Soil Survey

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Allen County Kansas

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UNITED STATES DEPARTMENT OF AGRICULTURE
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Kansas Agricultural Experiment Station

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SOIL SURVEY OF ALLEN COUNTY, KANSAS

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United States Department of Agriculture, Bureau of Chemistry and Soils, in Cooperation with the Kansas Agricultural Experiment Station

COUNTY SURVEYED

Allen County is in the southeastern part of Kansas (fig. 1). Iola, the county seat, is about 100 miles southwest of Kansas City, 45 miles west of the Missouri-Kansas line, and 65 miles north of the Kansas-Oklahoma line. The county is almost rectangular in shape, measuring 21 miles north and south and 24 miles east and west. The area is 502 square miles, or 321,280 acres.

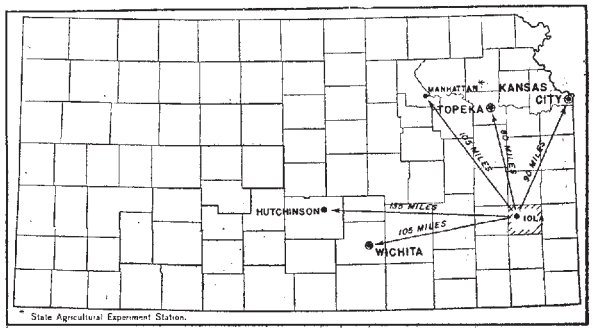


FIGURE 1.—Sketch map showing location of Allen County, Kans.

Physiographically, Allen County consists of a smooth to gently undulating prairie with few outstanding differences in relief. The surface is indented with a number of flat stream valleys that in most places are bordered by gently sloping or rolling land. Most parts are reached by streams, and the land in general is well drained. The principal divide, known as the Ozark divide, extends from northwest to southeast through the eastern part. This divide, as well as the minor divides between the smaller streams, includes considerable areas of flat land, and some of the larger streams are bordered by flat terrace benches lying from 5 to 20 feet above the present flood plains. The more rolling and hilly country, which includes low hills and some steep sloping areas, is in the extreme northeastern part of the county in the drainage basin of Little Osage River, in the southeastern part in Elsmore Township, and in the northwestern part in eastern Geneva Township. Figure 2 shows the general physiographic divisions.

In a few places along the larger streams, low bluffs of rock outcrop, and steep stony ridges occur in a few localities, especially in T. 25 S., R. 18 E.; T. 24 S., R. 17 E.; and T. 24 S., R. 18 E. Elevations in most sections range from about 925 to 1,100 feet above sea level. The elevation[1] at Iola in the western part at the edge of the

[1] GANNETT, H. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U. S. Geol. Survey Bull. 274, ed. 4, 1072 pp. 1906.

Neosho River Valley, is 962 feet; at Moran in the eastern part, 1,110 feet; 3 miles west of Moran on the divide, 1,050 feet; at Humboldt in the southwestern part, 961 feet; at Geneva, in the northwestern part, 1,012 feet; and at Savonburg, in the southeastern part, 1,058 feet.

Neosho River flows through the western part from north to south, in a shallow valley through flat bottom land ranging from three-fourths mile to 2 miles in width, and drains most of the county. The principal tributaries within the county are Owl, Martin, Deer, Elm, Coal, Big, and Canville Creeks. Much of the land in the eastern part is drained into Osage River through two smaller streams, Little Osage River and Marmaton Creek.

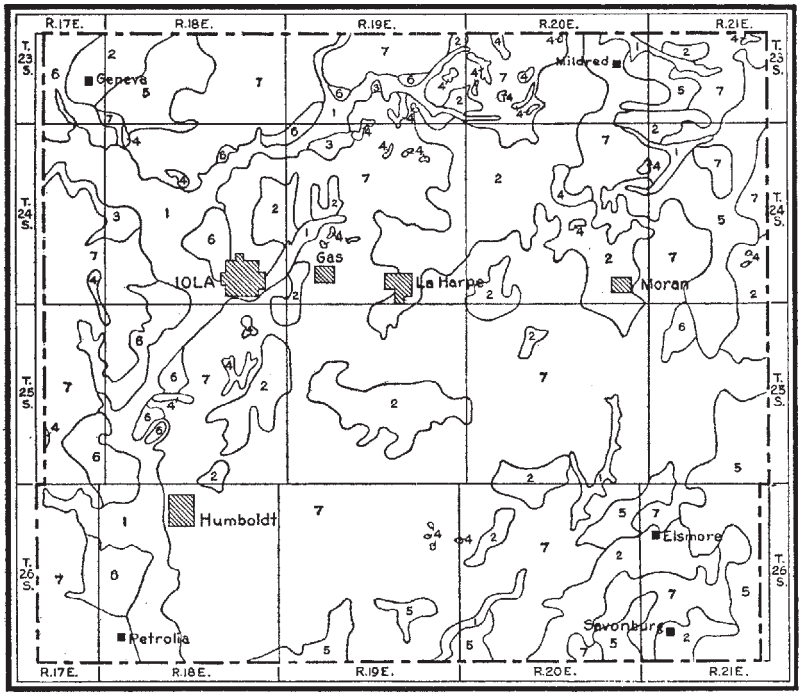


FIGURE 2.—Physiographic divisions of Allen County, Kans. (1) Flat flood plains, (2) smooth almost flat uplands, (3) rolling and sloping land, (4) ridges and knolls, (5) gently rolling uplands, (6) flat terraces bordering streams, and (7) undulating land.

The native vegetation on the upland prairie of this county consists almost entirely of bluestem grasses (*Andropogon* sp.), and the land also supports small quantities of buffalo and grama grasses. On some of the thinner and stony soils, pricklypear, a few shrubs, and small trees, including sumac, haw, and a few black oaks and post oaks, grow in a scattered stand. Originally the smaller stream bottoms were covered with elm, oak, cottonwood, ash, boxelder, sycamore, papaw, and a few pecan trees, but most of these have been cut for timber, and the cleared bottom lands are now in cultivation. On many farms, transplanted trees, largely elm, cottonwood, locust, and maple, are grown for shade and windbreaks. Many Osage-orange

trees line the roads and fields, as these were grown extensively as hedge fences by the early settlers.

A few people settled in Allen County as early as 1855, but the county did not become very thickly settled until railroads were built through it in 1870 and 1871. The 1930 census reports the population of the county as 21,391, of which 54.5 percent, or 11,673, was classed as rural. The average density of the rural population in that year was 22.9 persons a square mile. The population classed as urban, that is, people living in towns of more than 2,500 inhabitants, amounted to 9,718 persons in 1930. Most of the early settlers were Americans from States farther east, principally Missouri, Illinois, Iowa, Tennessee, and Kentucky. Norwegians settled in the southeastern part in the vicinity of Savonburg and Elsmore.

Since the early settlement, agriculture has been important. The principal crops grown in the early days were corn, oats, wheat, and hay. About 80,000 acres were devoted to these crops in 1879. Agricultural development has been rapid. The production of many crops has continued to be generally successful throughout the entire history of the county, and the same crops have been grown in different proportions during the last two or three decades, but, during the last few years, more attention has been given than formerly to the production of grain sorghums and other forage crops.

Iola, the county seat and principal town, is an important city and marketing center. Smaller towns, which have from one to several hundred inhabitants and comprise local trading and shipping points, are Humboldt, Moran, La Harpe, Elsmore, Savonburg, Gas, Mildred, Petrolia, Bayard, Geneva, and Carlyle.

Transportation facilities are very good. A main line of the Missouri-Kansas-Texas Railroad traverses the eastern part of the county, a branch line extends from Moran to Iola, and another passes through the southwestern part. An important line of the Missouri Pacific Railroad extends from east to west through the central part, and a line of the Atchison, Topeka & Santa Fe Railway traverses the western part from north to south. No farms are more than 10 miles from a shipping point. There are several well-paved highways, and an excellent system of graveled county and township roads extends into all parts. Practically all farms are within 2 miles of a graveled road.

The principal market for livestock and other farm products is Kansas City, though some are marketed in Fort Scott and Topeka, Kans., and in Springfield and Joplin, Mo. The towns and industrial centers within the county afford markets for considerable quantities of the food products of the local farms.

Important industries, other than farming, include the manufacture of cement in plants at Iola and Humboldt and of brick and tile in the same general localities. At one time these industries were more prominent and, with the operation of zinc and lead smelters near Iola, afforded employment to a large number of workmen. Their decline is attributed to the decline in the production of natural gas in the immediate vicinity. Considerable quantities of oil and gas are produced in some parts of the county and, although the wells have declined to a rather low production, they continue to furnish

some income to the landowners and producers. A number of pipe lines cross the county, and there are several oil and gasoline tank stations in the county. A large milk company, which manufactures condensed milk and an ice-cream mix, has a plant at Iola. This plant and the number of creameries and milk-shipping stations afford a market for the large quantity of milk produced and sold. Allen County has a larger number of milk cows a square mile than any other county of southeastern Kansas.

The towns and rural sections are amply supplied with schools and churches. A very good high school and a junior college are at Iola.

Good water is obtainable in wells in most parts, but in some sections it is obtained only from very deep wells. Water for livestock is provided on many farms by constructing reservoirs in small gullies and depressions.

CLIMATE

The climate is temperate, although the seasonal variation throughout a period of years is considerable. The winters are moderate, with a mean temperature of 34.3° F., but the range is from −18° to a maximum of 80°. Short periods of very cold weather occur, but otherwise the cold is not severe. The springs are cool, with occasional warm days, but the summers are hot and long. Hot winds during July and August cause some damage to crops, especially to corn when it is in a critical condition of fruiting, and sometimes they cause very great injury and reduction in yield.

Although the county lies within the humid section of the United States and has an average annual rainfall of 38.08 inches, the amount of rainfall varies from year to year, resulting in excessive moisture at times or inadequate moisture at other times for the successful production of crops. As a rule, most of the rainfall occurs during the growing season, from April to September, inclusive, when the average is 26.01 inches. Some of it falls as heavy torrential downpours and causes considerable loss through run-off and erosion. The annual snowfall averages 15.7 inches.[2]

Occasional high winds during the spring cause some slight drifting of the soil, although, as a rule, they do no serious damage to crops. Injury to field crops from early or late frosts is uncommon. Occasional seasons occur in which spring planting of crops is delayed because of excess moisture in the soil, and this causes the crops to mature so late that they are injured by early frosts. The average date of the latest killing frost is April 7 and of the earliest is October 23, giving an average frost-free season of 199 days. The latest recorded killing frost occurred on May 4 and the earliest on September 26.

[2] The total rainfall tends to give a wrong impression of the amount of moisture available for plants, as most of the soils have characteristics that practically place them in a section having less rainfall. The heavy claypan layer in some soils prevents the maximum absorption of moisture, consequently, a large proportion of the rainfall during the years of greater precipitation is lost; and the structureless condition of the soils and their tendency to compactness accelerates evaporation. These two factors produce an effect equivalent to that produced under a drier climate.

Table 1, compiled from records of the United States Weather Bureau station at Iola, gives the normal monthly, seasonal, and annual temperature and precipitation for Allen County. Figure 3 shows the average distribution of normal precipitation.

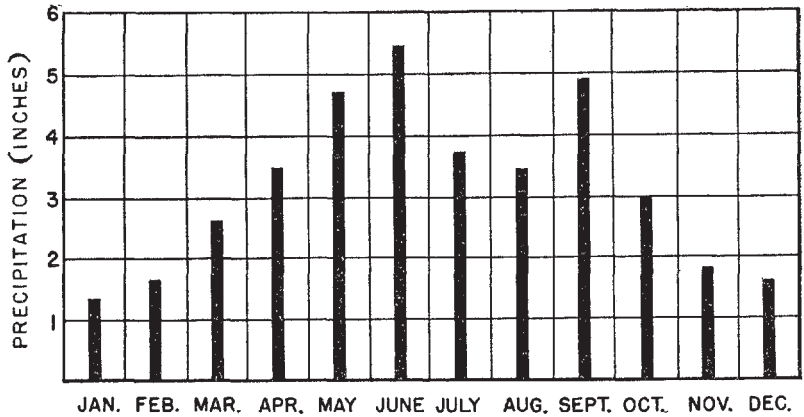


FIGURE 3.—Graph showing the distribution of the normal precipitation, by months, in Allen County, Kans. Data compiled from a 50-year record at the United States Weather Bureau station at Iola, Kans., by D. M. Braun, then county agricultural agent.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Iola, Allen County, Kans.*

[Elevation, 984 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1936)	Total amount for the wettest year (1915)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	34.4	70	−8	1.30	1.68	1.12	2.6
January	32.1	72	−18	1.33	1.08	2.14	3.5
February	36.3	80	−9	1.47	.24	4.26	4.8
Winter	34.3	80	−18	4.10	3.00	7.52	10.9
March	45.1	94	1	2.59	.18	2.25	3.1
April	56.3	92	18	3.90	.29	5.56	.4
May	64.9	98	28	4.74	4.36	7.77	.0
Spring	55.4	98	1	11.23	4.83	15.58	3.5
June	74.7	105	44	5.28	.83	8.56	.0
July	79.4	105	49	3.60	1.56	6.07	.0
August	78.4	107	44	3.64	.74	5.05	.0
Summer	77.5	107	44	12.52	3.13	19.68	.0
September	71.0	104	32	4.85	7.77	13.22	.0
October	58.3	92	18	3.16	2.33	1.00	.9
November	46.1	83	7	2.22	1.25	.31	.4
Fall	58.5	104	7	10.23	11.35	14.53	1.3
Year	56.4	107	−18	38.08	22.31	57.31	15.7

AGRICULTURAL HISTORY AND STATISTICS

The early settlers devoted themselves chiefly to the growing of subsistence crops, and to the raising of cattle on the luxuriant growth of bluestem and other grasses of this section. The Civil War, however, caused the development of the county to remain almost dormant until about 1870, when railroads were built and new settlers rapidly arrived. Following the increase in population, the production of farm crops became the principal agricultural activity.

The census of 1880 reported 1,520 farms in the county, with an average size of 144 acres, of which 77.6 acres were classed as improved land. At that time about 81,000 acres were used for crop production, including 24,636 acres of hay and forage crops, which consisted chiefly of native grass. As only one-fourth of the land was used for farm crops, of which 45,809 acres were in corn, the raising and feeding of cattle were important agricultural enterprises. About 5,000 acres each of wheat and oats were reported in 1879. Orchard and garden products for that year were reported as having a value of about $16,000, and they were no doubt used almost entirely on the farms.

The earlier settlers produced beef cattle for the market, but this enterprise has declined gradually, especially in the last 25 years, and at present dairy cattle are much more important. The 1930 census shows that the ratio of cows and heifers kept for milk production to cows and heifers kept for beef, or dual-purpose cattle, is about 5 to 1. This increase in dairying has accompanied an increase in the production of alfalfa and the growing of sweetclover for pasture. Dairy farms are rather uniformly distributed throughout the county. The census shows the value of dairy products sold in 1909, 1919, and 1929 as $132,349, $337,136, and $721,593, respectively. The principal breeds of dairy cattle are Holstein-Friesian, Jersey, and Guernsey, and the beef cattle are mainly Hereford and Shorthorn. The 1935 census reports 12,527 cows milked in 1934, 4,602,550 gallons of milk produced, and 141,933 pounds of butter made on farms.

