Issued May 10, 1913.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE KANSAS STATE AGRICULTURAL COLLEGE, H. J. WATERS, PRESIDENT; KANSAS AGRICULTURAL EXPERIMENT STATION, E. H. WEBSTER, DIRECTOR, W. M. JARDINE, AGRONOMIST.

SOIL SURVEY OF SHAWNEE COUNTY, KANSAS.

BY

W. C. BYERS, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND R. I. THROCKMORTON, OF THE KANSAS STATE AGRICULTURAL COLLEGE.

J. E. LAPHAM, INSPECTOR IN CHARGE NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1911.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1913.

BUREAU OF SOILS.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., June 24, 1912,

SIR: In the extension of soil survey work in the State of Kansas work was undertaken in Shawnee County during the field season of 1911. This work was done in cooperation with the Kansas State Agricultural College and Agricultural Experiment Station and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1911, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SOIL SURVEY OF SHAWNEE COUNTY, KANSAS.

By W. C. BYERS, of the U. S. Department of Agriculture, and R. I. THROCKMORTON, of the Kansas State Agricultural College.

DESCRIPTION OF THE AREA.

Shawnee County is situated in the northeastern part of the State of Kansas. It is bounded on the north by Jackson County, on the east by Jefferson and Douglas, on the south by Osage, and on the west by Wabaunsee and Pottawatomie Counties. It has an area of approximately 540 square miles, or 345,600 acres. The Kansas River crosses the county from west to east, Topeka, the State capital, being situated on this river within the county limits.

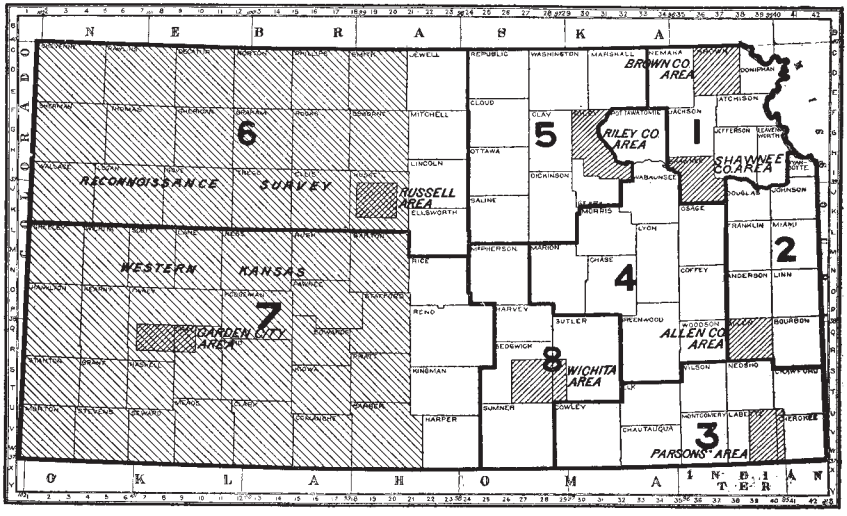

FIG. 1.—Sketch map showing areas surveyed in Kansas.

Topographically Shawnee County is a high plateau, frequently cut by valleys of varying size. As there has been no folding or faulting of the originally horizontally disposed rocks, the surface features are the direct result of erosion, which has acted in proportion to the relative hardness of the sandstones, shales, and limestones that underlie the region. The numerous and extensive shale horizons are characterized by level to undulating topography, which gives way to more

rolling relief where the underlying limestone has been exposed. Along the streams are long, gentle slopes, in which it is frequently difficult to determine the extent of the overflowed land, fringed by steep slopes of thoroughly dissected upland, giving rise to a belt of rough country. Abundant outcrops of thin beds of limestone accentuate the roughness.

There is a total range of elevation of over 350 feet. The lowest point where the Kansas River leaves the county, about midway of its eastern boundary, is about 800 feet, and the highest, in the southwestern corner, is over 1,150 feet above sea level. The broad plateau strip which enters the county at its southwestern boundary and extends in an easterly direction forms the highest land in the county. It comprises parts of Auburn, Dover, and Mission Townships and is the main watershed between Mission and Wakarusa Creeks. Shonganunga Creek heads in it. East of Mission Township the high, rolling prairie gives way to a flat, level plain, dissected by few streams and fully 100 feet lower than the prairie. In Monmouth Township, on the eastern boundary of the county, the elevation is fully as high as that in the western part, with deep valleys and numerous outcrops of limestone along the streams.

North of the Kansas River the topography is slightly modified by the presence of a thin layer of glacial till, although in general the topography is that of a residual rather than a glacial country. Here the elevation is slightly less than south of the river and in only a few instances does it exceed 1,100 feet. The tops of hills are a little more symmetrically rounded and erosion is less in evidence. Except where the till has all been removed by erosion, exposing the underlying rocks, the hills are more rolling, the valleys less steep, and the country more evenly dissected by streams than in a wholly residual country.

The valleys taken as a whole are broad. This is probably due to the large percentage of soft shale in the rocks of the county. In the rough limestone country the streams form narrow, covelike valleys, whose steep, rugged sides add picturesqueness to the landscape and break the otherwise monotonous uniformity of the topography.

The greater part of the drainage of the county flows into the Kansas River. Entering the county from the west, 6½ miles from the north county line, this stream takes a course through the county a little south of east and leaves the area a mile north of the center of the eastern boundary. The northern part of the county is drained mainly by the following tributaries of the Kansas—Bourbon, Cross, Big Soldier, Walnut, Little Soldier, and Muddy Creeks. Midday, Indian, and Little Muddy are creeks of minor importance rising within the county.

South of the river the larger part of the drainage is carried by Mission, Shonganunga, and Wakarusa Creeks and their affluents. Deer, Whetstone, and Tecumseh Creeks are streams of minor importance draining the east-central part of the county.

The first white settlement in the area was started at Uniontown, in what is now Dover Township, on the old California and Oregon trail, and soon became an important trading point. Both Tecumseh and Auburn were founded in 1854 and Topeka a few years later. Uniontown soon lost prestige and most of its inhabitants moved to other settlements. The early settlers were mainly from New England, the Middle Atlantic States, Ohio, Indiana, and Illinois, though many of the early settlers in Tecumseh came from Alabama, Louisiana, Tennessee, and Missouri. Shawnee County is one of the original 33 counties formed by the first territorial legislature in 1855, when the county extended only as far north as the Kansas River. The present boundaries were established in 1868.

Between the years 1855 and 1860 immigration was steady, after which the population remained stationary until after the Civil War, when immigration again became active, most of the later settlers coming from the Northern States. Immigration was stimulated by the advent of the Union Pacific (then known as the Kansas Pacific) and Santa Fe Railroads in 1866 and 1869, respectively. The population of Shawnee County for 1910, as given by the census, is 61,874.

Topeka, the county seat and capital of the State, is located on the Kansas River, in the eastern part of the county. According to the last census it has a population of 43,684 and is the third largest city in the State. Four lines of railroads enter the city, namely, the Union Pacific, the Atchison, Topeka & Santa Fe, the Chicago, Rock Island & Pacific, and the Missouri Pacific. The main offices and shops of the Atchison, Topeka & Santa Fe and the offices of the Chicago, Rock Island & Pacific are located in Topeka. Several large flouring mills and elevators, a packing house, a cold-storage plant, woolen mills, a canning factory, and two large creameries located in the city afford excellent markets for every kind of agricultural produce.

Rossville, the second town of importance, is located on the Union Pacific Railroad, in the western part of the county. It has a population of 1,576, with good markets and excellent shipping facilities. Silver Lake, 5 miles farther east on the same road, has a population of 998. Other towns within the county are Wakarusa and Tecumseh, on the Santa Fe; Richland, on the Missouri Pacific; Valencia and Willard, on the Rock Island; and Auburn and Dover, in the southwestern part of the county. Elmont and Grove are stations on branches of the Rock Island and Union Pacific, respectively.

There are 116.3 miles of railroad within the county and all sections except the southwestern have excellent shipping facilities. The Union Pacific crosses the county from east to west, following the north bank of the Kansas River. The Atchison, Topeka & Santa Fe enters the county from the east and follows the south bank of the river to Topeka, and thence south into Osage County. The Chicago, Rock Island & Pacific operates its trains over the Union Pacific tracks from Kansas City to Topeka, where it crosses the Kansas River and follows the south bank of that river westward into Wabaunsee County. A branch of the Missouri Pacific from Fort Scott enters the county near the southeastern corner and terminates at Topeka. A branch of the Santa Fe from Atchison enters from the northeast and runs to Topeka, where it connects with the main line. The Marysville cut-off of the Union Pacific runs northwest from Menoken into Jackson County, and a branch of the Chicago, Rock Island & Pacific from Topeka to St. Joseph follows north along Midday Creek.

Kansas City, 67 miles east, affords an excellent market for all grain and live stock and is reached direct by three lines of railroad.

The wagon roads throughout the county are good during the greater part of the year. The rural free delivery of mail is in operation in practically all parts of the county and nearly all the farmers have telephones. The farm buildings as a whole are good, though they are not extensive enough to house all of the crops and machinery. A very small portion of the farm machinery is housed, resulting in great waste above the general depreciation caused by ordinary wear. Fences are ample and generally kept in good repair.

CLIMATE.

Shawnee County has a distinctly humid climate. The precipitation is relatively light from October to March, inclusive, and is heaviest during the crop-growing season, from April through the summer, including September. There is sometimes a deficiency of rainfall during the latter part of July and August and corn at such times may suffer unless special care is taken to conserve the soil moisture.

The winters are comparatively mild and open, although occasionally the temperature may fall below zero for a few days at a time. The average annual snowfall is about 20 inches. The snow is seldom very deep and rarely remains on the ground for any length of time. The length of the growing season averages about 188 days.

The table following, compiled from the records of the Weather Bureau station at Topeka, represent the climatic conditions of Shawnee County.

