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SOIL SURVEY OF CHEROKEE COUNTY, KANSAS.

MANHATTAN, KANSAS.

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The soil survey of Cherokee county was made by the Kansas State Agricultural College in cooperation with the Bureau of Soils, United States Department of Agriculture. The field work was done by P. O. Wood, of the United States Department of Agriculture, and R. I. Throckmorton, of the Kansas Agricultural Experiment Station. The soil samples were obtained and the chemical analyses determined by C. O. Swanson, of the Department of Chemistry of the Kansas Station. The report was written by L. E. Call and R. I. Throckmorton, of the Department of Agronomy, and C. O. Swanson, all of the Kansas Station. The mechanical analyses of the soil types were made by the Rureau of Soils, United States Department of Agriculture.

SOIL SURVEY OF CHEROKEE COUNTY, KANSAS.

DESCRIPTION OF THE AREA.

Cherokee county is situated in the extreme southeastern corner of Kansas. It forms an almost perfect square, being slightly over twenty-five miles from east to west and twenty-three and one-fourth miles from north to south. The county comprises 585 square miles, or 374,400 acres.

While Cherokee county consists mainly of residual prairie country, the western extension of the Ozark uplift covers about thirty-five square miles in the southeastern part of the county. The elevation ranges from 780 feet to something over 1100 feet above sea level. The upland part of the county consists of undulating to gently rolling prairie, with occasional ridges and hillocks. The stream bottoms and terraces are usually level. In general, the county consists of a broad plain, with broad, shallow, flat-bottomed valleys along the larger watercourses.

There are two chief drainage divisions in the county, which are separated north and south by a divide, most pronounce D from the Oklahoma line to Columbus. The western section is drained by the Neosho river and the eastern part by the Spring river. The principal tributaries of the Neosho river are the Lightning, Deer, Cherry, and Fly creeks. These streams flow in a southwesterly direction, and with the Tarr and Four-mile creeks, which head about five miles from the Oklahoma line and flow south, drain the entire western half of the county. Spring river with its principal tributaries, the Cow, Shawnee, Brush and Willow creeks from the west, and the Short, Shoal and Killaboo creeks from the east, drains the eastern half of the county. All but the larger streams are dry most of the summer. Spring river is fed by springs in the limestone hills of the Ozarks, and the water is nearly always clear. The Neosho heads in and flows through the prairie country, and is usually muddy, with soft bottoms and banks. Nearly two-thirds of Neosho township and about one-third of Lola township are subject to overflow from the river. The Spring river also overflows frequently, but does not cover nearly as much territory during such periods as does the Neosho. The larger creeks have comparatively wide beds, and these, as well as the river bottoms, are inundated after heavy rains.

CLIMATE.

The climate of Cherokee county is not typical of Kansas nor of the other three states which practically meet at the southeast corner of the county. It has a longer growing season than any county in the state. Extreme temperatures vary from 28° below zero in winter to 110° above zero in summer. The average rainfall is 45.12 inches, higher than that of any other Kansas county. It is fairly well distributed throughout the year, and over half of the total precipitation occurs in the spring and summer, during the growing season. However. periods of drouth are by no means uncommon and crops frequently suffer from lack of moisture.

The following table gives the normal monthly, seasonal and annual temperature and precipitation as recorded at Columbus for a period of eighteen years, 1891 to 1908, inclusive:

NORMAL MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT COLUMBUS, CHEROKEE COUNTY, KANSAS.

MONTH.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	Deg. F.	*Deg. F.*	*Deg. F.*	*In.*	*In.*	*In.*	*In.*
December	35.8	78	−9	2.37	2.01	10.50	4.3
January	33.1	73	−16	1.95	1.10	1.23	4.3
February	33.0	80	−28	2.15	1.90	0.13	3.9
Winter	34.0	....	....	6.47	5.01	11.86	12.5
March	46.1	90	6	3.47	1.70	1.97	1.2
April	56.5	91	20	4.08	4.43	0.50	0.3
May	65.9	94	29	6.34	4.05	4.10	....
Spring	56.2	....	....	13.89	10.18	6.57	1.5
June	74.1	99	44	6.30	4.25	8.67	....
July	77.8	110	52	5.21	3.15	11.03	....
August	77.4	104	41	3.99	2.19	5.54	....
Summer	76.4	....	....	15.50	9.59	25.24	....
September	71.0	107	32	3.90	0.41	10.12	....
October	58.9	99	24	3.03	1.47	0.32	0.1
November	45.5	87	4	2.33	2.96	4.19	1.0
Fall	58.5	....	....	9.26	4.84	14.63	1.1
Year	56.3	110	28	45.12	29.62	58.30	15.1

SOILS.

The soils of Cherokee county may be divided into two broad groups: (1) Upland or residual soils, and (2) bottom land or alluvial soils.

The upland soils may be subdivided into those derived from limestone, including the Clarksville and Crawford series; those derived from limestone and shales forming the Summit series; and those derived from shales and sandstones, including the Bates, Cherokee and Oswego series. Four types of the Bates, one of the Cherokee and two of the Oswego were mapped.

The alluvial soils may be subdivided into terrace soils, occupying second bottom, and recent alluvium, occupying first bottom. Of the alluvial soils, three series, the Osage, Neosho and Shawnee, are derived entirely from reworked prairie material. The Osage series, embracing four types, includes first bottom, and the Neosho and Shawnee, with one type each, include second bottom or terrace soils. The remaining alluvial soils are derived from materials from the limestone valleys and uplands and from the Great Plains region. The first bottom soils in this group are the Holly and Huntington, each represented by one type, and the terrace soils or second bottoms are the Robertsville and Riverton with one and two types respectively.

The following table gives the name, relation and actual extent of each of the soils in Cherokee county:

AREAS OF DIFFERENT SOILS.

Soil.	Acres.	Per cent.
Bates silt loam	91,584	24.5
Cherokee silt loam	74,816	20.0
Osage silt loam	30,976	8.3
Osage loam	27,520	7.3
Neosho silt loam	27,520	7.3
Bates loam	20,032	5.3
Summit silt loam	16,384	4.4
Riverton silt loam	9,408	4.2
Shallow phase	6,528	
Osage clay	13,632	3.6
Bates fine sandy loam	9,664	2.6
Huntington silt loam	8,448	2.3
Osage silty clay loam	7,744	2.1
Oswego silty clay loam	6,656	1.8
Shawnee silt loam	6,208	1.7
Clarksville stony loam	4,160	1.1
Robertsville silt loam	3,008	.8
Riverton gravelly loam	2,624	.7
Bates very fine sandy loam	1,664	.4
Oswego clay	1,664	.4
Crawford silt loam	1,472	.4
Meadow	1,344	.4
Holly silt loam	1,344	.4
Total	374,400	......

Cherokee Series.

CHEROKEE SILT LOAM.

The Cherokee series is represented by one type, the Cherokee silt loam, locally known as "white ashy land." It is the second series in extent in the county.

This soil consists of an ashy-gray, floury silt loam to a depth of ten to twelve inches. When dry the soil is almost white, but with increasing moisture it becomes much darker. The subsurface is a silt loam, nearly white in color and usually somewhat more compact than the surface material. Underlying this subsurface layer, and beginning abruptly at fourteen to eighteen inches, is a tough, plastic, waxy, heavy clay of a dark drab color, usually mottled with red.

The topography is flat to gently undulating. As a whole, the type is more nearly level than any other soil in the county, with the exception of those of alluvial origin. It may occur on long, very gentle slopes, where it becomes an undulating prairie soil with occasional level areas. Sometimes level areas of the Cherokee silt loam are surrounded by soils of more rolling topography, thus giving the type a basin-like appearance.

Drainage is one of the great problems connected with this type. Its general levelness, the lack of organic matter, and the tough, dense, almost impervious subsoil combine to produce unfavorable drainage conditions.

The Cherokee silt loam is largely used for the production of prairie hay, for which it is unquestionably the best adapted. The type grows fair wheat, but wheat on this soil is benefited by manure and phosphoric fertilizers. Only poor to fair crops of corn and kafir are secured. Feterita has given better results than any other member of the sorghum family. The type is not well adapted to the growing of alfalfa or red clover, but cowpeas make a reasonably satisfactory crop.

The following table gives the results of mechanical analyses of samples of the soil, subsoil and lower subsoil of this type.

MECAHNICAL ANALYSES OF CHEROKEE SILT LOAM.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
381303	Soil	0.3	0.7	0.9	1.9	8.2	84.3	4.4
381304	Subsoil	.8	1.4	.4	1.4	8.1	81.2	6.6
381305	Lower subsoil	.0	.0	.2	.5	3.2	46.9	49.1

Oswego Series.

The Oswego series consists of Oswego clay and Oswego silty clay loam. The soils of this series are residual in origin, having been derived largely from dark-colored calcareous shales. They are locally known as "black limestone land." The soils of the Oswego series lie below the Summit silt loam and occupy level to very gently sloping areas, usually adjoining streams and draws.

The heavy, dense character of both soil and subsoil prevents or greatly retards percolation of water, and with the level topography causes poor drainage. Tiling is necessary for the fullest utilization of these soils. Not only would drainage aid in the removal of surplus surface water, but it would greatly improve moisture conditions during drouth. These soils crack badly when dry, and if they are not drained they are subject to leaching in winter. Soils of the Oswego series must be handled with great care because of their physical nature, and must not be plowed when too wet or too dry.

OSWEGO CLAY.

The Oswego clay is practically confined to the northwestern corner of the county in the region of the dark-colored calcareous shales and thin-bedded limestones. The soil of this series to a depth of sixteen to twenty inches is a black, heavy, plastic clay grading into a dark yellowish-brown, sticky, plastic clay, which in the lower portion contains some black oxide of iron. Occasionally, the lower subsoil, from about thirty to thirty-six inches, contains large quantities of gypsum crystals.

OSWEGO SILTY CLAY LOAM.

Small areas of Oswego silty clay loam occur as bands on gently sloping to nearly level areas bordering small streams and drainage ways. The most extensive development is in the northeastern part of the county, but it is also found along small watercourses over a large part of the district.