During the same period, the raising of poultry has shown an increase paralleling that of dairying, and the 1930 census shows that poultry and poultry products valued at $524,559 were sold in 1929. The 1935 census reports 212,920 chickens on farms on January 1 of that year, and 351,992 chickens were raised and 1,363,932 dozens of eggs produced in 1934.

Swine are kept on most farms, and many farmers feed a few hogs for sale. A few farmers make a practice of buying hogs or cattle and feeding them the surplus corn. The number of hogs fed for the market is governed largely by the prevailing prices of corn and pork. Poland China, Duroc-Jersey, and Chester White are the principal breeds of hogs. The 1935 census reported 11,194 swine on the farms on January 1 of that year.

Table 2 gives the acreage of the principal crops grown, as recorded by the Federal census for the years 1879, 1889, 1899, 1909, 1919, 1929, and 1934.

TABLE 2.—*Acreages of the principal crops grown in Allen County, Kans., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	45,809	85,635	96,429	77,981	35,482	56,487	47,952
Oats	4,960	10,580	4,070	4,966	21,780	13,475	20,839
Wheat	4,886	1,966	4,640	14,156	53,944	13,601	18,550
Flax	-------	13,023	17,463	2,886	3,407	7,543	17,590
Sorghums for grain	-------	-------	2,077	5,825	7,561	15,763	965
Potatoes	-------	910	590	893	438	286	248
Broomcorn	-------	855	-------	774	316	379	-------
Hay and forage	24,636	56,951	50,275	46,560	52,756	44,323	54,400
Timothy and clover	-------	-------	-------	14,572	2,447	3,153	507
Clover	-------	-------	2,708	897	235	1,311	494
Alfalfa	-------	-------	146	579	4,433	4,180	4,938
Other tame grasses	-------	-------	9,666	876	765	505	-------
Wild grasses	-------	-------	33,395	28,304	29,845	23,710	[1] 27,220
Grains cut green	-------	-------	333	76	451	182	1,600
Legumes for hay	-------	-------	-------	-------	65	548	1,595
Sorghums for forage	-------	-------	201	1,256	-------	2,820	19,546
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples	-------	96,098	175,368	92,353	12,387	11,051	9,783
Peaches	-------	44,257	30,565	39,908	12,736	6,856	8,572
Pears	-------	-------	-------	4,576	3,093	3,106	3,371
Plums	-------	-------	-------	7,171	2,391	1,966	858
Cherries	-------	-------	-------	4,908	4,184	1,031	1,456
	Vines	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*
Grapes	-------	-------	81,110	37,684	13,478	13,043	9,381
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Strawberries	-------	-------	17	19	16	41	-------
Blackberries	-------	-------	20	51	10	12	-------

[1] Includes other tame grasses.

A study of table 2 shows that since 1909 no extreme or radical changes have taken place in the relative importance of the principal crops grown. A few changes have taken place, however, some of which show a recognition of the influence of soil characteristics on successful crop production. The chief adjustment is the increase in the acreage of grain sorghums and the decrease in the acreage of corn. This indicates that the farmers recognize that the claypan soils are better suited to the production of grain sorghums than to corn. The acreages of these crops probably will show further adjustment as the acreage of the recently introduced soybean is increased. Soybeans were grown on 2,318 acres in 1934. The radical differences in the acreages of the different crops shown in 1919 were due to the World War. The decrease in the production of flaxseed probably was due to flax wilt, but with the introduction of wilt-resistant varieties and better soil and farm management, flax is again becoming an important crop. The increase in the acreage of alfalfa, from 579 acres in 1909 to 4,938 acres in 1934, also indicates a readjustment and parallels the increase in dairy products.

Corn always has been the principal crop. Most of the corn is grown on the soils of the stream flood plains and on the permeable soils of the upland. The acreage of corn has decreased gradually since 1899, but oats have shown a considerable increase in acreage in the last 15 years. Wheat also has shown a corresponding increase. Most of the wheat is grown on land bordering the Neosho River Valley and in the section extending southeast and east of Iola. Most of the flax is grown in the central part of the county, and broomcorn

is grown principally in the southeastern part in the vicinity of Elsmore and Savonburg. Grain sorghums are grown almost entirely on the claypan upland soils. The hay crops include various tame grasses, but wild grasses occupy over half the acreage devoted to these crops and alfalfa ranks second.

The common tree fruits are grown on many farms for home use, and the surplus is sold locally. There are only two or three small commercial orchards. The most important small fruits are blackberries and strawberries. The principal truck crops are tomatoes, sweet corn, cabbage, lettuce, snap beans, asparagus, cantaloups, and watermelons. These are produced near the larger towns and in the vicinity of Leanna.

The 1935 census reports 165,356 acres of land from which crops were harvested in 1934, and on 4,310 acres crops were a failure. The same census classes 202,279 acres, or 62.2 percent of the county, as available for crops.

On a few farms some income is obtained from the sale of timber products. Those farms having areas of bottom lands in forest sell some timber as sawlogs or have the timber cut by small portable mills and sell the lumber. Most of it is used as bridge flooring or in the construction of frame buildings. An increasing number of farmers are removing the Osage-orange hedgerows bordering their fields. These trees make excellent posts and are used for that purpose. The part not usable for posts is cut into firewood. The surplus of posts and wood above the needs of the farmers is sold.

Commercial fertilizers are not used extensively, but the amount is increasing. The use of crushed limestone for land in alfalfa and sweetclover is rather common and is increasing rapidly. The limestone is purchased from the local quarries and from quarries in surrounding counties. Most of the commercial fertilizer purchased is superphosphate. The 1930 census reports that 264 farmers spent $14,514 for lime and commercial fertilizers in 1929 and that 220 farmers used 472 tons of commercial fertilizers.

Most of the farm labor is obtained locally or from western and southern Missouri. In general, labor is hired only during the periods of crop production. The census of 1930 shows that 798 farmers reported the hiring of labor in 1929, with an average cost of $156.47 a farm reporting. Much of the necessity for hiring labor is avoided during the harvest season because the farmers exchange labor and the use of teams.

A study of the census records from 1880 to 1930, inclusive, shows that the number of farms, percent of the county area in farms, average size of farms, percent of improved land in farms, and acres of improved land on each farm have not shown any radical changes since 1890. The 1930 census shows a total of 1,958 farms. The same census gives a total area of 300,131 acres in farms, of which 171,654 acres were used for crops and 111,576 acres were in pasture. About 55,177 acres of the pasture land was plowable. These figures give a total of 226,831 acres that could be used for crops, or an average of 115.7 acres a farm. Of the 1,958 farms, 36.4 percent included less than 100 acres, and about 50 percent ranged from 100 to 260 acres in size. Most of the farms were between 100 and 175 acres, and four contained more than 1,000 acres each. The average size of

farms was 153.3 acres in that year. The 1935 census reports 2,166 farms, with an average size of 141.3 acres.

In 1930, owners operated 55 percent of the 1,958 farms; tenants, 44.8 percent; and managers, 0.2 percent. Of the 878 tenants, 250 paid cash rent and 628 gave a share of the crops as rent. The 1935 census reported that tenants operated 1,041 farms, or 48 percent of the 2,166 farms in the county.

The usual price for cash rent is $2 an acre for good land and less in proportion, according to productiveness. Pasture land rents for $1 or $1.50 an acre. Under a cash-rental system the tenant usually furnishes everything. On farms where the landlord furnishes land and seed he also pays one-half of the threshing bill. On a crop-rent basis the landlord receives from one-third to two-fifths of the crop as rent. Some farmers rent on the half-and-half basis, the landlord furnishing land, equipment, livestock, and seed for the first year. After the first year the seed comes from the crop, and the increase in livestock is shared half and half, the original herd remaining in the landlord's possession. After the first year all the feed produced on the farm is fed to the livestock.

Most of the farms in this county are well supplied with fair to good buildings. According to the 1930 census, the average value of land and buildings was $7,253 in that year. The value of the land was $5,458 and the value of the buildings, including dwellings, was $1,795. The same census reports that 1,954 automobiles were owned by farmers, 167 motortrucks, 509 tractors, 505 stationary gas engines, and 76 electric motors for farm work. Telephones were reported by 1,354 farmers, 278 had water piped into the house, and 177 farmhouses were lighted by electricity. Mowers, binders, plows, harrows, corn planters, cultivators, grain drills, and wagons are common equipment. Many farmers own manure spreaders, hay rakes, hay stackers, and silage cutters, and a small number own threshers. The 1930 census gives the average value of farm machinery as $470.78 a farm. Most farms are well fenced. The Osage-orange hedges used by the early settlers as fences are gradually being replaced by wire fences.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [3] and its content of lime and salts are determined by simple tests.[4] Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

[3] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[4] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics, soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. In places, two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a map, but must be mapped as (4) a complex. Areas of land, such as coastal beach or bare rocky mountain sides that have no true soil, are called (5) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics, and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first recognized. Thus, Verdigris, Osage, Labette, and Summit are names of important soil series in this county.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Verdigris very fine sandy loam and Verdigris silt loam are soil types within the Verdigris series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS[5]

The soils of Allen County are smooth Prairie soils of fairly deep development and moderate productiveness, but rather large areas of stream-bottom soils are highly productive. The soils are grouped, on the basis of their characteristics and agricultural adaptability, into four broad groups, as follows: (1) Soils of the alluvial flood plains, which include Verdigris very fine sandy loam, Verdigris loam, Verdigris silt loam, Verdigris silty clay loam, Osage silt loam, Osage silty clay loam, and Osage clay; (2) Prairie soils having permeable subsoils, including Labette silt loam; Labette silt loam, shallow phase; Labette silt loam, cherty phase; Summit silty clay loam; Summit silty clay loam, shallow phase; Summit clay; Newtonia silt loam; Bates very fine sandy loam; Bates very fine sandy loam, deep phase, and Riverton silt loam, slope phase; (3) Prairie soils with dense very slowly permeable subsoils, including Woodson silt loam; Woodson silty clay loam; Parsons silt loam; Parsons silt loam, cherty-subsoil phase; Parsons very fine sandy loam; and Neosho silt loam; and (4) soils and land types generally better suited for pasture than for cultivation, including Labette stony clay loam, Riverton silt loam, Summit stony silty clay, Newtonia stony loam, Summit-Bates complex, rough stony land (Summit soil material), riverwash, and waste land. The last three land types have little true soil development.

The systems of agriculture practiced have developed largely according to the general suitabilities of the soils to crops and with regard to the economic factors that determine the markets for the products of the farms. By far the greatest acreage is devoted to corn and other feed crops, much of which are used on the farms and locally for feeding dairy cattle, farm work animals, and some beef cattle. In addition to the income from the feed crops, some of which may be marketed outside the county, some cash crops, consisting of wheat, oats, broomcorn, flax, and truck crops, are grown, and considerable farm income is derived from the sale of dairy and poultry products and small numbers of beef cattle raised on a few farms.

The principal feed crops are corn, oats, grain sorghums, and sorgo. Grain and forage for feed from these crops are supplemented by hay crops from native grasses, alfalfa, timothy, clover, and sweetclover. Corn and alfalfa are grown largely on the Verdigris and Osage soils—the alluvial soils—on which, owing to their favorable moisture condition, yields are highest. Although these crops generally are more successful on the bottom lands, occasional injury and loss are caused by overflows. Corn and alfalfa are also grown successfully, but with generally lower yields, on the Prairie soils, of which the best suited to these crops are the deeper and smoother soils of the Labette, Summit, and Newtonia series. The grain sorghums and sorgo give high yields on the alluvial soils and smooth Prairie soils with permeable subsoils, but owing to the drought-

[5] A few small areas of soils along the eastern, western, and southern county lines do not join with similar soils in the earlier and less detailed soil surveys of Bourbon, Woodson, and Neosho Counties, respectively. For instance, Parsons very fine sandy loam in Allen County adjoins areas mapped as Parsons silt loam in Neosho County, and areas of Bates soils in the northern part of Allen County adjoin areas of Labette soils in Bourbon County.

resistant qualities of these crops, they are grown largely on the claypan soils—the flat soils of the prairies.

Native-grass hay is cut from the bluestem grasses of the virgin prairies, some from soils not suited for cultivation, and a sawgrass which grows mostly in Osage clay.

Wheat and oats are the most important small-grain crops. Although these crops yield well on the alluvial soils, they are grown more extensively on the upland and terrace Prairie soils.

Flax, an important cash crop produced mainly in the central part of the county, is grown on Woodson silty clay loam and Parsons silt loam and to less extent on the Labette and Newtonia silt loams. Broomcorn, grown successfully and in quantities proportionate to the demand, is produced mostly on the silt loams of the Parsons and Labette series. Soybeans have been grown considerably of late years and do well on the claypan soils, and some are produced on many other Prairie soils.

Fruits, vegetables, potatoes, melons, and various truck crops are grown on a small scale in the home orchards and gardens, and the surplus products are marketed locally. These crops do well on many of the well-drained alluvial soils and on Prairie soils with friable subsoils. The soils of lighter texture are the most suitable for these crops.

In the following pages the soils of Allen County are described in detail, and their agricultural relations are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in Allen County, Kans.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Verdigris silt loam	14,464	4.5	Woodson silt loam	50,496	15.7
Verdigris silty clay loam	6,272	2.0	Woodson silty clay loam	4,160	1.3
Verdigris very fine sandy loam	256	.1	Parsons silt loam	57,920	18.0
Verdigris loam	320	.1	Parsons silt loam, cherty-subsoil phase	1,920	.6
Osage clay	7,424	2.3	Parsons very fine sandy loam	13,056	4.1
Osage silty clay loam	2,240	.7	Neosho silt loam	9,344	2.9
Osage silt loam	2,176	.7	Labette stony clay loam	7,296	2.3
Labette silt loam	37,184	11.6	Riverton silt loam	3,072	1.0
Labette silt loam, shallow phase	6,080	1.9	Newtonia stony loam	3,840	1.2
Labette silt loam, cherty phase	7,232	2.3	Summit stony silty clay	10,048	3.1
Riverton silt loam, slope phase	1,088	.3	Summit-Bates complex	1,088	.3
Summit silty clay loam	42,624	13.1	Waste land	128	.1
Summit silty clay loam, shallow phase	2,560	.8	Riverwash	320	.1
Summit clay	1,088	.3	Rough stony land (Summit soil material)	64	(1)
Newtonia silt loam	6,976	2.2	Quarries	128	.1
Bates very fine sandy loam	15,296	4.7			
Bates very fine sandy loam, deep phase	5,120	1.6	Total	321,280	

[1] Less than 0.1 percent.

SOILS OF THE ALLUVIAL FLOOD PLAINS

The soils developed from alluvial materials are deep permeable soils, most of them well drained and in cultivation, and they are, on the whole, very productive and considered valuable farm land. Although at times crops are damaged considerably by overflows, the high inherent fertility and favorable soil-moisture condition of these soils

make them valuable for the production of crops, and they are rather intensively farmed. These soils are well suited to all the crops commonly grown. Differences in productiveness and in suitability for certain crops result from differences in soil texture, drainage, and moisture-holding capacity. These soils are used largely for the production of corn and alfalfa, because these crops are very susceptible to a deficiency of moisture and find on these deep soils of excellent moisture-holding capacity the most favorable environment for their growth. Many other crops are grown also.