Normal monthly, seasonal, and annual temperature and precipitation at Topeka.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	31.1	74	−10	0.84	0.63	0.91	3.6
January	25.6	71	−23	1.21	0.63	0.44	4.2
February	30.0	78	−25	1.50	1.03	1.14	6.1
Winter	28.9			3.55	2.29	2.49	13.9
March	40.9	93	− 1	2.15	2.30	1.27	3.0
April	53.7	97	20	2.53	2.13	3.08	0.8
May	65.0	94	28	5.09	1.00	8.63	0.1
Spring	53.2			9.77	5.43	12.98	3.9
June	73.5	101	36	4.78	2.07	4.91	.0
July	77.6	107	50	4.79	2.56	3.74	.0
August	76.0	105	40	4.57	7.67	12.69	.0
Summer	75.7			14.14	12.30	21.34	.0
September	68.3	104	33	3.33	1.31	2.74	T.
October	56.3	92	22	2.01	0.33	3.50	.1
November	41.7	83	− 5	1.27	2.83	1.09	1.3
Fall	55.4			6.61	4.47	7.33	1.4
Year	53.3	91.5	−25	34.07	24.49	44.14	19.2

Average date of last killing frost in spring, Apr. 9; of first in fall, Oct. 15.

AGRICULTURE.

The history of agriculture in Shawnee County is not materially different from that of the entire western prairie region. The early settlers found a vast prairie covered by an exceedingly heavy mat of grass and broken only by narrow wooded valleys along the streams, which furnished excellent locations for the settlements, as fuel, timber, and water were always available. The valleys also offered protection from winds and prairie fires and abounded in wild fruits, game, and fish.

A few acres were cleared of the timber in building operations and the land planted to corn. Usually some of the adjacent prairie land was broken and also planted to corn, though this practice did not become general until later years. With the extensive free range covered with a heavy mat of grass, it was natural that stock raising should first claim attention. The cattle were raised and fattened on the prairie and fed only what little corn was available. Prior to

the opening of the Union Pacific Railroad early in 1866 the cattle were driven to market at Kansas City. With the settling of the country the free range passed, but stock raising within fenced pastures continues to be one of the leading industries and at present is extensively carried on in the county.

It was not until 1860 that the county received its first reverse. But scant vegetation was produced that year, on account of the drought, and in September the first pest of grasshoppers completely devastated the country. Fully 20 per cent of the inhabitants left the county. The favorable season that followed, however, brought most of these back, with the usual number of new settlers. In the summer of 1874 a second and worse swarm of grasshoppers visited the county and left devastation in its path.

Agriculture was completely demoralized during the Civil War and very few men remained in the county to carry on the farm operations. With the close of the war a great number of homesteaders arrived and agricultural operations began with increased vigor.

Wheat was one of the first crops tried by the pioneers. It was first grown for home use entirely, but lately it has become a money crop. A few mills for the grinding of the grain were early built near the streams, but these have now been replaced by the more modern mills in Topeka, where practically all of the flour for the surrounding country is made. Formerly spring wheat was more important than winter wheat, the Ninth Census giving the production of spring wheat in the county as almost four times that of winter wheat. Since 1870 the production of spring wheat has declined and at present there is none grown in the county. Winter wheat has proven a more profitable crop than spring wheat. The late spring and early summer is too hot in this county for the best results with spring wheat. The chinch bug has been an important factor in restricting wheat production. The largest acreage of wheat is reported for the year 1880, when 12,863 acres produced 183,564 bushels. About this time the chinch bugs became numerous and since that date the crop has never recovered its former prominence. The Twelfth Census gives this crop 3,441 acres.

Oats were also grown from the first and apparently reached a maximum production about 1890, when the county produced 291,965 bushels. From this date the production has declined until now oats are an unimportant crop. Tobacco was tried by the southern settlers, but it never attained more than local importance and was all consumed in the county. Sorghum is another of the early crops that has survived, and the quantity of molasses manufactured has risen from 6,768 gallons in 1860 to about 25,000 gallons in 1900. The sirup was formerly a home product, but now at least one plant

manufactures it on a larger scale as a commercial product. Flax was introduced between the years 1870 and 1880, but never became an important crop. The census for 1880 reports the production of about 3 tons of seed, which is the largest ever reported for the county. There is none grown at present. Broom corn was introduced prior to 1880 and small patches are still grown, though the crop is of purely local importance.

Irish potatoes have been grown continuously in the county since its early settlement and the production of this staple has steadily increased until now it is a crop of considerable importance. Sweet potatoes have also been a constant crop. Alfalfa and kafir are crops that have been introduced in comparatively recent years and have risen to places of prominence. The production of nursery stock has lately become a specialized industry in the river bottom lands.

Indian corn is and always has been the main money crop of the area. It has been grown in the same fields continuously for many years and in few instances the same fields have produced corn year after year since the first settlement of the county. The crop is almost entirely fed to stock. No effort has been made to improve the strains by seed selection, nor is any care taken to plant established varieties having special value for feeding stock. Seed corn is selected from the crib, and though some effort is made to select the best looking ears, this method must necessarily result in the ultimate deterioration of the product. Recently there has been some awakening of interest among the more prosperous farmers, who have begun to employ modern methods of seed selection and are growing only improved varieties. Of the white varieties, Boone County white is the favorite, and of the yellow corn Reed's Yellow Dent and Kansas Sunflower are preferred. Practically an equal quantity of the white and yellow varieties are grown on bottom land and upland alike.

There is a difference of opinion among the farmers as to the best way to plant corn. About one-half of the corn is drilled, and both methods of drilling in the row and check rowing are employed. The latter is to be preferred, as it permits of more thorough cultivation. It is important to keep corn clean from weeds and grass, which are certain to injure the crop, and this is sufficient reason for discouraging the practice of drilling in the row. Part of the corn is listed. This practice is accomplished by running a lister drawn by two or three horses between the rows of the preceding corn crop about 3½ feet apart, which opens a furrow from 4 to 6 inches deep, at the bottom of which the kernels are dropped by the same implement. This operation leaves the field in a succession of ridges and furrows.

Under this system of planting several methods of cultivation are practiced. The chief method is to cultivate the corn first with a

lister disk cultivator which stirs the soil thoroughly between the rows but does not throw dirt toward the corn. The later cultivations work the soil into the furrow and around the corn so that after three or four cultivations the field is practically level. Corn planted by this method roots deeper and is more easily tended than when surface planted, but when a good seed bed can be prepared surface-planted corn will usually outyield listed corn, except on shallow soils on the upland.

Modern machinery of all kinds is in general use in the culture of corn. Weeders are occasionally used, but the harrow usually replaces the weeder in the early cultivation of the crop. Late cultivation of the crop with a one-horse implement is not practiced, but is to be recommended, as much moisture now lost through evaporation would be conserved for the use of the maturing crop. This would be especially desirable in a year like that of 1911, when insufficient moisture fell during the growing season. The corn harvester is frequently used, though the larger part of the crop is harvested by hand. Nearly all of the crop is husked by hand and the fodder fed entire. Shredding of fodder is not practiced. A large part of the corn is husked in the field from the standing stalk and the stalks pastured. Where this method is practiced it would be advisable to sow cowpeas in the corn at the last cultivation, and thereby improve the soil for the suceeding crop, as well as furnish an abundance of forage for the stock. The entire crop of corn is fed in the ear. The small producer and tenant disposes of his crop to the cattle feeder and only a very small quantity is shipped from the county.

More money comes to the farmer from the sale of live stock than from any other source. Most of them feed stock of some kind, buying much of their grain from tenants or owners of small farms and keeping much of their own land in permanent pasture. In the more remote parts of the county the larger part of the land is in pasture and has never been plowed. Most of the cattle fed are raised in the county or brought from adjoining counties. Grades of Shorthorn or Angus blood form a large part of the herds and some show evidence of the infusion of Hereford blood. Several excellent herds of purebred Shorthorns were seen in the county, and some purebred Angus are also raised.

Dairy cattle are attaining considerable importance, and many farmers, especially those close to Topeka, are readjusting their herds with a view to milk production. Several herds of purebred Guernseys and some herds of grade Holsteins are maintained for dairy purposes. A few Red Polled cattle are also used in milk production. Two large creameries in Topeka furnish a steady market for milk and cream, and this demand, with the supply needed by the city,

affords an opportunity for extension in this branch of farming. Milk and cream are carried into the city daily by all the railroads, and wagons sent out by the creameries gather cream along specified routes. Other wagons are operated by middlemen, who collect the cream at local points in the more remote parts of the county and deliver it daily to the creameries. The supply from Dover and Auburn is gathered in this way.

Most of the farmers have separators, and only the cream is sold. Silos are common on the dairy farms and a great many more are in course of construction. For silage corn is used. It is cut with a harvester, shredded, and elevated by power. Silos are filled from the middle of August to the middle of October, depending upon the crop used for silage.

Hogs are raised by all the farmers, and some of them make this stock more or less a specialty. Duroc-Jerseys are probably the most common, though Berkshires and Poland-Chinas are preferred by some. Purebred herds of each are raised in the county, though grades and crosses between purebred animals are the most numerous. Hogs are marketed either at the packing house in Topeka or shipped to the market at Kansas City.

Horses and mules are raised by nearly every farmer, though no farm is devoted solely to this industry. The Percheron is the most commonly seen, and many exceptionally fine animals are owned in the county. Mules are common and many are used on the farms in preference to horses. The surplus of horses and mules is bought by a few men, who put them in better condition for marketing and sell them either in Topeka or Kansas City. There are a few sheep in the county and several flocks of Angora goats.