Much of the type is in permanent pasture, to which it is best adapted in its present condition. All the ordinary farm crops of the region, however, are grown on it to some extent, the slightly lighter phase especially being under cultivation. Alfalfa can be grown without lime, but tile drainage is necessary to prevent serious damage from heaving and freezing in the winter and early spring.

Bates Series.

The Bates series includes four types: Bates silt loam, Bates loam, Bates fine sandy loam, and Bates very fine sandy loam. The soils of this series are residual from soft shale and fine-grained soft sandstone. The loam and silt loam types have been formed where the shales predominate.

The Bates series is the most extensively developed upland soil of the county. It occupies ridges, and slopes, the topography being undulating to slightly hilly. This series has its greatest development in the northern townships, including Ross, Mineral, Cherokee and Pleasant View, and in the section between Baxter Springs and Columbus. Over the remainder of the prairie it occurs in small bodies, being closely associated with the Cherokee silt loam, occurring both above and below this soil.

BATES SILT LOAM.

The soil of the Bates silt loam to a depth of ten inches is a grayish-brown to brown silt loam. It does not have the floury feel characteristic of the Cherokee silt loam. The surface soil is underlaid by a grayish-brown, brown or yellowish-brown silt or friable clay loam, which extends to a depth of about eighteen inches, where it changes to a yellowish-brown silty clay, usually mottled with red. Sometimes this red mottling continues through the remainder of the three-foot section, but it usually gives way to a gray or drab, the subsoil in such cases being a mottled yellowish-gray and drab silty clay. This subsoil is not plastic and waxy like that of the Cherokee and Oswego soils, but is rather friable or brittle. When thoroughly dry, however, it is quite hard.

The Bates silt loam occupies the slopes and crests of low ridges, the topography being undulating to gently rolling. It is a typical prairie soil in both topography and elevation.

The mellow surface soil, rather friable subsoil and gently rolling topography produce fair natural drainage over this type. Some of the lower and heavier areas, however, are kept in a more or less saturated condition and would be greatly improved by tile drainage.

The Bates silt loam is generally considered a desirable farming soil. It is more easily handled than the Oswego or Cherokee soils, can be kept in better physical condition, and is better drained, warmer and earlier. Where a choice can be made, it is commonly used as a corn and potato soil, while wheat and grass are more commonly grown on the Cherokee silt loam. Corn, wheat, oats and prairie hay give fair yields. Some kafir and cowpeas are grown with good results. Very little alfalfa is being grown on this soil, but with the aid of barnyard manure, lime, inoculation, drainage, and care in seeding, it may be grown successfully.

BATES LOAM.

The Bates loam is closely associated with both the silt loam and the fine sandy loam of the same series, and is a variable soil both in color and texture. To a depth of six to eight inches the soil consists of a grayish-brown or brown loam, silty in some areas. The color becomes much darker with the increase of moisture content. The surface material typically grades through a yellowish-brown friable loam into a friable fine sandy loam or fine sandy clay at about fourteen to eighteen inches. The subsoil is often mottled with bright yellow and red. Rock is usually encountered at fifteen to thirty inches; it is almost always found within the three-foot section.

The Bates loam has a rolling topography. It occupies the wide or rather wide ridges and the slopes bordering higher areas of the fine sandy loam. The loose, open structure and the rolling topography render the drainage good, and the soil is mellow and easily worked. Owing to the open character of the soil, and to the fact that the underlying rock occurs at shallow depths, the type is rather susceptible to drouth.

The Bates loam is used for general farm crops, and yields are fair in favorable seasons, but low in seasons of scant rainfall. Production on this type may be greatly improved by increasing the supply of organic matter through the application of barnyard manure and by the plowing under of green manuring crops.

BATES FINE SANDY LOAM.

The soil of the Bates fine sandy loam consists of a grayish-brown to brown or reddish-brown fine sandy loam to a depth of six to fourteen inches. This grades throughout lighter-colored material of about the same texture into a fine sandy clay loam to fine sandy clay at ten to sixteen inches. The subsoil, while compact, is friable, and usually the sand content increases with the depth until bedrock is encountered. The subsoil is mottled with red, yellow, and yellowish-brown, the colors becoming more intense with depth. A stratum of yellow, red and brown sandy material, which is really rotten rock, often immediately overlies the rock. The bedrock is encountered at depths varying from ten to thirty inches, depending largely upon the slope.

This type is rolling, with ridges and hillocks. A chain of sandstone hillocks extends in the form of the letter S to the southeast and south of Columbus, the soils resulting from the weathering of these hillocks being largely the Bates fine sandy loam. Small mound-like elevations or knolls, which usually consist of fine sandy loam, are often encountered in areas of the Bates loam.

Owing to the loose structure, comparatively coarse texture, and rolling to hilly topography, the drainage is good to excessive.

Fair yields of all general farm crops are obtained in seasons of plentiful and frequent rainfall, but crops suffer during dry periods.

This fine sandy loam should be given special treatment and be utilized for special crops, such as potatoes and truck crops. General farming is not so promising. The soil is very low in organic matter, and some areas are in need of lime.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Bates fine sandy loam:

MECHANICAL ANALYSES OF BATES FINE SANDY LOAM.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
381335	Soil	1.4	0.9	0.8	23.9	32.5	25.8	8.9
381336	Subsoil	.6	.9	1.0	30.9	25.3	24.6	16.7

BATES VERY FINE SANDY LOAM.

The surface soil of the Bates very fine sandy loam consists of a grayish-brown to brown very fine sandy loam to a depth of eight to ten inches. The subsoil is a light-brown to yellowish-brown fine sandy clay, which at about twenty to twenty-four inches becomes lighter in color and mottled with brown, gray, red and yellow. The subsoil is quite heavy and compact in spite of its content of fine and very fine sand. The underlying rock is encountered at three to ten feet, the soil being shallowest on the slopes. The rock is often exposed where small draws and drainage ways have become established.

Although this type has a rolling surface and sandy soil, drainage is somewhat deficient because of the compact nature of the subsoil. The surface soil often remains saturated for some time after heavy rains. The organic matter content is low and the soil is in need of lime in many places.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

MECHANICAL ANALYSES OF BATES VERY FINE SANDY LOAM.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
381323	Soil..............................	0.0	0.5	0.6	23.2	28.0	40.6	7.4
381324	Subsoil.........................	.0	.5	.4	23.5	28.3	31.0	16.5

Summit Series.

SUMMIT SILT LOAM.

The Summit silt loam is the only type of the series found in the county. The soil of the Summit silt loam to a depth of twelve inches is a brown to dark mellow silt loam, which sometimes varies locally from yellowish-brown to nearly black. This material grades into a yellowish-brown friable clay loam mottled with red, yellow and brown. A light-brown to brown friable clay, somewhat mottled with red in the upper portion, is encountered at about eighteen to twenty inches. With increasing depth the brown color gives way to a yellowish-brown, and the red mottling becomes fainter, the material becoming a yellowish or rusty color. The subsoil is brittle or moderately friable.

The main development of the type is in Sheridan township, in the northwestern corner of the county, where it is the most important agricultural soil. In this vicinity the Summit and the Oswego soils are locally referred to as "black land," and are much more highly esteemed than the lighter-colored prairie soils.

The Summit silt loam is residual, being derived from the weathering of limestone interbedded with fine-grained sandstones and shales. The various rocks entering into the composition of this type outcrop in many places on the slopes, and are frequently within a few inches of the surface on the crests of the slopes.

The topography is gently rolling, the type occupying low, narrow ridges and intervening slopes. The rolling topography insures fairly good surface drainage. The subsoil, while friable, is compact, and does not permit the rapid penetration of water. In places, especially on the more level areas, tile drains would be beneficial.

Clarksville Series.

CLARKSVILLE STONY LOAM.

The Clarksville stony loam is the only type of this series occurring in the county. It consists of a yellowish-brown to light-gray silt loam, and extends to a depth of six to eight inches. The subsoil is a yellowish to brownish silty clay, which is often bright red in the lower part. Both soil and subsoil contain large quantities of angular chert fragments of varying size.

The type is developed only in the southeastern corner of the county in the Kansas extension of the Ozark region. The topography is rolling to hilly, and drainage is well established. This soil is a residual soil derived from cherty limestone. Erosion has kept pace with weathering to such an extent that the soil is not deep, and the type is characterized by the presence of rock fragments, usually in quantities sufficient to prevent cultivation.

Very little of the Clarksville stony loam is used for farming. It is seldom utilized for general farm crops, but produces good fruit, especially apples.

Crawford Series.

CRAWFORD SILT LOAM.

The Crawford silt loam, locally known as “red land,” consists of a brown to dark brown or reddish-brown mellow silt loam to a depth of eight or ten inches, underlaid by a reddish-brown friable clay which becomes heavier and more intense in color with depth, the deep subsoil being a rather plastic clay of pronounced red color. Both the soil and the subsoil contain numerous fragments of limestone. Limestone rock underlies the type and often occurs at twenty-two to thirty-six inches.

The type is of small extent and is confined to a few small areas in the northwest corner of the county. It occupies gentle slopes and narrow ridges and has an undulating to gently rolling surface. The Crawford silt loam is derived principally from the weathering of the limestone.

Osage Series.

The Osage series consists of four types: Osage clay, Osage silty clay loam, Osage silt loam, and Osage loam. The soils of this series are alluvial in origin, and occur along all streams of the area with the exception of those in the southeastern part.

The soils of this series are almost level, are subject to overflow, and artificial drainage is usually necessary in order to produce maxinrum crops.

OSAGE CLAY.

The Osage clay consists of a black, waxy, plastic clay of variable depth, fifteen to eighteen inches being about the average, underlain by a drab or dark drab to dark grayish-brown clay. In places there is but a very slight difference between the soil and the subsoil either in color or in texture.

This type occurs along the Neosho river and Lightning creek, comprising a large part of the Neosho bottoms in the southwestern part of the county. On drying, the soil breaks up into cubical blocks and large cracks form, sometimes three or four inches wide and several feet deep.

The Osage clay is a strong soil of high natural fertility. With adequate protection against overflow and by means of the installation of tile drains, it would prove productive and quite valuable.

OSAGE SILTY CLAY LOAM.