The soils of this group are brown, dark gray, or black, and, although not calcareous, they are not strongly acid in reaction. Two series, the Verdigris and the Osage, are represented by a number of soil types. Soils of both are developed largely on sediments from upland Prairie soils. The Verdigris soils comprise brown well-drained soils consisting of soil materials washed from Prairie soils and underlain in places by thin layers of sandy and clayey materials. These soils originally were forested. The Osage soils are very dark gray or black, are not so well drained, and are developed largely under a prairie cover.

These soils, which are widely distributed along the stream bottoms, cover an area of 33,152 acres. They are very largely in cultivation. Originally they supported a heavy forest growth of elm, oak, cottonwood, and boxelder. Grasses grew in the open spaces.

Verdigris silt loam.—Verdigris silt loam has a 10-inch surface soil of brown friable silt loam. It grades into yellowish-brown or brown friable silty clay loam which, in places, contains thin horizontal layers of very fine sand and silt below a depth of 2 feet, accompanied by some faint gray mottlings. Plant roots penetrate readily to a depth of several feet, where they find a large feeding area, In places in the bottom land along Deer and Little Deer Creeks the surface soil dries to a somewhat gray color, and in places it is underlain by a rather dense heavy clay subsoil. The soil as mapped includes areas of heavier and lighter textured soil that are too small to show separately.

This is one of the most extensive alluvial soils in the county. It occurs in the flood plains along most of the streams, the larger areas lying along Neosho River, Deer Creek, and Little Deer Creek. The land in general is flat, but in places along old shallow stream channels it is slightly undulating and gently sloping. Although the land is subject to occasional overflows, both surface and internal drainage are good, and the crops grown produce high yields.

Probably 90 percent of this soil is in cultivation. The principal crop is corn which yields from 20 to 50 bushels an acre and averages about 35 bushels. Wheat is grown to a considerable extent and produces an average acre yield of about 17 bushels, and oats yield about 35 bushels. Excellent and fairly constant yields of alfalfa, grown without lime or fertilizer, are 3 or 3¼ tons. Therefore this soil probably ranks highest for this crop in the county.

Verdigris silty clay loam.—Verdigris silty clay loam is an important agricultural soil in the Neosho River flood plains. It differs from Verdigris silt loam chiefly in that it is of heavier texture throughout. The surface soil is brown or dark-brown friable and slightly granular silty clay loam, ranging from 8 to 14 inches in thickness, which grades below into yellowish-brown or light-brown

silty clay loam or, in places, clay. At a depth of about 24 inches the color is yellowish brown with, in places, a few pale-gray mottlings which become more pronounced and numerous with increase in depth. At a depth ranging from 24 to 30 inches, the subsoil is underlain by strata of very fine sand and silt in places. As in the silt loam, plant roots penetrate readily throughout the soil mass and establish large feeding areas.

Verdigris silty clay loam has smooth relief and, in most places, lies slightly lower than Verdigris silt loam. Both internal drainage and surface drainage are good, but crops sometimes are damaged during overflows.

The total area of Verdigris silty clay loam is 6,272 acres, and probably 95 percent of the soil is in cultivation. Although adapted to all the locally grown crops, corn, wheat, alfalfa, and oats are the chief crops produced. Average yields are about the same as those obtained on Verdigris silt loam. Two large commercial apple orchards are located on this soil about 8 miles northwest of Iola, and some truck crops are grown successfully in the vicinity of Iola.

This is a valuable soil of about the same character as Verdigris silt loam, with about the same productive capacity, but, owing to its heavier texture and less free drainage, it is less easily cultivated and worked than the lighter textured and better drained silt loam soil.

Verdigris very fine sandy loam.—The 10- to 15-inch surface soil of Verdigris very fine sandy loam is brown very fine sandy loam. It grades into friable yellowish-brown very fine sandy loam or silt loam, which in places contains faint gray mottlings. Thin layers of silt, very fine sandy loam, or even finer textured material occur in many places below a depth of 2 feet. Small unmappable areas of Verdigris silt loam are included.

Verdigris very fine sandy loam occurs in some of the stream bottoms. The largest areas are just west of Humboldt in the flood plain of Owl Creek, and smaller bodies are in the flood plain of Neosho River southwest of Iola. The total area of this soil is very small. The soil occupies the higher elevations of the smooth bottom land, chiefly along present or old stream channels, and drainage is comparatively good, although the land occasionally is overflowed. Included with this soil in mapping are two small areas in section 6 of Logan Township, 1½ miles west of Humboldt. These areas differ from the typical soil chiefly in that they occupy a low-terrace position.

Most of Verdigris very fine sandy loam is in cultivation, and the same crops are grown, with about the same or slightly lower yields, as are grown on Verdigris silt loam. This soil probably is somewhat better suited to early preparation and planting than are the less well drained and heavier soils of the stream bottoms. It is used largely for the production of vegetables for local markets.

Verdigris loam.—The surface soil of Verdigris loam is brown or dark-brown friable loam from 12 to 18 inches thick. This grades into yellowish-brown or light-brown friable loam or clay loam which extends to a depth of several feet, In places gray mottlings occur in the subsoil below a depth of 2 feet, and in places below this depth are stratified layers of sand and silt loam.

This soil is of small extent. The principal areas are in the stream bottoms in sec. 20, R. 18 E., T. 26 S., and sec. 29, R. 18 E., T. 24 S.

The land is farmed in conjunction with larger areas of other Verdigris soils, and the crops grown and yields obtained are approximately the same as those on Verdigris silt loam.

Osage clay.—Osage clay is an agriculturally important soil and the second most extensive alluvial soil in the county. The surface soil consists of black clay ranging in thickness from 4 to 12 inches. When wet it is very sticky, but on drying it crumbles naturally to small subangular particles which give a friable surface layer in cultivated fields. The material in this layer grades into very dark gray or black clay which is compact when dry but sticky and plastic when wet. Below a depth ranging from 15 to 34 inches, the subsoil grades into gray or dark-gray heavy clay which is plastic and sticky when wet. The soil material becomes gradually lighter in color with increase in depth, and brown or yellowish-brown mottlings occur in most places throughout the subsoil. Both surface soil and subsoil are slightly acid in reaction. The surface soil appears to have a large content of organic matter, and in places the black clay is 3 feet thick. Although the surface soil and subsoil consist of heavy clay, this is of such physical character that plant roots penetrate it readily and establish a well-developed root system.

Practically the entire area of Osage clay is in the Neosho River bottoms. The largest bodies are northwest of Iola and southwest of Humboldt.

Osage clay comprises the finer soil materials washed largely from dark Prairie soils, such as those of the Summit series and similar soils in southeastern Kansas. This soil occupies the lower flat or slightly depressed bottom lands, and much of it is adjacent to the higher upland slopes. Internal drainage is slower than in the Verdigris soils, owing to the heavy subsoil. Surface drainage is fairly good, although in places it is slow, and occasionally water remains for some days after overflows. A native sawgrass grows extensively in places and is cut for hay, yielding from 1½ to 1¾ tons an acre.

Much of the land is in cultivation, but it is difficult to handle, and, unless plowed or cultivated under optimum moisture conditions, the material forms large clods if too dry or sticks to the plow if too wet. When worked at the proper stage of moisture content, the material breaks into fine particles and produces a friable seedbed.

The principal crop grown is corn which, according to local reports, yields an average of about 30 bushels an acre. The average acre yield of wheat is about 17 bushels and of alfalfa 3 tons, but very little alfalfa or oats are grown on this soil, probably owing to the unsatisfactory drainage or unfavorable physical condition of the soil for alfalfa and to the rank growth and lodging of oats. During very dry periods of summer, when this soil becomes thoroughly dry, cracks from 2 to 3 inches wide develop. This condition is more noticeable in the virgin soil than in cultivated fields.

Osage silty clay loam.—The surface soil of Osage silty clay loam consists of a 14- to 20-inch layer of moderately friable and granular heavy black or very dark gray silty clay loam. It grades below into a layer of dark-brown, black, or dark grayish-brown clay which extends to a depth of 3 feet, or deeper. In places, at a depth of 30 inches, it grades into dark-gray plastic clay. The soil has a high organic-matter content, and plant roots readily penetrate it. One

area along Rock Creek north of Gas has a browner surface soil and subsoil than most of the soil. A few small areas contain some sand in the surface soil and approach a clay loam in texture. Such an area is at Union School 2 miles west of Iola.

The larger areas of this soil are in the flood plains of Neosho River, and Rock, Deer, and Big Creeks, the largest being 2 miles northwest of Iola in the Neosho River flood plain. The total area of Osage silty clay loam is not large. This soil lies at a slightly higher elevation than Osage clay, and the relief is almost flat. Internal drainage ranges from good to fair, and surface drainage is good. As a rule, drainage of this soil is better than that of Osage clay.

About 70 percent of this soil is in cultivation. Corn and wheat are the principal crops, and alfalfa and oats are grown to a slight extent. Yields are about the same as or higher than those obtained on Osage clay, but the crops occasionally are damaged by floods. Osage silty clay loam is not so difficult to cultivate as is Osage clay.

Osage silt loam.—The surface soil of Osage silt loam is dark-brown or black friable silt loam extending to a depth ranging from 12 to 18 inches. This grades into a brown silty clay loam subsoil which extends to a depth of 36 or more inches. In places pale-gray mottlings appear below a depth of 30 inches. This soil has a high organic-matter content and a slightly acid reaction. Roots can penetrate the soil readily and range through a large feeding area.

This soil occurs in the flood plains of most of the larger streams. The total area is small. The largest body lies along Marmaton Creek in the eastern part of the county.

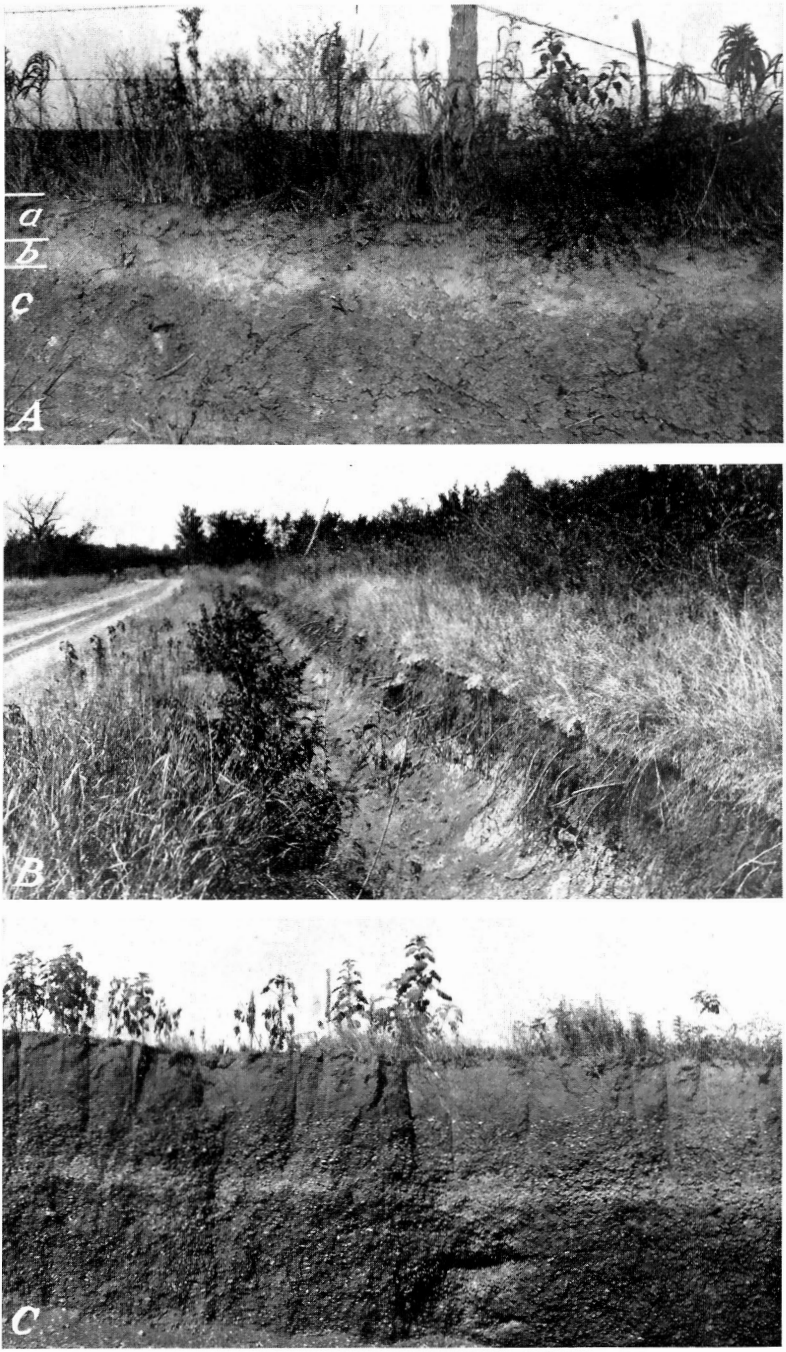
The relief in general is smooth, but, along some old stream channels, the land is sloping. Both surface and internal drainage are good, although crops are apt to be damaged occasionally by floods.

Originally this soil was forested with oak, hackberry, elm, and some papaw, but at present probably from 80 to 90 percent of it is in farm crops. It is considered an excellent soil for the production of corn, and most of it is used for that crop. Wheat and alfalfa are grown to some extent. The yields obtained are about the same as those obtained on Verdigris silt loam.

PRAIRIE SOILS HAVING PERMEABLE SUBSOILS

The second group of soils includes the Prairie soils having permeable subsoils. The dominant members of this group rank next to the alluvial soils in value for agricultural use. These soils are fairly dark colored, ranging from nearly black to brown or reddish brown, and most of them occupy smooth well-drained situations. For the most part, these soils are not sufficiently sloping to cause rapid run-off, although in places more advantageous collection and retention of rain water in the soil are provided by proper systems of farm management. These soils are well suited to all the crops commonly grown, and most of them range from moderately to highly productive. The soils range texturally from fine sandy loam to clay, but most of them are silt loams and silty clay loams.

The dominant soils of this group are fairly well suited to the growing of corn and alfalfa, and much is grown. Some of the soils, although well suited to corn and alfalfa, are sufficiently sloping to allow rapid run-off or percolation of rain water and are so shallow that



A, Profile of Parsons silt loam: *a*, Surface soil; *b*, subsurface soil; *c*, clay pan subsoil. *B*, Development of Osage-orange roots above the clay pan of Parsons silt loam. *C*, Profile of Riverton silt loam.

insufficient moisture is absorbed and retained for the best production of these crops. Soils of this group are used largely for the production of wheat, oats, grain sorghums, sorgo, clovers, flax, and broomcorn. These are extensive soils, and many of the farms on which they occur are well improved and highly productive. Small orchards and home gardens, from which the surplus products above home requirements are marketed locally, indicate that the principal soils of the group can produce good yields of fruit and truck crops.