Winter wheat is a money crop, though one of minor importance. It is usually sown from the middle of September to the 1st of October. Experience has shown that the best yields are obtained from September 25 to October 5 seedings. Wheat is generally planted continuously on the same piece of ground for a number of years and is often sown on poorly prepared seedbeds. The better farmers, however, plow the stubble each year, though the plowing is shallow, seldom exceeding 4 inches in depth. Wheat sometimes follows corn, in which case the soil is disked and the seed sown between the rows of corn shocks. The varieties most commonly grown are of the hard Turkey type. Turkey Red and Kharkof are preferred and yield better than the softer winter wheats. Of the soft varieties, Zimmerman, Fultz, and Currell are the most prominent. As a general rule the hard wheats yield better on the upland and the soft varieties make the best yield in the bottoms, though they are sometimes sown without regard to this adaptation. Deeper plowing is recom-

mended for wheat and a more thorough preparation of the seedbed, with seeding from September 25 to October 5.[1]

Much of the wheat is marketed at the local mills, though some is shipped from the county.

Alfalfa has attained a position of importance in recent years. It is grown on all types of soil, both bottom and upland, and four or five cuttings are made each year. The best results have been obtained by sowing the seed in August on a well-prepared seedbed, free from weeds. Although the bottom soils are particularly adapted to this crop, satisfactory stands and good yields are secured on practically every type in the area. Some farmers have experienced difficulty in securing a stand on the uplands, probably because of the absence of the necessary bacteria from the soil, but after two or three attempts this difficulty is finally overcome and later seedings on the same ground are more satisfactory. Crops of seed are usually secured from the second cutting. Alfalfa hay for market is usually baled in the field, and that for home use is either stacked in the field or stored in barns or hay sheds. At the time of the Twelfth Census (1900) there were about 2,000 acres in this crop, and since that time the acreage has steadily increased until alfalfa is now an important crop on almost every farm.

Prairie grasses are the most abundant grasses in the area and are used for both pasture and hay. In favorable seasons cuttings of 1 ton per acre are not uncommon and sometimes two cuttings are made each summer. This, however, is exceptional. The grass is mowed at any time from June to November, and the hay baled or stacked in the field. The larger part of the hay for the market is baled, the remainder being fed loose on the farm. Small horsepower balers are used exclusively. Most of the surplus hay is sold in Topeka, and only a small quantity is shipped from the county.

Red clover is not grown extensively, though some farmers prefer it to alfalfa. It is usually seeded with wheat or oats in the spring, mowed the two following years, and pastured the third. Some mow it even longer than this, though the crop does not seem to justify mowing longer than two years, or three at the most.

The oat crop is very uncertain. Occasionally large yields are secured, but often the yields are very low and sometimes the crop is cut for hay before it matures. Probably the low yields are mainly the result of the climatic conditions. The sun usually scalds the plants during their early growth, which fact emphasizes the importance of getting the seed into the ground as early as possible in the spring. Oats are usually sown with a drill on corn or potato land.

[1] Bulletin 176, Kansas State Expt. Sta. How to Grow Wheat in Kansas.

Irish potatoes have always been an important crop, and the acreage devoted to this staple has steadily increased from the early settlement of the county. Although nearly every farmer raises enough for his own use, the production for market purposes has been developed most extensively along the Kansas River bottoms. Little attention in either case is given to improvement of seed. Nine-tenths of all the potatoes grown in the county are of the Early Ohio variety. There has been very little trouble experienced from the potato beetle or any of the fungus diseases which often hamper the production in other localities, and it would seem from the excellent market and shipping facilities so close at hand that this industry could be developed to a much larger extent. Care should be taken to rotate crops so that potatoes will not occupy the same ground continuously. Where this is not done the soil is likely to become infected with the potato-rot fungus, which greatly impairs the keeping quality and market value of the crop. Equal care should be exercised in the introduction of seed, that they are free from disease. Treatment of the seed with any of the standard formalin preparations before planting insures freedom from these infections. The Kansas Valley potatoes are locally famous for their size and cooking and keeping qualities. The opportunity for potato production has not been appreciated in Shawnee County as it has in the counties to the east.

In the local practice there is no rotation in which potatoes have a place, and the general plan is to grow the crop on the same land for several years. They are usually planted after corn or on newly-broken sod and followed in turn by a market-garden crop or by wheat or corn. During favorable seasons there is a surplus of the crop in the county, most of which goes to the Kansas City market, but in less favorable years the crop is not sufficient to supply the local demand, the shortage being supplied usually from Colorado. Average yields extending over a large number of years are, for the bottom soils, 150 bushels per acre, and for the upland soils about 100 bushels. Yields of 300 bushels are not exceptional on the bottom lands, where care has been taken to prepare the soil properly and to give careful cultivation during the growing season. No commercial fertilizers are used with the potato crop. In harvesting the crop the tubers are usually plowed out and then picked up by hand.

Market gardening is specialized in the river bottoms, where practically all the vegetables are produced in large quantities. The product finds a ready market in Topeka. A large acreage near Topeka is devoted to cabbage and tomatoes, while watermelons and cantaloupes are grown in nearly every part of the bottoms, the latter on the lighter and more sandy soils, where they attain a good size

and excellent flavor. Sweet potatoes are grown extensively and produce large crops of excellent quality and size. Asparagus is also produced as a commercial crop. No fertilizers are used in market gardening, nor is the importance of manures and leguminous crops appreciated.

Another highly developed industry of considerable importance is the production of nursery stock, mostly apples. This is carried on almost exclusively on the Osage very fine sandy loam, though small areas of the Osage silty clay loam are sometimes utilized. The ease with which the very fine sandy loam is cultivated and its natural fertility make it especially suitable for this industry, to which a large proportion of the bottom land of the county is devoted. It is claimed that the larger part of the apple seedlings used in the United States is grown in the Kansas River bottoms, and probably one-third to one-fourth of the output is grown in Shawnee County. The seeds, the larger part of which come from France, are dropped by a planter in rows about 3½ feet apart at intervals of about 8 inches. The crop receives almost continuous cultivation during the growing season, the 1-horse walking cultivator with small shovels being used exclusively. During the latter part of October or early November the seedlings are lifted by hand, bunched, and stored. A large part of the crop is disposed of at this stage to nurserymen, who use the roots for grafting purposes. Some, however, are grafted by nurserymen in the county. After the grafting the seedlings are stored until early spring in cellars especially constructed for the purpose, when they are set out in rows 4 to 5 feet apart, with about 1 foot between the trees. As during the first season, they receive almost continuous cultivation with a 1-horse cultivator.

Ornamental trees and shrubs are also grown, but are of minor importance. Most important of these are the catalpas, which are used for both ornamental and forest plantings. A grove of these has been set out on the sandy soil adjacent to the river in Rossville Township, an example which is being followed on a smaller scale by other towns in different parts of the county, and particularly on the sandy soils next to the river. A small acreage of nursery stock was also seen on the Shelby loam type of upland soil, but the industry is otherwise confined almost wholly to the bottoms.

The county is practically free from San Jose scale and other pests injurious to fruit trees and nursery stock.

As the growing of nursery stock requires clean culture and almost continuous cultivation, it is advisable to rotate the seedlings with other crops, so that the fertility of the soil may be maintained. It is especially important to keep up the content of organic matter. It is noticed that after several years this becomes very low, as evi-

denced by the light color and the loose, sandy nature of the soil. This condition can be rectified by the adoption of rotations including a legume to be plowed under for green manure. Stable manure is at all times beneficial. It is best applied in the fall, as soon as the seedlings are removed, when it will add to the capacity of the soil to conserve the winter rainfall for the use of the growing crop the following year.

Sorghum is grown on practically every type of soil in the area. Many farmers grow a small quantity, which they make into sirup for home use. On one farm an average of 72 acres is devoted to this crop, and this represents the largest single acreage seen during the survey. A plant for the grinding of the cane and its manufacture into sirup is maintained on the farm and a high-grade product is marketed in Topeka. Sorghum for sirup is always planted in rows about 3 feet apart and is given the same cultivation as corn. In October it is cut, usually by hand, though the larger producers use the corn harvester. When grown for forage the seed is sown broadcast and the harvesting is done by hand.

Kafir has lately become a crop of considerable importance because of its drought-resistant nature. It is drilled in rows about 3½ feet apart in the latter part of May and receives the same cultivation as corn. As kafir is sown somewhat later than corn it often replaces the latter crop in a field that shows a poor stand of corn. In this way a field often produces an abundance of succulent feed which would otherwise produce only a small crop of corn. Kafir is harvested in October, shocked much the same as corn, and thrashed in November. Yields obtained depend upon the season and vary from 30 to 45 bushels of grain per acre, with an average of about 35 bushels for all soils. Millet is grown by some farmers. It is almost entirely fed to cattle.

It is the opinion of the old residents that the yields obtained are growing less each year and that the improved methods of cultivation do not make up for the loss in the fertility of the soil. This can best be explained by the fact that no rotation of crops has ever been practiced. It has been the rule to keep the same fields in corn year after year until the yield became so small that its production was no longer profitable. There are fields that have been in corn continuously since the early settling of the country. The yields have gradually decreased, but are still sufficient in most instances to justify the planting of the crop.

Every farmer should adopt a crop rotation which will answer the requirements of his farm and the different soil types occurring thereon. Either alfalfa, red clover, or cowpeas should be included

in every rotation. Cowpeas are not extensively grown, but could be adopted in almost every rotation. They can be planted with corn after the last cultivation or in July after wheat, mowed for hay in early October, or plowed under and the land planted to corn the following year. When sown with corn cowpeas not only add to the amount of forage, but also are beneficial to the succeeding crop. Red clover sown in the spring in wheat makes excellent pasture after the wheat is removed and can be mowed for two years, but seedings made in this manner frequently fail for lack of moisture. Alfalfa can be grown on all soils of the area and is an excellent soil renovator. Corn should not be grown on the same land continuously more than two years.