The Osage silty clay loam to a depth of eight to fourteen inches is a brownish-gray to dark silty clay loam, grading into a clay loam of somewhat lighter color and heavier texture. This surface soil is nearly black when thoroughly wet. The subsoil, which is encountered at sixteen to twenty inches, consists of a dark gray to nearly black clay loam or silty clay, which is often very heavy and plastic. In places the subsoil is yellowish-brown faintly mottled with rusty brown.

The type usually occurs at a slightly higher elevation than the Osage clay and slightly lower than the Osage silt loam. It is developed in small areas in the bottoms of Neosho river and Lightning creek and is a comparatively unimportant type.

On drying, this soil cracks considerably. Tile drainage would improve it greatly and make cultivation less difficult.

OSAGE SILT LOAM.

The Osage silt loam to a depth of eight to fourteen inches consists of a gray silt loam. Underlying this surface soil is a light gray to nearly white floury silt loam, usually mottled with rusty brown and yellow and containing concretions and concretionary material of feruginous character. The subsoil from twenty-four to thirty inches is a drab silty clay mottled with rusty brown.

The type as a whole has a level topography. Sometimes there is a very slight slope, usually away from the stream, particularly where areas of bottom soil of heavier texture lie between it and the upland.

The Osage silt loam is particularly adapted to corn and alfalfa where danger from overflow is not great. The brown, lighter phase produces excellent corn and is the soil most commonly used for alfalfa, giving very good results with this crop. Wheat and oats also give good yields on the better-drained areas.

OSAGE LOAM.

The Osage loam is neither uniform in texture nor color. Typically, the soil is a loam to silty loam, but in many places varies within a short distance from a rather sandy loam to a silty clay loam. It has ordinarily a grayish-brown to dark brown color, and when wet is often nearly black. This type occurs exclusively in the draws and minor drainage ways of the prairie soils. It is of small extent, but differs so widely from the soils in which it occurs that its separation seems advisable. It is almost always left in sod and is generally used for pasture.

Neosho Series.

NEOSHO SILT LOAM.

The Neosho silt loam is a light gray or ashy, floury silt loam underlaid at about eight to twelve inches by a layer of nearly white, more compact silt loam. Where erosion has occurred it is very shallow, while in other places it extends to a depth of two feet. The subsoil, which begins abruptly at about fourteen to eighteen inches, consists of a drab to dark drab or nearly black clay, very tough, dense and plastic. This clay usually extends to about thirty inches, where yellowish-brown mottlings sometimes appear. Below this the material is slightly more friable owing to a higher content of silt. Deep excavations, as for wells, disclose large quantities of rounded chert gravel, which is locally known as "river gravel." Typically the subsoil is a solid drab, becoming slightly lighter in color with depth.

The soil has a lifeless appearance characteristic of many imperfectly drained silt loams. The surface is practically level. There is a very slight slope toward the large streams and main river bottoms.

The type occurs as second bottom or terrace areas lying from five to fifteen feet above the bottoms along the Neosho river and Lightning, Cherry and Shawnee creeks. It is developed as a belt along the river, unbroken except by bottom soils, and varying from one to four miles in width.

Owing to its level topography and to the very heavy subsoil, the drainage of the Neosho silt loam is poor. In a few areas where the slope is comparatively steep or adjacent to the bottoms and larger streams, erosion is rather a serious factor. The type has a very low organic content and is acid. The addition of organic matter and the correction of acidity, together with improvement of the drainage, is essential to its best utilization.

The Neosho silt loam is naturally adapted to small grain and grass, and is largely used for these crops, wheat and prairie hay being the crops chiefly grown.

Huntington Series.

HUNTINGTON SILT LOAM.

The only type of the Huntington series mapped in the area is the Huntington silt loam, which consists of a brown, mellow silt loam, which at a depth of twelve to fourteen inches grades into a yellowish-brown, more compact silt loam or silty clay-loam.

The type occurs as first bottom land along Spring river and its tributaries, particularly Cow creek. A few small bodies are developed in the Spring river bottoms, which vary from the main type in having a dark-brown to nearly black heavy silt loam or silty clay loam surface soil, underlaid by a dark to nearly black silty clay, which is in places quite plastic and impervious.

The Huntington silt loam is composed of material washed in part from the sandstone and shale soils of the adjacent prairies and in part from the soils derived from the cherty limestone of the Ozark region. The topography is level, and in many places, particularly in those local areas where the subsoil consists of or contains heavy material, artificial drainage would prove beneficial.

Holly Series.

HOLLY SILT LOAM.

The Holly series is represented by the Holly silt loam, which consists of a brownish-gray to gray silt loam for about eight or ten inches, where it grades into a light-gray or nearly white floury silt loam containing some iron concretions and concretionary material. At about twenty to twenty-four inches this subsurface material becomes more compact, and at twenty-four to twenty-eight inches it grades into a drab silty clay loam to silty clay.

The type occurs as first bottoms along Spring river, nowhere in large areas, and usually associated with bodies of Huntington silt loam.

The topography is level, the soil is poorly drained, and many field tests have shown it to be decidedly acid. The addition of organic matter, the establishment of tile drainage, and heavy applications of lime would result in marked improvement.

Robertsville Series.

ROBERTSVILLE SILT LOAM.

The Robertsville silt loam is the only type of this series occurring in the county. To a depth of about eight to twelve inches it is a gray silt loam which is very light gray or almost white. This surface soil grades into an almost white, floury silt loam which passes into a drab, very plastic, heavy clay at sixteen to twenty inches. Some small, well-rounded gravel is found in the subsurface soil and subsoil, and occasionally on slight elevations this material is present in considerable quantities on the surface.

It occurs typically as second bottom along Spring river, lying either completely or largely above overflow. The topography is level and drainage is deficient.

The Robertsville silt loam resembles the Neosho silt loam in many respects, and, like it, is used largely for wheat and grass. The water-holding power of the soil is low, owing to the deficiency of organic matter and to the impervious subsoil. Because of its inability to hold moisture in time of drouth, crops may be an utter failure. Deeper plowing, the incorporation of organic matter, and tile drainage would greatly improve the physical condition of this soil.

The results of mechanical analyses of samples of the soil, subsoil and lower subsoil of this type are given in the following table:

MECHANICAL ANALYSES OF ROBERTSVILLE SILT LOAM.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
381309	Soil	0.0	0.6	1.1	7.0	7.6	78.9	4.6
381310	Subsoil	1.2	1.7	1.2	6.3	8.8	66.8	14.3
381311	Lower subsoil	.4	.7	.6	4.7	5.5	51.0	37.2

Riverton Series.

The Riverton series is represented by the Riverton silt loam, Riverton silt loam shallow phase, and Riverton gravelly loam. The soils of this series occur as terraces along and near Spring river. The topography is level to rolling, some of the higher terraces having been badly cut by erosion. The soils of the Riverton series are of alluvial formation, consisting mainly of material washed from the cherty limestone soils of the Ozark region, with some shale and sandstone material from the prairie.

RIVERTON SILT LOAM.

The soil of the Riverton silt loam consists of a grayish-brown to brown mellow silt loam, with a depth of ten to twelve inches, where it passes into a light brown to a yellowish-brown silt loam to silty clay loam, which is often mottled with rusty brown to a depth of eighteen to twenty inches. Beneath this the subsoil is a yellowish-brown, brown or reddish-brown plastic clay.

Although occurrng uniformly as terraces, the type varies greatly in its elevation above the river. Although underlaid by gravel in many places, this soil is inadequately drained because of the heavy clay subsoil.

RIVERTON SILT LOAM, SHALLOW PHASE.

The Riverton silt loam, shallow phase, consists of a grayish-brown to brown mellow silt loam, underlaid at about eight to ten inches by a light brown to reddish-brown silty clay loam, which at fourteen to twenty-four inches overlies a stratum consisting mainly of rounded and angular chert fragments. Such fragments occur on the surface, being particularly noticeable on the slopes.

This soil represents an eroded phase of Riverton silt loam. It is associated with the latter soil and also with the Clarksville stony loam, usually occupying an intermediate position between these two types.

The result of mechanical analyses of samples of the soil and subsoil of typical Riverton silt loam are given in the table following:

MECHANICAL ANALYSES OF RIVERTON SILT LOAM.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
381301	Soil........................	0.0	1.7	2.1	11.7	10.4	68.9	5.5
381302	Subsoil......................	.2	.9	1.5	9.8	9.2	51.1	27.6

RIVERTON GRAVELLY LOAM.

The Riverton gravelly loam consists of a brown to grayish-brown silty loam, underlaid at a depth of about six to eight inches by a lighter brown silty clay loam which passes into a reddish-brown to red clay loam to clay at fifteen to eighteen inches. This heavy subsoil is often absent and is never of great thickness, giving way to a stratum of chert, gravel and fragments. The gravel, generally well rounded, is scattered over the surface soil and throughout the soil, often in quantities sufficient to interfere with cultivation. The gravel is usually encountered at sixteen to thirty inches.

The district in which Riverton gravelly loam occurs is undulating to gently rolling. The type is of small extent, being practically confined to narrow strips and bands. The soil occupies relatively high, old terraces along Spring river which have been cut away in places by erosion.

Shawnee Series.

SHAWNEE SILT LOAM.

The Shawnee silt loam to a depth of about eight to twelve inches is a brown silt loam, passing through a lighter brown silt loam into a brown silty clay subsoil at fifteen to twenty inches. In places the lower subsoil contains large quantities of black oxide or iron concretions.

This type resembles the Neosho silt loam in origin, material and relative position, but is quite different in color, both of soil and subsoil. It also resembles the Riverton silt loam as developed on the low terraces, but differs from this soil in that it lacks the limestone material entering so largely into the composition of the Riverton soils.

The type is developed as second bottoms or terraces above normal overflow, although the lower areas or edges adjoining the bottoms are inundated for a short time during very high water. It is alluvial in origin. The material is derived from the shale, sandstone and limestone soils of the residual prairies, the material having been transported from its original position and deposited in its present location by the streams. Owing to the heavy, plastic subsoil and the level surface, drainage is poor. This condition can be remedied properly only by the installation of tile drains. The use of lime is also recommended.

Meadow.

The material composing the beds of the drainage ways and minor streams in the southeast corner of the county, or in the group of soils largely influenced by the cherty limestone formation, has been classified as Meadow. The soil varies widely in texture, color, and depth, ranging from a fine sandy loam to a clay loam, and from gray to black in color. Chert, gravel and rock fragments are abundant.

