

SOIL SURVEY OF RILEY COUNTY KANSAS

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DESCRIPTION OF THE AREA.

The Riley County area consists of Riley County, Kans., and that part of the Fort Riley Military Reservation which lies north of the Kansas and Republican rivers. The total area represented in the survey comprises 406,080 acres, or about 634 square miles, the part of the military reservation surveyed constituting about 29 square miles of the area.

Riley County is situated in northeastern Kansas and is the second county south from the Nebraska line and the fourth west of the

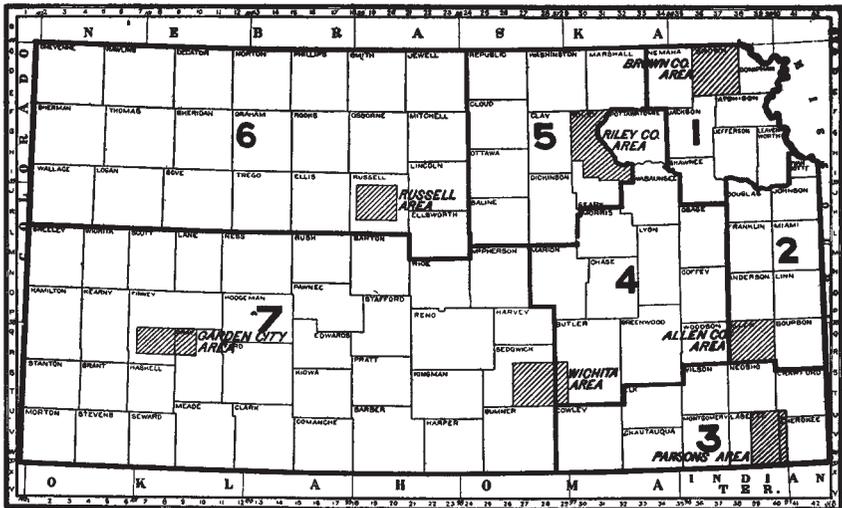


FIG. 31.—Sketch map showing location of the Riley County area, Kansas.

Missouri River. The county is irregular in outline. It is bounded on the north by Washington and Marshall counties; on the east by Pottawatomie and Wabaunsee counties; on the south by Wabaunsee and Geary counties, and on the west by Geary and Clay counties. The Fort Riley Military Reservation is located in the southwestern corner of the county.

In topography Riley County has the appearance of a much-dissected high plateau, consisting of three distinct topographic divisions. The first of these constitutes the high rolling prairies in the north-

ern, central, and western parts of the county, covering approximately one-half of the county. These prairies lie at an elevation of from 1,200 to 1,400 feet above sea level and are very rolling. Being the highest land of the county, the stream valleys cut into this plateau, and its outward boundaries are very irregular. The second topographic division consists of the river and creek valleys, lying at an altitude of from 1,000 to 1,100 feet above sea level. The river valleys range from 1 mile to 3 or 4 miles in width and are nearly level or gently sloping and rolling. The creek valleys range from one-fourth to one-half mile in width and are high above the creek beds and gently rolling. This valley topography is found in the southern, eastern, and northern parts of the county. The third topographic division occupies an intermediate position between the plateau and the valley and consists of the broken and hilly country reaching from the edge of the prairies down to the valley bottoms. This broken country lies at an elevation of from 1,100 to 1,250 feet above sea level and constitutes a considerable portion of the county and is located principally in the northern, eastern, and southern parts of the county. It consists of steep, eroded, and stony slopes, forming the valley walls, and series of precipitous rocky slopes leading down from the prairies to the valleys. This rugged topography is cut by numerous small valleys, and nearly horizontal layers of limestone outcrop may be traced for miles along the edges. This topography follows along the river valleys and up the creek valleys, finally disappearing as the creeks become smaller, or is confined to small areas of stony outcrops near small streams on the prairies. In the vicinity of Manhattan, Ogden, and Zeandale there are on the borders of the valleys some important areas of rolling low upland quite free from stones, which has an elevation of from 1,050 to 1,200 feet and is probably due in part to the weathering of the softer limestone and partly to refilled material from glacial waters.

Riley County has a thorough and intricate drainage system. The Kansas River, the second largest in the State, is formed at Fort Riley by the conjunction of the Republican and Smoky Hill rivers and flows through the southern part of the county in a general northeasterly direction, forming the northern boundary of the county east of Manhattan. The Kansas River drains a large proportion of the southern and central parts of the county and a considerable part of the Fort Riley Military Reservation. Its principal tributaries are Wild Cat Creek, which has its origin in the upland prairie near Leonardville, flows in a southeasterly direction, and empties into the Kansas River near Manhattan; Seven Mile and Three Mile creeks, which drain the southwestern parts of the county and the eastern part of the Fort Riley Military Reservation; McDowells and Deep creeks, which flow

northward and drain that part of the county south of the Kansas River, and numerous smaller branches and streams.

The Big Blue River, which forms the eastern boundary of the county north of Manhattan, flows in a southwesterly direction for about one-third of the distance and then in a southeasterly direction and empties into the Kansas River near Manhattan. The principal tributaries of the Big Blue River are Swede and Timber creeks, which drain a considerable proportion of the northeastern part of the county; Fancy Creek, which, with its tributaries, drains the principal sections of the northern and northwestern parts of the county; Tuttle, Baldwin, and Mill creeks, which drain large areas of the eastern part of the county; and numerous other small creeks and branches. A small section of the western part of the county is drained by the headwaters of tributaries of the Republican River, the largest of which are Timber and Madison creeks. The western part of the Fort Riley Military Reservation is drained by the Republican River, which forms the southern boundary of the reservation for several miles.