This group includes members of the Labette, Summit, Newtonia, and Bates series. The Labette soils are dark-brown Prairie soils developed from limestone and have smooth to undulating relief. The surface soils are underlain by heavy brownish-red or red crumbly subsoils which, at a depth ranging from 2 to 3 feet, contain some gray mottlings. These soils are neutral to slightly acid in reaction. The Summit soils comprise dark Prairie soils developed from limestone. The surface soils are black or very dark brown, and the subsoils are heavy dark-brown or gray clay which is more or less granular. These soils are not calcareous nor are they of acid reaction. The Newtonia soils have dark brownish-red or red surface soils underlain by subsoils of red crumbly clay. These soils differ from the Labette soils in having a more red color, less organic matter, and more readily permeable and crumbly subsoils which are moderately friable. These soils are neutral to slightly acid in reaction. The Bates soils are dark Prairie soils developed from sandstone or sandstone and shale. The sandy members have sandy subsoils that are very permeable. These soils are not calcareous and probably range from slightly acid to acid in reaction.

Labette silt loam.—The surface soil of Labette silt loam consists of brown to dark reddish-brown friable granular silt loam ranging from 10 to 14 inches in thickness. This material grades into lighter reddish brown granular silt loam, a few inches thick, which, in turn, grades into silty clay loam extending to a depth ranging from 20 to 26 inches. Below this, to a depth of more than 3 feet, the subsoil is red or brownish-red clay which, in places, contains pale-gray mottlings. The material in this layer does not, as a rule, have the decided granulation of the overlying material and is more plastic. The organic-matter content is rather high, and root penetration is easy. Both surface soil and subsoil are slightly acid.

The surface soil shows considerable variation in color and depth. In slightly depressed areas or where the land receives surface wash, the color is black and the soil is thicker and heavier than elsewhere. Most of such areas are associated with areas of Summit silty clay loam, and some occur near Elm Creek between La Harpe and Moran. In places the surface soil is reddish brown and resembles the Newtonia soils in color, but such areas were included with Labette silt loam because of a more plastic, less granular lower subsoil layer, as in areas northwest of Leanna. In places small areas of Labette silt loam, shallow phase, and Newtonia silt loam were included in areas mapped as Labette silt loam, because of their small size and indistinct development. Areas of Labette silt loam bordering the Bates soils have a noticeable quantity of very fine sand in the surface soil.

Labette silt loam occurs throughout various sections of the county, but most of it lies in that section encompassed by a line extending from

Humboldt to Mildred, thence south to Moran and Leanna and west to Neosho River. The total area is 37,184 acres, or 11.6 percent of the total land area of the county.

The relief ranges from smooth or very gently sloping to undulating. The parent material from which this soil has developed is derived mainly from limestone, but in a few small areas evidently some sandstone materials are included. Internal and surface drainage are good except in a few depressed situations at the heads of small imperfectly developed drainageways. The native vegetation is largely big bluestem.

Labette silt loam probably is adapted to a wider range of crops than is any other upland soil. All the common crops are grown on it, and practically all the land is under cultivation. It is recognized as especially well suited for the production of corn, alfalfa, and sweetclover. Corn is probably the predominant crop, yields of which average about 25 bushels an acre. Wheat ranks next in acreage, and yields average about 18 bushels an acre. Grain sorghums average about 20 bushels, oats 30 bushels, sweetclover 5 bushels of seed, sorghums about 10 tons of silage, and alfalfa from 2 to 3¼ tons. Most areas of Labette silt loam become favorable for tillage earlier in the spring than most of the other upland soils, except those of the Bates and Newtonia series, and planting is not greatly retarded by wet spring seasons. Plowing for crops is done both in the fall and spring.

Sheet erosion occurs on some of the steeper slopes during the heavy spring and fall rains when the ground is bare, but as a rule, erosion is not severe. Wind erosion also does some slight damage by blowing and drifting the soil when the ground is bare. Areas of lighter colored soil are most subject to this kind of erosion. Almost all the erosion can be prevented by contour cultivation and by the growing of cover crops which reduce the period of exposure to a minimum.

Labette silt loam, shallow phase.—The 6- to 10-inch surface soil of Labette silt loam, shallow phase, is dark-brown or almost black friable granular silt loam. It is underlain, to a depth ranging from 12 to 18 inches, by lighter brown granular silty clay loam. Below this depth, the subsoil grades into a brownish-red friable clay which, in places, contains some yellowish-gray mottlings, limestone fragments, or both. The parent limestone rock generally is reached at a depth ranging from 24 to 36 inches. This rock occurs as solid beds or as broken fragments of stone embedded in fine earth which extends to a depth of more than 3 feet. The normal soil contains a comparatively high proportion of organic matter. It is slightly acid in the upper layers and slightly acid or neutral in the subsoil. A few stones are on the surface in places. Roots readily penetrate this soil to the parent rock, where their downward progress is limited to the interstices between the rocks. Concretions of calcium carbonate occur in places in the material just above the parent rock.

Small areas of this soil are associated with areas of Labette silt loam. The larger areas are from 4 to 6 miles north of Gas, 7 miles north of Iola, and in the vicinity of Carpenter School 6 miles northwest of Iola. The total area is 6,080 acres.

The relief ranges from smooth to slightly undulating, and both internal and surface drainage are good. As the soil is shallow, it has but a slight storage capacity for water, and much of the soil water is lost by downward seepage through the broken rock material.

About 60 percent of the land is in cultivation. The principal crops grown are corn, wheat, sorghums, alfalfa, and sweetclover. In seasons of ample and well-distributed rainfall crops do very well, but in most years yields are reduced because of insufficient moisture. Crops requiring large quantities of moisture are more seriously damaged by drought, and drought-resistant crops should be planted more extensively.

Labette silt loam, cherty phase.—The surface soil of Labette silt loam, cherty phase, is dark-brown or dark reddish-brown friable granular silt loam about 10 inches thick. It grades into the subsoil of light-brown or reddish-brown granular silt loam or silty clay loam, which, below a depth ranging from 16 to 20 inches, passes into friable brownish-red or red crumbly clay containing yellow or gray mottlings and, in places, a few iron concretions. At a depth ranging from 22 to 36 inches the subsoil rests on a mass of angular chert fragments. The difference in depth to the chert material is as much as 18 inches within a horizontal distance of a few feet. In places where the soil is deepest a thin layer of grayish-yellow and brown mottled crumbly clay is just above the chert. This layer is less pronounced in areas in which the chert lies near the surface, and only a trace of it exists in places where the chert is within 2 feet of the surface. The soil contains a moderate amount of organic matter. Root penetration is fairly easy through the soil and even through the clay which fills the spaces between the chert fragments.

The principal areas of Labette silt loam, cherty phase, are in the southeastern and northeastern parts of the county, within the watersheds of Marmaton and Canville Creeks and tributaries of Osage River. A few small areas are within the watershed of Big Creek. The total area is 7,232 acres.

The relief ranges from slightly undulating to rolling. The parent material from which this soil has developed is derived from cherty limestone. The native vegetation consists largely of big bluestem.

About 20 or 25 percent of the soil—the shallower areas—is in meadow or is used as pasture. The principal cultivated crops are corn, grain sorghums, and sweetclover. Yields are somewhat less than those obtained on Labette silt loam, but they are better and more certain than those obtained on Labette silt loam, shallow phase. This is because clay fills the spaces between the chert fragments and affords a good reservoir for soil moisture. This soil dries and has good tilth early in the spring.

Riverton silt loam, slope phase.—The 4- to 10-inch surface layer of Riverton silt loam, slope phase, consists of gray friable silt loam. The subsurface layer is lighter gray silt loam which continues to a depth ranging from 12 to 24 inches. Reddish-brown mottlings and iron concretions occur in this layer. They are more numerous in the lower half of the layer and give the surface soil a brownish-gray color when they become mixed with the soil material. The subsoil, to a depth ranging from 30 to 36 inches, is reddish-brown slowly permeable clay. Below this the material is gray-brown and yellow mottled heavy crumbly clay. Both surface soil and subsoil are decidedly acid.

This soil has developed in the valley of Neosho River on the outer edges of the high river terraces on which soils of the Neosho series

have developed and is essentially better oxidized Neosho silt loam. The areas are small. The largest bodies are in sec. 21, T. 24 S., R. 18 E., 2 miles northwest of Iola. Others are in secs. 8, 9, 16, 17, 29, T. 25 S., R. 18 E., and T. 26 S., R. 18 E. The total area is not large.

The relief is sloping or slightly undulating. Surface drainage is good to excessive, and internal drainage is fair. The native vegetation consists chiefly of big bluestem.

In section 8 of Iola Township, 3½ miles southwest of Iola, an area mapped with this soil has a brown surface soil and a brown or reddish-brown friable subsoil, and in places the lower subsoil layer consists of interbedded layers of loam, silt loam, and fine sandy loam. This area has a profile similar to that of Labette silt loam and represents a better and more productive body of this soil.

A considerable proportion of the land is used for the production of farm crops, principally corn and wheat. Corn yields about 15 bushels and wheat an average of about 12 bushels an acre. On some of the more sloping areas, considerable sheet erosion occurs, and the subsoil is exposed. Crops produce low yields on most areas of this soil. Measures to protect the soil from sheet erosion should be practiced, and some of the narrow, steep, badly eroded areas should be kept in grasses or planted to sown crops rather than to intertilled crops which do not afford adequate protection from erosion.

Summit silty clay loam.—The surface soil of Summit silty clay loam is dark grayish-brown or black granular heavy silty clay loam from 6 to 12 inches thick. This material grades into the subsoil of granular brown, dark-brown, or black clay which, below a depth ranging from 16 to 30 inches, passes into dark-gray, yellow, or yellowish-gray plastic clay having no developed structure. Below a depth ranging from 24 to 40 inches the material is yellow and gray mottled plastic clay. Concretions of calcium carbonate associated with the yellow and gray mottled clay occur in places and seem to be more abundant where internal drainage is restricted. In places the surface soil has a decidedly gray cast when dry. The soil granules of the surface layer are roughly rounded and about the size of bird shot, and they are of practically the same character as those of Labette silt loam. The granules in the subsoil are slightly subangular, differing from those in the subsoil of Labette silt loam, which are more rounded. In the more smoothly sloping areas bordering Summit stony silty clay, the surface soil is shallowest over the dark-brown or black subsoil, but in the smoother areas or those in slight depressions, the surface soil is thicker and the color of the subsoil is grayish brown or dark gray. In practically all areas, especially the smoother ones, the subsoil shows a slight tendency to be compact or claypanlike.

The organic-matter content is comparatively high. Although the soil is heavy, plant roots seem to penetrate it rather easily. Small quantities of soft fine crystalline material, possibly calcium sulphate or magnesium sulphate, occur in places at a depth ranging from 4 to 5 feet. When wet the soil is sticky and plastic.

Summit silty clay loam occurs throughout various parts of the county. The largest areas border the south side of the valley of Elm Creek, 2 miles south of Iola, and 4 miles west of Iola. The total area is 42,624 acres.

The relief ranges from smooth or gently sloping to decidedly rolling. The greater part of the land has a slope of less than 5 percent,

but a very small part has a slope slightly exceeding 10 percent. The more sloping areas comprise low escarpments and ridges, such as those south of Iola and north of La Harpe. A few areas north of Elm Creek south of La Harpe occupy flat terracelike positions. Most of this soil has developed over fine-grained dark-gray calcareous shale, although some areas have developed over limestone.

Surface drainage in general is good, although in some depressed areas and at the bases of gentle slopes both surface and internal drainage are imperfect, and artificial drainage through open ditches is provided in places. Internal drainage ranges from fair to good but is not so good as in soils of the Labette, Newtonia, and Bates series, owing, primarily, to the heavy texture of the Summit subsoil.

Agriculturally, this is one of the best upland soils and ranks about the same as Labette silt loam. It is as fertile or more fertile, but its heavy texture has a tendency to restrict its use for some crops. From 75 or 85 percent of the land is in cultivation, and most of the remainder is used for pasture. Corn, the principal crop, yields an average of about 22 bushels an acre. A small acreage is devoted to wheat which yields an average of about 13 bushels. Alfalfa yields from 3 to 3¼ tons of hay, and sweetclover from 5 to 6 bushels of seed. In places applications of lime for sweetclover have given good results, and applications of lime and phosphorus have proved beneficial for alfalfa. Very little flax is grown on this soil.

Because of the heavy character of the soil, it is sometimes impossible to cultivate the crops properly during rainy periods, and they become weedy. Also, hay crops cannot be harvested at the proper time, because, if cut, the hay may spoil before it can be raked and stacked. In some years spring planting is delayed by spring rains, and the plants do not become sufficiently established to fully withstand the ill effects of the dry summer months, and the crops mature late.

Sheet erosion and some gully erosion occur on the more sloping areas. Much of this erosion could be eliminated by contour cultivation, and terraces would be advantageous on such areas.

Summit silty clay loam, shallow phase.—The 10- to 15-inch surface soil of Summit silty clay loam, shallow phase, is dark-brown or black granular silty clay loam. It grades into light-brown, brown, or grayish-brown crumbly friable clay which, at a depth ranging from 20 to 30 inches, rests on limestone. In the more poorly drained situations the subsoil is more distinctly gray. The soil, as a whole, has slow internal drainage, and water accumulates and seeps out in low places. The relief is sloping, and surface drainage is good, but internal drainage is only fair or poor. The soil is sticky and plastic when wet.

Areas of this soil are 1 mile southwest of Iola, 1½ miles west of Petrolia, one-half mile southeast of Carpenter School, 1½ miles east of West Liberty School, 1½ miles north of Moran, and 3½ miles northwest of Leanna.

About 80 percent of the land is used for pasture or for cutting of the native bluestem grass for hay. A small acreage is planted to corn, but yields are very uncertain and usually are low. Sweetclover seems to do well, but its chief value is for hay and pasture.

Summit clay.—The surface soil of Summit clay is black heavy granular clay ranging from 8 to 12 inches in thickness. It grades into

the slightly compact heavier black clay subsoil. This passes, at a depth ranging from 22 to 26 inches, into dark-gray sticky plastic clay containing a few brown mottlings in the lower part. Below a depth of 3 feet the material is heavy gray and yellow mottled sticky plastic clay. Some fine crystals, possibly gypsum, occur in the substratum in places.

This soil is of small extent. Two areas are mapped just south of Moran. The relief is smooth or slightly undulating, and surface drainage ranges from fair to good, but internal drainage is slow. Although the soil is fertile, most of it is in pasture, owing to the difficulty of properly cultivating the heavy soil. Small areas are used for the production of corn, and the yields obtained are about the same as those obtained on Summit silty clay loam.

Newtonia silt loam.—The surface soil of Newtonia silt loam is brownish-red or red granular silt loam 8 or 10 inches thick. It grades into red granular silt loam or silty clay loam, which, below a depth ranging from 20 to 24 inches, passes into red friable granular clay. Gray mottlings appear in places in the subsoil below a depth ranging from 26 to 32 inches. The clay subsoil rests on limestone bedrock at a depth ranging from 3 to 5 feet. This soil has an acid reaction, and the organic-matter content is medium. Roots readily penetrate the soil. In areas bordering the Bates soils the surface soil contains considerable quantities of very fine sand.