The Meadow areas are partly colluvial, but mainly alluvial, consisting of material washed down from the higher-lying soils on the uplands and slopes. Drainage is characteristically poor. The type is subject to overflow after each heavy rain, remaining in a wet or soggy condition for some time after such overflow, and is therefore of practically no agricultural value.

Chemical Analyses of the Soil Types of Cherokee County.

The detailed report of the chemical analyses of the soil types in Cherokee county is given in the table in the Appendix. The grouping is made with partial reference to the parent rock from which these soil types have been derived. This table gives the location where each sample was taken, the type as given in the soil survey, and the percentage of plant food elements found in the different types. The acidity is given in pounds of lime requirement per acre. In Table I are given the pounds of fertility elements per acre in the surface soil. These calculations are made on the assumption that an acre of soil seven inches deep weighs 2,000,000 pounds.

TABLE I.

Average number of pounds of plant food elements per acre in surface soils classified on the basis of physical texture

TYPE OF SOIL.	Nitrogen.	Phosphorus.	Potassium.	Calcium.	Carbon.
Oswego clay	4,400	700	22,800	15,400	48,400
Osage clay	4,600	1,140	30,400	12,200	53,600
Oswego silty clay loam	2,300	800	18,400	10,200	36,000
Osage silty clay loam	3,400	800	21,600	8,000	35,800
Bates silty loam	3,000	710	12,600	6,500	29,500
Cherokee silt loam	2,400	620	13,500	6,200	18,800
Summit silt loam	3,000	310	18,100	8,400	32,300
Crawford silt loam	3,000	200	16,000	9,600	30,800
Neosho silt loam	2,000	480	17,400	5,600	20,200
Shawnee silt loam	2,400	240	18,800	10,400	26,600
Robertsville silt loam	2,400	160	13,800	5,400	23,400
Riverton silt loam	1,000	120	13,800	4,200	15,000
Osage silt loam	3,400	620	20,200	6,000	33,000
Holly silt loam	2,800	320	21,400	4,800	28,600
Huntington silt loam	2,900	700	18,400	8,700	30,800
Bates loam	2,000	480	7,400	4,200	20,600
Bates very fine sandy loam	4,400	580	10,200	6,200	20,000
Bates fine sandy loam	1,900	640	8,200	2,700	20,300
Riverton gravelly loam	1,700	360	17,000	8,000	21,400
Clarksville stony loam	2,400	220	18,000	6,400	39,000
Meadow	3,400	660	21,600	10,600	....
Average of good soil*	4,300	1,025	32,500	12,000	50,400

*This average is computed from the composition of seven samples of Marshall silt loam from Brown county, six samples of Oswego silt loam from Riley county, seven samples of Oswego silt loam from Allen county, and six samples of Summit silty clay loam from Greenwood county.

THE AVERAGE COMPOSITION OF GOOD SOIL.

The amount of nitrogen, phosphorus, potassium, calcium and carbon which should be present in an acre of surface soil is not fixed. Table I shows the average computed from the composition of twenty-six samples of silt loam. The amount of plant food elements entirely adequate for the production of good crops in a sandy loam may be insufficient for the production of profitable crops in a silty clay loam. Other things being equal, heavy soils require larger amounts of plant food than light soils. Furthermore, the amount of lime and decaying organic matter also influences the degree of plant food adequate for the production of profitable crops. In the presence of decaying organic matter and enough lime to keep the soil sweet, smaller amounts of plant food are more effective than larger amounts in soils where the organic matter is old and relatively inert and where the amount of lime is small.

THE NITROGEN CONTENT.

The highest nitrogen content is found in the Osage clay, 4600 pounds; the Oswego clay, 4400 pounds; and Bates very fine sandy loam, 4400 pounds. The Osage clay was sampled in native timber, hence the large nitrogen content. The other two types are of little importance, as they represent small areas. The average upland soils in Cherokee county, represented by Cherokee silt loam and Bates silt loam, contain 2400 and 3000 pounds, respectively. This is considerably below the average for good soil. The bench-land types are low in nitrogen content; Riverton silt loam the lowest, 1000 pounds; Shawnee silt loam the highest, 2400 pounds, and Neosho silt loam the most extensive, 2000 pounds. These are the lowest figures for nitrogen content of any soils examined in eastern Kansas. With the exception of the unimportant Bates very fine sandy loam, the alluvial types average the highest in nitrogen, but even these are low in nitrogen as compared with average alluvial soils.

Sandy soils, as a class, contain less nitrogen than heavier clay, silt and loam soils, but under the same climatic conditions the nitrogen in the sandy soils is more effective. The more open soil is more favorable to the rapid transformation of nitrogen into such forms as the plants need. As a class, the soils of Cherokee county, with few exceptions, are heavy. They need a larger stock of nitrogen to produce the same result as lighter soils. This fact should be kept in mind when the nitrogen content of certain types is compared with that of others. A more open soil also gives a larger feeding ground to the roots. The heavy, close texture of the subsurface and the subsoil in most of the silt loam soils of Cherokee county restricts the feeding area of the roots. Loss of organic matter and the leaching out of calcium or lime makes this condition worse.

One ton of alfalfa hay contains fifty pounds of nitrogen. The surface soil of the Cherokee silt loam contains as much nitrogen as there is in forty-eight tons of alfalfa, Yet it is a well-known fact that should a crop of alfalfa or cowpeas equivalent to one ton per acre be plowed under the crop improvement would be noted. One ton of fresh barnyard manure contains about ten pounds of nitrogen. Five tons per acre would show improvement. These are facts well known to the farmer. Nitrogen from fresh organic matter is the most valuable. Loss of crop-producing power is due to the fact that the more available nitrogen originally present in the virgin soils has been depleted.

THE PHOSPHORUS CONTENT.

The bench-land types average the lowest in phosphorus content. Some of these have an extremely small amount of phosphorus, only 120 pounds in the Riverton silt loam, and 160 pounds in the Robertsville silt loam. Neosho, the most extensive of all the bench-land types, has a higher phosphorus content, but this is only 480 pounds. Such a low phosphorus content makes profitable crop production impossible without the addition of phosphorus in some form of fertilizers. The average of all the bench-land types is only 270 pounds per acre in the surface soil.

All of the upland types average only 520 pounds of phosphorus per acre in the surface soil. The most extensive types, Cherokee silt loam and Bates silt loam, average 620 and 710 pounds, respectively, per acre. This is as high as some of the good wheat soils in the central part; of the state, but the wheat lands have an open subsoil, while all the upland silt soils in Cherokee county have a close, compact, heavy subsoil. This limits the feeding area for the roots. All of these soils have a lower phosphorus content than the average for good silt soils.

Only one sample of the alluvial soils, the Osage clay, has as high a phosphorus content as is usual to find in alluvial silt or clay soils. If this is omitted, the rest will average only 610 pounds per acre in the surface soil—much below the reguirement for good soils.

The figures given for the phosphorus content of the soil types in Cherokee county show that all are low in this element. The hard, compact nature of the subsoil makes this deficiency more serious. Phosphorus is of use to plants only as it is made soluble. Cultivation and the addition of organic matter are the means which will make phosphorus available, and these are under the Cherokee county farmer's control. But because of the low phosphorus content this element must usually be added in some form of fertilizer.

THE POTASSIUM CONTENT.

The percentage of potassium in all of the soil types in Cherokee county is low as compared with most Kansas soils. The four common types, Cherokee silt loam, Bates silt loam, Osage silt loam and Neosho silt loam, average 15,925 pounds of potassium in the surface soil. This would seem large as measured by crop requirements. But the larger part of this potassium can not be used for crop production, and may require hundreds of years of organic decay and deep cultivation to make it available. Unlike phosphorus and nitrogen, potassium accumulates to the larger extent in the leaves and the stems of the plant. Forty bushels of wheat contains eleven pounds of potassium in the grain and thirty-six pounds in the straw. A fifty-bushel corn crop contains nine and one-half pounds of potassium in the grain and twenty-six pounds in the stalk. This same relative proportion holds true for all cereal crops. A ton of prairie hay contains sixteen and three-tenths pounds of potassium, equivalent to that found in sixty-eight bushels of wheat or eighty-five bushels of corn, grain only. One ton of alfalfa contains forty-eight pounds of potassium, or as much as occurs in 175 bushels of wheat or 252 bushels of corn, counting the grain only. This means that although the supply of total potassium in the soil is not as great as in many soils of the state, yet the supply of available potassium can be maintained if the proportions of the plants classed as roughage are returned to the soil in the form of farm manures or crop residues. When these substances are added to the land the potassium stored in the plant tissues becomes available for the use of other plants as soon as the organic matter undergoes decay. It is absolutely necessary in this county to return straw or cornstalks to the soil as farm manures or crop residues.

THE CALCIUM* CONTENT.

With the exception of one subsoil sample from the Summit silt loam and one from the Oswego clay, the soils of Cherokee county are low in calcium. This element is the most difficult

* Calcium is the element found in quicklime, slaked lime and pure limestone. Lime as a term represents any of these forms. Calcium never occurs in its elemental state in the soil, but only in the form of compounds, the most common being carbonate of lime, or limestone. Calcium is applied to the soil only in its compounds.

of all to fix in available form in the soil, as the drainage waters usually carry off large amounts. Limestone generally contains about 30 per cent of calcium, but twenty-six Kansas soils of limestone origin averaged only .75 per cent of the element. The drier soils of central and western Kansas contain much more calcium than do similarly derived soils in Cherokee county with its heavy rainfall. Furthermore, there is no inorganic carbon indicated in the Cherokee analyses, hence calcium carbonate, the most desirable form of lime, is absent. Normal limestone usually contains about 9 per cent of inorganic carbon, further evidence of the leaching in this district.

The problem with calcium is to supply the needs of the soil, not the crop. Lime has been called "the dominant factor in soil fertility" because of its chemical and physical effect on soil properties. Decaying organic matter in the soil generates an acidity which is harmful both to the beneficial soil organisms and to the crops. Chemically, however, it makes the phosphorus and potassium available. Lime neutralizes the excess acidity, when present in proper quantities, aids in transforming the phosphorus and potassium into a form useful for the plant, and improves the physical character of the soil. The absence of calcium carbonate is responsible for the hard, impervious subsoils of Cherokee county. The principal calcium compound in this area is calcium silicate, which is practically insoluble in water.