The river valleys are bounded by steep, rugged, and stony bluffs from 50 to 200 feet high. At intervals these bluffs are broken by creeks and ravines. The topography of Riley County and its drainage is largely due to preglacial erosion and the various topographic divisions are due to the difference in hardness and solubility of the Permian rocks. The rivers have nearly reached the base level of their operations and their erosion is confined principally to lateral cutting. Overflows rarely occur in the rivers and larger creeks. During the greater part of the year the small streams contain very little or no water. The larger creeks, which are fed to some extent by springs, are perennial. The upland prairies have few large streams, but adequate drainage is furnished by numerous small, shallow draws or branches, which seldom contain water except after rains or from occasional springs. These drains form the headwaters of the large streams of the county that have their sources in these high prairies.

The population of the county consists almost entirely of farmers. The county is quite thickly settled in the valleys and on the high rolling uplands. The inhabitants of the county, who are principally settlers from the older States, are industrious and thrifty, and the foreign element, mainly Swedes and Germans, which constitutes a considerable percentage of the population, is prosperous and progressive. The population is not transient in character and few are at present moving into the county.

Riley County, with a population of about 14,000, ranks forty-sixth in population in the State. Its inhabitants are well distributed over the county, there being few towns. The broken and hilly section of the county has the fewest inhabitants, owing to the uncultivable

condition of a large part of that section. Manhattan, with a population of nearly 5,000, is the county seat and the largest town. It is located in the southeastern part of the county at the junction of the Kansas and Big Blue rivers, and is on the main line of the Union Pacific and the Chicago, Rock Island and Pacific railways, and is also the southern terminus of the Manhattan and Blue Valley Railroad. Leonardville and Riley are small railroad towns in the central part of the county in the prairie region. Ogden is a small town in the southern part of the county on the Union Pacific Railroad. Randolph, Cleburne, and Stockdale are small towns in the eastern part of the county on the Manhattan and Blue Valley Railroad. Zeandale, a small town in the eastern part, and Keats, in the central part of the county, are both on the Chicago, Rock Island and Pacific Railway. These towns have a population of from 100 to 800 inhabitants. May Day, Winkler, and Bodaville are small villages in the northwestern part of the county and are not on railroads.

There are 100 miles of railroad in the county, and all sections have adequate shipping facilities, except the northwestern part. The main line of the Chicago, Rock Island and Pacific Railway enters the county on the east and closely follows the Kansas River to Manhattan, and from that point extends through the south-central and western parts of the county in a general northwesterly and southeasterly direction. The main line of the Union Pacific Railroad enters at Manhattan and extends in a general northeasterly and southwesterly direction through the southern part of the county, closely following the Kansas River and extending through the southern part of the Fort Riley Military Reservation. The Manhattan and Blue Valley Railroad, a branch of the Union Pacific, extends north along the eastern border of the county, closely following the Big Blue River. The Leavenworth, Kansas, and Western Railway extends through the north-central part of the county in a general east and west direction. Kansas City, 120 miles east, is the great market for stock, and is reached by the Union Pacific and the Chicago, Rock Island and Pacific Railway. These roads are also used for shipping in sheep and steers for feeding purposes from points in the West. In the northern section of the county, where the hauling of farm products to railroads is impracticable, most of the grain and other products is fed, and the stock is driven to the nearest station. Nearly all the county is reached by rural free delivery routes. The great majority of the farmers have telephones, some of them private lines and some the property of incorporated companies.

Some truck is shipped from Manhattan, and corn is often brought into the county for fattening stock, although sometimes it is shipped to outside markets. The wheat is stored or sold to the elevators and to buyers, although much is made into flour at Manhattan and Junc-

tion City, a nearby town in Geary County. There are two elevators at Manhattan, one at Riley, one at Leonardville, and one at Lasita switch.

The educational facilities in Riley County are very good, there being numerous substantial schoolhouses distributed throughout the county. The Kansas State Agricultural College is located at Manhattan and has an attendance of about 1,800 students.

The towns of the county afford very small markets. Manhattan utilizes some farm products, but not to any great extent. About 16 miles southwest of Manhattan is Fort Riley, one of the largest military posts of the United States.

The Kansas State Agricultural Experiment Station is located at Manhattan, and many valuable experiments in the production, breeding, and selection of farm crops, as well as in animal husbandry, are carried on there. The results are available to farmers throughout the State. A classification of the soils of the State, such as is being made in the soil surveys, will enable the farmers to correlate these experimental results with the local conditions and thus make them of more certain application and of greater value.

CLIMATE.

The climate of Riley County is marked by extremes of precipitation and temperature. The annual precipitation has varied from about 17 to 47 inches, and the temperature from 115° F. to -32° F. The following table, compiled from the records of the Weather Bureau station at Manhattan, gives the normal monthly and annual temperature and precipitation:

Normal monthly and annual temperature and precipitation.

Month.	Manhattan.		Month.	Manhattan.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	° F.	In.		° F.	In.
January	31.0	0.75	August	79.2	3.58
February	26.6	1.13	September	69.0	3.04
March	42.6	1.35	October	61.1	2.24
April	55.3	2.73	November	44.1	1.28
May	66.8	4.32	December	31.2	.85
June	74.7	4.42	Year	5.52	30.36
July	79.5	4.67			

An examination of the above table shows an annual precipitation of 30.36 inches. The distribution is favorable for crops, as only about one-tenth falls in the three winter months, the remainder being distributed through the growing season, with a maximum rainfall in the months of May, June, and July, and sometimes August. The rainfall is not always evenly distributed and occa-

sional dry spells may occur, although droughts sufficient to cause serious damage to crops are seldom experienced. It is known that vastly more moisture is utilized and conserved for crops than formerly, due to the cultivation of widely extended areas, the increase of timber following the extinction of prairie fires and the destruction of the short, water-shedding buffalo grass and the growth of bluestem. More than half of the winds blow from a southerly direction at an average of 12 miles an hour and bring the bulk of the moisture from the Gulf of Mexico. If the winds are continuously from the south moisture may be in excess, as in the flood season of 1903, or if from the west or north a condition of scant precipitation will ensue. Destructive winds are not common; occasional hailstorms affect local areas, but crops are so seldom destroyed that insurance against hail is not practiced. The average depth of snow is 22 inches. More than 6 inches seldom falls at one time, and this may remain all the winter and be added to occasionally, or it may soon disappear. As a general rule, however, the ground is seldom covered for any length of time, and plowing during the winter is not unusual. Thunderstorms occur from April to August or September.