A system of rotation practiced by a dairyman consists of corn for grain one year, after which a heavy application of stable manure is made and the land plowed the same fall for the succeeding corn crop. Corn the second year is used for silage. Wheat follows for two years, in which red clover is sown the spring of the second year and the clover and stubble pastured after the wheat has been removed. The clover is then mowed twice each year for two years, after which the land is broken in the fall for corn. Cowpeas in the second corn crop or after the first wheat crop would be an improvement on this plan. This simple rotation could be modified to supply the needs of the individual farmer and crops substituted or added as his needs demand. For a rotation covering a longer period of years alfalfa could be admirably used. Red clover is better suited for shorter rotations and is preferred to alfalfa by many. Cowpeas can be added to almost any system as a catch crop. Both clover and alfalfa are suited for rotations where the special crops are important.

The average size of the farms is about 130 acres and about three-fifths of the farms are operated by the owners. Cash rent, which ranges from about $4 per acre for pasture land to $12 per acre for land suited for the growing of nursery stock, is the pevailing system of leasing. The share system is not much in vogue in the county.

SOILS.

The soils of Shawnee County may be divided into three broad groups, viz, glacial, residual, and alluvial. The glacial soils are found principally north of the Kansas River, the residual soils south of the river, and the alluvial soils in the river and creek bottoms.

The glacial soils, where typically developed, are easily recognized by their uniform reddish-brown color throughout the soil section, their gently rounded, even topography, the absence of shale or limestone fragments in the soil and subsoil, the rounded pebbles and

bowlders scattered over the surface and throughout the soil section, and by the presence of sharp quartz sand in the subsoil. Foreign bowlders and waterworn pebbles give evidence of the occurrence of the ice sheet in the northern part of the county. During the glacial period the ice extended approximately as far south as the Kansas River with a few lobes protruding south of this boundary. In fact, small local areas of glacial soil are found within 2 miles of the southern boundary of the county on the north bank of Wakarusa Creek.

The glacial soils in Shawnee County are derived from the Kansan till, which consists of rocks and crushed rock fragments transported by glacial action from territories farther north. The rocks are identical with those found in southwestern Minnesota and western Iowa and as the glacial movement was from north to south it is logical to assume that the Kansan till is originally from these sources. It consists of quartzite, granite, and conglomerate. Originally the Kansan till was deposited as a layer of varying thickness upon the underlying shale and limestone, but by the process of erosion it has been greatly modified, so that now the till often appears only on the tops of hills. In such cases the underlying limestone and shale are exposed on the slopes and become the main source of soil-forming material. Where the till was deposited in a thicker layer and where the agencies of erosion have been less active the topography is undulating to gently rolling and the soil is uniformly of glacial origin. The latter case is particularly noticeable on the gentle rise from the river bottom on the north. Where the change of topography is more abrupt, forming a bluff, the underlying limestone and shale are exposed and the soils are of residual origin.

In many instances the till is quite thin along the northern boundary of the county, with many rock outcrops, and in some spots the material is entirely lacking. Along the southern boundary, which is approximately the Kansas River Valley, the soil derived from the glacial material is quite deep and in several places where cuts have been made for roads a section of 10 feet or more has been exposed without any appearance or indication of the underlying rocks. It is noted that the glacial soils bordering the alluvial soils of the bottoms are much more sandy than those encountered farther into the uplands. This would indicate some reworking of the soil or soil-forming material since its deposition as till, similar to the sorting action in the case of residual soils.

The Kansan till has given rise to the Shelby series of soils, previously mapped in Missouri. Two types of this series were found, viz, loam and stony loam. The separation of these is based upon the quantity of fragmental rocks which they contain.

The soils of the unglaciated portion of the county are of residual origin, i. e., derived from the immediately underlying rocks. The rocks of this region belong to the Pennsylvania division of the Carboniferous and consist of interbedded shale, sandstone, and limestone.

Shale, the predominating rock, may vary from sandy to clayey in the different beds or even in the same stratum. It is light yellow to black, and ranges from soft micaceous rock to one approaching the character of a slate. The beds of sandstone and limestone are comparatively thin and uniform. The strata lie nearly horizontal, with only a slight dip to the northwest. Faulting and folding are nowhere in evidence. Were the present surface level it is evident that the soils would be practically the same all over the county, but this condition has been altered by the effect of erosion, with the result that different strata of rocks have been exposed to the processes of weathering and soil formation at different levels, giving rise to varying soil conditions.

The residual soils of the area are separated according to their origin. Shale has entered more largely into the formation of the soils than either limestone or sandstone and has given rise to two series of soils—the Summit and the Oswego. In the Summit series there are three separations—the silty clay loam, characterized by its light color, the silty clay loam, heavy phase, distinguished by its dark surface soil and more rolling topography, and the silty clay loam, stony phase. The Oswego silt loam is the sole representative of this series. It may be recognized by its dark-gray or dark-brown surface and the presence of a so-called "hardpan" in the subsoil.

The sandstone gives rise to the Boone fine sandy loam, which has a chocolate-brown surface soil and a relatively high sand content in both soil and subsoil. The limestone gives rise to the Crawford silty clay loam.

The bottom land soils, or those of alluvial origin, are related in respect to their origin and the manner of their formation, and are placed in the Osage series. There are five types. The Osage very fine sandy loam occupies the highest position in the Kansas valley, while the Osage silty clay loam occurs along some of the larger creeks of the area and follows the local drainage in the Kansas bottoms. The Osage silt loam predominates along the smaller streams and in the bottoms of Mission, Shonganunga, and Wakarusa Creeks. The Osage silt loam also occurs as a colluvial phase. The Osage very fine sand is a light type which occurs along the Kansas River and has its largest development where the river makes sharp bends.

Along the larger creeks are broad areas locally known as "second bottom" land. There is ample reason to believe that these areas are not alluvial in origin, but residual, and therefore they were mapped as the Oswego silty clay loam.

The following table gives the name and extent of each soil mapped in the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Summit silty clay loam	113,472		Osage silty clay loam	22,400	6.5
Stony phase	1,856	33.7	Oswego silty clay loam	18,688	5.4
Heavy phase	1,152		Crawford silty clay loam	7,936	2.3
Shelby loam	54,848	16.4	Osage very fine sandy loam	4,096	1.2
Light phase	1,856		Boone fine sandy loam	2,368	.7
Oswego silt loam	41,984	12.1	Shelby stony loam	832	.2
Osage silt loam	15,104	10.9			
Colluvial phase	22,464		Total	345,600	
Osage very fine sand	36,544	10.6			

SUMMIT SILTY CLAY LOAM.

The Summit silty clay loam to a depth of 8 to 14 inches consists of a dark-brown, drab or light-gray, medium heavy, friable silty clay loam, becoming lighter in color and heavier in texture at depths below 10 inches, underlain by a brown, granular silty clay or clay loam, which becomes lighter in color with depth and finally grades into a yellow or light brown clay loam. Occasional mottlings of drab, yellow, or yellowish brown are found in the deeper subsoil.

The surface soil has a decided tendency to granulate or break up into small particles, with the result that it does not pack, bake, crack, or run together. Limestone outcrops are frequent and small angular chert fragments and iron concretions are occasionally found throughout the soil profile.

The Summit silty clay loam is one of the most important soil types of the area and the largest in extent. It is found in all of the townships in the county, its greatest extent being in the southern sections.

The topography is rolling to hilly, the type occupying ridges and gentle slopes which form the sides of valleys. Occasional flat areas occur on the tops of hills and between ridges, though these are of small extent and constitute but a small part of the type. Limestone outcrops occur frequently and as far as possible have been shown by symbols on the map. Flat limestone fragments are scattered over the surface of the type in the locality of the outcrops. The rolling topography insures good drainage, though the character of the subsoil is such that water does not penetrate as quickly as might be desired and tile drains would be beneficial in carrying off the surplus soil water and in aerating the soil.

Elevations within the type will not vary more than 150 feet, most of the land lying above the 1,000-foot contour line.

The Summit silty clay loam is of residual origin, being derived from the weathering of the shale which underlies the county. Occuring both above and below the shale are thin strata of limestone, which frequently outcrop on steeper slopes. Immediately over this outcrop and where the limestone lies near the surface the soil is more or less influenced by the admixture of limestone material. The presence of occasional chert fragments and lime concretions in the subsoil give evidence of the influence of limestone, though only those soils having a bright red subsoil of limestone origin were included with the limestone soils.

The type was originally prairie and supported a heavy growth of grass. Since the settling of the country some trees have been planted on the type for ornamental purposes, cottonwood, elm, oak, hickory, and black walnut being most extensively used.

When plowed the soil is loose, friable, and easily tilled. Where the topography is at all steep the soil washes badly and gullies are formed. Even in virgin land these gullies occur. With a little labor water could be diverted from them to channels where erosion would be less severe.

A large part of the type is in grass and has never been plowed. The rougher areas are kept exclusively for pasture land and support large herds of stock for the greater part of the year. Prairie grass hay is probably the most important crop harvested from the type and good yields are annually obtained. In favorable seasons two cuttings are made, though this is somewhat exceptional, and the general practice is to mow the grass as early as the growth warrants and to pasture the land the remainder of the season. Yields of one ton per acre are not at all exceptional in good growing seasons, though three-quarters of a ton is more nearly an average for all years. The second cuttings are usually light and the quality of the hay is inferior.

Corn does well on the Summit silty clay loam and yields from 30 to 35 bushels per acre. Wheat averages from 15 to 20 bushels per acre. Alfalfa has been tried and promises to become an important crop. Trouble has been experienced in getting a satisfactory stand at the first seeding, owing probably to the absence of the particular bacteria in the soil that promotes the growth of the plant. After several attempts a good stand is usually secured. Four cuttings a year are made, which average from one-half to three-quarters of a ton each.

Some attention has been given to orcharding, and the growth and general appearance of the trees would seem to indicate that fruit growing may be made a profitable industry. Apparently little or no attention is given the trees after they are set out, and neither spraying nor pruning is practiced. So far the quality of the apples has

been poor, but it is thought that with proper care this defect would largely disappear. The deeper phases of the type, where the rock is not encountered within the first five feet, are best for the production of tree fruits.