The physical texture of a soil determines the amount of lime necessary for the best results, the heavier soils requiring larger amounts than lighter, sandier soils. Cherokee farms will thus need greater amounts of calcium than those farther north or west. Calcium is only supplemental to plant food, however, and can not produce desired effects in the absence of nitrogen, phosphorus and potassium, Because of the deficiencies of these elements, particularly phosphorus, in Cherokee county, lime will have little effect. Lime will usually help, but is never a "cure-all."

THE CARBON CONTENT.

Carbon is determined as organic and inorganic. The organic carbon comes from plant residues, and the inorganic carbon arises from undecomposed carbonates, such as limestone. The soils of Cherokee county have no inorganic carbon.

The significance of this was discussed in the previous paragraph.

The organic carbon is an index of the organic matter in the soil, and the amount of organic matter is assumed to be twice that of the carbon. This assumption is based on the study of the organic matter found in plants and the changes it undergoes in the soil. The term humus is applied to this organic matter, but it has different meanings in the minds of different writers. Frequently it is considered as synonymous with organic matter, but strictly speaking, it is organic matter in a certain stage of decay. Organic matter includes humus, but all organic matter is not humus. When soils contain an abundance of organic matter, humus is continually formed.

To properly understand the significance of organic matter in the soil something must be known of its condition. If the organic matter is twice the carbon, then the organic matter in the surface soils alone of Cherokee county varies from over fifty-three tons per acre in the Osage clay to fifteen tons per acre in the Riverton silt loam. Bates silt loam has 29.5 tons per acre, Cherokee silt loam 18.8 tons per acre, and Neosho silt loam 20.2 tons per acre. It has required an enormous amount of plant residue to produce the organic matter found in the soil.

This large amount of organic matter in the soil is present in three stages or conditions: (1) undecomposed, (2) partially decomposed and decomposing, and (3) that which decomposes very slowly. The first is represented by the crop residues and fresh manure added to the soil. Under proper conditions this soon begins to decay, and then the organic matter belongs to the second class, which is the most important of all in relation to crop-producing power. Humus proper belongs in this class of organic matter. The black straw found near straw piles is a familiar example of this stage, which is characterized by the lack of strength and toughness. The slowly decomposing organic matter is in an advanced stage of decay. As organic matter decays, that which is most easily decomposed is attacked first. The organic matter in the subsurface and subsoil and most of the surface organic matter in old, worn soils also belong to this class. A great deal of this organic matter affects the soil only as so much mechanical matter. That is why some soils, such as Neosho silt loam, have such a lifeless appearance. Yet this organic matter is not without value, as it improves the physical condition of the soil.

ACIDITY IN CHEROKEE COUNTY SOILS.

Acidity in the table in the Appendix is expressed in terms of pounds of pure calcium carbonate required to correct the acidity. Limestone will average about seventy-five per cent pure calcium carbonate. If these figures were increased by one-third then they would represent approximately the number of pounds of ordinary good ground limestone required to neutralize these soils. The amount of acidity in subsurface and subsoil should also be noted.

Organic matter rich in carbohydrates produces more acids than that rich in protein, such as the legumes. This acidity is not by itself an evil. It is one of the necessary agents to liberate phosphorus and potassium, and is also one of the necessary stages in converting nitrogen into usable forms. It becomes harmful only when it accumulates in the soil.

Since these soils contain no inorganic carbon, part of the original carbonates must have been used in neutralizing the decay of the organic matter. When these carbonates were all utilized the acids accumulated and the soils became sour. The best remedy for this condition is the addition of ground limestone, although burnt or slaked lime will also neutralize acidity.

The amount of limestone required to neutralize the acidity present in most of these soils is rather small, according to the figures given in the table, but these show only the amount required to neutralize the acid present in the soil at the time the samples were taken. Most acids are unstable, and these samples were taken when the soil was very dry. If only enough limestone were added to correct this minimum acidity, there would be no surplus, to correct the acidity continually forming. As much of the limestone disappears from soils by leaching, and as lime is needed to improve the physical condition of the soil, large applications of limestone are necessary.

MAINTAINING SOIL FERTILITY.

The system of farming that has been followed in Cherokee county for the past fifty years has not maintained the fertility of the soil. The soil is not as productive to-day as it was fifty or twenty-five years ago if the acre yield of such crops as corn and wheat can be taken as a measure of productiveness. In the last forty-five years the yield of corn, which is the principal field crop of the county, has declined over 120 per cent; in other words, over twice as much corn was produced on an acre of land during the five-year period from 1878 to 1883 as during either of the five-year periods from 1903 to 1908 or 1908 to 1913. The decline in the acre yield of wheat has not been as great, but less wheat is produced to the acre to-day than forty-five years ago.

The rapid exhaustion of the fertility of the soil is due to cropping the ground continuously with one crop and to the neglect of leguminous crops which secure nitrogen from the air and thus enrich the soil in this element. The following table, compiled from data obtained from the seventeenth biennial report of the State Board of Agriculture, gives the acreage devoted to different crops for the season of 1910:

Area Devoted to Different Crops in Cherokee County, 1910.

Crop.	Area in acres.	
Corn	79,035	
Wheat	29,322	
Oats	19,912	
Sorghums	4,271	
Flax	780	
Potatoes	700	
Barley	485	
		134,505
Timothy	4,006	
Clover	294	
Blue grass	272	
Alfalfa	90	
Orchard grass	72	
Other grasses	1,748	
		6,482

In 1910 over ninety-five per cent of the land was devoted to grain and cultivated crops that tend to exhaust the fertility of the soil, while less than five per cent of the land was devoted to grass and leguminous crops that add to the fertility of the soil. Since 1910 the acreage in grass has become much smaller, due to the dry, unfavorable seasons of 1912 and 1913. The acreage of ground given to cowpeas, an important leguminous crop in this county, can not be obtained, but is certainly not more than two thousand acres each season. Thus it is not surprising that the fertility of the soil is being rapidly depleted. No country in the world has been able to maintain the fertility of its soil over any long period of time without devoting from twenty-five to thirty per cent of the cultivated land to grasses and leguminous crops. Cherokee county is no exception. If the soil of this county is to improve in fertility, or even be maintained in its present state, a larger acreage must be devoted to grasses and legumes, and a rotation with the grain crops established.

At the present time large portions of the Cherokee silt loam, Bates and Neosho silt loam, three of the most extensive upland soils of the county, are in wheat each season. Some of these fields have been cropped to wheat continuously for over thirty years, and no organic matter has been returned to the soil. Part of the Osage soil series has likewise been in corn for many years. On these soil types particularly a different system of cropping should be established and the corn and wheat grown in rotation with soil-restoring crops. A rotation of greatest value should be so planned that some leguminous crop should occupy the ground from one-third to one-fifth of the time. There are four leguminous crops that under proper conditions can be grown successfully in Cherokee county, namely: cowpeas, soy beans, clover and alfalfa.

COWPEAS AND SOY BEANS IN ROTATION.

The cowpea is a good leguminous crop to grow for the purpose of supplying nitrogen and organic matter to the soil. This crop may be planted in the summer immediately after harvesting a crop of wheat or oats, and in seasons of ordinary rainfall will produce an abundant growth by fall on practically every soil in the county. An excellent practice is to plow the crop under before frost, leaving the ground rough over winter, and planting the field next season to corn, kafir or feterita. This practice will allow the organic matter to decay during the winter and spring, and the nitrogen will become available for the following crop.

Cowpeas may be used in the manner mentioned above, or they may be grown in a rotation as a hay crop. However, in this case the results obtained are not as good as when the crop is plowed under.

Soy beans may also be grown either as a hay or seed crop on most of the soil types of the county. They are not as satisfactory to use as a catch crop after small grain as cowpeas, are often injured by rabbits, and on some soils require inoculation. For these reasons cowpeas are more generally grown.

ALFALFA IN ROTATION.

Soils such as the Neosho silt loam, Cherokee silt loam and Bates silt loam, Bates loam, Bates sandy loam, and Bates very fine sandy loam are not typically alfalfa soils. The Summit silt loam, Oswego clay, Oswego clay loam, Crawford silt loam, and most of the bottom land soils where adequate drainage exists may be successfully used for growing alfalfa if properly handled.

Alfalfa is a good crop to grow in rotation for the purpose of adding nitrogen to the soil. Like cowpeas, alfalfa is a leguminous crop, and therefore has the ability, due to bacteria growing with it, to utilize as food the nitrogen of the atmosphere. Some of the nitrogen taken by alfalfa bacteria from the atmosphere and utilized by alfalfa for growth may in turn be used by other crops, providing the alfalfa grown is fed to live stock and the manure returned to the soil. Alfalfa will not add a large amount of nitrogen to the soil when the crop is cut for hay and sold from the farm. It must not be forgotten that alfalfa uses in its growth not only the nitrogen secured from the air, but also uses some nitrogen secured from the soil.

When the alfalfa hay is cut and sold from the farm nearly all the nitrogen secured from the air is sold with the hay, and that left in the alfalfa roots will not much more than offset the nitrogen secured from the soil. It becomes necessary, therefore, to feed the alfalfa raised on the farm and return the manure to the land if any large gain in nitrogen is to be secured from it.

Alfalfa Removes Mineral Plant Food.

Alfalfa uses in its growth mineral plant food which it can secure only from the soil. It removes from the soil very rapidly both phosphorus and potassium. Selling alfalfa hay is one of the most rapid methods of removing these plant-food elements. By feeding alfalfa hay and carefully using the manure, more than three-fourths of the mineral plant food can be saved. It is evident, therefore, that if alfalfa is grown for the improvement of the soil it must be fed to live stock on the farm, and when so used will add organic matter and nitrogen to the soil.

Conditions Necessary for Growing Alfalfa.

In order that alfalfa may be grown profitably it is necessary that the soil contain plenty of lime and organic matter. It also must have good drainage and possess the right kind of bacteria. A fair stand at seeding time may be obtained without these conditions, but the plants soon become weak and finally die or are crowded out by weeds.