Riley County has a long summer of high average temperature, favorable to all the great staple crops of the middle latitudes, and especially to fruit and truck.

Dates of first and last killing frosts.

Year.	Manhattan.		Year.	Manhattan.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1897.....	Apr. 17	Oct. 29	1901.....	Apr. 17	Oct. 14
1898.....	Apr. 14	Oct. 14	1902.....	Apr. 30	Sept. 13
1899.....	Apr. 16	Sept. 29	1903.....	May 3	Oct. 18
1900.....	Apr. 13	Oct. 8	Average.....	Apr. 20	Oct. 9

The average dates of last and first killing frosts, as shown by the above table, are April 20 and October 9, respectively. A growing season of 172 days gives time for all crops. The April frosts seldom injure vegetation. Tender-budded fruits that open early in the spring should be planted on north slopes of the highlands, as the frosts here are less severe and the buds open later than in the valleys or on southern exposures. It is asserted that the average temperature is 3° higher on the bluffs than in the valleys, and that Concord grapes ripen from eight to ten days earlier on the higher ground. Peaches are the only crop permanently injured by a fall to 15° below zero during the winter, and this extreme is reached very rarely. Temperatures below zero are usual for a few days each winter, but are not felt seriously by man or animals because the air is very dry.

March and November may have winter temperatures occasionally. The second half of May and the first half of September are invariably warm, with fine weather for agriculture. The extreme heat of summer may approximate 90° for nearly forty days on the average. This heat is not as oppressive as 75° or 80° in a humid region like the Atlantic seaboard. The relative humidity is low, and muggy days are rare. The summer nights average 30° cooler than the days. The climate is salubrious and conducive to the highest development of agriculture. The hot winds, formerly so destructive of crops, have recently been of a much milder character, and July—the critical period—has usually passed with little damage.

AGRICULTURE.

The pioneer settlers of Riley County came mostly from Ohio and other western States, although some were from New England. The county was organized in 1855. The first settlement was at Manhattan, and the early attempts at agriculture were confined to the creek and river valleys, as it was thought by the early settlers that the high prairie land could never be utilized except for grazing and hay. Some timber growth was found in the river and larger creek bottoms, enough to supply all needs for fuel, buildings, and fences, although the forest was generally kept down by prairie fires started by Indians in hunting. There were a few small patches of land in the bottoms that had been cultivated by Indians, and these were utilized by the new settlers.

The size of the areas cultivated depended upon the settler's equipment. If he had good teams and a large family to help him, considerable land would be broken the first year. Each settler pre-empted 160 acres, and the cultivated area was gradually increased, more land being broken each year. The first crops grown were corn and vegetables for home use, although as early as 1858 corn was marketed at Fort Riley and other western army posts, being hauled to these markets by ox teams or purchased on the farm by Government contractors.

At the first plowing, which required from one to four yokes of oxen, the land was never broken deeper than 2½ to 3 inches, as the grass roots and vegetable matter decayed quicker when plowed under shallow. The corn at first was not cultivated, and only from 10 to 20 bushels per acre was obtained. After considerable land was broken up it was realized that some form of cultivator was needed, and the bull-tongue or double-shovel plow was used for this purpose.

About 1858 spring wheat was introduced. It was grown only in small quantities and was utilized for home use, being ground on corn burrs at Manhattan. Wheat yielded from 20 to 30 bushels per acre. Fall wheat began to be grown about 1868, taking the place of the

spring wheat. This change was brought about by the ravages of the chinch bug and also by the fact that some wheat was beginning to be marketed, and better yields and higher prices could be obtained for the winter wheat. Oats were also grown at this time, yielding from 30 to 45 bushels per acre, but they often grew too rank and lodged.

The horses used in the early history of the county consisted principally of half-breed Indian ponies, which were very hardy and easy to keep. The first impetus to stock raising in the county was started by the Winkler brothers, who brought in a herd of cows and heifers and some hogs and sheep from Missouri. Some meat was marketed at Leavenworth, selling for 2 or 3 cents a pound. The first wheat drill was brought into the county in 1870, and about this time an increased acreage of wheat was grown and marketed at Manhattan and Waterville, as well as at small mills along the streams. The Union Pacific Railroad was constructed as far west as Manhattan about 1864, thus opening up the eastern markets to farmers of Riley County.

In 1860 a severe drought and in 1873 and 1874 grasshoppers and drought caused a total failure of crops. Although occasional dry years since then have reduced production, the years mentioned are the only ones in which crops were a total failure in the county. About 1868 the chinch bug began to attack the crops and caused considerable damage to wheat, oats, and corn. This pest proved so injurious to wheat that many farmers abandoned it as a staple crop, but for the last few years there have been very few chinch bugs and there are practically none at present, and as a result the acreage of wheat is increasing.

About 1864 the upland prairies began to be settled by a few immigrants from the more eastern States and by Scandinavians and Germans, many of whom came direct from Europe and were very poor. A settlement of Germans was made in the vicinity of where Riley now stands and a settlement of Scandinavians where Leonardville is now located. The northern part of the county was also settled by these foreigners. They had little money, and owing to the scarcity of funds they could cultivate only small areas of sorghum and corn and they lived in a very primitive manner. By industry and thrift, however, they gradually built up good homes, and now some of the best-tilled and most productive farms in the county are to be found in the thickly settled prairies which were at one time considered useless for cultivation.

Native wild fruits, such as grapes, plums, and strawberries, were plentiful, and in the early days many of the settlers brought with them fruit trees of eastern varieties, but most of these trees died because they were not adapted to western conditions. However, the

introduction of home nurseries and the propagation of western varieties of fruit made it possible later to establish good orchards.