Newtonia silt loam occurs throughout the county in association with soils of the Labette and Summit series. The total area is nearly 7,000 acres, most of which is south and east of Humboldt.

This soil is developed from parent material derived from weathered limestone. The relief ranges from smooth to slightly undulating. Surface drainage is good, and internal drainage is excessive, owing to the crumbly granular structure of the entire soil mass which allows the water to percolate rapidly to the parent rock where it enters rock fissures or is lost by lateral movement. The same condition prevents the upward movement of water by capillary action.

Practically all the crops commonly grown are produced on this soil, but yields often are reduced by drought during the dry summer months of July and August. Almost all of the soil is in cultivation, as it is easily tilled and warms early in the spring. Yields of corn, one of the principal crops, average between 15 and 20 bushels an acre, wheat probably ranks second in acreage and yields 10 or 12 bushels, and yields of grain sorghum are about the same as those obtained on Labette silt loam. This soil is considered very good for alfalfa, yields of which range from 2½ to 3½ tons an acre. Sweetclover also is grown. Additions of organic matter have proved beneficial to crops on this soil, as the organic material not only increases the fertility but aids in preventing wind erosion and in conserving soil moisture.

Bates very fine sandy loam.—The surface soil of Bates very fine sandy loam is grayish-brown friable very fine sandy loam from 8 to 14 inches thick. When the soil is moist, the color is brown. The surface soil grades into brownish-yellow or light-brown friable very fine sandy loam or fine sandy clay loam. Below a depth ranging from 2 to 3 feet, the subsoil merges with the disintegrated fine-grained gray or yellowish-gray sandstone material, from which the soil has de-

veloped. In places the subsoil contains red mottlings. This soil has an acid reaction and is low in organic matter. Roots penetrate the soil and the underlying disintegrated sandstone.

In the less well drained places, or where oxidation has been retarded, the subsoil grades into yellowish-gray or yellow and gray mottled sandy clay, and in such places the sandstone parent materials generally lie at a depth ranging from 28 to 32 inches. In a few places the sandstone parent material lies below a depth of 36 inches, and in spots a claypan has developed. Small unmappable areas having sandstone fragments on the surface and in the soil material comprise a stony fine sandy loam. The soil in the area in the vicinity of Leanna is more sandy and coarse than the average and approaches a fine sandy loam in texture.

Most of Bates very fine sandy loam is on the watersheds of streams flowing south and east out of the county, with the exception of several small areas at the headwaters of Little Deer Creek. The total area is 15,296 acres. The relief ranges from undulating to strongly rolling, and both surface drainage and internal drainage are good.

About 60 percent of Bates very fine sandy loam is used for the production of crops, and the rest is used for hay or pasture. The areas in which the parent sandstone lies closest to the surface are less productive and are used principally for pasture. Grain sorghums and oats are the principal crops grown on this soil. Grain sorghums yield from 12 to 15 bushels of grain or 6 or 7 tons of silage an acre, and oat yields average about 13 bushels. Corn is grown to some extent, but the yields are comparatively low and uncertain. Broomcorn yields from 250 to 300 pounds an acre. According to reports of farmers, sweetclover can be grown only with applications of lime and phosphate fertilizers, and even then yields are uncertain. Small acreages are devoted to melons and other minor crops, especially in the vicinity of Leanna, but these crops frequently are affected by drought. Dewberries, blackberries, and strawberries should do well, as the wild dewberry seems to be indigenous to this soil. Soybeans probably would be a valuable crop for improvement of the soil.

On the more sloping areas sheet and gully erosion are pronounced and are more serious, on the whole, than on any other soil. When such areas are cultivated, farm practices should be employed that tend to prevent erosion. Some areas are so low in productivity that they should be used only for pasture and hay crops. Bates very fine sandy loam is an open porous soil that dries early in the spring and may be plowed and cultivated early.

Bates very fine sandy loam, deep phase.—The surface layer of Bates very fine sandy loam, deep phase, is grayish-brown or dark-brown friable very fine sandy loam from 6 to 12 inches thick. This grades into a subsurface layer of lighter brown or yellowish-brown friable very fine sandy loam which, below a depth ranging from 12 to 15 inches, grades into yellow or brownish-yellow loam or sandy clay, mottled with gray and brown. At a depth of about 30 inches this grades into the subsoil of grayish-yellow or brown sandy clay, containing sandstone fragments and a few iron concretions. The subsoil, at a depth ranging from 40 to 48 inches, grades into disintegrated fine-grained sandstone which constitutes the parent material. A few small areas, occurring at the upper or lower limits of some

slopes, have a rather dense clay subsoil, the result of seepage. The areas mapped on the higher elevations or divides generally are lighter in color and in texture throughout the entire soil mass, and, as a rule, the parent sandstone lies closer to the surface. This soil is decidedly acid and the organic-matter content is low, especially in the areas on the divides. Roots easily penetrate both the surface soil and subsoil.

Bates very fine sandy loam, deep phase, is associated with typical Bates very fine sandy loam. The total area is 5,120 acres. The greater part of this soil has gently sloping or undulating relief, and in most places both internal and surface drainage are good.

This soil ranks next to soils of the Summit, Labette, and Newtonia series in crop adaptation and productiveness, and probably 85 or 90 percent of the land is in cultivation. Corn is the principal crop, the average acre yield of which is between 15 and 25 bushels. Some wheat and oats are grown, but yields are moderate. Sweetclover makes good yields when lime is used, and fair to good crops of alfalfa are obtained when lime and phosphate fertilizers are used. Grain sorghums and broomcorn produce approximately the same yields as on other upland soils, except possibly on soils of the Summit and Labette series, where yields are higher. The areas on the ridges are less desirable than those on the slopes, and they are not so well adapted to the growing of corn, sweetclover, and alfalfa.

PRAIRIE SOILS WITH DENSE VERY SLOWLY PERMEABLE SUBSOILS

The third group of soils comprises the Prairie soils with dense very slowly permeable subsoils. Such soils are known technically as claypan soils or planosols. These soils are extensive and occupy smooth nearly flat areas of prairie land in all parts of the county. The surface soils are not very dark, and some of them dry to a very light color. The subsoils are dense and tough and allow water to penetrate very slowly. These soils are not high in available plant nutrients and physically are not so readily cultivated as are soils of the other groups, as in flat places they remain wet for considerable periods after rains and bake hard on drying. The physical character of these soils results in unfavorable moisture conditions in very dry weather, and they are droughty.

These soils, however, are cultivated extensively, and all the crops common to this section are grown, although only small acreages are devoted to corn and alfalfa, as these heavy soils are not well suited to those crops. A very large proportion of the crops grown on these soils are the grain sorghums and sorgo, as these crops are resistant to unfavorable moisture conditions and produce better yields on these soils than do most other crops during droughty seasons. Various other feed crops, including sweetclover, are grown on the claypan soils and yield fairly well. Wheat, oats, flax, and broomcorn are grown to some extent, and moderate yields are obtained.

Most of these soils are strongly acid in reaction throughout the entire soil mass and are low or only moderate in fertility. They have been correlated in the Woodson, Parsons, and Neosho series.

The Woodson soils are slightly undulating Prairie soils developed from deeply weathered shale, with possibly some limestone influence in places. The surface soils are gray or dark gray, and the subsoils are dense dark-gray or grayish-brown waxy clays. The surface soil

and subsoil layers are slightly darker than the corresponding layers of Parsons soil which are smooth gray Prairie soils resting on dense gray waxy subsoils mottled with brown and yellow. The Parsons soils also have developed from shale. The Neosho series includes claypan soils that have developed from old alluvium on high stream terraces lying above present-day overflows. The surface soils and subsoils are gray, and the subsoils are dense and heavy. Both surface soils and subsoils are acid. The color of the surface soil of the Neosho soil is similar to that of the Parsons soils, but the subsoil or claypan is darker than the claypan of the Parsons soils.

Woodson silt loam.—The surface soil of Woodson silt loam is dark-gray or grayish-brown heavy silt loam from 5 to 10 inches thick. When wet it is almost black. It is underlain by a 2- to 4-inch gray silty clay loam layer which rests on the subsoil—a very dark gray or almost black heavy sticky dense impervious clay which, on drying, breaks into small and fine sharply angular particles. In this heavy clay subsoil, known as a claypan, which extends to a depth ranging from 28 to 36 inches, the structure particles are larger in the lower part than in the upper part. Small brown iron stains and specks occur in places in the upper part of the claypan, and these are larger in the lower subsoil layers. Below a depth ranging from 28 to 36 inches, the material is brown or brownish-yellow and gray mottled plastic sticky clay having no structure, which is more readily crushed than the claypan material and becomes increasingly lighter colored with increase in depth. At a depth ranging from 4 to 5 feet, fine crystals, probably gypsum, are embedded in the clay. This soil has developed from a fine-grained drab shale which forms the parent material, but in places the parent material includes some limestone. It is not possible everywhere to determine the parent material, as the rock has weathered deeply.

In some of the flat and slightly depressed situations, such as those at streamheads or along small drainageways, the surface layer is thicker and darker; the subsurface layer is grayer, thicker, and more pronounced; and the claypan material is darker and extends to a depth of about 42 inches. In section 25 of Geneva Township and secs. 14 and 23, T. 25 S., R. 19 E., the surface soil is grayer than the average. The soil in these areas closely resembles Cherokee silt loam of the southeastern counties of the State. Small slightly depressed areas, known as buffalo wallows or alkali spots, in which the claypan extends to a depth of 4 feet, occur in places.

Both the surface soil and subsoil of Woodson silt loam are decidedly acid. The surface soil has a higher organic-matter content than have the other claypan soils. Root penetration is easy in the surface and subsurface layers, but the claypan is penetrated with difficulty, except along cracks which have developed during excessively dry weather, and most of the plant roots are above the claypan. Root penetration, however, is more favorable in this soil than in Parsons silt loam, probably because the transition from the surface soil to the claypan is less abrupt.

Woodson silt loam is mapped on the broad smooth slightly dissected stream divides, on gentle slopes, and on some high flats that border streams and resemble old stream terraces. The areas northwest of Iola and from 1 to 2 miles northwest of Humboldt occupy

such positions. Some areas are in the central part of the county, the largest lying northeast and south of Iola, around Gas, and northeast of La Harpe. The total area is 50,496 acres.

The land is smooth or slightly undulating. Internal drainage is only fair or inferior, and surface drainage is fair. The native vegetation is big bluestem, but only a small proportion of the land is still in bluestem, as from 85 to 95 percent of it is in cultivation. Most of the remainder is used for pasture. Locally this soil is called ashy-gray land, but it is considered a more desirable soil and one on which crops are less susceptible to drought than any other claypan soil. Wheat is one of the principal crops grown, acre yields of which average about 13 bushels. Corn also is an important crop and produces about 17 bushels, oats yield about 19 bushels, grain sorghums 21 bushels, sorgo about 10 tons of green silage, flax 8 bushels, sweetclover 4.5 bushels of seed, and alfalfa 2½ to 3 tons of hay an acre. Soybeans grow well and are becoming an important crop.

According to local information, land for wheat is fertilized with an acre application ranging from 80 to 120 pounds of 18- to 20-percent superphosphate or equivalent amounts of higher analyses. In preparing the land for sweetclover, 2 tons of ground limestone an acre are broadcast or 500 pounds used in the drill. Two tons of ground limestone (broadcast) an acre are used for alfalfa, and the addition of 100 pounds of 45-percent superphosphate or an equivalent amount of lower grade material every 2 years gives much better results.

Woodson silty clay loam.—The 10- to 14-inch surface soil of Woodson silty clay loam is dark-gray silty clay loam. The lower part, a subsurface layer 4 inches thick, is grayer and slightly heavier than the material above. It rests on the subsoil of dark-gray, dark grayish-brown, or nearly black heavy sticky plastic almost impervious clay. Below a depth ranging from 26 to 30 inches, this material grades into yellow and gray mottled plastic clay. The organic-matter content of the surface soil, degree of acidity, and ease of root penetration are about the same as those features of Woodson silt loam.

This is not an extensive soil. The largest area is 3 miles northwest of Moran. The relief is smooth or very slightly sloping. Both surface drainage and internal drainage are only fair. Probably more than 90 percent of the land is in cultivation. The crop yields and fertilizer treatments do not differ materially from those on Woodson silt loam.

Parsons silt loam.—The surface soil of Parsons silt loam ranges from 8 to 16 inches in thickness and consists of two distinct layers, an upper layer of gray or grayish-brown silt loam ranging from 6 to 12 inches in thickness, grading below into the subsurface layer which is a distinct light-gray silt loam from 2 to 8 inches thick. A laminated structure is apparent in places. Brown specks are present in most places. The surface soil is abruptly underlain by gray and brown mottled heavy dense clay—a claypan—ranging from 2 to several feet in thickness. When wet the material in this layer is very plastic, but when dry it is very hard and tough and breaks into small angular particles. The surface soil contains little organic matter, and the entire soil mass is strongly acid. Plant roots and moisture penetrate the claypan with difficulty. In cultivated fields

the surface soil packs and crusts on drying after rains, which causes excessive evaporation, and the hard crust prevents germinating plants from pushing through. The parent materials of this soil are shales and fine-grained shaly sandstones. Plate 1, *A* shows the profile of Parsons silt loam, and *B* shows the development of plant roots above the claypan.

Small local depressed spots, known as buffalo wallows or alkali spots, occur throughout many areas of this soil, mostly on flat areas or slopes having a tendency to be seepy, and in such places the claypan is from 4 to 5 feet thick. In the more undulating and better drained places, the transition from the gray subsurface layer to the claypan is gradual instead of abrupt, and the gray subsurface material has the appearance of merging with the claypan along the vertical cleavage planes or cracks. Where this occurs, the upper part of the subsurface layer is gray silt loam, and the lower part is gray and reddish-brown crumbly heavy silt loam or silty clay loam. This indicates that degradation is taking place. In slightly depressed areas, the gray subsurface layer in places is 12 inches thick, contains numerous small rounded iron concretions, and the transition from the subsurface material to the claypan is sharp and abrupt. The areas on the flat divides, within areas of Labette silt loam, have a brown surface layer with a less pronounced gray subsurface soil, and the claypan contains more red, is heavy and plastic, but apparently is not so compact and tight. The soil in these areas probably has developed, at least in part, from limestone materials.

Parsons silt loam is the most extensive soil in the county, and it occurs in large widely separated areas. The largest developments are in Geneva, Logan, and Elsmore Townships. Large areas are west and southeast of Iola, and north of Gas. The total area is 57,920 acres, or nearly one-fifth of the total land area of the county.

The relief ranges from smooth to slightly rolling. Surface drainage generally is good, but internal drainage is poor. Bluestem grasses constitute the principal native vegetation. On a large part of the more undulating areas, the native grass is cut for hay, and some is pastured.