The Summit silty clay loam can best be improved by the application of stable manure or the growing and occasionally the plowing under of alfalfa, clover, or cowpeas. Manure and organic matter is needed to replenish the supply of humus, which originally was relatively very great, but which is fast becoming depleted. Organic matter is neccessary to keep the soil in the best physical condition.

The type is usually valued at $40 to $60 an acre, the price depending largely on the surface features and proximity to markets.

Summit silty clay loam, heavy phase.—The Summit silty clay loam, heavy phase, consists of a dark-brown to almost black heavy loam or silty clay loam, resting at an average depth of 10 inches on a dark-brown clay loam subsoil, which, at about 24 inches, grades into a pale yellowish brown to yellow sticky clay loam or clay.

The only body of this phase of the type of any importance lies east of Topeka, in Mission Township, although areas too small to map exist in other parts of the county. Stratigraphically it occupies a position immediately over the limestone and lower than the Oswego silt loam.

The soil is derived from shale, but is influenced to more or less extent by the underlying limestone. The dark color is no doubt due mainly to the influence of the color of the shale from which the type is derived, though the decay of vegetation in the presence of lime may intensify the color in some areas. The Summit silty clay loam, heavy phase, occupies a gently rolling topography, usually the gentle slopes from the streams to the higher uplands.

When wet the Summit silty clay loam, heavy phase, is sticky and tends to clod badly, closely resembling the Oswego silt loam in this respect. When exposed to the action of air and frost it breaks down into its characteristic crumby structure. The type is well drained and appears to hold moisture well during the dry seasons. It sometimes tends to crack, though it is not as bad in this respect as the Oswego silt loam. It does not suffer from erosion to any great extent, the heavy subsoil holding it against the action of water, except on the steeper slopes.

The greater part of the heavy phase is in prairie grass, which is almost always mowed. It is an excellent soil for grass and is everywhere covered with a heavy mat of sod. The yield of hay obtained is above the average for the other types of the area. One small commercial apple orchard lies partly on the Summit silty clay loam, heavy phase. The trees are thrifty and bear well. The Ben Davis, Winesap, Jonathan, and Gano varieties are grown. Corn

also does well, though the yields obtained are usually less than on either the Oswego silt loam or the typical Summit silty clay loam. Kafir and a little wheat were also seen.

Summit silty clay loam, stony phase.—The summit silty clay loam, stony phase, includes those areas of upland soil of residual formation whose steep topography and stony nature render them unsuited for cultivation. Outcrops of limestone rock are frequent. Some areas occur on the tops of hills and here the surface is less steep, but the bed rock is usually encountered at about 12 inches below the surface. Flat limestone fragments are scattered everywhere over the surface, making cultivation almost impossible. This stony phase is derived from both shale and limestone. It is found in almost every part of the county, though no large areas occur. Almost all of the type is devoted to pasture.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Summit silty clay loam:

Mechanical analyses of Summit silty clay loam.

Number.	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.*
380929	Soil	3.4	3.3	1.5	2.7	5.9	54.9	28.3
380930	Subsoil	.9	1.9	.9	2.0	3.8	45.2	45.2

OSWEGO SILT LOAM.

The Oswego silt loam is characterized by its dark color, nearly level topography, and the presence of a stiff subsurface stratum. The typical development consists of 6 to 12 inches of a dark-gray, dark-brown, or black loose silt loam, of ashy feel, underlain by a stiff, impervious, tenacious silty clay or silty clay loam, uniformly black or very dark brown in color. This is in turn underlain at an average depth of 26 inches by a loose silt loam or silty clay loam, varying in color from light drab to light brown or mottled drab and brown. Small iron and lime concretions in the subsoil are largely responsible for the mottled condition that sometimes occurs. The lines of demarcation between surface, subsurface, and subsoil are well established, the changes being abrupt.

When wet the type has a uniform black color, is very sticky, and if cultivated in a too moist condition tends to clod badly. Unless well cultivated during the dry seasons the soil bakes, packs, and runs together, and cracks 3 or 4 inches across are not at all uncommon.

The Oswego silt loam is locally known as "gumbo" or "hardpan" land, because of the presence of the stiff subsurface layer. It occupies level to undulating areas on the tops of hills, and is developed most extensively on the divides between streams.

Small areas of this type occur in every township of the county. The largest single area is found on the divide between Wakarusa and Shonganunga Creeks, in Topeka, Williamsport, Monmouth, and Tecumseh Townships.

The Oswego silt loam is a residual soil derived from the different strata of soft, black, argillaceous shale that occur both immediately above and below the limestone. The shale is so perfectly weathered that no trace of it can be seen in the soil, though in several places it was seen in banks where it had been protected from the processes of weathering by a ledge of limestone. Because of its softness and susceptibility to weathering it has played but little part in the formation of any of the other soil types in the area, and only in nearly level areas where erosion has been slight are its derivative soils found. Where a slight change in elevation occurs, either above or below a given area, the type gives way to those derived from the harder shale, limestone, or sandstone, usually soils of the Summit series. The level topography is no doubt caused by the horizontal stratum of limestone that underlies the Oswego silt loam at varying depths. Outcrops of thin-bedded limestone can almost always be seen in cuts, and occasional limestone fragments are scattered over the surface. This underlying bed of limestone acts merely as a support for the overlying soil and gives character to the topography, but has had no influence in the formation of the soils.

The type as a whole is poorly drained. The level surface does not permit of the free flow of surface water, nor does the heavy subsoil permit of a free downward movement of moisture. However, the topography and location of the soil are such as to make artificial drainage practicable and easy. Tile drainage would not only be beneficial in removing the excess water but also in aerating the soil and thereby improving its structure. While the results would not be immediate, perfect aeration would eventually break down the close structure of the soil and make it loose and friable. Open ditches are sometimes used where the type occurs in a large body and are beneficial in removing the surface water, but where placed at wide intervals are of little value in aerating the soil. A white crust resembling alkali was noticed in several places, but such spots are of small extent and of little importance. The small spots of "gumbo" that appear where the surface soil has been removed by erosion can best be improved by the application of lime, which detroys the dense structure and flocculates the soil particles. Manures would then be beneficial to the grass crop on such spots.

The original vegetation of the Oswego silt loam was a rank growth of prairie grass. Timber growth was probably prevented by prairie fires and the inability of the trees to start in the dense mat of sod that covered the surface. All of the general crops are now grown extensively on the type, though considerable areas are still unbroken.

Aside from drainage, the two main factors controlling crop production on this type are the maintenance of a supply of organic matter and thorough cultivation. Although the soil is naturally black or very dark, the color does not indicate the presence of a large quantity of humus. Deep plowing and incorporation of organic matter in the stiff subsurface would improve the structure of the soil, make it more friable, and also add to its moisture-holding capacity. The deficiency of humus is largely responsible for the cold, soggy nature sometimes noted in the type. Humus can best be supplied by the addition of stable manure or by plowing under green leguminous crops, such as clover or cowpeas. The close nature of the soil gives rapid capillarity, and it is always advisable to maintain an earth mulch to prevent the loss of soil moisture by evaporation during the growing season. During the progress of the survey it was noticed that where an earth mulch was constantly maintained the subsurface and subsoil contained a relatively large quantity of moisture, while the fields that were less thoroughly cultivated or in grass were dry, hard, and baked, with cracks of considerable width everywhere in evidence.

The Oswego silt loam is one of the best upland corn soils in the county and a large part of its area is devoted to this crop. Its value as a corn soil is recognized by the farmer, and small, isolated areas are often fenced off from pasture land for the production of corn. The loose, mellow surface, underlain by the stiff subsurface, adapt it especially to this crop. Large yields are secured by some farmers, but the insufficient cultivation given by others brings the average below what the soil is capable of producing. Corn averages about 40 bushels, wheat 18 to 20 bushels, and alfalfa 3 tons per acre.

Kafir is grown to a considerable extent on this soil and yields from 30 to 40 bushels per acre. Alfalfa does well where the drainage is sufficient to carry off the excess water, though many areas are too wet and soggy for the crop.

OSWEGO SILTY CLAY LOAM.

Along most of the larger creeks and a few of the smaller ones of the area are strips of land of varying width, lying between the bottoms and the more rolling upland, whose topography is almost level, with only a gentle slope toward the stream. This is locally known as "second bottom" or "gumbo" land, though close examination shows that the soil is not of alluvial origin, but is derived from the

weathering of black shale. The main differences between this soil and the Oswego silt loam are in position, depth of soil, drainage, and crop producing capacity.

The Oswego silty clay loam consists of a black, loose silty clay loam, with an average depth of 12 inches, overlying a stiff, plastic, impervious, black silty clay, which extends to an average depth of about 26 inches. The line of demarcation between surface and subsurface is abrupt and in no place does the one grade into the other. At 26 inches the subsoil becomes lighter in color and is either light drab, light brown, or mottled drab and brown. Small iron and lime concretions usually occur in the subsoil, its mottled condition being caused by the iron salts and imperfect drainage.

The soil is derived from the weathering of soft, black argillaceous shales occurring immediately over the limestone. Limestone fragments occur on gentle slopes and thin outcrops of the rock were seen in several places.

The largest areas of the Oswego silty clay loam occur along Wakarusa Creek and Mission Creek, though small areas are found in almost all parts of the county. The elevation at which the type is found is usually about 1,000 feet.

The boundary between the Oswego silty clay loam and the alluvial soils is often indistinct, though sometimes a difference of a few feet in elevation occurs where the residual soils end and the bottom land begins. The type is never overflowed, though in times of continued rainfall the imperfect drainage of the soil is likely to cause surface accumulations of water for a short time. Near its outer edge, where it joins the more rolling upland, there is probably some colluvial material mixed through the surface soil, making it slightly deeper than the average, though it is believed that the type is almost wholly of residual origin.