As railroads were built through the county and the eastern markets were made accessible, larger areas were annually placed under cultivation, better varieties of farm crops were grown, and improved stock brought from the East. Good farm machinery was also introduced and better farmhouses and substantial buildings were constructed, until at present Riley County constitutes a very prosperous agricultural section.

About 1889 or 1890 alfalfa was introduced, and this crop has almost revolutionized farming. Much land previously in corn has been seeded to alfalfa, more and better stock has been raised, and the tendency has been to check exhaustive cultivation and to rotate crops, although the rotation is as yet far from perfect.

At present there are practiced three closely allied types of agriculture corresponding to the three kinds of topography in the county. The first is found in the river and creek valleys, and consists of the production of corn, alfalfa, wheat, oats, sorghum, and Kafir corn. Some cattle and hogs are raised, and small orchards of apples, peaches, and other fruits are planted. Some trucking is done in the river bottoms near Manhattan, Zeandale, and Ogden. The second type consists of grazing upon considerable areas of broken upland, on which large numbers of cattle are pastured and fed. The third type consists of the production of corn, wheat, alfalfa, rye, oats, Kafir corn, sorghum, millet, and prairie hay. In this section, on the high rolling prairies in the central, western, and northern parts of the county, considerable numbers of cattle and hogs are raised and fed for market. Small orchards of apples and peaches are seen on nearly every farm in this section.

According to the Fourteenth Biennial Report of the State Board of Agriculture of Kansas, there was produced in Riley County, in 1904, 118,755 bushels of winter wheat, 2,095,808 bushels of corn, 395,120 bushels of oats, 6,390 bushels of rye, 60,119 bushels of Irish potatoes, 34,500 bushels of sweet potatoes, 39,000 pounds of broom corn, 6,552 tons of millet, 5,000 gallons of sorghum sirup, 14,217 tons of Kafir corn, and 21,412 tons of prairie hay. There were 9,485 acres of alfalfa, 600 acres of bluegrass, and 1,876 acres of sorghum planted for forage and grain. These products, with a small quantity of other farm crops, had a valuation of \$1,353,516. The farm stock in Riley County in 1904 was valued as follows: Horses, \$548,550; mules, \$49,525; milch cows, \$204,600; other cattle, \$595,393; sheep, \$39,486; swine, \$255,150; total, \$1,692,704. The wool clip was valued at \$888, the dairy products at \$48,445, and the poultry products at \$82,725.

Cattle feeding is locally a very important industry, and large numbers of steers are fed every year. Many of these steers are brought

as feeders from Kansas City or from points farther west, and only about 25 per cent are home grown. They are put on grass during the summer and gain from 300 to 400 pounds by the 1st of September, when grain feeding begins. The steers are fed from 30 to 150 days, depending on market conditions, on a ration consisting of corn, alfalfa, and occasionally cotton-seed meal. These cattle are shipped to Kansas City, and the highest price is usually obtained for home-grown steers, western feeders coming second, and Texas and Oklahoma stock third. The steers are usually high grade, the Hereford and Shorthorn breeds predominating. Large numbers of sheep are also fed for market, although few are raised in the county. They are fed by turning them into corn fields, beginning about the 1st of September, for 20 to 40 days, and are then shipped to market. Sheep feeding is done in the county only around Manhattan and Zeandale. Hogs are kept to some extent by nearly every farmer, and some raise a large number. The hogs are either pure bred or very high grades, the Poland China predominating, some Duroc-Jersey, Chester White, Tamworth, and Berkshires also being found. The dairy products are utilized on the farm, or else small hand separators are used and the cream sold to local buyers, who ship it to Topeka or to towns west of the county. The large number of stock raised and fed in Riley County makes it possible for most of the corn, alfalfa hay, sorghum, Kafir corn, and millet to be consumed in the county.

Truck farming is carried on to some extent on the lighter soils of the Kansas River bottoms near Manhattan, Ogden, and Zeandale. The products consist principally of melons, sweet potatoes, and Irish potatoes, considerable quantities of which are shipped to the west, as well as to Topeka and Kansas City.

The farmers of the county in general recognize the adaptation of certain soils to special crops. They realize that the heavier alluvial soils are the best for alfalfa and corn and that the silt loams of the uplands are better adapted to small grain than are the alluvial soils. It is, of course, understood that the eroded slopes of the high prairies and the Rough stony land are best adapted to grass and pasturage. They also recognize that the "gumbo" phase of the silt loams is best utilized for Kafir corn and sorghum, and that the sandy alluvial soils are best adapted to the production of truck crops. However, the recognition of the adaptation of soils to crops is not always followed in farm practice, as small grain is often grown on the light alluvial soils, but this is due to the fact that the farmers wish to change their land from corn to some other crop.

The rotation of crops is not as well systematized nor as generally practiced as it should be, though much more attention is being paid to it than formerly. Often the same crops are grown on the same

land for a number of years. The farmers realize that this method of cropping causes a decline in the productiveness of the soil, and although they are beginning to use more manure on the land than has previously been the custom, they have as yet worked out no good method of crop rotation. They realize that alfalfa greatly improves the soil, but the fact that alfalfa seed is quite costly and that difficulty is sometimes experienced in getting a good stand deters them from including alfalfa in a short rotation, where it could be utilized to great advantage. After the alfalfa has stood for a number of years, usually eight or ten, it begins to get thin as a result of damage by gophers and from other causes, and it is then plowed up and the land planted in corn.