Probably 75 percent of this soil is in cultivation. Grain sorghums, sorgo, and wheat are the dominant crops. The sorghums withstand the dry hot seasons and succeed better on this soil than do most other crops, as they remain dormant through very dry periods and resume growth when rains provide moisture. Grain sorghums yield an average of about 18 bushels of grain, or about 8 tons of silage an acre, wheat yields an average of about 12 bushels, and oats an average of about 16 bushels. Flax is grown on a small acreage and yields 5 or 6 bushels an acre. Sweetclover is not considered a reliable crop, but some excellent fields of sweetclover were noticed on this soil during the course of the survey. Liming of the soil is essential for the production of satisfactory yields of this crop. Little alfalfa is grown on this soil, but results on the State Agricultural College experimental field near Moran have proved that it can be grown successfully by using lime and phosphate fertilizers.

Corn is grown to some extent but is not a reliable crop on this soil, as the claypan restricts the necessary root development, and the soil is susceptible to droughty conditions during the dry summer months.

The hot summer winds also are detrimental to corn, especially if it is in the fruiting stage, as they sometimes destroy the pollen even when the soil contains sufficient moisture for plant development. A small acreage of broomcorn is grown and yields about 275 pounds an acre. Soybeans do well and are becoming an important crop.

Erosion, although not very noticeable on account of the smooth surface, is occurring largely as sheet erosion, especially on the more sloping areas, and to less degree on the gentle slopes. In the spring when the ground is bare and the surface soil saturated, heavy rains cause much sheet erosion. The damage is less severe if the land has been freshly tilled, but even under such conditions the damage is greater than would be suspected from casual observation. This is due to the fine texture and structureless properties of the surface soil, the first rains having a tendency to wash the finer material into the soil pores, sealing them, thus causing greater run-off and consequent erosion. The same result occurs to a greater degree if rains fall when the soil is crusted. Terraces and contour cultivation on the more sloping areas have been recommended to prevent erosion. A system of cropping to keep the land, or strips of it, protected by growing crops would doubtless prevent considerable sheet erosion.

Parsons silt loam, cherty-subsoil phase.—The surface soil of Parsons silt loam, cherty-subsoil phase, is gray or grayish-brown friable silt loam ranging from 8 to 14 inches in thickness. The lower part of the surface soil is lighter colored than the upper part, and in places it is mottled with brown and contains some dark concretions. The subsurface layer is from 4 to 6 inches thick and has a laminated or platy structure. It rests on brown or brownish-yellow heavy compact waxy clay which continues to a depth ranging from 30 to 40 inches. The material in the lower 12 inches of this layer is mottled with gray, and in places the gray mottling occurs throughout the entire claypan subsoil. Angular and subangular chert fragments occur in the yellow and gray mottled heavy waxy plastic clay subsoil. The chert fragments and gravel do not lie horizontally to the surface of the ground, and the upper part of this layer has a wavelike form. The gravel layer occurs generally as a thick bed but in places is only a foot thick. In some places the gravelly material occurs above the claypan. This soil has a low organic-matter content and is very acid in reaction. Roots penetrate the claypan with difficulty.

Most of Parsons silt loam, cherty-subsoil phase, occurs in the northwestern part of the county in areas associated with Labette silt loam, cherty phase. In places it comprises transitional areas between Labette silt loam, cherty phase, and Parsons silt loam. The largest bodies are in the extreme northwestern part between Geneva and Carlyle, and a few small areas are mapped in other parts. The total area is small.

The relief ranges from undulating to slightly rolling, and surface drainage is good, but internal drainage is poor. Probably 60 percent of this land is in cultivation, and a large proportion is used for native-grass hay. Most of the cultivated areas are susceptible to erosion.

Parsons very fine sandy loam.—The surface layer of Parsons very fine sandy loam is gray or grayish-brown structureless very fine

sandy loam from 6 to 12 inches thick. This grades into a subsurface layer, about 8 inches thick, of gray or light grayish-brown slightly heavier very fine sandy loam containing some yellowish-brown dark concretions and stains in the lower part. This material, in turn, is abruptly underlain by brown or reddish-brown heavy compact almost impervious clay of dense claypan character. At a depth ranging from 24 to 28 inches, yellowish-brown or yellowish-gray mottlings appear, and these are larger and more abundant with increase in depth. Below a depth of 2½ or 3 feet the substratum is yellow and brown mottled plastic or sandy clay. Iron concretions and sandstone fragments occur in this layer. In places the parent material, which consists of fine-grained sandstone or shaly sandstone, is reached at a depth of 42 inches, but in most places it lies below a depth of 4 feet.

This soil probably has the lowest organic-matter content of any soil of the claypan group. It is very acid in both surface soil and subsoil. As in all the soils of the claypan group, root development is confined mostly above the claypan. The same variation—the occurrence of buffalo wallows or alkali spots—occurs in this soil as in Parsons silt loam.

Most of Parsons very fine sandy loam is on the smoother areas of the sandstone belt within the Big Creek watershed, extending from the vicinity of Leanna to a short distance northeast of Moran. The total area is 13,056 acres.

The relief ranges from flat to undulating, and surface drainage ranges from fair to good, but internal drainage is poor. About 80 percent of the land is in cultivation. Like Parsons silt loam, it puddles and crusts after rains, but when freshly stirred it seems to absorb a larger amount of the summer rains than does Parsons silt loam.

Grain sorghums are the chief crops, and the yields obtained are about the same as, or slightly lower than, those on Parsons silt loam. Wheat and oats are grown with about the same results as on the silt loam. Corn does not do well on this soil, and yields generally are low. Sweetclover and alfalfa do not yield well, and stands are difficult to establish, even where applications of lime are made. Soybeans are being planted more extensively and give fair yields. This soil, like the other claypan soils, is susceptible to droughty conditions, and crop yields are frequently reduced in dry seasons, as the heavy claypan interferes with the development of plant roots and prevents the storing of available moisture for plant use. Evaporation of the surface soil moisture also takes place rapidly. Sheet erosion and some gully erosion occur on the more sloping areas.

Neosho silt loam.—The surface soil of Neosho silt loam consists of gray or dark-gray structureless silt loam grading, at a depth ranging from 4 to 9 inches, into gray or light-gray slightly laminated silt loam which continues to a depth ranging from 10 to 16 inches. This material rests on plastic almost impervious dark grayish-brown or almost black clay of claypan character. The change from the gray subsurface material to the claypan is sharp and distinct. The claypan, to a depth ranging from 26 to 40 inches, is lighter colored in the lower part and contains some yellowish-brown or gray mottlings. Gray plastic clay, mottled with yellowish brown, lies beneath the

claypan and continues to a depth of several feet. Gravel beds occur at a depth ranging from 5 to 20 feet. This soil is low in organic matter, is very acid, and roots penetrate the claypan with great difficulty. An area in the southwestern corner of sec. 18 and the northwestern corner of sec. 19, T. 26 S., R. 18 E., has a silty clay loam surface soil. A few areas have a more decidedly gray surface soil, a thicker and grayer subsurface layer, and a browner claypan layer than the average.

Neosho silt loam has a total area of 9,344 acres. It occupies terraces along the larger streams, and the larger areas border the Neosho River flood plains. The area in the southeastern corner of sec. 35, T. 23 S., R. 17 E., southwest of Geneva, occupies a low position and is subject to occasional overflow.

Areas of this soil in general are flat or very slightly sloping, and this feature, together with the heavy claypan, causes poor surface and internal drainage.

Grain sorghums, wheat, and oats are the principal crops. Although corn is grown to some extent, yields are uncertain and probably average only about 12 bushels an acre. Oats produce about 15 bushels, and grain sorghums 16 or 18 bushels. A small acreage is in sweetclover and alfalfa. This soil has about the same agricultural value and adaptability to crops as has Parsons silt loam. Open ditches, to remove surface water, could be used advantageously in places and probably would best serve the purpose.

SOILS AND LAND TYPES GENERALLY BETTER SUITED FOR PASTURE THAN FOR CULTIVATION

Most of the soils and land types comprising this group are stony or shallow members of the series represented in the permeable subsoil group, which, owing to their stoniness and shallowness, are not adapted to cultivation. They have red, dark-brown, or black friable surface soils, mostly of very imperfect development, and friable subsoils. This group includes Labette stony clay loam, Riverton silt loam, Newtonia stony loam, Summit stony silty clay loam, Summit-Bates complex, waste land, riverwash, and rough stony land (Summit soil material).

Labette stony clay loam.—The surface soil of Labette stony clay loam is dark-brown granular clay loam from 4 to 10 inches thick, and the subsoil is brownish-red or red clay resting on limestone at an average depth of less than 2 feet. Numerous limestone fragments are on the surface and throughout the soil mass. In places the stones have been removed from the surface and used in the construction of fences and buildings. A few small areas of Labette silt loam, shallow phase, are included in mapped areas of this soil.

This soil is associated with the other Labette soils, and the larger areas lie within the Big Creek, Marmaton Creek, and Little Osage River watersheds. The total area is 7,296 acres. Most of this soil occupies slopes where the upland breaks to the stream flood plain, and it has sloping to rolling relief. Both surface drainage and internal drainage are good.

Some hawthorn, small oak, and hackberry trees grow on this soil, but the native vegetation consists chiefly of big bluestem grass. Very little of the land is cultivated. Crops are planted in a few places

where the stones have been removed from the surface, but yields are very uncertain, as the shallow soil holds only a slight amount of soil moisture. In places the native grass is cut for hay.

Probably 95 percent of this soil is used for pasture, and it is best suited for that purpose. If overgrazed, the grass cover becomes sparse, and sumac, pricklypear, and other shrubs and weeds gradually take the pastures. Overgrazing also causes sheet erosion, as it removes the protecting cover. Removal of the stones from the surface would increase the pasture value, and it is probable that sweetclover and some other grasses could be grown to advantage in many of the pastures that now have a scant grass cover, but the native grasses will prove most satisfactory where conserved and given an opportunity to grow properly without overgrazing.

Riverton silt loam.—The 6- or 8- inch surface soil of Riverton silt loam consists of dark grayish-brown or brown friable granular silt loam. The upper subsoil layer is lighter brown or reddish-brown friable granular silt loam to a depth of 12 or 14 inches, and the lower subsoil layer is brownish-red or red granular silt loam. Stratified beds of rounded gravel and sand are reached at a depth ranging from 14 to 24 inches. The gravel substratum ranges from 2 to 15 feet in thickness, and most of the gravel are less than 2 inches in diameter. Plate 1, *C* shows a profile of Riverton silt loam.

In places where areas of this soil merge with areas of Parsons silt loam, cherty-subsoil phase, the surface soil is grayish brown, and the gravel layer, which is not more than a foot thick, is intermixed with reddish-brown clay. In such places yellowish- or reddish-brown plastic clay occurs under the gravel at a depth ranging from 24 to 30 inches. Areas of this variation are most numerous in the northwestern corner of the county, and they occupy the lower slopes of the Parsons silt loam areas. In such places the boundaries between the two soils must be arbitrarily drawn. Where the gravel occurs in thick beds and is of sufficient quantity, it is used in road construction. Roots readily penetrate both the soil material and the substratum.

Most of this soil is in the western third of the county. The largest area is 3 miles west of Carlyle, and smaller bodies are west of Iola and in the southwestern corner. The relief ranges from undulating to rolling. Surface drainage is good, and internal drainage is excessive.

The native vegetation is big bluestem grass. Probably 90 percent of the land is used for pasture or for the cutting of the native grass for hay. Sometimes corn is grown, but it seldom makes a good crop, because of the dry condition of the soil which contains insufficient clay in the subsoil to hold a supply of soil moisture. Crops planted on this soil should be of the drought-resistant kinds that mature early, before the advent of hot summer weather. This soil is much more gravelly in the subsoil than typical Riverton silt loam mapped elsewhere in the State, and it is of much lower value for cultivated crops.

Newtonia stony loam.—The 4- to 8-inch surface soil of Newtonia stony loam is brownish-red or red granular silt loam. The subsoil is red granular crumbly clay which rests on limestone bedrock at a depth ranging from 6 to 24 inches. Small and large stones are strewn over the surface and through the soil. Gray or grayish-yellow

mottlings occur just above the rock in some places, especially where the limestone parent rock is at a depth of 2 feet. In places the stones have been removed from the surface and used in the construction of farm buildings and fences. Small areas of Newtonia silt loam are included in mapped areas of this soil.

Newtonia stony loam occurs chiefly in the Coal Creek watershed east and south of Humboldt. The total area is nearly 4,000 acres. The relief ranges from almost flat to rolling on the stream slopes, and in most places both internal and surface drainage are good.

Big bluestem grass is the chief native vegetation, and a few hawthorn and post oak trees grow in places. Practically all of this soil is used for pasture, although a few of the less stony areas are cultivated and planted to crops, but yields are uncertain. The native grasses are cut for hay in places. If the land is pastured heavily, pricklypear, sumac, and other plants spread rather rapidly.

Summit stony silty clay.—The surface soil of Summit stony silty clay is black granular silty clay from 4 to 6 inches thick. The subsoil is brown or brownish-yellow friable clay and rests on the parent limestone rock at a depth ranging from 12 to 24 inches. Large and small rock fragments are strewn over the surface and through the soil, but in places the stones have been removed from the surface. Plant roots penetrate the material easily. In a few small areas the soil is 3 feet deep. Some spots of Labette stony clay loam occur within areas of this soil and are not mapped separately because of their small extent.

Most of this soil is in the western and northern parts of the county. Some areas are 2 miles south and 5 miles west of Iola, 7 miles north of Gas, and north of Carlyle. The total area is 10,048 acres. The relief ranges from gently undulating to strongly rolling, the steeper slopes occurring where the upland breaks to the stream flood plains, such as 3½ and 5 miles northwest of Iola. Both internal and surface drainage are good.

Practically all of this soil is used for pasture. In a few places where the stones have been removed from the surface, the native grass, principally bluestem, is cut for hay. Pricklypear grows extensively in some of the more stony places. Overgrazing of this soil causes sheet erosion and the spread of useless plants. The removal of the larger stones from the surface probably would increase the value of this land for grazing by providing more soil area for the grass to spread.

Summit-Bates complex.—The areas of soils mapped as the Summit-Bates complex include three distinct soils which occupy such small and intricately associated spots that their separation on a small-scale map was considered impractical. Land of this type occupies a very small total area, and it is confined to a few higher rather steep shale ridges capped in places by thin beds of sandstone, these materials representing the Bates soils; and lower lying gentle slopes of deep dark soils of the Summit series. The three soils included in this complex are Bates shale loam, Bates silt loam, and Summit silty clay loam.

Bates shale loam occupies the sharper crests and some of the steeper slopes of the knolls and ridges. The surface soil consists of grayish-brown silt loam about 10 inches thick, which contains a large amount

of fine particles of fine-grained shaly sandstone or a soft slick shale containing considerable very fine sand. The material in this layer grades into a bed of yellow disintegrated soft shale. This soil is of little value for farm crops, and pasture on the native grass probably is the most suitable use to which it can be put. Bates silt loam occurs on the less steep slopes of the ridges and consists of a 10-inch layer of grayish-brown silt loam which is underlain by yellow and gray mottled soft silty clay loam with a slick greasy feel caused by the very fine shale particles throughout the subsoil. This material, in turn, grades, at a depth of about 30 inches, into soft weathered yellow shale which is slightly sandy, and below a depth of 40 inches there is a bed of solid unweathered shale. Summit silty clay loam occurs on the smoother lower lying slopes and the small knolls capped with limestone.

