are deficient in available phosphates and respond to the application of fertilizers of this nature. It is well known that bone meal will aid materially in getting a stand of clover and in increasing the yield on many Missouri soils. Bone meal has been used in these experiments for the same purpose and

has proven of benefit in more than 65 per cent of the cases. The application of soluble phosphates at the time of seeding enables the plants to get started quickly and gives them a rapid and vigorous growth. On lands that have been farmed fairly hard and where the supply of available phosphates is low, the use of bone-meal with alfalfa will be of much benefit in securing a stand. It is best applied with a fertilizer drill and drilled into the ground at the same time or before the seed is sown, but it may be applied broadcast immediately after plowing and worked into the ground while preparing the seed bed. Two hundred and fifty to three hundred pounds per acre should be used.

Effect of Inoculation: Most upland soils in Missouri that have never grown alfalfa, except the very richest spots like gardens and old feed lots, respond to inoculation. By inoculation is meant supplying the bacteria that live on the roots of the alfalfa plants and through which they are able to gather part of their food—nitrogen—from the air. Where the crop has never been grown the bacteria are not usually present, or at least only in small numbers, and it becomes necessary to supply them. In these experiments more than 62 per cent of the trials have indicated the advisability of inoculation, and it is safe to conclude that most Missouri soils will be benefited by this treatment. There are, doubtless, a small number of the proper bacteria present in most soils, but usually not in sufficient quantities to inoculate all plants. The bacteria spread, however, and in time all plants may become inoculated, but usually the weeds and grass, or other unfavorable conditions, will have killed most of the plants before this occurs. In very rich soils well supplied with organic matter there is usually enough nitrogen present to maintain the plants until the bacteria spread, and hence, such lands seldom respond to inoculation.

Inoculation is best accomplished by scattering over the new field soil taken from one where alfalfa is growing successfully. If there is no alfalfa in the neighborhood, soil where sweet clover grows will do as well, since the bacteria of sweet clover are the same as those of alfalfa. Sweet clover grows along the roadside and railroad right of ways in practically every section of Missouri, and is easily found. It resembles alfalfa very much when young, but is easily distinguished when mature by its white or yellow blossoms, coarse heavy stem, bitter taste, and rank odor. From 300 to 1000 pounds of soil per acre is required for inoculation, depending upon the manner of application, and should be taken from the top six or eight inches of the soil. It may be scattered on with a shovel,

in which case the larger amount will be necessary in order that the ground will be evenly covered, or it may be scattered through an endgate seeder or other machine. If dried, it should be done in subdued and not direct sunlight, and when applied, covered immediately by harrowing in, as the bacteria are easily killed if left exposed to strong light for any length of time.

Artificial cultures of alfalfa bacteria, as well as those for other legumes, are on the market, but these have not given entire satisfaction and are still in an experimental stage. These cultures are preparations containing myriads of the bacteria grown from bacteria taken from the alfalfa root nodules. This preparation is usually diluted with water and the solution sprinkled over the seed until all are moistened, then they are dried in a shady place and are ready for sowing. On the whole, however, one will usually have better success by inoculating with soil than with these artificial cultures.

Effect of Lime: Alfalfa is a fairly heavy feeder on lime and grows best where there are large quantities of lime in the soil. Soils deficient in lime have a tendency to sourness, a condition which is detrimental to alfalfa and which, in many cases, is responsible for the failure of this crop. In Missouri, however, lime is not of such great importance in growing alfalfa as in some other regions, chiefly because most of the soils here that are otherwise suitable for alfalfa are well supplied with lime. A great many Missouri soils have a tendency to sourness, usually due, however, to lack of drainage. The lack of drainage is in turn due to the topography of the land or the character of the subsoil, conditions which cannot be economically altered by the use of lime. The level prairies comprise the greatest areas of sour soils, but there are other conditions here unfavorable to alfalfa, even though the sourness be corrected. There are some well drained soils in Missouri, however, which have a tendency to sourness, due to the fact that the lime carbonate has been largely leached away, and it is with these soils that lime has given favorable results with alfalfa. Table VIII shows that 17.2 per cent of the successful trials with alfalfa gave some benefit with lime, and most of these have been in the Ozark region. Some are classed here in the level prairies of Southwest Missouri, but most of these were located on the red and black limestone lands of that region which are geologically classed as Border Ozark soils. These lands have a more open subsoil than the gray silt loam prairies which lie immediately north, are better drained, and have a physical make-up better suited for alfalfa. While they are limestone soils, the