The prevailing topography is not such as to insure perfect drainage. The gentle slope and the impervious nature of the soil do not permit of the easy flow of water that is to be desired, and open ditches or tile drains are necessary to carry off the excess moisture. Open ditches are more often used, but tile drains are the more satisfactory. The gentle fall toward the stream is sufficient for either system. Tile drains are more beneficial in the improvement of the physical condition of the soil, and by giving more perfect aeration the subsurface layer becomes less compact and more disposed to break down and crumble. The effects of aeration are not immediate and the physical condition continues to improve with time after laying the drains. Tile drainage should be more general on the type. Some areas of alkali occur, but they are of small extent and of purely local importance. Thorough drainage is the most efficient means of removing the alkali salts. Small "gumbo" spots also fre-

quently occur. These may be treated with heavy applications of lime, which flocculates the particles and changes the structure of the soil. Later applications of manure will prove beneficial to crops.

Corn is the main crop. The yields are slightly larger than on the Oswego silt loam. Forty-five bushels per acre is considered a good yield. The larger yield on this type is probably due to the difference in topography and the larger amount of moisture secured through the closer proximity of the water table. Wheat averages 20 to 25 bushels per acre and alfalfa yields about 4 tons. Alfalfa has lately become an important crop on this soil and a few farmers are practicing a rotation of corn and alfalfa.

This type is usually valued at about $80 an acre.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Oswego silty clay loam:

Mechanical analyses of Oswego silty clay loam.

Number.	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.*
380903	Soil	0.1	0.3	0.5	1.1	3.5	62.6	32.0
380904	Subsoil	.0	.3	.5	1.5	3.5	64.1	29.8
380905	Lower subsoil.	.0	.4	.6	.9	1.7	63.4	32.8

SHELBY LOAM.

The Shelby loam comprises the greater part of the glaciated section of the county and is considered one of its best upland soils. To an average depth of 10 inches the surface soil consists of a dark chocolate-brown to dark reddish-brown loam or silt loam containing varying quantities of sharp quartz sand. Below this the soil grades into a reddish-brown to reddish-yellow stiff clay loam, which becomes lighter in color with depth. From 24 inches downward the clay content increases rapidly and at 36 inches the subsoil is a reddish-yellow clay or heavy clay loam. Quartz gravel and sand are disseminated throughout the soil profile and small gravel often appears on the surface. Large quartz and conglomerate bowlders are found in many places, sometimes outcropping and sometimes buried in the soil and subsoil. Small lime concretions are sometimes present in the latter.

While the larger part of the type occurs north of the Kansas River in Soldier, Menoken, Silver Lake, and Rossville Townships, small extensions are found south of the river and small isolated areas exist in almost all of the southern townships. The southernmost area of the Shelby loam in the county extends to within 2 miles of the southern boundary, on the bluff bordering the Wakarusa

Valley. Most of the areas south of the river are small, and, while typical in development, are of only minor importance.

The Shelby loam is of glacial origin, being derived from the weathering of the Kansan till. The stone and gravel in the Kansan till is composed almost wholly of quartz, granite, and conglomerate mixed with varying quantities of sandstone and chert. It was originally deposited over the entire northern part of the county, but erosion has removed it in many places, exposing the country rock. In this case only the tops of hills and the divides between streams are of glacial origin, the steeper slopes being composed of limestone and shale and their derivative soils. The limestone outcrop in such cases usually forms the boundary between the glacial and residual soils.

The prevailing topography of the Shelby loam is gently rolling. Few level areas occur and on the steeper topography the glacial material has been eroded away.

The drainage of the type is usually good, though small areas on the lower slopes become waterlogged during the wet seasons. The prevailing topography is such as to insure good drainage, with a minimum damage from erosion, though the subsoil is rather too heavy to permit the free downward percolation of moisture. This latter condition is somewhat improved by the presence of rounded gravel, which makes the mass more porous. There is no doubt, however, that tile drainage, while not necessary for the removal of excess water, would be beneficial from the standpoint of more thorough aeration of the subsoil. The lower elevations, receiving the seepage water from the higher adjacent areas, are less perfectly drained and often support rank growths of "slough grass." The subsoil in such places is usually mottled, showing poor drainage and lack of aeration. Such areas are of small extent, seldom exceeding a few rods in width, and are not typical. During dry seasons the subsoil becomes hard and baked, and unless thoroughly cultivated cracks to a considerable depth. This not only increases the loss of moisture by evaporation, but is a detriment to the growing crop in that it breaks the roots of plants and thus reduces the area from which they can feed. Where a mulch of fine earth was maintained during the growing season cracks were not noticed. This emphasizes the importance of thorough cultivation on the type.

The Shelby loam is a good corn soil, and most of the type under cultivation is devoted to this crop. Ordinarily yields of 40 to 50 bushels per acre are secured, though in years of scant rainfall they drop considerably below this figure. Wheat is also grown successfully and averages from 20 to 25 bushels per acre. Alfalfa and red clover do well, the former yielding about 3 to 3½ tons and the latter about 2 tons per acre. Difficulty in securing a good stand of alfalfa

has been experienced, but after inoculation takes place further failures are not experienced. Red clover is preferred to alfalfa by some of the farmers, though its culture is not extensive. Apple trees grow well, though their bearing is impaired by the lack of proper care. The type is well adapted to this fruit, and several small commercial orchards are maintained. Ben Davis, Winesap, Jonathan, and Gano are the principal varieties.

The type ranges in value from $65 to $100 an acre, the price depending on the character of the improvements and proximity to markets. A large part of the land is in virgin prairie and used for pasture and mowing land.

Shelby loam, light phase.—The Shelby loam, light phase, consists of a fine sandy loam of dark reddish-brown to dark chocolate-brown color and loose, open structure resting at an average depth of 10 inches on a fine sandy loam or fine sandy clay loam of reddish-yellow color. The subsoil is compact to a depth of about 24 inches, where it usually becomes more friable, the sand content being greater. At lower depths the subsoil is lighter in color and at 36 inches it is usually a reddish yellow. Numerous well-rounded quartz gravel are encountered in both soil and subsoil, though they are not so abundant as in the typical soil. When exposed to the air the subsoil crumbles and breaks down into a mealy, loose, fine sandy loam.

The type occurs in small areas in Soldier, Menoken, Silver Lake, and Rossville Townships, and its total area is slight. It lies most frequently along the gentle slopes near the Kansas River valley, though small areas were also found in a similar position along some of the smaller streams and on the tops of hills.

The prevailing topography is gently rolling, and the soil does not differ materially in this respect from that of the typical Shelby loam.

The Shelby loam, light phase, is of glacial origin, being derived from the weathering of the Kansan till. It has probably been subjected to more or less reworking since its formation, as it is usually deeper than the heavier soil. It is well drained on the surface, and the loose, friable subsoil allows the free movement of water. It is easily eroded, and not infrequently deep gullies are formed, large quantities of soil being carried away by each rain.

The loose, mellow structure of the soil makes tillage easy, and it can be worked much sooner after a rain than can the typical soil. This is important, in that more moisture can be conserved for the use of the growing plants through cultivation. The phase is not as strong as the typical soil.

Alfalfa does well on the light phase after it has become inoculated, and the production of this legume should become more general, as the deep roots of the plant tend to hold the soil particles

together and prevent erosion. Corn also does well, but yields less than on the typical loam. Sorghum attains a good growth and yields a sirup of good quality. The phase is better adapted to fruits than the typical soil, and a few apples of large size and good flavor are produced. Peaches also should do well, though their culture is restricted to a few trees around the farmsteads.

Several small areas of true Shelby sandy loam are found in the county, and these are included with this phase. They differ from the light phase only in the size of the particles composing the soil. Their productiveness is almost identical with that of the finer-textured type. The extent of the sandy loam areas, however, is so small that they could not be mapped separately on the scale used. They were included with the Shelby loam, light phase, rather than with the typical Shelby loam. The Shelby loam, light phase, is valued at about $55 an acre.

SHELBY STONY LOAM.

The Shelby stony loam is one of the most variable types in the area. It includes those areas of the glacial soils which, on account of the prevalence of glacial bowlders disseminated throughout the soil section and scattered over the surface, can not be cultivated successfully. The fine earth of these areas ranges from a silt loam or loam to a gravelly loam. To an average depth of 8 inches the type consists of a chocolate-brown silt loam to loam containing varying quantities of glacial stones ranging in size from coarse gravel to large bowlders. Below 8 inches the soil grades into a reddish-brown to brown clay loam, the clay content of which increases rapidly with depth. The color of the deeper subsoil usually becomes lighter. At 36 inches the material is usually a reddish-yellow to yellow clay or heavy clay loam. As with the soil, the subsoil contains varying quantities of quartz gravel and bowlders of varying size.

The topography is steep, the type usually occupying hills or the slopes near streams. The largest area is located in Monmouth Township, southeast of Tevis, though other smaller areas are found in the county, mostly south of the Kansas River and near the southern extremity of glaciation.

The type is of glacial origin, being derived from the Kansan till. The drainage is good, though not excessive. Part of the type supports a growth of small oaks, hickory, elm, and black walnut, though originally it was prairie. The larger part of it is in grass and used for pasture.

Areas of the type could be reclaimed for cultivation by removing the stones and bowlders, though the most gravelly areas are of such

small agricultural value as to make reclamation unprofitable. In many places the gravel is used for road-building purposes.

BOONE FINE SANDY LOAM.

The Boone fine sandy loam, to a depth ranging from 6 to 12 inches and averaging about 10 inches, consists of a dark, slightly reddish brown to chocolate brown lose, fine sandy loam, underlain by a reddish-brown to reddish-yellow fine sandy loam of slightly heavier texture. Both soil and subsoil are loose and friable, with a rather floury feel, due to the presence of large quantities of mica. In places the bed rock is encountered in boring at about 15 inches and is seldom more than 4 feet from the surface. Small iron concretions occur throughout the soil section.

The largest area of the Boone fine sandy loam occurs in Dover Township, with other small areas in various parts of the county.