Many farmers have a rotation which includes corn, oats, and wheat. The corn is grown one or more years, being listed in without plowing, then the land is plowed in the spring and sown to oats, which being harvested, the land is plowed late in the summer and wheat drilled in early in September. The wheat stubble is always plowed under late in summer. In this way the land is plowed every two or three years and the rotation is very advantageous. Corn is planted during the latter part of April or the forepart of May. It is the usual practice to plant all corn by listing. The corn is usually listed each year in the old middle, but is sometimes cross listed. The rows are about 3 feet 4 inches apart and the stalks are usually about 18 inches apart in the row. The corn is usually cultivated three times, the first cultivation being with a disk cultivator, which is arranged with inside shields so as to prevent the soil from covering the corn. The other two cultivations are usually done with an ordinary cultivator. The soil is always thrown toward the corn and the high furrow in the middle which was formed by the lister is leveled and worked toward the row, the corn standing finally on a slightly elevated ridge. This practice makes the corn deep rooted and enables it to withstand drought. The crop is either gathered late in the fall by husking in the field and leaving the stalks for stock, or it may be gathered with corn harvesters and the fodder fed to stock.

Wheat is sown early in September and is harvested in the latter part of June. Alfalfa is mowed first about the 10th of May and every thirty days thereafter until frost. Sorghum is used largely for fodder, but some of the seed is sold. The same applies to Kafir corn, the grain of which is excellent feed for hogs, chickens, and sheep.

Improved machinery is used on all the farms and such labor-saving devices as hay loaders and stackers are common. Large plows usually 16 inches in size are used. Some gang plows and some disk plows are used, requiring 3 or 4 good horses to pull them. The land is usually plowed to a depth of 4 or 5 inches.

Labor is scarce in Riley County and good wages are paid farm hands. The usual wage for a man the year round is \$20 or \$25 a month and board. During harvest laborers are paid at the rate of \$1.50 to \$2 a day with board. The farms vary in size, but usually contain from 160 to 320 acres. Some hold no more than 80 acres and others may own several hundred acres. According to the Twelfth Census the average size of farms for the county is nearly 213 acres. This is probably somewhat higher than the average cultivated farm, as it includes large fenced pastures on the stony uplands of several thousand acres extent.

The larger number of farms are operated by the owners, the exact proportion, according to the Twelfth Census, being 57.6 per cent. The percentage is no doubt much higher now, as the farmers have been quite prosperous during the last few years and many renters have been able to buy farms. Most of the farms now mortgaged are those which have been recently bought by the younger generation, and as a rule the mortgages run for only a few years and are rapidly paid off.

Where farm lands are rented for cash the rent is about \$2.50 an acre, but land is usually tenanted on shares, the owner receiving two-fifths to one-half of all products and furnishing nothing but the land and buildings. Although the farmers have had very good crops for the last few years and are now in a prosperous condition, it is beginning to be realized that a system of soil improvement is necessary. It would add greatly to the natural productiveness of the soil if it were plowed more often and more organic matter turned under. Especially is this treatment needed in case of the upland soils, the Oswego silt loam in particular. The adoption of a rotation in which a leguminous crop is included every three or four years would greatly increase the yields of corn. As alfalfa is considered too valuable to be used for this purpose, cowpeas could be grown and the land thus be greatly benefited. A rotation, consisting of cowpeas, corn, oats, and wheat, on the uplands would doubtless be a good one, and for the bottom lands a rotation of corn with cowpeas every two years or so would be good. To preserve good tilth and improve the texture the soil should be sown to alfalfa or grass for three or four out of every sixteen years.

The farm machinery used by the farmers is modern in every respect, but only a few shelter their farming implements. Leaving the machinery exposed to the weather shortens its life and the use of shelters would prove a great saving.

The farmers cultivate large areas, considering the scarcity of labor, and in order to get over the land rapidly the work is not so thorough as it would be if smaller areas were farmed. Especially is this true in growing corn. A more thorough cultivation of corn, with a practice of adding more manure and plowing oftener, would

add greatly to the corn yield of the section. The farmers are beginning to disk their corn land in the spring before listing. This kills the young weeds and forms a surface mulch which prevents evaporation of soil moisture.

SOILS.

The underlying rocks of Riley County are Permian and consist of interbedded shale and limestone, certain layers of which are very cherty. The county in its northern and eastern parts, as already stated, is a very much eroded and rugged region. The topography here consists of steep stony bluffs and broken slopes, which form deep and rather narrow valleys, and of broken and eroded rolling uplands in the vicinity of large streams. This surface is due to preglacial erosion of the Permian rocks. The deep valleys in the central and western parts of the county, which extend from the rivers far into the plateau or upland prairie, were formed in like manner. The rock deposits lie nearly horizontal, but have a slight dip to the northwest. In places there are evidences of slight depressions in the rock strata toward the stream valleys, which indicate synclines as the basis of the original drainage.

Several miles east of Manhattan, near Zeandale, there seems to be a glacial moraine on the bluff near the Kansas River. This consists principally of a deep deposit of red quartzite, and is thought to mark the southwest limit of the glacial region. Another similar deposit, consisting of red quartzite and granite, exists a few miles north of Cleburne, on the low bluffs near the Big Blue River. This material is found at an elevation of 1,100 to 1,200 feet above sea level, while occasional fragments of sandstone, granite, quartz, and quartzite are found at an elevation of not over 1,250 feet, showing that the glacial waters were dammed by the southeast extension of the glacier across the Kansas River Valley and covered a large portion of the county and the Fort Riley Military Reservation. It is believed by geologists that the ice was several hundred feet thick east of the county, and with the aid of continental depression the glacial waters were dammed and drainage was shifted southward over the top of the Kansas-Neosho divide. This change of drainage perhaps cut the pass in the Kansas-Neosho divide on the high, rolling plateau southeast of Riley County. In the central and western parts of the county no evidences of glacial material are seen, and if the glacial waters covered this region the material deposited was very fine and has since been removed by erosion.

Of the eight soils mapped in Riley County two are of residual origin, five are alluvial, and one consists of water-deposited material constituting the formation called "loess" by Robert Hay in his work

entitled "A Geological Survey of Fort Riley Military Reservation and Vicinity."