Those soils which have been mentioned as not being adapted to alfalfa do not have these requirements, and therefore can not be said to be suited especially to this crop. However, the Bates loam, Bates fine sandy loam and Bates very fine sandy loam, where the rock is not near the surface, can be used successfully for the growing of alfalfa by the addition of barnyard manure and lime, by inoculation, and by great care in preparing the seed bed. On the soils which are adapted to alfalfa this crop may be grown successfully by careful preparation of the seed bed and inoculation, and by drainage on the heavier soils, such as the Osage clay, Osage silty clay loam, Oswego clay and Oswego silty clay loam. Soils of this kind must be drained before they will grow alfalfa successfully.

Preparation of the Seed Bed.

Many farmers of Cherokee county have experienced great difficulty in starting alfalfa, even where natural conditions are good, because of carelessness in preparing the seed bed. In starting alfalfa for the first time the best soil condition possible should be obtained. There are two methods which have been successfully used in southeastern Kansas. The first is by summer-fallowing before seeding. This may best be done by plowing the ground in the late spring and then by cultivating frequently enough during the spring and summer to kill all weeds and maintain a soil mulch. This will conserve sufficient moisture to insure a good fall growth and will aid greatly in eliminating the injury from weeds.

The second method is to follow wheat or oats with alfalfa, and to prepare the seed bed by plowing just deep enough to cover the stubble well as soon as the crop has been removed. The ground should be worked thoroughly and at frequent intervals with a disk and harrow until the middle or last of August, when the alfalfa should be sowed. In either type of preparation an application of ten to twelve tons of manure should be given the preceding fall or winter. This will furnish the necessary plant food to start the alfalfa well. On sour or acid soils an application of one to three tons of finely ground lime rock should be made six months or a year before seeding. It will pay to inoculate with alfalfa bacteria on practically all soils of Cherokee county. This may be done by using a commercial culture or by applying soil taken from an alfalfa field which has a good, healthy stand. If soil is used, it should be distributed at the rate of three hundred to four hundred pounds to the acre and harrowed in immediately. This should be done only a few days before seeding.

On some of the heavier soil types, such as the Oswego clay, Oswego silty clay loam, Osage clay and Osage silty clay loam, fall-sown alfalfa frequently winterkills. On these types of soil spring seeding is advisable. Cowpeas or soy beans make a good crop to precede alfalfa in such cases, but the bean or pea crop should be given thorough cultivation so that the ground will be left free of weed seed. The alfalfa may be sowed in the spring with a light nurse crop of oats, but when the nurse crop is used it is generally best to cut the crop for hay.

CLOVER IN ROTATION.

Glover has been grown more extensively in this county in the past than at the present time. Within the last five or ten years it has been very difficult to secure a stand of clover on soil types which formerly grew the crop successfully. This has been partly due to unfavorable weather, but also due to the depletion in organic matter, available plant food and lime. Clover is adapted to all of the soil types in the county with the exception of the Cherokee silt loam, Neosho silt loam and the various types of the Bates series. On many of these soil types to which it is not naturally adapted it may be grown successfully if the soil is manured and limed. Clover, like alfalfa, is a lime-loving plant and will not grow successfully on acid soils. On such soils an application of one to three tons of ground lime rock to the acre should be applied a year or more before sowing clover. Barnyard manure or commercial fertilizers applied to the nurse crop with which the clover is sowed will also benefit the clover crop. Barnyard manure is to be preferred because it supplies organic matter as well as plant food, but when barnyard manure is not available an application of commercial fertilizers rich in phosphorus applied on the wheat or oats crop with which the clover is sowed will usually prove beneficial.

Clover does not require as well drained a soil as alfalfa, and for this reason will succeed where it is too wet for alfalfa. Clover is also better than alfalfa to use in a rotation of crops. It is advisable in seeding clover to mix at least one-third alsike clover with the red. Alsike clover is a smaller-growing plant than the red clover and will not make as heavy a yield of hay to the acre when the red clover catches well, but it is more hardy, will grow on a wetter soil, and is less sensitive to acid conditions. It will often succeed where red clover fails, or will fill in spots in the field where red clover does not make a stand. A mixture of about three pounds of alsike and five pounds of red clover to the acre make a good combination.

ORGANIC MATTER.

The supply of organic matter in most of the soils of Cherokee county is extremely low, and the problem of increasing this supply is a very serious one. Organic matter is constantly being depleted by decay in cultivated soils, and unless applied in some form soon becomes so deficient that low crop yields result. It is largely because of the lack of organic matter than such soils as the "white ashy land" have their characteristic lifeless feel. Organic matter enables the soil to hold water, keeps it in good tilth, and in decaying makes available the insoluble plant food of the soil. The depletion of organic matter may cause decreased crop production, not because the essential plant-food elements have been exhausted, but because the fresh organic matter which releases plant food from the soil is no longer present.

BARNYARD MANURE.

Barnyard manure is the best form in which to apply organic matter. As large a quantity as possible should be produced on every farm, and the manure produced should be saved and applied to the soil. Fresh manure furnishes the largest amount of organic matter, and for this reason manure should be applied in a fresh condition. If manure is stored it decays rapidly, and organic matter as well as plant food is lost. One of the greatest wastes of plant food on the average farm results from the leaching and fermentation of manure. Half the fertilizing value of manure is lost when it is allowed to lie in the barnyard for six months. Because of this fact it is best, whenever conditions permit, to apply manure to the field as fast as it is produced. Manure gives best results with crops like alfalfa, corn or kafir. It should be distributed in small quantities and evenly spread over a large area. Twenty tons of manure will have greater value upon two acres than upon one. Manure can also be used with profit as a top dressing upon wheat, provided it is distributed evenly. When used on wheat it should be applied in the fall or early winter, where it will serve as a protection during a severe freeze and as a mulch to prevent evaporation during the following spring and summer.

When such materials as cornstalks and straw can not be utilized as feed or made into manure, they should be worked into the soil, because large amounts of organic matter may be added in this way. Such materials should never be burned, for when burned the organic matter is destroyed.

GREEN MANURING.

Upon many farms it is not possible to maintain the supply of organic matter by means of barnyard manure, and even the return of all straw and cornstalks to the soil is not sufficient to replace the organic matter as rapidly as destroyed. On such farms it will be necessary to grow crops for the purpose of plowing under as green manure. Cowpeas, sweet clover, red clover and rye may be used for this purpose. Rye is inferior to the others because it is a nonleguminous crop and does not add nitrogen. It can, however, often be used to advantage, and will supply a large amount of rapidly decaying organic matter if plowed under green.

COMMERCIAL FERTILIZERS.

Commercial fertilizers are manufactured and sold for the purpose of supplying one or more of the three essential elements of plant food — nitrogen, phosphorus, or potassium. Commercial fertilizers have been used in Cherokee county for several years, and at present this county uses more of this material than any other district in the state. Fertilizer may be purchased as “complete fertilizers” that supply all three of the elements mentioned, or they may be purchased in forms that carry but a single element.

NITROGEN.

A forty-bushel crop of wheat removes from the soil in the grain alone about fifty-seven pounds of nitrogen. Nitrogen when purchased on the market as commercial fertilizer costs about nineteen cents a pound. At this rate the fifty-seven pounds of nitrogen removed from the soil in a forty-bushel crop of wheat would be worth $10.83. It would, therefore, cost over one-fourth of the value of the wheat to supply by means of commercial fertilizer the nitrogen removed in the grain. It would be impracticable under present market prices to attempt to supply the nitrogen removed by wheat in this way. It would also be foolish to do so, as in the air above the soil there are millions of pounds of nitrogen which may be obtained by means of leguminous crops. In order that the wheat crop may receive the benefits of introgen thus secured, leguminous crops must be grown in rotation with wheat, or manure obtained from feeding leguminous crops must be applied to the ground upon which wheat is grown. With such a cheap and practical means of securing nitrogen from the air, it is only the unthinking farmer who would purchase commercial nitrogen in any large quantity.

Potassium.

A forty-bushel crop of wheat removes from the soil about ten and one-half pounds of potassium. The chemical analyses of the soils of Cherokee county show that the potassium content is sufficient to last for many years, and it is doubtful if it will be necessary for a long time to supply potassium by means of commercial fertilizers. The problem in potassium fertilization is not to supply larger quantities of this plant food, but to liberate and make available the supply that is now in the soil in an unavailable condition. This may be done by practicing good methods of cultivation and by keeping the soil well supplied with organic matter.

Phosphorus

Phosphorus occurs in the soils of Cherokee county in very limited amounts, especially in such types as the Cherokee silt loam and the Neosho silt loam, commonly called the "white ashy land." This has been shown by the chemical analyses of the soils, by experimental plots, and by actual farm practice. There is no cheap source of supply of this element, as is the case with nitrogen. Neither can it be liberated from the soil in sufficient quantities to grow crops indefinitely, as appears to be true of potassium. Where good methods of cultivation are practiced and crop rotations are followed, phosphorus will be the first element of plant food necessary to supply. It may be obtained in commercial fertilizers, such as bone meal, acid phosphate or raw rock phosphate. Phosphorus may be obtained most cheaply in the form of raw rock phosphate, but when used in this form it must be applied with barnyard manure or plowed under with a green manuring crop.

The results obtained from the use of phosphorus fertilizers on the Cherokee silt loam soil in this county are shown in the following table, which gives the yield of wheat for three different seasons from unfertilized ground, and also from adjoining ground prepared for the crop in the same way but treated with commercial fertilizer. The tests for the seasons of 1912 and 1913 were conducted on the farm of O. A. Rhoades, four and one-half miles southeast of Columbus, while the 1914 test was conducted on the farm of C. W. Karsten, nine miles southeast of Columbus. A different field was used for the test each season. The nitrogen fertilizer was applied at the rate of 200 pounds per acre, half in the form of blood meal and the other half nitrate of soda. The potassium plot was furnished with sulphate of potash at a rate of 100 pounds per acre. The phosphorus was supplied in acid phosphate at the rate of 250 pounds per acre in 1912 and 150 pounds per acre in 1913, but in 1914 bone meal at the rate of 250 pounds per acre was used.

The following table gives the yields of wheat secured:

A FERTILIZER TEST WITH WHEAT IN CHEROKEE COUNTY, KANSAS.