Small areas of Summit silty clay loam are cultivated, but most areas of the other soils are left in native grass, as they are not suitable for cultivation. Where unprotected, these soils erode rapidly.

Waste land.—Waste land comprises slag dumps that occur at former smelter sites in the vicinities of Iola, Gas, and La Harpe. The land on which these slag dumps have accumulated has no particular agricultural value, and the total area is very small. Most of the waste material has been used as a base for concrete sidewalks and for surfacing some of the less heavily traveled roads.

Riverwash.—Riverwash includes low areas lying along the banks of Neosho River. In places it consists merely of sand or gravel bars, but in slightly higher lying areas it is dark loamy sand and supports some trees, principally elm and oak. Areas of riverwash are overflowed frequently and are of no value except for scant grazing and some timber. The higher areas could be used for the growing of some truck crops and melons were it not for the frequent overflows.

Rough stony land (Summit soil material).—Rough stony land (Summit soil material) includes very steep slopes of prairie land and consists chiefly of outcrops of massive limestone strata and broken fragments of the stony material. The small quantity of fine earth between the rocks consists chiefly of dark clay material. This land is of very slight extent and occurs in narrow strips as bluffs or very steep slopes of upland adjacent to the east side of the Neosho River flood plain near the Allen County-Neosho County line. Prairie grasses grow thinly and afford scant pasture. A few oak trees are growing on this land in places.

LAND USES AND AGRICULTURAL METHODS

The soils of Allen County are decidedly different in their suitability for crops. The alluvial soils and the Prairie soils with permeable subsoils have the wider range of crop adaptation and are very good soils for the production of all the crops commonly grown. The soils of the alluvial flood plains return the highest yields, as they are more fertile and have the best moisture conditions. Summit silty clay loam, Summit clay, Labette silt loam, and Bates very fine sandy loam, deep phase, also have excellent moisture-conserving characteristics and are very fertile. Corn, oats, wheat, alfalfa, and sweetclover grow well and produce good yields on most of the soils

except Bates very fine sandy loam which probably has the narrowest range of crop adaptability.

The farmers of this county do not practice any definite crop rotation, but most of them alternate corn, wheat, and oats to some extent, especially on the Prairie soils having permeable subsoils. On the Verdigris soils, a few farmers grow alfalfa. They leave a field in alfalfa until the stand becomes thin or weedy, then plow it under and use the field for corn, wheat, and oats, in rotation, and sow another field to alfalfa. Sweetclover is grown most extensively on the upland soils. Flax, wheat, oats, grain sorghums, and some broomcorn are grown by some farmers on the upland soils. The grain sorghums may replace corn in any rotation practiced.

On the Prairie soils with dense very slowly permeable subsoils, sorghums, wheat, and oats are the dominant crops, as sorghums are better able to resist the droughty conditions that usually develop during July and August, and wheat and oats are harvested before the summer dry season sets in. Corn frequently is grown on Woodson silty clay loam, as this soil is less adversely affected by drought than are the other members of this group. This soil is also better suited to the growing of alfalfa and sweetclover, and these crops are grown to some extent. A small acreage of Parsons silt loam is devoted to sweetclover. Big bluestem is the native grass in the upland pastures. Sawgrass on Osage clay is cut for hay and is also grazed. The Verdigris soils and the stony soils of the Labette and Newtonia series, which occur on slopes, are the only soils that produce native trees of sufficient size and quantity for the manufacture of lumber.

Commercial fertilizers are not used to a great extent except for wheat, for which the usual practice is to make an acre application of 40 to 60 pounds of 45-percent superphosphate or equivalent amounts of lower grades. Lime is nearly always used when seeding alfalfa or sweetclover, and 160 pounds of 45-percent superphosphate or equivalent amounts of lower grade materials have been found to give satisfactory increases in yields of alfalfa. Many farmers apply some manure to the land.

A rather successful system of management on the uplands is the production of milk and the growing of feeds for home use, selling only the surplus and crops not usable on the farm. This system requires a considerable acreage of pasture, and if legumes and crop rotations are used, it is possible to build up the fertility of the soil and increase its organic-matter content. Bates very fine sandy loam and the Prairie soils with dense very slowly permeable subsoils (claypan soils), especially those of the Parsons and Neosho series, are decidedly deficient in organic matter.

According to local information the principal varieties of white corn are Pride of Saline and Commercial White and the principal yellow varieties are Reid Yellow Dent and Midland Yellow Dent. Kanota comprises about 75 or 85 percent of the oats grown and Red Rustproof (Red Texas) most of the remainder. The varieties of wheat produced are chiefly Harvest Queen, Blackhull, Turkey, Fultz, and Fulcaster. The principal varieties of sorghums are Blackhull, White, Red, and Pink kafir, Dwarf hegari, and Atlas and Kansas Orange sorgo. About 60 percent of the flax produced is of

the Linota variety, but Southwestern and Bison are two other varieties grown. The chief varieties of soybeans are A. K., Virginia, and Laredo. About 85 percent of the sweetclover is of the white variety, and the remainder is yellow. Kansas Common and Grimm are the principal varieties of alfalfa.

The department of agronomy of the State agricultural college, recommends an acre application of 3 tons of ground limestone a sufficient time before the seeding of alfalfa or sweetclover to insure good distribution and incorporation with the soil.[6] Liming is not profitable when applied to such crops as wheat, oats, corn, flax, and soybeans, but it is essential to the production of alfalfa and sweetclover on the claypan soils. Applications of lime are not necessary for the production of alfalfa and sweetclover on the Labette, Summit, and Newtonia soils, but if applied with manure or phosphates, lime seems to be beneficial. From 300 to 500 pounds of lime drilled in with the sweetclover has proved advantageous. The limestone should be of high purity and ground to a fineness so that 100 percent will pass through a 10-mesh sieve and 40 percent through a 100-mesh sieve. An application of 3 tons an acre is effective for 10 years.

The agronomy department has several experimental fields in southeastern Kansas. One of these, near Columbus, in Cherokee County, is located on Cherokee silt loam, a soil very similar to Parsons silt loam but lower in fertility and probably having a heavier claypan subsoil. One is located near Moran in Allen County, principally on Woodson silty clay loam, though a small part is on Parsons silt loam.

According to Bulletin 249, the average annual increased value per acre for all crops following an application of 3 tons of lime an acre at the Columbus station was $4.79. The lime was applied before seeding to alfalfa which was allowed to remain until the stand became thin or weedy, usually from 3 to 5 years. The alfalfa was plowed under and the field used in the following rotation: (1) Corn, (2) oats and sweetclover, (3) sweetclover plowed under for green manure in the summer, (4) wheat, and (5) wheat. This rotation was changed in 1931 to (1) corn, (2) soybeans for seed, (3) flax, (4) wheat, and (5) oats and sweetclover. Most of the increased value from the use of lime was due to the alfalfa.

At the Moran field the average increased value for all crops a year was $5.10. The same procedure was followed as at the Columbus station. The rotation used was (1) corn, (2) corn, (3) oats, (4) wheat, and (5) red and alsike clover. This was changed in 1931 to (1) corn, (2) corn, (3) soybeans for seed, (4) oats and red clover, and (5) red clover for hay. Soybeans were substituted for red clover when the clover failed.

PRODUCTIVITY RATINGS

The soils of Allen County are rated in table 4 according to their productivity for the more important crops. The soil types and phases are listed in the order of their general productivity under the prevailing farming practices, the most productive soils at the head of the column.

[6] MEYERS, H. C., CLAPP, A. L., and DAVIDSON, F. E. LIMING KANSAS SOIL. Kans. Agr. Expt. Sta. Cir. 185, 26 pp., illus. 1937.

TABLE 4.—*Productivity rating of soils in Allen County, Kans.*

Soil [1]	CROP-PRODUCTIVITY INDEX [2] FOR—										
	Corn (grain)	Wheat	Oats	Flax	Grain sorghums	Soybeans	Sweetclover seed	Silage (sorgo)	Alfalfa	Wild hay (big bluestem)	Pasture [3]
Verdigris silt loam	70	70	70	----	----	----	----	[4] 90	75	----	[5] 70
Verdigris silty clay loam	70	70	70	----	----	----	----	[4] 90	75	----	[5] 70
Osage silt loam	70	70	70	----	----	----	----	[4] 90	75	----	[5] 70
Verdigris loam	65	70	60	----	----	----	----	[4] 85	75	----	----
Osage silty clay loam	70	60	----	----	----	----	----	[4] 90	70	----	[5] 70
Verdigris very fine sandy loam	60	60	----	----	----	----	----	[4] 80	75	----	[5] 60
Labette silt loam	50	70	60	----	50	60	65	[4] 85	65	----	90
Summit silty clay loam	50	50	----	----	----	----	70	[4] 80	70	----	100
Bates very fine sandy loam, deep phase	40	50	50	55	45	----	65	85	45	----	70
Newtonia silt loam	35	50	45	55	45	----	50	[4] 60	60	----	80
Labette silt loam, cherty phase	40	50	50	----	40	50	60	65	45	110	90
Woodson silty clay loam	35	[6] 65	40	55	55	60	[7] 55	85	[7] 65	125	90
Woodson silt loam	35	[6] 60	40	55	55	60	[7] 55	85	[7] 65	125	90
Osage clay	60	70	----	----	----	----	----	[4] 80	60	[8] 150	----
Parsons silt loam	30	[6] 50	35	35	45	50	[7] 50	70	[7] 40	----	70
Parsons silt loam, cherty-subsoil phase	30	[6] 50	35	35	45	50	[7] 50	70	[7] 40	110	70
Neosho silt loam	25	50	30	35	40	----	[7] 50	60	----	100	70
Parsons very fine sandy loam	25	40	30	30	40	40	[7] 40	50	----	----	60
Bates very fine sandy loam	30	40	25	25	35	----	[7] 30	55	----	----	40
Labette silt loam, shallow phase	30	50	40	----	30	----	40	50	40	----	80
Summit silty clay loam, shallow phase	35	----	----	----	----	----	60	----	----	125	90
Riverton silt loam, slope phase	30	50	30	----	----	----	[7] 30	----	----	----	60
Summit clay	50	----	----	----	----	----	70	----	----	----	100
Riverton silt loam	30	40	----	----	----	----	50	----	----	85	80
Summit-Bates complex	----	----	----	----	----	----	----	----	----	90	90
Summit stony silty clay	----	----	----	----	----	----	----	----	----	75	80
Labette stony clay loam	----	----	----	----	----	----	----	----	----	----	50
Newtonia stony loam	----	----	----	----	----	----	----	----	----	----	40
Rough stony land (Summit soil material)	----	----	----	----	----	----	----	----	----	----	20
Riverwash	----	----	----	----	----	----	----	----	----	----	10
Waste land	----	----	----	----	----	----	----	----	----	----	----

[1] The productivity of each of the various soil types for each specific crop is compared to a standard—100—which stands for the inherent productivity of the most productive soil (or soils) of significant acreage in the United States for that crop. This productivity rating of the soils of Allen County is based on their productivity under the prevailing farming practices.

[2] Soils are listed in the approximate order of their general productivity, the most productive first.

[3] These indexes indicate only the comparative ratings of the soils in the county for pasture. Although these ratings are not based on the standard commonly used in the productivity tables prepared for other soil survey reports—100=100 cow-acre-days—it is believed they are fairly comparable. Cow-acre-days is a term used to express the carrying capacity of pasture land. As used here, it is the product of the number of animal units carried per acre multiplied by the number of days the animals are grazed without injury to the pasture. For example, a soil able to support 1 animal unit per acre for 360 days of the year rates 360, whereas another soil able to support 1 animal unit per 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days the rating is 25.

[4] Corn is also grown rather commonly for silage on these soils. The same standard—12 tons—is used for either sorgo or corn silage.

[5] These indexes refer to the timbered pasture that occurs on these soils in Allen County. The cleared parts of these soils are used for cultivated crops.

[6] These yields of wheat for these soils are obtained with the use of superphosphate as a fertilizer.

[7] Lime and superphosphate are used as amendments on these soils for the production of sweetclover seed and alfalfa.

[8] This index refers to sawgrass rather than to big bluestem.

NOTE.—Leaders indicate that the crop is not commonly grown on the particular soil.

The rating compares the productivity of each soil for each crop to a standard—100. This standard index represents the inherent productivity of the most productive soil of significant extent in the United States for that crop. An index of 50 indicates that the soil is about half as productive for the specified crop as is the soil with the standard index. Soils given amendments, such as lime, commercial fertilizers, and irrigation, or unusually productive soils of small extent, have productivity indexes of more than 100 for some crops. The following tabulation sets forth some of the acre yields that have been set up as standards of 100. They represent long-time average yields

of crops of satisfactory quality on the better soils without the use of amendments.

Corn	bushels	50
Wheat	do	25
Oats	do	50
Flax	do	15
Grain sorghum	do	40
Soybeans	do	25
Sweetclover seed	do	8
Broomcorn	pounds	600
Silage	tons	12
Alfalfa	do	4½
Wild hay	do	1

The crop indexes in table 4 refer to the productivity of the soils under the prevailing farming practices in this county. These indexes may differ from county to county, inasmuch as practices of management and certain characteristics of soil types may vary from county to county. In Allen County little commercial fertilizer is used except for the production of wheat and legumes on the soils characterized by claypans. Productivity under current practices usually differs from inherent productivity and may or may not coincide with productivity without the use of amendments.

The natural factors influencing the productivity of land are mainly climate, soil, and relief, or lay of the land. In addition to these are the factors of management and amendments. Crop yields over a long period of years furnish the best available summation of those factors contributing to productivity, and they have been used largely as the basis for the determination of the productivity indexes in the table. A low index for a particular crop may be due to some local conditions of unfavorable relief, drainage, or climate rather than to a lack of fertility in the soil. It will be seen from the note at the foot of the table that no rating is given if the crop is not commonly grown on the particular soil. It should be understood that this productivity rating is not to be interpreted directly into specific land values. It is based on the essentially permanent factors of productivity of the soils and their responsiveness to management, and little attention is given to the more transitory economic conditions or land values. In some instances the information on which these ratings is based is not so complete as desirable, and further study may suggest changes. This is particularly true for the pasture ratings that have been assigned.

MORPHOLOGY AND GENESIS OF SOILS

Allen County lies entirely within the Prairie soils province, near the southern part of the northern division of that province which extends in a broad north-south belt across the United States. The relief in general is undulating to gently rolling, but considerable areas of almost flat land occur in low stream bottoms and on the uplands. The subsoils of a large number of soils, although heavy, allow moderately free underdrainage, but large areas of soils have subsoils so dense that underdrainage is very deficient. Such soils absorb water very slowly but retain comparatively large quantities, and, therefore, not a large reserve of soil water is available for plants during most of the year. The surface soils of about 50 percent of the county are dominantly dark. The remainder dry to a very light brown or grayish-brown color.