The most important residual soil, the Oswego silt loam, is located on the high plateau or prairie, which has an elevation of 1,250 to 1,400 feet. The soil is derived by weathering principally from the underlying shales. The surface soil washes easily, passing down the draws and being deposited in the valleys to add to the alluvial soils. The type is also found quite extensively on the lower uplands at an elevation of 1,100 to 1,200 feet, where its formation is due to the washing away of the glacial material deposited by the glacial waters and the exposing of the shales, which later weathered into the Oswego silt loam.

On the slopes of the high plateau the limestone outcrops and the broken fragments of limestone and chert cover the surface and give rise to the Rough stony land. Beneath the limestone fragments the weathered material consists largely of a yellow and white silt or red and sometimes blue silty clay which seems to be the product of the weathering of limestone and shale. Throughout the stony material near the surface there is found a black silt loam, which may be derived in part from weathering of the rock or, as is more probable, has been washed or blown from the higher areas of the Oswego silt loam.

The loessial soil, the Marshall silt loam, derived from the material formed by the deposition of transported soil from the deflected waters of the glacier, is found usually at an elevation of not over 1,200 feet above sea level, occurring as lower slopes of valleys and on the low, rolling uplands. This type was originally of much greater extent, especially in the lowlands of the county, and has undoubtedly been largely removed by erosion. This material probably constitutes the greater part of the creek bottoms and has been thinly covered with recent alluvial wash from the surrounding hills. The valleys were probably filled much deeper originally, and the material has been removed to a considerable extent by its streams. The alluvial soils of the area are of two kinds. The first class is of recent origin and is found in the first bottoms of the streams, the several types still being added to during the occasional inundations. The Laurel silt loam, the Laurel fine sandy loam, and the Laurel fine sand belong to this division. The texture of the alluvial soils gradually changes from fine to coarse as the river is approached and no well-defined soil boundaries can be located. In going toward the river the silt loam is first encountered, next the fine sandy loam, and last, in the sharp bends and as sand bars, the fine sand, the graduation of one type into another being very gradual.

The second kind of alluvial soils consists of a high bench or terrace in the river and creek valleys. This bench occupies a well-defined,

nearly level position at the sides of the valleys, next the bluffs or upland, and on the river side drops suddenly into the more recent first-bottom deposits. It is seldom overflowed. The boundary between the first and second bottoms is well defined, the border of the bench being 8 or 10 feet higher than the first bottom. This bench reaches into all the creek valleys and constitutes the only bottom of these valleys. It sometimes abuts on the river and forms a steep bluff 30 or 40 feet above the river bed.

This bench was formed by the deposition of silt and clay when the valleys were being overflowed from bluff to bluff, and probably constitutes the loess material covered by alluvial wash from upland slopes. When this material was laid down there must have been wide expanses of quiet waters over the valleys, and the river beds were doubtless much higher than at present. It is probable that at one time the valleys consisted entirely of this second-bottom material and that most of it has been removed by the streams. The Wabash silt clay, or the "black gumbo" soil, is the second-bottom type of the river valleys, and the Wabash silt loam is the almost exclusive type in such topographic position in the creek valleys. In most places the river valley alluvium is underlain at from 20 to 40 feet by gravel beds, and it is into this water-bearing stratum that wells are sunk. The wash from high upland areas into the basinlike areas in the second bottoms forms a poorly drained soil which has been named Wabash silt clay.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Oswego silt loam	193,152	47.6	Laurel fine sandy loam	5,056	1.3
Rough stony land	100,992	24.9	Wabash silt clay	4,992	1.2
Wabash silt loam	42,368	10.4	Laurel fine sand	2,112	.5
Marshall silt loam	39,808	9.8	Total	406,080	.....
Laurel silt loam	17,600	4.3			

OSWEGO SILT LOAM.

The soil of the Oswego silt loam consists of a rather heavy silt loam, varying in color from dark brown under ordinary moisture conditions to black when wet. The depth of the soil ranges from 2 to 4 inches on the high, eroded uplands, from 6 to 10 inches on the high, rolling prairies, and from 6 to 12 inches on the lower slopes of the valleys and on the low uplands. The soil is remarkably uniform in color and texture and is entirely free from stones, except on some of the narrower slopes at the edge of the valleys where it joins the

Rough stony land. Here in some small areas the soil contains small angular flint or chert fragments which have washed down from the higher areas of Rough stony land.

On the eroded high uplands the subsoil consists of a brown or a reddish-brown mottled silty clay, grading at 20 to 24 inches into a light-brown clay which becomes lighter in color and in texture as the depth increases, until at 36 inches it consists of a light-brown or gray silt clay or heavy silt loam. The subsoil was examined to a depth of 36 inches and was often found to contain small irregular lime concretions or unweathered limestone at from 30 to 36 inches. On the high rolling prairies the subsoil consists usually of a dark-brown clay or silt clay, with a slight mottling of red, grading at from 24 to 30 inches into a lighter brown or grayish-brown silt clay which often contains small lime concretions. The texture of the subsoil is usually a heavy clay to a depth of 24 inches. It is very compact, hard, and brittle when dry. When exposed to the surface it bakes hard and cracks considerably during dry weather, but when wet it is quite tenacious. The subsoil contains considerable silt and often consists of a silty clay.

The soil of the Oswego silt loam has excellent tilth if plowed or cultivated at the right time. If cultivated when too wet, it works up into large lumps which dry out into hard clods, making the land difficult to cultivate for a year or longer. When allowed to dry without cultivation, the soil becomes so hard that it can be plowed only with great difficulty. On the high, broken uplands where the soil is shallow the clay is sometimes exposed on the slopes, and these spots are locally termed "gumbo." The "gumbo" spots are difficult to cultivate, owing to the impossibility of plowing or cultivating without stirring up the intractable subsoil. These areas are, however, quite small and unproductive and are usually left in grass.