TREATMENT.	Yield of wheat in bushels per acre.				Increase in yield due to fertilizer in per cent.
	1912.	1913.	1914.	Average.	
Underfertilized	10.00	5.60	16.33	10.64	0
Potassium	11.00	....	15.34	....	0
Phosphorus	22.00	10.03	30.97	21.00	97
Potassium and phosphorus	24.30	11.80	30.99	22.54	111
Potassium and nitrogen	....	....	16.54	....	1
Potassium, phosphorus and nitrogen	16.00	13.60	32.33	20.64	94
Lime	14.30	6.70	....	....	34

It will be seen from this table that phosphorus gave very marked increases in yield wherever it was applied. When used alone it increased the yield 97 per cent, when used combined with potassium it increased the yield 111 per cent, and when used combined with nitrogen and potassium it increased the yield 94 per cent. Potassium when used alone gave no increase in yield, but when used with the phosphorus gave a slight increase over the potassium alone. Nitrogen gave practically no increase in yield, and in 1912 decreased the yield, due to the rank growth of straw, which did not fill out well. The fields upon which this test was conducted were plowed early in the summer and thoroughly prepared for the wheat crop. They were also fields that had been better farmed and had received more barnyard manure than the majority of fields on this type of soil. On fields supplied with less organic matter and where the seed bed was not as well prepared, nitrogen and potassium would be liberated in smaller quantities from the soil itself. Under such conditions a small amount of nitrogen and potassium applied in the form of commercial fertilizer might pay.

This emphasizes the importance of preparing a good seed bed for crops, for by so doing plant food is liberated from the store of unavailable plant food in the soil, making it, therefore, unnecessary to buy it.

Greater care should be exercised in preparing the soil for wheat. The practice of disking in wheat following wheat is one that may occasionally give good yields, but upon the average will prove very unsatisfactory. If wheat is to follow wheat or oats, the best method is to plow the ground as soon as possible after removing the preceding crop, and then cultivate frequently during the summer months. The soil should be turned to a depth of about seven inches if plowed in July or the first of August, but if plowed later the soil should not be stirred so deeply, as it will not have sufficient time to settle and form a good seed bed.

It should not be assumed that because phosphorus has been shown to be deficient in the Cherokee silt loam soil it will prove profitable to apply it upon all the soil types in the county. It seems probable from our present knowledge that it will pay to use a fertilizer supplying phosphorus on wheat and alfalfa on the Cherokee silt loam, Neosho silt loam and most of the soil types of the Bates series. Whether it will pay to apply phosphorus on the Summit silt loam, the Oswego clay loam and other soil types has not as yet been determined.

It will undoubtedly not pay to fertilize corn and other rowed crops as well as it does to fertilize wheat, clover and alfalfa. Corn and similar crops are given thorough cultivation during the growing season, consequently more plant food is liberated from the soil itself. Where corn is grown in rotation with wheat and other crops it will usually be more practical to apply the barnyard manure on corn and buy a commercial fertilizer for wheat.

Lime.

Lime should not be considered as a fertilizer in the same sense that materials supplying nitrogen, phosphorus or potassium are fertilizers. These materials furnish plant food and are used only for that purpose. Lime is seldom, if ever, used to supply plant food, but to correct the acid condition of the soil and thus permit alfalfa, clover and sweet clover to be grown. Lime will undoubtedly benefit other crops, for if by using lime a field can be made to grow alfalfa or clover, the crops which succeed alfalfa or clover on that field will undoubtedly be benefited. Lime also improves the physical condition of heavy clay soils and aids in the liberation of plant food. The increase in the yield of wheat secured from lime in the fertilizer test discussed above was due undoubtedly to indirect effects of the lime in improving the physical condition of the soil and liberating plant food and not to any plant food that the lime itself supplied. The benefit secured indirectly from lime will very seldom pay for the cost of applying it. Therefore, lime should seldom be applied to such crops as wheat, corn or oats, but upon acid soils it will pay to apply it in preparing the ground for alfalfa and clover.

APPENDIX.

METHODS OF CHEMICAL ANALYSIS OF THE SOIL.

The methods used by chemists in the investigation of soil fertility elements may be divided into three classes: (1) Solution by water or weak acid; (2) solution by strong acids; (3) solution by fusion. Which of these three methods is used depends on the object in view. The first method gives the amount of water-soluble material at the time the analysis is made. It furnishes an index to the immediate crop-producing power of the soil. This method is very valuable in investigations on methods of handling the soil and on systems of cropping. In most of the older books the results obtained by solution in strong acids are generally given. This method was originally adopted because it was thought that the amount so dissolved represented all that the plant could ever obtain from the soil. In this method nearly all the calcium is obtained, about eighty per cent of the phosphorus, and about twenty to twenty-five per cent of the potassium. These percentages should be kept in mind when results obtained by strong acid solution are compared with the amounts obtained by the method of fusion. Very valuable results were obtained by the use of this method. The chief objection to the method is that the results obtained are relative. In a soil survey it is desirable to obtain the total amount of each element. The same agencies which made the soil from the original rock are still operative. The decay of organic matter and the freezing and thawing every winter slowly affect all the insoluble compounds in the soil. The method of fusion gives the total amount, and is the method used in the analysis of Kansas soils.

In sampling the soil a tube two inches in diameter is used for taking the surface sample. By means of this it is possible to obtain a uniform core, even if the ground is recently plowed. The surface sample is taken to a depth of seven inches. The subsurface is taken to a depth of twenty inches, and the subsoil to forty inches. These two latter are taken by means of a 1½-inch auger. For the surface sample soil is taken from eight, ten or more borings in the field. For the subsurface and subsoil samples soil is taken from at least five borings. The whole of each sample is put in a strong cloth bag and shipped to the chemical laboratory. Sampling soil is an operation that requires care, thought and experience.

The place where a soil sample is taken is located by the method of the United States land survey, ten acres being the smallest limit. The more important types were sampled in several locations. An acre of soil seven inches deep is assumed to weigh about 2,000,000 pounds. The subsurface, thirteen inches deep, then weighs 4,000,000 pounds, and the subsoil 6,000,000 pounds. This makes it easy to compute the pounds per acre when the chemical composition is known. This calculation involves multiplying the percentages of the constituent by 2, 4 or 6, with due regard for the decimal point. A percentage of 0.1 means 2000 pounds per acre for the surface soils, 4000 pounds for the subsurface, and 6000 pounds for the subsoil. 0.01 per cent is equivalent to one-tenth of the above amounts. The soil sample is designated by a whole number, and the different portions by the decimals .1, .2, and .3 placed after the number. Thus, 1231.1, 1231.2 and 1231.3 mean soil, subsurface and subsoil from sample 1231. Sometimes by reason of the shallowness of the soil or unimportance of the types only the surface soil is sampled.

In an average very fertile soil the elements nitrogen, phosphorus, potassium, calcium and carbon constitute between four and five per cent of the total soil mass. The soil must also furnish iron, magnesium and sulphur to the plants. But practically all soils furnish these elements in great abundance and the plants use comparatively small amounts. All these elements needed by plants are present in the form of compounds, and it is the form of these compounds that determines the availability of these elements, and consequently the crop-producing power of the soil.

The following table gives the analyses of all the soil types sampled in Cherokee county. It shows the location at which the sample was taken; the type of soil and stratum sampled; the sample number, and the percentage of plant-food elements nitrogen, phosphorus, potassium, calcium, organic carbon, inorganic carbon, and acidity. The acidity is expressed by the number of pounds of pure calcium carbonate, or pure limestone, required to correct the amount of acid present in the soil at the time the sample was taken.

ANALYSIS OF SOILS FROM CHEROKEE COUNTY.—ALLUVIAL TYPES.

Location by Land Survey.	Type as given in soil survey.	Stratum sampled, inches.	Sample No.	Percentages of plant-food elements.						Acidity, pounds of $CaCO_3$.
				Nitrogen.	Phosphorus.	Potassium.	Calcium.	Organic carbon.	Inorganic carbon.	
N. W. 10 of N. W. 40 of S. W. ¼, Sec. 4, T. 32 S., R. 22 E.	Osage clay	Soil............0-7	1240.1	0.20	0.048	1.30	0.76	2.23	Trace.	None.
		Subsurface.....7-20	1240.2	.12	.039	1.23	.70	1.18	Trace.	None.
		Subsoil.......20-40	1240.3	.07	.022	1.16	.69	.65	Trace.	None.
N. E. 10 of S. E. 40 of S. E. ¼, Sec. 1, T. 35 S., R. 21 E.	Osage clay	Soil............0-7	1105.1	0.25	0.066	1.74	0.45	3.13	None.	160
		Subsurface.....7-20	1105.2	.13	.048	1.87	.52	1.15	None.	160
		Subsoil.......20-40	1105.3	.09	.039	1.82	.62	.68	None.	264
S. E. 10 of S. W. 40 of S. E. ¼, Sec. 33, T. 34 S., R. 22 E.	Osage silt loam	Soil............0-7	1106.1	0.18	0.034	1.16	0.26	1.67	None.	230
		Subsurface.....7-20	1106.2	.09	.019	1.21	.34	.88	None.	720
		Subsoil.......20-35	1106.3	.08	.026	1.18	.27	.60	None.	....
N. W. 10 of N. W. 40 of S. E. ¼, Sec. 32, T. 32 S., R 23 E.	Osage silt loam	Soil............0-7	1242 1	0.16	0.028	0.85	0.34	1.62	None.	680
		Subsurface.....7-20	1242.2	.09	.024	.95	.23	94	None.	3,720
		Subsoil.......20-40	1242.3	.06	.031	.87	.31	.44	None.	4,500
S. W. 10 of N. W. 40 of S. E. ¼. Sec. 26, T. 31 S., R. 22 E.	Osage silty clay loam	Soil............0-7	1238 1	0.17	0.040	1.08	0.40	1.79	Trace.	None.
		Subsurface.....7-20	1238.2	.09	.036	1.09	.38	.87	Trace.	None.
		Subsoil.......20-40	1238.3	.08	.021	1.12	.69	.81	None.	240
N. W. 10 of N. W. 40 of S. E. ¼, Sec. 6, T. 35 S., R. 25 E.	Holly silt loam	Soil............0-7	1246.1	0.14	0.016	1.07	0.24	1.43	None.	6,800
N. E. 10 of N. E. 40 of S. W. ¼, Sec. 11, T. 33 S., R. 25 E.	Huntington silt loam	Soil............0-7	1229.1	0.18	0.053	1.08	0.42	1.70	None.	240
		Subsurface.....7-20	1229.2	.11	.047	1.06	.30	.90	None.	1,800
		Subsoil.......20-40	1229.3	.08	.039	1.13	.33	.38	None.	4,410
N. E. 10 of N. E. 40 of S. E. ¼, Sec. 4, T. 34 S., R. 25 E.	Huntington silt loam	Soil............0-7	1252.1	0.11	0.017	0.75	0.45	1.37	None.	140
S. W. 10 of S. W. 40 of N. W. ¼, Sec. 9, T. 35 S., R. 25 E.	Meadow	Soil............0-4	1247.1	0.17	0.033	1.08	0.53	....	....	....