The soils have developed in a temperate climate with a moderate rainfall, beneath a heavy grass cover—conditions favoring a fairly high accumulation of organic matter. The underlying rock formations which have weathered to furnish the soil parent materials are chiefly limestone, shale, and sandstone, with, in places, a small amount of old alluvium consisting chiefly of clay. Some of the shales are fine grained and somewhat calcareous, but in other places the shaly material is sandy. The calcareous shales contain salts that may have been an important factor in the development of a claypan.

Although climate and native vegetation are fairly uniform throughout the county, local differences of relief and parent materials have caused rather important differences in the soils.

The more or less well developed soils of the upland prairies belong to two main groups, namely, those having permeable subsoils, and those having dense heavy clay subsoils that are very slowly permeable—the soils of claypan character. The soils of the permeable-subsoil group have been developed largely from parent materials originating from limestone, sandstone, and shale, and the upper horizons are more or less granular. These soils are correlated in the Summit, Newtonia, Labette, and Bates series.

The Labette and Newtonia soils are developed on limestone; the free calcium carbonate, however, has been leached from these soils to considerable depths. In the instance of Labette silt loam the soil is free of calcium carbonate to a depth ranging from 3 to 6 feet, although each horizon has a comparatively high content of colloidal calcium. The adequate lime content of each of these soils tends to maintain a granular structure, and only moderate eluviation has taken place. Eluviation is greater in the Labette soils which in general have slightly heavier subsoils than the Newtonia.

Labette silt loam has a profile which represents about the normal regional profile for this group. Following is a description of a typical profile of this soil:

1. 0 to 1½ inches, dark decayed vegetable matter covering the surface of the virgin soil.
2. 1½ to 12 inches, dark-brown granular silt loam with the grains roughly rounded and darker coated on the outside than on the inside.
3. 12 to 24 inches, brown granular silt loam or clay loam, which is slightly heavier in the lower part.
4. 24 to 30 inches, brown or brownish-red crumbly but heavy clay.
5. 30 inches+, red crumbly clay containing some gray or yellow splotches.

The soil material in all the horizons is slightly acid. The limestone bedrock lies below a depth of 4 feet. In low situations the surface soil is heavier, deeper, and darker, but in sloping areas the color is brown and in places reddish brown, approaching the color of Newtonia silt loam which also is developed from limestone material and has much the same physical structure but is much redder.

The Summit soils are closely related to the Labette and Newtonia but may be formed either from calcareous shales or from limestone materials. Those formed on limestone materials are particularly closely related to the Labette soils. In gently sloping areas of the Summit soils there is a tendency toward the formation of a claypan. In places where the land is flat, the Summit soils merge with areas of Woodson and Parson soils which have well-developed claypans. The slope of the Summit soils with the attendant differences in erosion and eluviation, have prevented the development of a definite claypan.

Summit silty clay loam is a member of the group of the heavier Prairie soils having freely permeable subsoils. It is developed from shale. Following is a description of a typical profile of this soil:

1. 0 to 15 inches, black silty clay loam containing much organic matter. The material, on drying, separates into a mass of subangular granules. The topmost 2- or 3-inch layer is slightly laminated.
2. 15 to 30 inches, brown crumbly clay. The material separates into sharper granules or grains than those in the layer above.
3. 30 to 40 inches, grayish-brown or yellowish-brown heavy crumbly clay.
4. 40 to 60 inches+, yellow, gray, or mottled heavy crumbly clay.

The soil material is slightly acid to neutral, but the underlying material in places is alkaline.

The Bates soils have developed from noncalcareous sandstone under prairie conditions and are more acid, coarser textured, and lighter colored and, though very friable, do not have the organic-matter content or the granular development of the soils developed from limestone materials.

The surface soils and upper subsoil horizons of the shallow phases of the soils having permeable subsoils are similar to the corresponding horizons of the typical soils in character, but they differ chiefly in the depth of the solum above the parent rock; that is, the subsoil horizons are thinner.

The Prairie soils with dense very slowly permeable subsoils (the claypan group) are known as gray ashy soils. These soils have developed from calcareous shales and other fine-textured materials. They have been correlated in the Parsons, Woodson, and Neosho series. The first two have developed on the upland, and the last one has developed on old stream terraces. These soils dry to a gray color and are strongly acid throughout.

The Parsons and Woodson soils, although developed on the same or similar parent material as the Summit, are very different in character. Two theories are advanced for the development of the claypan. The processes of both theories have been probable factors in the development of the claypan soils of Allen County. One theory is that, due to the fine texture of the parent material, the salts, which are readily soluble, are not carried off by percolating waters. This results in a higher relative concentration of salts in proportion to the calcium carbonate which is less soluble. Under these conditions the bases in the salts replace the calcium, producing a salt-saturated colloid. As the replaced calcium and excess salts are leached out of the soil, deflocculation results in the formation of the claypan. The second theory is that the flat surface and poor natural drainage have promoted the accumulation of heavy almost impervious B horizons by eluviation. Regardless of development, these claypans on flat areas have made possible long-continued periods of waterlogged conditions. Under submerged soil conditions and in the presence of natural organic matter, extensive anaerobic biological activity takes place, with the result that excessive quantities of calcium, magnesium, and particularly iron are rendered soluble in the form of bicarbonates.[7] Such seepage or other drainage as occurs carries with it much of these

[7] The chemistry of submerged soil conditions is discussed in the following: ROBINSON, W. O. SOME CHEMICAL PHASES OF SUBMERGED SOIL CONDITIONS. Soil Sci. 30: 197–217. 1930.

soluble basic compounds, leaving the substituted hydrogen-saturated clay behind, which has a markedly acid reaction.

Parsons silt loam is representative of this group of soils. Following is a description of a virgin profile of this soil:

1. 0 to 2 inches, a gray mass of disintegrated organic matter in loam or silt loam fine earth, which is light gray when dry but grayish brown when moist.
2. 2 to 9 inches, gray or dark-gray silt loam with little or no structure. A few dark concretions are present, the soil is very acid, and the organic-matter content is low.
3. 9 to 12 inches, light-gray silt loam with brown splotches and dark concretions.
4. 12 to 15 inches, light-gray silt loam of laminated platy structure, containing many dark concretions.
5. 15 to 24 inches, brown dense compact heavy clay which becomes lighter in color with increase in depth. On drying, the material separates into large angular clods which crumble to small rectangular-shaped fragments, ranging from one-sixteenth to one-eighth inch in thickness, that are very hard when dry but plastic when wet. The material in this layer is very strongly acid.
6. 24 to 32 inches, brown and yellow mottled heavy dense clay which is almost impervious and very acid.
7. 32 to 60 inches+, tight heavy mottled gray, yellow, and brown clay which is highly acid in reaction.

The alluvial soil materials have been correlated on the basis of the developed soil from which they have been removed by erosion. The Verdigris and the Osage soils have developed from alluvial material of the upland Prairie soils.

The thin soils and land types, which are more or less shallow and stony and have had little or no soil development, are included in a separate group. These soils have no value for cultivated farm crops and are correlated largely on their slight relationships to the normal soils.

Table 5 gives the results of mechanical analyses of samples of two soils.

TABLE 5.—*Mechanical analyses of two soils from Allen County, Kans.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Woodson silt loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
382805	0–9	0.1	0.3	0.6	1.1	1.3	68.2	28.4
382806	9–14	.1	.4	.5	1.1	1.5	61.4	34.9
382807	14–26	.1	.1	.2	.5	.7	40.2	58.2
382808	26–32	.0	.2	.3	.7	1.3	45.4	52.1
382809	32–40	.1	.5	.4	.8	1.9	55.7	40.6
Summit silty clay loam:								
382872	0–10	.3	1.0	.8	3.0	8.1	47.9	39.0
382873	10–18	.1	.5	.4	1.3	5.1	37.4	55.1
382874	18–36	.0	.3	.2	1.0	4.7	36.5	57.2
382875	36–42	.5	.8	.5	1.1	4.9	38.2	54.0

SUMMARY

Allen County is in the southeastern part of Kansas. It consists of almost level to gently rolling prairie indented by a number of flat stream valleys bordered by gently sloping areas. The Ozark divide extends from northwest to southeast through the eastern part of the county, and low hills and some steeply sloping areas occur in the

northeastern, southeastern, and northwestern parts. The streams reach into and drain well most parts of the county. In a few places along the larger streams low bluffs of rock outcrop occur.

A few settlers arrived as early as 1855, but the county did not become thickly settled until after 1870, when railroads were built through it. The urban population in 1930 was 9,718. Transportation facilities are excellent, and both towns and rural sections have very good schools and many churches. Cement, brick, and tile are manufactured at Humboldt and Iola. Iola is the principal town and county seat. Good water may be obtained from wells in most sections.

The average annual rainfall is 38.08 inches, and the average length of the frost-free season is 199 days.

Since the early settlement, agricultural development has been rapid. In 1879, cattle raising and feeding were important agricultural enterprises, and only about one-fourth of the land was used for the production of farm crops. By 1934, however, 52.1 percent of the total area of the county was in crops. Corn has always been the principal crop, but wheat, oats, grain sorghums, and flax are important. During the last 25 years there has been an increase in the number of dairy cows, accompanied by increased acreages in alfalfa and sweetclover. Soybeans are rapidly gaining in importance.

The soils are placed in four broad groups: (1) Soils of the alluvial flood plains, which include members of the Verdigris and Osage series; (2) Prairie soils having permeable subsoils, which are of the Labette, Summit, Newtonia, Bates, and Riverton series; (3) Prairie soils with dense very slowly permeable subsoils, consisting of soils of the Woodson, Parson, and Neosho series; and (4) soils generally better suited for pasture than for cultivation, which include soils of the Labette, Riverton, Summit, and Newtonia series, the Summit-Bates complex, rough stony land (Summit soil material), riverwash, and waste land.

The soils of the alluvial flood plains are deep, permeable, and very productive. Most of them are well drained but occasionally they are overflowed. They are largely in cultivation and are suited to all the crops commonly grown, although they are used principally for the production of corn and alfalfa. The Verdigris soils are brown, well drained, and consist of soil materials washed from the Prairie soils. The Osage soils are very dark gray or black, and they also consist of soil materials washed from the dark Prairie soils.

The Prairie soils having permeable subsoils have been developed largely from limestone and sandstone parent materials, and the upper horizons are more or less granular. They are suited to all the crops commonly grown and range from moderately to highly productive. Wheat, oats, grain sorghums, sorgo, clover, flax, and broomcorn are the chief crops.

The Prairie soils with dense very slowly permeable subsoils, or the soils of claypan character, occupy smooth nearly flat areas of prairie land, have unfavorable moisture conditions, and are low in available plant nutrients. They are cultivated extensively, however, and all the common crops are grown.

The soils and land types generally better suited for pasture than for cultivation are stony and shallow members of the friable-subsoil group, and most of them are imperfectly developed.

The soils of this county differ widely in their suitability for crops. No definite crop rotations are practiced, and commercial fertilizers are not used to a great extent, except for wheat. Applications of lime have given satisfactory increases in yields of alfalfa and are essential to the production of alfalfa and sweetclover on the claypan soils.

This county lies entirely within the region of Prairie soils, and the soils have developed in a temperate climate with moderate rainfall and beneath a heavy grass cover. The parent materials largely originated from limestone, shale, and sandstone, with some old alluvium consisting chiefly of clay.

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THIS SOIL SURVEY IS A CONTRIBUTION FROM

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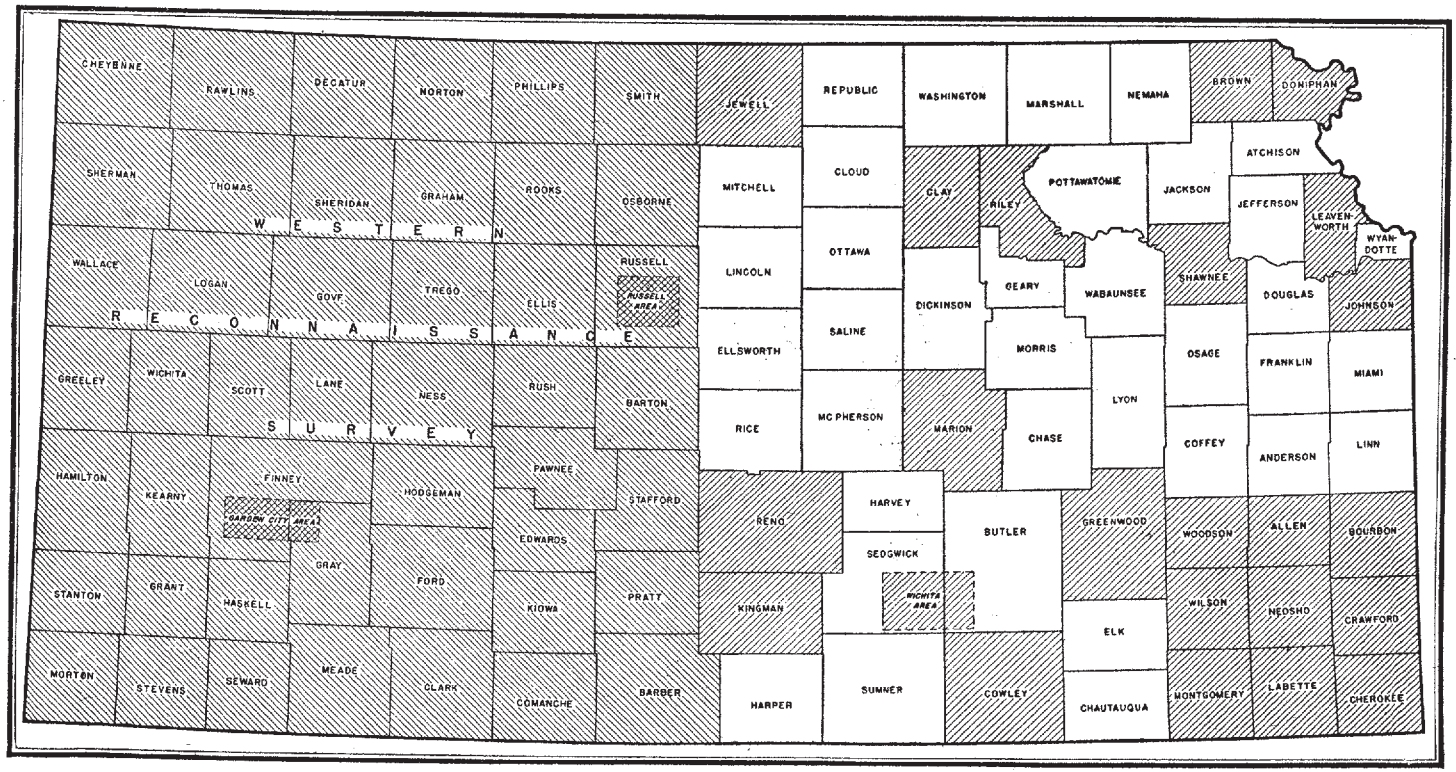

Areas surveyed in Kansas shown by shading. Detailed surveys shown by northeast-southwest hatching; reconnaissance surveys shown by northwest-southeast hatching; cross-hatching indicates areas covered in both ways.

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