The Oswego silt loam is the most extensive type of soil in the county. It constitutes the principal soil type on the high rolling prairies in the central, western, and northern parts of the county, where it is found in large connected areas of very irregular outline. Small areas of the eroded phase are found within the areas of Rough stony land, many of them from 1 to 5 acres in extent and too small to be shown on the map. The largest and most typically developed areas of the Oswego silt loam are found in the vicinity of Riley, Leonardville, May Day, and Bodaville, extending westward to the county line. In the vicinity of Manhattan and along the Kansas River Valley slopes and low uplands this type is found quite extensively developed, and good sized areas are found in the southern part of the county on the eroded uplands.

The Oswego silt loam occupies a very rolling to gently sloping topography. It occupies positions at altitudes ranging from 1,050 to

1,200 feet on the edges of the river and creek valleys, and from 1,200 to 1,400 feet on the high rolling prairies. The type is very rolling on the high prairies, and is quite broken on the edges of the prairies where it joins the Rough stony land, but is gently rolling on the edges of the river valleys. No areas have very steep or precipitous slopes and very little of the surface approaches a level condition.

The type is well drained throughout. The prairies are drained by numerous small streams of intermittent flow, which reach in all directions. These small streams, called "draws," empty into large creeks, which flow through all parts of the county, being fed largely by springs which come from the areas of the Rough stony land. During periods of considerable rainfall this type is eroded on some of the steeper slopes where the land is cultivated or is bare of vegetation, and sometimes this washing may do serious damage. In lower areas the soil is always deeper and consequently more productive than on the upland areas.

The Oswego silt loam is derived principally from the weathering of the underlying shales. Only a small percentage of the type is derived from the cherty limestone and consequently very few flint fragments are found in the soil or subsoil. Where the soil is derived from the cherty limestone, the surface soil is very much the same as found elsewhere, but the subsoil is red or reddish-brown in color. These areas are really the Crawford silt loam, and had they occurred in large enough areas would have been so mapped.

In the northern part of the county, in the vicinity of Randolph and Cleburne, fragments of red quartzite, sandstone, and water-worn quartz are to be found in the soil and subsoil. This would indicate that a part at least of the areas which this type now occupies was at one time covered with glacial waters. This foreign material, however, is not found over the greater proportion of the soil.

Where uncultivated the Oswego silt loam is covered with a natural growth of prairie grass, principally blue stem, with small patches of buffalo grass here and there. The soil where it is of good depth is adapted to the production of grass, small grain, corn, and alfalfa, and a number of general farm crops. The crops grown are corn, alfalfa, wheat, oats, sorghum, Kafir corn, millet, rye, and prairie grasses. A small quantity of broom corn is also grown. Corn is an important crop on this type. In the northwestern part of the county, which is not near railroads, a greater amount of corn is grown in proportion to the other crops than on this type in any other part of the county. The yield of corn depends largely on the season, the depth of soil, and the system of cultivation. On the lower slopes, where the soil is deeper, the yields are much higher than where erosion has reduced the surface soil to a depth of only 2 or 3 inches. Yields range from 20 to 40 bushels per acre and sometimes go as high

as 50 bushels. Probably 25 or 30 bushels is a good average for the type. Alfalfa is cut three or four times each year and yields from three-fourths to 1 ton per acre for each cutting, a yield of $2\frac{1}{2}$ tons of cured hay being about the average for a season. Wheat yields from 20 to 35 bushels per acre. Kafir corn is grown largely for fodder, but yields from 25 to 40 bushels of grain per acre. It is chiefly grown on the gumbo phase, as the crop withstands dry soil conditions better than other cultivated crops. Prairie hay yields an average of 1 ton per acre. Sorghum, millet, and rye do well. Apples and peaches do well on this type, but pears are not so successful. Small fruits, berries, grapes, and vegetables yield abundantly, but are grown only in small gardens for home use. The yields given above apply to the better phases of the type. On the eroded spots the yields are less, and these places are usually left in the native growth of prairie grass. During dry years this phase of the type is rather unproductive, but with the proper amount of rain some good yields are obtained.

The cultural methods followed on this type are about the same as practiced throughout the county on all the soil types. No commercial fertilizers are used and little manure, except by a few farmers, though, especially in the western and northwestern sections, more barnyard manure is now applied to the fields than has been customary in the past.

The Oswego silt loam is a valuable soil type, which has been cropped with too little attention to the maintenance of its natural productiveness. Still little of the Oswego silt loam is for sale, and whenever offered for sale the typical soil is held at from \$35 to \$40 an acre, with prices of \$60 to \$75 in exceptionally good locations, as near a town or railroad station.

The reclamation of the eroded areas of this phase and the prevention of its further erosion is a problem which the farmer is beginning to study. It is undoubtedly best not to try to cultivate this phase. It should be broken once quite deeply, alfalfa or grass planted, and allowed to stand for several years. By this means and by the application of manure it may be reclaimed and made quite productive, but owing to its steeply sloping position great care will always have to be taken to prevent washing.

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

Mechanical analyses of Oswego silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>				
15776, 15782.....	Soil.....	0.0	0.6	0.3	1.5	6.9	71.8	17.8
15777, 15788.....	Subsoil.....	.0	.4	.5	4.4	3.2	61.3	30.4

MARSHALL SILT LOAM.

The soil of the Marshall silt loam consists of from 10 to 14 inches of a brown to dark-brown silt loam. The subsoil to a depth of 36 inches is usually a light-brown or reddish-brown to yellow silt loam, but is often composed of a silty clay for the first few inches and gradually changes to a silt loam at 18 inches. Frequently the soil and subsoil contain a considerable quantity of sand. The Marshall silt loam is very easily cultivated and has excellent tilth, excepting areas of the heavier phases, which are much more exacting as to moisture conditions under which plowing may best be done.

The Marshall silt loam is not a very extensive type in Riley County. It is found principally in the southern part of the county and occupies the rolling lands which constitute the highest part of the river valleys. The largest areas are found in the vicinities of Manhattan, Ogden, and Fort Riley.