ANALYSIS OF SOILS FROM CHEROKEE COUNTY.—UPLAND TYPES.

LOCATION BY LAND SURVEY.	Type as given in soil survey.	Stratum sampled, inches.	Sample No.	Percentages of plant-food elements.						Acidity, pounds of $CaCo_3$.
				Nitrogen.	Phosphorus.	Potassium.	Calcium.	Organic carbon.	Inorganic carbon.	
N. E. 10 of N. W. 40 of N. E. ¼, Sec. 4, T. 34 S., R. 23 E.	Cherokee silt loam	Soil 0-7	1243.1	0.10	0.024	0.56	0.30	1.05	None.	580
		Subsurface 7-20	1243.2	.09	.033	.67	.34	.87	None.	1200
		Subsoil 20-40	1243.3	.05	.034	.77	.40	.29	None.	210
S. W. 10 of S. W. 40 of S. E. ¼, Sec. 32, T. 33 S., R. 24 E.	Cherokee silt loam	Soil 0-7	1231.1	0.14	0.038	0.79	0.32	0.84	None.	270
		Subsurface 7-18	1231.2	.10	.026	.62	.30	.83	None.	980
		Subsoil 18-40	1231.3	.09	.039	.87	.28	.61	None.	1710
S. W. 10 of S. W. 40 of S. W. ¼, Sec. 2, T. 32 S., R. 22 E.	Summit silt loam	Soil 0-7	1239.1	0.13	0.016	0.83	0.51	1.38	None.	490
		Subsurface 7-20	1239.2	.12	.018	1.10	.54	1.06	None.	2520
		Subsoil 20-40	1239.3	.04	.021	1.14	1.32	.43	None.	540
N. E. 10 of S. E. 40 of N. E. ¼, Sec. 24. T. 31 S., R. 21 E.	Summit silt loam	Soil 0-7	1099.1	0.17	0.015	0.98	0.33	1.85	None.	120
		Subsurface 7-20	1099.2	.11	.028	1.02	.45	1.43	None.	520
		Subsoil 20-36	1099.3	.09	.028	.95	.49	.61	None.	180
N. E. 10 of N. W. 40 of S. W. ¼, Sec. 36, T. 31 S., R 21 E.	Crawford silt loam	Soil 0-7	1235.1	0.15	0.010	0.80	.048	1.54	None.	180
		Subsurface 7-20	1235.2	.12	.018	.86	.53	1.29	None.	140
		Subsoil 20-40	1235.3	.09	.024	.86	....	.87	None.	1050
S. W. 10 of S. W. 40 of N. W. ¼, Sec. 2, T. 35 S., R. 25 E.	Clarksville stony loam	Soil 0-4	1248.1	0.12	0.011	0.90	0.32	1.95	None.	240
N. E. 10 of N. E. 40 of S. E. ¼, Sec. 36, T. 31 S., R. 22 E.	Oswego clay	Soil 0-7	1234.1	0.22	0.035	1.14	0.77	2.42	None.	100
		Subsurface 7-20	1234.2	.13	.032	1.17	.95	1.41	None.	None.
		Subsoil 20-40	1234.3	.06	.025	1.17	1.18	.56	None.	120
S. W. 10 of S. W. 40 of S. E. ¼, Sec. 19, T. 31 S., R. 21 E.	Oswego silty clay L.	Soil 0-7	1236.1	0.14	0.040	1.11	0.63	1.76	None.	314
		Subsurface 7-20	1236.2	.10	.033	1.22	.89	1.02	None.	440
		Subsoil 20-40	1236.3	.07	.029	1.38	.95	.76	None.	240

N. E. 10 of N. E. 40 of N. W. ¼, Sec. 5, T. 32 S., R. 24 E.	Oswego silty clay loam	Soil.....0-7	1233.1	0.09	0.039	0.83	0.39	1.84	None.	270
		Subsurface.....7-20	1233.2	.07	.025	1.10	.33	1.11	None.	960
		Subsoil.....20-40	1233.3	.05	.028	1.14	.36	.62	None.	17,040
S. E. 10 of S. E. 40 of S. W. ¼, Sec. 9, T. 33 S., R. 24 E.	Bates loam	Soil.....0-7	1228.1	0.10	0.024	0.37	0.21	1.03	None.	1,240
		Subsurface.....7-20	1228.2	.09	.032	.64	.31	.80	None.	1,960
		Subsoil.....20-40	1228.3	.05	.027	.65	.32	.49	None.	840
S. W. 10 of S. W. 40 of S. E. ¼, Sec. 26, T. 34 S., R. 24 E.	Bates silt loam	Soil.....0-7	1245.1	0.14	0.035	0.63	0.36	1.38	None.	None.
		Subsurface.....7-20	1245.2	.09	.035	.74	.26	.79	None.	None.
		Subsoil.....20-40	1245.3	.07	.026	.79	.34	.41	None.	None.
N. F. 10 of S. E. 40 of N. E. ¼, Sec. 10, T. 32 S., R. 24 E.	Bates silt loam	Soil.....0-7	1232.1	0.16	0.036	0.63	0.29	1.57	None.	620
		Subsurface.....7-20	1232.2	.12	.010	.64	.37	1.06	None.	2800
		Subsoil.....20-40	1232.3	.07	.013	.72	.32	.48	None.	4,920
N. E. 10 of S. E. 40 of N. E. ¼, Sec. 29, T. 33 S., R. 25 E.	Bates fine sandy loam	Soil.....0-7	1255.1	0.11	0.020	0.42	0.16	1.17	None.	840
N. W. 10 of S. W. 40 of N. W. ¼, Sec. 25, T. 33 S., R. 25 E.	Bates fine sandy loam	Soil.....0-7	1244.1	0.08	0.044	0.40	0.11	0.86	None.	1,020
		Surface.....7-20	1244.2	.07	.046	.44	.11	.69	None.	6,800
S. W. 10 of S. E. 40 of S. E. ¼, Sec. 32, T. 32 S., R. 23 E.	Bates very fine sandy loam	Soil.....0-7	1241.1	0.22	0.029	0.51	0.31	1.00	None.	1,080
		Subsurface.....7-20	1241.2	.13	.028	.62	.25	.66	None.	2,460
		Subsoil.....20-40	1241.3	.06	.017	.73	.43	.42	None.	2,520

ANALYSIS OF SOILS FROM CHEROKEE COUNTY.—BENCH LAND TYPES.

LOCATION BY LAND SURVEY.	Type as given in soil survey.	Stratum sampled. inches.	Sample No.	Percentages of plant-food elements.						Acidity, pounds of $CaCO_3$.
				Nitrogen.	Phosphorus.	Potassium.	Calcium.	Organic carbon.	Inorganic carbon.	
S. E. 10 of S. E. 40 of S. E. ¼, Sec. 8, T. 33 S., R. 25 E.	Neosho silt loam	Soil 0–7	1230.1	0.11	0.018	0.59	0.35	1.05	None.	200
		Subsurface 7–20	1230.2	.10	.017	.76	.30	.56	None.	1,400
		Subsoil 20–40	1230.3	.07	.028	.88	.20	.45	None.	19,980
N. W. 10 of S. E. 40 of S. W. ¼, Sec. 8, T. 33 S., R. 22 E.	Neosho silt loam	Soil 0–12	1001.1	0.11	0.021	0.83	0.25	1.08	None.	92
		Subsurface 12–22	1001.2	.13	.031	.84	.28	1.19	None.	480
		Subsoil 22–40	1001.3	.07	.024	.86	.28	.53	None.	300
S. E. 10 of S. E. 40 of N. E. ¼, Sec. 7, T. 33 S., R. 22 E.	Neosho silt loam	Soil 0–12	1002.1	0.09	0.032	1.20	0.25	0.91	None.	176
		Subsurface 12–30	1002.2	.12	.028	1.17	.32	.96	None.	1,024
		Subsoil 30–40	1002.3	.06	.034	1.23	.30	.46	None.	30
N. E. 10 of N. E. 40 of S. E. ¼, Sec. 31, T 31 S., R. 22 E.	Shawnee silt loam	Soil 0–7	1237.1	0.12	0.012	0.94	0.52	1.33	None.	240
		Subsurface 7–20	1237.2	.08	.015	.94	.44	.77	None.	660
		Subsoil 20–40	1237.3	.06	.017	1.05	.49	.53	None.	1,410
S. W. 10 of S. W. 40 of S. E. ¼, Sec. 33, T. 33 S., R. 25 E.	Robertsville silt loam	Soil 0–7	1253	0.12	0.008	0.69	0.27	1.17	None.	300
N. W. 10 of S. W. 40 of N. W. ¼, Sec. 11, T. 34 S., R. 25 E.	Riverton silt loam	Soil 0–10	1251.1	0.05	0.006	0.69	0.21	0.75	None.	None.
N. W. 10 of N. W. 40 of N. E. ¼, Sec. 33, T. 33 S., R. 25 E.	Riverton gravelly loam	Soil 0–8	1254	0.08	0.016	0.60	0.27	0.97	None.	90
N. W. 10 of N. E. 40 of N. E. ¼, Sec. 29, T. 34 S., R. 25 E.	Riverton gravelly loam	Soil 0–4	1249.1	0.09	0.019	1.10	0.53	1.16	None.	None.

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