lime carbonate has been largely removed under cultivation and hence, they respond to an application of lime.

Where lime is to be used, any sort is suitable save that from gas works, which contains poisonous compounds. The cheapest kind is ground limestone, which one can obtain from various companies in this state at a price of approximately $1.00 per ton in car lots at the crusher. Air or water slaked lime my also be used where small amounts are desired but these are more expensive than the ground limestone, and where one has any great area to lime, the latter is to be preferred. The lime should be applied at the rate of from 3000 to 6000 pounds per acre, preferably with a lime distributor just after plowing the ground and worked into the soil while preparing the seed bed. Where one has only a small area to lime, it may be scattered with a shovel, or by means of a lime hood on a manure spreader, but for larger areas a distributor will be more satisfactory.

Effect of Cultivation. — These experiments have not demonstrated definitely the economic value of cultivation of alfalfa. It

Experiments with cultivating alfalfa at Columbia. Plot on right was cultivated after each cutting; plot on left uncultivated. No further soil treatment in either case.

was found impossible to get the co-operators to cultivate after each cutting as should have been done. This was due partially to the fact that wet weather often interferes with the harvesting and before the alfalfa is off the ground the young alfalfa has made considerable growth, thus making cultivation doubtful. It was also found that the co-operators feared to cultivate, thinking it would injure the alfalfa. Where cultivation was given, however, it was

found to keep the alfalfa cleaner of weeds and grass. At the experiment station at Columbia it has been shown that cultivation can be used to good advantage in keeping down the grass and weeds which usually come in after the second cutting. The cultivation, if very thoroughly done with disc and spring tooth harrow, especially after the second and third cuttings, will give practically clean alfalfa, but it costs considerable to do this, since the ground must be gone over usually three times with the harrow. An ordinary drag harrow is not sufficient for this purpose. It is to be regretted that the experiments are not sufficiently conclusive as yet to determine whether or not the practice is really economical when the cost of the labor is considered.

It should be said here that one of the great difficulties in alfalfa growing on many soils in Missouri is the growth of grasses, particularly crabgrass and foxtail after the second cutting. On many soils only two cuttings of clean alfalfa can be secured, the last two being mainly grass. This is particularly true on soils that are not sufficiently fertile to make alfalfa a thorough success without manuring. Many farmers plow up the alfalfa in the fall if the grass has taken it in this way, thinking that the alfalfa has been ruined while if they would leave it until the next spring they would find that it would come out practically as well as the spring before. This has been shown very definitely by the experiments at Columbia and the indications are that the use of manure together with thorough cultivation after the second and third cuttings will remedy this difficulty.

GENERAL RECOMMENDATIONS FOR THE VARIOUS SOIL GROUPS.

The results of these investigations as summarized in Table VIII indicate that the use of manure, bonemeal and inoculation are the soil treatments most likely to be of benefit in getting a profitable stand of alfalfa on most upland soils of Missouri. Of fifty-eight successful trials throughout the state 86 per cent were benefited by manure, 65 per cent by bonemeal and 62 per cent by inoculation. These treatments have been especially beneficial on the rolling prairies of west central Missouri and on the timber lands and rolling prairies of the northern part of the state. Where one is attempting to grow alfalfa in these sections a liberal use of stable manure is always advisable except where the field to be sown is an old feed lot or other especially fertile spot where manure has been freely used before. There is little use in attempting to grow