The type is derived from a fine-grained, micaceous, red or reddish-brown sandstone, occurring in this strata interbeded with shale and limestone. In Dover Township the rock overlies the limestone and shale, capping the ridge that forms the highest land in the county. Its elevation at this point is about 1,500 feet. The only other exposures of any importance are in Soldier Township, southeast of Elmont, where outcrops occur on the sides of hills at elevations between 950 and 1,050 feet. In the latter case the sandstone is below the same bed of limestone which underlies the first-named area.

The topography is rolling. Erosion is very marked, because of the loose, fluffy structure of the type, and gullies of considerable depth dissect the areas, giving a topography of well-rounded hills and knobs of slightly greater elevation than the adjacent valleys. Although numerous outcrops of the sandstone giving rise to this soil occur in many places in the county, they are, except in the areas referred to, of little importance in the formation of the soil.

The drainage of the type is well established and in places where the country rock is near the surface is even excessive. The topography insures good surface drainage and the loose nature of the soil and subsoil allow the rapid downward movement of water. Where the rock lies near the surface crops suffer from drought. The loose, sandy nature of the soil makes its cultivation practicable over a wide range of moisture content.

A large part of the type is deficient in organic matter, which can best be supplied by applications of stable manure or the plowing under of legumes. These coarse organic materials should be incorporated as deeply as possible in the soil, the looseness of which demands more frequent applications than would a heavier type.

Much of the type is in grass, though some corn is produced. The latter yields about 20 bushels and wheat about 10 bushels per acre. Prairie grass hay yields on the average about one-half ton per acre. The Boone fine sandy loam is one of the best upland soils for market-garden crops, though it is not utilized for this purpose. On the deeper phases of the type peaches should do well.

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

Mechanical analyses of Boone fine sandy loam.

Number.	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.*
380927	Soil	0.1	0.2	0.8	37.1	13.4	26.2	22.0
380928	Subsoil	.5	.7	1.1	43.2	11.7	22.0	20.7

CRAWFORD SILTY CLAY LOAM.

The Crawford silty clay loam is a limestone soil. It consists of from 8 to 10 inches of dark brownish-gray to dark-brown heavy silty clay loam, underlain by a brownish-red clay loam, which at 12 to 15 inches grades into a red clay loam. At about 24 inches the clay content increases and at lower depths the subsoil is a red, plastic, and sticky clay. Except for the red color of the subsoil, the type very much resembles the Summit silty clay loam, being granular in structure and rather mellow, which makes it easily tilled. Flat limestone blocks are scattered over the surface and smaller fragments of limestone and chert are disseminated through the soil section. Lime concretions are frequently found in the soil and subsoil.

Most of the type is developed at a lower elevation than the Summit silty clay loam, though some areas occur at a greater elevation. The range in elevation is from 1,000 to 1,100 feet above sea level. The topography is rolling, the type occupying gentle slopes and narrow ridges. The parent limestone rock is frequently struck in boring at depths of 24 to 36 inches.

The type is usually well drained, though the subsoil is rather too heavy for the free percolation of water. When wet the soil is sticky and plastic, but when exposed to the action of air and frost it breaks down into a crumbly, mellow seedbed. There is no tendency to wash or gully. The type is usually well supplied with organic matter and seems to withstand drought well.

The area of the Crawford silty clay loam is small, owing to the fact that the shales which overlie the limestone have played a more important part in the formation of the soil than the limestone, with

the result that the purely limestone residual soil is not widely developed.

Its largest development is on the lower slopes of hills and on the gentle slopes to the stream valleys. In either case the steeper slopes are composed of shales, which are less resistant to erosion. Occasional areas of Crawford silty clay loam cap the tops of hills. These are usually rough, with limestone fragments scattered over the surface and the limestone rock lying close to the surface, usually within 36 inches.

The largest area of Crawford silty clay loam is in Tecumseh Township, though a large tract also occurs in Auburn Township.

The Crawford silty clay loam is devoted almost wholly to pasture. Some areas are mowed. It is a good corn soil and wheat does well. The yields obtained are about the same as for the Summit silt loam.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Crawford silty clay loam:

Mechanical analyses of Crawford silty clay loam.

Number.	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.*
380915	Soil	0.0	0.2	0.4	1.3	3.9	67.6	26.5
380916	Subsoil	.0	.3	.5	.7	4.0	49.2	45.5

OSAGE SILT LOAM.

The Osage silt loam consists of 10 inches of a dark-brown or somewhat grayish brown loose silt loam, containing a large quantity of very fine sand, resting on a subsoil of slightly lighter color and more compact structure, which becomes heavier in texture with depth. At 36 inches this grades into a light-brown, heavy loam, compact when first exposed but breaking down into a mealy, crumbly loam when worked between the fingers. The subsoil also contains varying quantities of very fine sand.

The type occupies the first bottoms along the smaller streams. Its largest development is along Mission, Wakarusa, and Shonganunga Creeks and their tributaries. Although subject to frequent overflow, the porous nature of the soil and subsoil permit of rapid drying out and the soil is soon ready for cultivation. Where the bottom is broad the Osage silt loam is usally bordered by the Oswego silty clay loam, which rises a few feet above the general level of the bottom.

The drainage for a bottom soil is good, though some areas occur that are deficient in this respect. The soil is easily tilled and ordi-

narily maintains its loose, crumbly structure, though when wet it tends to clod slightly.

The type is alluvial in origin. It was originally wooded, and portions of it still support a timber growth, though the larger part is under cultivation. Corn, the leading crop, yields about 40 bushels per acre. Alfalfa is also important and good stands are easily maintained. Some wheat is also produced.

Osage silt loam, colluvial phase.—The Osage silt loam, colluvial phase, consists of a dark-brown to black loam about 14 inches in depth. While the subsoil is very often seen to be a dark-brown, dark-drab, or black loam, there is usually not much change in color or texture between the soil and subsoil, though the tendency is toward a somewhat lighter color and greater compactness as the depth increases. In nearly all instances the line of demarcation between the two was indistinct.

The type is colluvial in origin and varies somewhat in the different parts of the area according to the texture and origin of the soils on the adjacent higher elevations. The topography is almost level, with a slight slope upward away from the streams. Areas of this soil occupy a position next to the local drainage channels and are found in all parts of the country. Where the stream bottoms are overflowed the type gives way to one of the alluvial soils.

The cropping system depends entirely upon the system employed on the higher adjacent areas. When plowed the type is subject to erosion and frequent deep gullies are everywhere seen. Otherwise it is easily tilled and produces fair yields of corn, wheat, and grass. Most of the phase is in grass for both mowing and pasture purposes. Because of the small areas in which it occurs, no representative value can be put upon it.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Osage silt loam:

Mechanical analyses of Osage silt loam.

Number.	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.*
380908	Soil	0.0	0.1	0.4	8.1	16.5	51.9	23.0
380909	Subsoil	.0	.0	.2	4.9	15.8	51.7	27.2

OSAGE SILTY CLAY LOAM.

The Osage silty clay loam to an average depth of 8 inches consists of a heavy, black silty clay loam, underlain by a heavier, more compact, plastic silty clay loam or silty clay usually of uniform black

color, though occasionally at about 28 inches the subsoil changes to a dark-drab color.

The type occupies the lowest position in the Kansas River bottoms, and is well developed along some of the larger streams coming from the north. Cross Creek and Big Soldier Creek bottoms are made up of this type. In the Kansas bottom the type follows the local drainage channels and is best developed at the outer edge of the bottoms near the upland. Although its position is lower than the other bottom types, the difference in elevation is not marked by terraces, but the slope is an almost imperceptible one. For this reason there is a zone of gradation from the Osage silty clay loam to the Osage very fine sandy loam. The type is almost level, with a very slight slope to the stream. It is alluvial in origin.

The Osage silty clay loam is subject to frequent overflows from the creeks along which it is developed, but only in extreme instances is it overflowed by the Kansas River. Cross Creek and Big Soldier Creek frequently overflow their bottoms, often delaying the sowing of crops or injuring those already planted. Drainage is necessary and on most of the type some system is in use. Tile and stone drains are used to some extent, but are not as common as the open ditch or furrow. Tile drains are recommended above all others as they not only carry off the surplus water, but are advantageous in improving the structure of the soil and subsoil. Attempts have been made to keep out the overflow water by dikes, but these have been more or less unsuccessful as they do not regulate the seepage water. Several community drainage systems are in operation, the largest of which is known as the Rossville Ditch. It consists of a main ditch about 10 feet deep, beginning just east of Rossville and extending to Big Soldier Creek near the point where that stream enters the Kansas Valley. Laterals are run into all sections of the poorly drained areas. While this system is efficient in removing the surface water it should be supplemented by tile drains.

Where well drained the Osage silty clay loam is an excellent corn soil and it also gives good yields of wheat and alfalfa. Corn averages 60 bushels per acre, wheat 35 bushels, and alfalfa 1 ton per cutting. Many areas, however, are too wet for alfalfa, and in such locations even corn and wheat would be benefited by artificial drainage.

Although the soil and subsoil are heavy and can not be worked when the moisture content is high, when exposed to the action of air and frost they break down into a friable condition closely resembling the buckshot structure. For this reason it is preferable to plow deeply for corn in the fall and expose the soil to frost during the winter. One successful farmer plows for corn late in October. For wheat the land is usually plowed as soon as the preceding crop has been removed. Much plowing for this crop is done in July. The

crop is sown about the middle of September. Yields of over 40 bushels per acre have been secured. Red clover is sometimes sown with wheat in the spring and is better than alfalfa on this soil. Two cuttings a year are made for four years and crops of seed are not unusual at the second cutting.

Although the type is naturally rich in organic matter it is desirable where fields are long in cultivation to grow leguminous crops and to turn under the entire growth occasionally in order to maintain the supply. The presence of organic matter in the soil tends to keep it open, favoring the free movement of water and air and preventing the soil running together, cracking, and baking. Experience has shown that crop yields are considerably increased also by deep plowing. In dry seasons the surface soil has a tendency to crack when not sufficiently cultivated. It seems to hold moisture well when a proper mulch is maintained.