alfalfa on thin lands even on these soil types unless one can build up the fertility of the soil by heavy applications of manure which is usually so expensive as not to be profitable except on small areas. Bonemeal has likewise given good returns on these lands and is to be generally recommended, especially on the medium to thin soils. It starts the plants off well and gives them a quick thrifty growth in the fall which enables them to become deeper rooted and better able to stand the winter. From these experiments most alfalfa failures in Missouri seem to be due to freezing out during late winter and early spring, especially the first winter after seeding and any treatment that will overcome this will aid materially in getting a profitable stand. Bonemeal also shows in the yield of hay, especially the first year as these soils are usually lacking in available phosphates and respond to an application of fertilizers of this nature. The soils of these regions in most cases are fairly well supplied with lime carbonate, and except in special cases, lime is not to be recommended. In only a little more than 10 per cent of the successful trials with alfalfa here has lime been of any benefit in securing a stand. Inoculation pays on most of these lands as

Experiments at Columbia, showing first cutting alfalfa, 1912. Excellent alfalfa on a plot to which 20 tons per acre of manure were applied. The third and fourth cutting even with manure on this soil are badly infested with crabgrass.

is indicated by these experiments, where sixty-five per cent of all successful trials have been benefited. While it is not always necessary to inoculate, especially on very rich lands, it is safer to do so and it is generally recommended since it can usually be done with little expense.

It will be seen that the prairies of southwest Missouri, besides being benefited by manure, bonemeal, and inoculation, also respond to applications of lime. It should be remembered, however, that three of the five successful trials in this region have been on the red and black limestone lands and that all of the trials on the gray prairies have failed. On these limestone lands the lime carbonate has been largely leached away and hence an application of lime has given good returns by sweetening the soil and putting it into a sanitary condition for the growth of the alfalfa plants. While lime has been of benefit in correcting the acidity of the level prairie soils in this region yet the effect of the subsoil is more important than that of soil acidity so that these soils have not proved suited to alfalfa even where treated with lime. From the results of these experiments, it is evident that the use of lime will be of benefit on many lands in southwest Missouri that are otherwise well suited to the production of alfalfa.

The Ozark soils have responded to an application of lime in only 20 per cent of the successful trials which would indicate that lime is necessary only on certain soils of this region. The wide diversity of soils in the Ozark region makes it impossible from the results of these experiments to state definitely which soils will respond to lime with alfalfa. As a general rule the soils most needing lime in this section of the state are the high ridges which have been subject to much leaching together with certain lands that have been badly worn by cropping. Ozark soils respond quickly to good soil treatment and manure, bonemeal, and inoculation have all given good returns. This is especially true in the case of manure, 94 per cent of all successful trials responding to its use. These results would indicate that from the standpoint of the physical makeup of the soil the best Ozark lands, which are usually the valley lands, are fairly well suited for alfalfa and can be made to grow it very well provided the proper soil treatments in the way of fertilization and inoculation are given. There are also certain upland soils in this region that will grow alfalfa, especially with proper soil treatment, but as a rule the uplands of the Ozarks are not well suited for the production of this crop.

SELECTING LAND FOR ALFALFA.

It is evident from the results of these investigations that alfalfa cannot be grown successfully on all Missouri soils and that one should use considerable precaution in selecting a piece of ground for seeding. A great deal of money has been spent by

Missouri farmers in attempting to grow alfalfa on lands not suited to its growth because they have not generally understood the requirements of the plant. While it can be grown successfully on many soils of this state yet there are sections where the expense is so great as to make its economic production very uncertain. Alfalfa grows best on a deep, rich, loose and well drained soil, conditions best found in the drier regions of the west. While it often grows on medium to thin lands even in the humid sections, it takes good land under such conditions to grow it without considerable care. It seldom pays to attempt to grow alfalfa in Missouri on land that will not produce 50 or 60 bushels of corn on average seasons. Manure will often bring success on the thinner lands, as these experiments indicate, but unless a man is handling a small acreage of alfalfa, sufficiently heavy manuring may not be feasible or economical. As a rule the best alfalfa lands in Missouri are the sandy and silt loam soils found along the Missouri and the Mississippi rivers, underlaid with a porous subsoil through which the roots can readily penetrate and which affords excellent underdrain-

Effect of character of soil on alfalfa. In background on the higher land where the soil is deep the alfalfa is excellent. In the foreground where the surface soil has been largely washed away the weeds and grass have replaced the alfalfa, although both the deeper soil and washed soil had been heavily manured before seeding.

age. Similar soils are also found in smaller areas along the rivers and smaller streams in various parts of the state and produce in many cases from four to six tons of hay during the season. Such soils are rich in plant food, well drained, and in second bottom lands are ideal for alfalfa. In the first bottoms, however, some

difficulty is experienced with overflows. Alfalfa can stand considerable overflow in the winter or spring provided water does not freeze solid on it, but during the growing season floods are disastrous if the water stands on the alfalfa any length of time or sediment is washed on the plants. Overflows of small creeks and branches that last only a few hours seldom do much damage except when the alfalfa is well advanced and it is washed down and more or less covered with sediment.

Poorly drained bottom lands are not suitable for alfalfa. It does not thrive well on wet lands where the water table is permanently within two or three feet of the surface of the ground. Such lands can probably be improved by tiling, although there is lack of sufficient data at present to definitely establish this point. There are large areas of such lands in Missouri along many of the smaller rivers where it is not feasible to attempt to grow alfalfa.

It is more difficult to grow alfalfa on most upland soils in Missouri than on the best bottom lands, since they are usually less fertile and since they are often underlaid with tight clay subsoils. It is therefore necessary to use greater precautions in selecting

Good alfalfa on well drained Missouri River bottom land where no treatment is necessary other than a proper preparation of the seed bed.

upland that is suitable for alfalfa if one is to make it a success. The chief factors to be considered are the subsoil, drainage and fertility. Select a piece of land with a loose, open subsoil well drained and fertile. An old feedlot is an ideal place and where the subsoil is open such lands grow alfalfa well without further treatment than a possible soil inoculation and a good preparation

of the seedbed. If the subsoil is tight and clayish even these lands seldom grow it profitably and in such cases it will be found a better plan to depend upon such other legumes as clover, cowpeas, and soybeans, and leave alfalfa for the man who has soil suited to its growth.

SUMMARY.

1. Alfalfa can be profitably grown on a number of Missouri soils but it does not have as wide adaptations as most forage crops grown in this state.

2. The most important factors which determine the adaptability of the soils of Missouri to alfalfa are drainage, the character of the subsoil, the fertility and the quantity of lime carbonate present.

3. The best alfalfa lands in Missouri are the well drained silt and sandy loam bottom lands, underlaid with porous subsoils.

4. The best upland alfalfa soils in Missouri are the fertile rolling prairies of the north and west central part of the State, the better timbered lands of north Missouri including the brown loess and the more fertile valley lands of the Ozark region.

5. The large number of failures on the level prairie lands of the State demonstrates the poor adaptation of these soils to alfalfa growing.

6. A liberal application of manure has been found beneficial and often necessary in these investigations in securing a satisfactory stand of alfalfa on most upland soils.

7. Since most Missouri upland soils are lacking in available phosphates the use of bonemeal has aided in securing a profitable stand and in giving an increased yield of hay.

8. Most Missouri soils that are adapted to alfalfa growing are well supplied with lime carbonate and hence lime has not usually given profitable returns with alfalfa on these lands.

9. Inoculation of the soil with alfalfa bacteria has been found beneficial or necessary on the majority of the soils covered by these experiments.

10. These experiments indicate that cultivation of alfalfa will aid materially in preventing the growth of grasses during late summer, thus giving a better quality, although not necessarily a larger amount, of hay.