The type was originally wooded with oak, elm, hickory, black walnut, cottonwood, ash, and box elder.

Land of this type of soil is valued at $70 to $150 an acre, the drainage conditions being the important factor controlling the price.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Osage silty clay loam:

Mechanical analyses of Osage silty clay loam.

Number.	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.*
380925	Soil	0.0	0.2	0.2	0.8	5.8	61.4	31.5
380926	Subsoil	.0	.3	.4	.7	3.2	70.3	25.0

OSAGE VERY FINE SANDY LOAM.

The Osage very fine sandy loam comprises a large part of the bottom land along the Kansas River. It consists of a loose, very fine sandy loam of brownish-gray to grayish-brown color and an average depth of 12 inches, resting upon a more compact and somewhat heavier very fine sandy loam of brownish-drab color, becoming lighter in color with depth. The color of the soil is darker where the content of organic matter is large. Occasionally the subsoil is slightly mottled with yellow, though this is not typical. A variation occurs in areas adjacent to the river, where there is a dark or almost black stratum in the subsoil. This layer appears at a depth of about 12 inches and consists of a somewhat heavier, very fine sandy loam, grading at about 10 inches into a light-drab, loose, very fine sandy loam. The presence of the darker layer can best be explained by a

later deposition of surface soil and the incorporation of vegetation existing at the time of deposition as organic matter in the subsoil.

Another variation occurs directly south of the confluence of Big Soldier Creek with the Kansas River in Menoken Township. Both soil and subsoil in this case are slightly darker in color and somewhat more compact than is typical and the texture of each is slightly finer. This is probably caused by the incorporation of finer material brought down by Big Soldier Creek during times of extremely high water, when it overflows the river bottom. Where the two currents meet some of the finer soil particles in suspension are deposited. This soil here, however, differs from the larger proportion of the type, not so much in the size of the soil particles as in their arrangement. Both soil and subsoil are compact and approximate a loam, though a large quantity of very fine sand is revealed upon close examination.

The Osage very fine sandy loam occupies the highest elevations in the Kansas bottom. Though there is a slight difference in elevation between the several types in the bottom, the change is usually a gradual one, and it can not be said that each type occupies a distinct terrace. The terraces are not continuous nor well defined, and where they are discernible they appear to have little effect on the soil.

The Osage very fine sandy loam is of alluvial origin, the material having been deposited from suspension in water. The topography is level to slightly undulating. Small hummocks and mounds sometimes occur, on which the soil is more sandy. The drainage is good, though not excessive.

The Osage very fine sandy loam is the most highly valued soil in the area, ranging in price from $125 to $200 an acre, according to the location. An annual rental of $12 an acre is paid for land of this type for use in the production of nursery stock.

Nursery stock is one of the most important products of the type. Its natural fertility and the ease with which it is cultivated makes it especially desirable for the production of seedling trees. However, the clean and constant cultivation required soon exhausts the supply of humus in the soil and impairs its physical condition. This should be guarded against by the application of stable manures or the plowing under of green manures, consisting of leguminous crops, such as cowpeas, red clover, etc. Irish potatoes have always been an important crop on the type, though their production has not developed in this county as in other counties. Early Ohio is the favorite variety. Yields of 300 bushels of potatoes per acre have been secured, though for all years 150 bushels is about the average. Sweet potatoes also do well, and yields as high as 400 bushels have been reported, though this figure is somewhat above the average. Alfalfa does exceptionally well and a great deal of the type is sown to this crop. Five cuttings in good years are not unusual, and ordi-

narily four cuttings are secured. One ton per acre per cutting is a fair average for the type.

Much of the Osage very fine sandy loam is devoted to corn, and though some of the heavier types are better adapted to this cereal, good yields are secured. Fifty bushels per acre is about the average. This yield could be increased by seed selection and the adoption of a systematic rotation designed to maintain the organic content of the soil. Market-garden crops of all kinds are produced and large yields are annually obtained. Cabbage and tomatoes receive the most attention, though cantaloupes and watermelons are also grown in large numbers. Sorghum is grown to a small extent and a high-grade sirup is made from it. Some wheat is also grown, though the yields are less than on the heavier types.

Irrigation is not practiced, though private plants would be very advantageous, especially for the highly specialized industries. The topography and the looseness of the soil and subsoil make the type especially suited for irrigation. Water could be pumped from the river over nearby lands at a very small cost, while water can be obtained by means of wells in all places at a very shallow depth. Small centrifugal pumps driven by gasoline motors are probably best suited to private irrigation systems. For larger areas more expensive plants would be necessary. Irrigation is not at all needed in normal seasons, yet in extremely dry summers the loss occasioned by the deficiency of moisture during the growing season would in many instances pay for an irrigation system.

The soil is rapidly becoming depleted in humus, and crop rotation with a view to restoring the supply of vegetable matter to the soil is especially urged. This is particularly necessary on land that has been under intensive cultivation for a number of years. The physical condition of the soil is also becoming impaired in these cases and is best corrected by the restoration of the supply of humus.

Originally the type supported growths of oak, hickory, elm, black walnut, ash, cottonwood, and sycamore.

OSAGE VERY FINE SAND.

The Osage very fine sand consists of 20 inches of loose, incoherent, light-brown, light-gray, or yellowish very fine sand, underlain by a loose very fine sand or light very fine sandy loam of light color. The subsoil may vary from almost white very fine sand to a yellowish-gray or grayish-brown, loose, light very fine sandy loam. The color of the surface soil varies with the organic content. Areas under cultivation, where the supply of organic matter has been maintained or increased, are light-brown in color and of loamy structure. The larger part of the type, however, is very light and blows badly when left uncovered.

The type has a hummocky topography, caused by the action of wind. It occupies a position adjacent to the river at about the same elevation as the Osage very fine sandy loam. It supports a light growth of cottonwood and willow, and portions in Rossville Township have lately been set to hardy catalpa.

Market-garden crops are the most important of those grown on the type, especially sweet potatoes, watermelons, and cantaloupes, the latter being of excellent flavor. Asparagus is grown successfully for market and yields large returns. Cabbage and tomatoes are also grown. Some corn and alfalfa are produced, though the type is too light for best results with these crops.

The drainage of the type is good and in places even excessive. Irrigation could be carried on successfully for market-garden crops, as the largest areas of the type occur near the river and within the sharp bends. It is alluvial in origin and subject to only occasional overflow. It is valued at about $40 an acre.

Maintaining the humus content is the most important factor influencing crop production on the type. Being of a loose and leachy nature, the organic matter is soon exhausted, and green crops of leguminous plants should be plowed under deeply about every fourth year. This will have a tendency to hold the soil against the action of wind and change its structure until it more closely resembles the fine sandy loam. The water-holding capacity of the soil is greatly increased by organic matter, and this effect alone is of great importance in the successful production of crops on the type.

SUMMARY.

Shawnee County is located in northeastern Kansas. It has an area of approximately 540 square miles, or 345,600 acres.

The surface features have been developed by erosion and are influenced by the relative hardness of the sandstone, shale, and limestone which form the country rock. In general the topography is undulating to rolling, with rougher areas in the limestone country. North of the Kansas River the topography has been modified by glaciation.

The county is drained by the Kansas River and its tributaries.

The first settlement was at Uniontown in 1848. This town ceased to exist, however, after a few years, and Auburn, Tecumseh, and Topeka became the important cities.

The present population of the county is 61,874. Topeka, the capital of the State, is located in the county and has a population of 43,684. Rossville, with a population of 1,576, is next in size.

There are 116 miles of railroad in the county. Lines of the Union Pacific, the Chicago, Rock Island & Pacific, the Atchison, Topeka & Santa Fe, and the Missouri Pacific cross the county.

Topeka and Kansas City are the chief markets of the area.

The climate is distinctly humid and adapted to all general farm crops.

The crops grown in the area, named in the order of their importance, are corn, prairie hay, nursery stock, alfalfa, potatoes, kafir, wheat, orchard products, oats, sorghum, and millet. Corn is the main crop and is almost all fed to stock. Prairie hay is marketed in Topeka as a money crop. Apple seedlings are sold mainly outside the county. Potatoes are largely marketed in Topeka and in favorable years shipments are made from the county. Alfalfa has lately become an important crop and is grown extensively, especially in the bottoms. Oats are grown chiefly for grain, though some are thrashed. Sorghum is grown by some of the farmers for the manufacture of sirup. Some sirup is marketed. Millet is grown principally for the feeding of cattle.

No rotation of crops is in general practice. Rotation of crops, with the introduction of legumes, is especially urged.

Land rents for $3 to $12 an acre and values range from $40 to $200 an acre.

Eleven types of soil were mapped in the county. These are glacial, residual, alluvial, or colluvial in origin.

Summit silty clay loam is the predominating type and occupies rolling topography. It is adapted to corn, wheat, and grass. The Oswego silt loam and Oswego silty clay loam are deficient in drainage. They are derived from a black shale, occupy level topography, and are adapted to corn, alfalfa, wheat, and grass.

The Shelby loam and its light phase are of glacial origin and occupy rolling topography. They are general farming soils, corn and alfalfa doing especially well on them. The Boone fine sandy loam is a residual soil derived from sandstone.

The Summit silty clay loam, heavy phase, and the Crawford silty clay loam are heavier soils, occupying rolling topography, adapted to corn and the general farm crops.

The Osage very fine sandy loam is an alluvial soil occurring in the river bottom. On it is developed the nursery stock industry, and corn, alfalfa, and potatoes do exceptionally well.

The Osage silty clay loam is a heavy bottom soil, frequently overflowed. When well drained it is a good corn soil. The Osage silt loam occurs along the larger creeks and is a good corn and alfalfa soil. The colluvial phase of the Osage silt loam borders streams and draws.

The Shelby stony loam and the stony phase of the Summit silty clay loam are too rough for cultivation, but form good pastures.

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[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Apriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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