The type has a gently rolling topography and may be found on hills at an elevation as high as 1,200 feet or as slopes in stream valleys at an elevation of 1,050 feet. It has excellent drainage, being cut by a great number of draws or streams of intermittent flow, which lead into larger adjacent streams. The soil, especially the lighter phase, is subject to erosion and is easily and quickly washed away. As a result ditches and deep ravines with vertical banks are formed. A marked example of this occurs just north of Manhattan, on the north side of Bluemont, where the soil has been washed out and left a ravine about 30 feet deep with vertical walls. The soil is quite retentive of moisture and when cultivated properly is not easily affected by dry weather, except on the very sandy phase.

The Marshall silt loam is undoubtedly an alluvial formation, the result of the deposition of material from water which was dammed by the southern extension of the glacier east of the county. In the northeastern part of the county, and in other places, where considerable red quartzite and waterworn stones are found, this type is found coexistent. Small areas of heavier soil, approaching the Oswego silt loam in texture, are scattered through the typical areas. These are probably due to the fact that the original deposit of Marshall silt loam has been removed and the underlying limestone has entered into the composition of the soil in these local spots.

Where not cultivated the Marshall silt loam is covered with a natural growth of bluestem prairie grass. The crops grown on this soil type are corn, alfalfa, wheat, oats, sorghum, Kafir corn, and prairie grass. It supports small orchards of apples, peaches, etc., and is an excellent soil for vegetables and small fruits and berries. Corn yields from 25 to 50 bushels per acre, oats from 25 to 50 bushels, and prairie hay about 1 ton per acre. Alfalfa may be cut four or five times in one year and averages from 2½ to 3 tons per acre

annually. Kafir corn and sorghum yield very well and furnish large quantities of fodder and grain. All fruits do well, especially apples, peaches, plums, and cherries. Very little is grown for commercial purposes, although in some years apples are shipped to outside markets. Truck crops are grown principally for home use.

This is a very good type of soil, and with proper cultivation to prevent erosion and with a system of rotation to include a leguminous crop the soil may be readily kept in a high state of productivity. The areas on the slopes where considerable wash is brought down from the surrounding hills are more productive than elsewhere.

The cultural methods used on this type are about the same as those used on the other soils of the area. Owing to the readiness with which this type washes, considerable care must be used to prevent erosion. No commercial fertilizers and little manure are added to this soil, and too little organic matter is turned under, and consequently the soil is not as productive as it should be. If more attention were paid to plowing under leguminous crops and barnyard manure the yields of crops would be considerably increased.

The Marshall silt loam is valued at from \$50 to \$75 an acre, depending largely on location. Some of the type in the vicinity of towns is held as high as \$100 an acre, but there is little of it that would bring this price. Agricultural conditions on this type are very good, and the abundant evidences of prosperity show the natural productiveness of the soil.

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

Mechanical analyses of Marshall silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>				
15790, 15794	Soil	0.0	0.6	0.4	3.7	13.6	61.3	19.9
15791, 15795	Subsoil .....	.0	.5	.4	4.7	16.1	57.5	20.4

ROUGH STONY LAND.

The Rough stony land consists of rock outcrop and slopes covered with limestone and flint fragments. The ledges consist of thick strata of cherty limestone. Lower down on the slopes are numerous fragments of limestone varying in size from a few inches to several feet in diameter. The cherty or flinty fragments are usually but a few inches in diameter. The interstitial soil is a black silt loam which is the same in texture as the soil of the Oswego silt loam. At the depth of several feet beneath the rock outcrops and rock fragments, as shown in road cuts, there is a light textured white or

yellowish silt, undoubtedly formed by the weathering of the limestone and shale.

Areas of Rough stony land are found in nearly all parts of the county, forming the valley walls of the river and creek valleys. It exists principally as long strips, the width varying with the size of the valley. Near the river and the larger creek valleys the areas may be several miles wide. As one ascends the streams the strips become narrower, and finally disappear altogether or occur only as occasional small areas on the steeper slopes. Some of the areas in the prairie section of the county where the streams have their sources consist of but a few acres and can scarcely be shown on the map.

The topography of the Rough stony land is abrupt and precipitous in the larger areas. The small areas are confined to slopes which are moderately steep. The type is to be found at altitudes ranging from 1,100 to 1,400 feet above sea level.

As the Rough stony land has such a precipitous topography it is naturally very much eroded. In fact the formation of the type is due to erosion. It is cut by numerous short draws or small streams of intermittent flow. Small areas of Oswego silt loam are to be found on the shelves between the series of slopes and sometimes on the tops of narrow promontories in large areas of the Rough stony land. These areas are too small to be mapped and consist of the eroded phase from which the surface soil has been almost entirely removed by wind and water. There are many springs flowing from the slopes of the Rough stony land, which find an outlet through the numerous draws and branches in this type.

The Rough stony land owes its origin to outcrops of Permian limestone, from which the surface soil has been largely removed by erosion. The soil is being slowly but continuously washed away and more and more rock exposed. The black silt loam that is found in the crevices and fissures has probably been washed or wind blown from the higher areas of the Oswego silt loam.

The Rough stony land is covered by a natural growth of prairie grass. On some of the most stony areas clumps of small sumac bushes grow, and in the narrow ravines or draws a forest growth of burr oak, chestnut, hickory, and box elder has sprung up.

This type is uncultivable and is utilized principally for pastures, some of which contain several thousand acres. All the land is now fenced. A good growth of natural prairie grass covers the type and makes good grazing, and many head of cattle are pastured on it.

The numerous deep draws which extend into the type have narrow valleys, which are so small that they can not be mapped separately. These valleys have considerable washed soil in the bottoms which could be utilized for growing alfalfa. The land is valued at from \$15 to \$20 an acre.

WABASH SILT LOAM.

The soil of the Wabash silt loam consists of from 12 to 24 inches of a dark-brown heavy silt loam, with an average depth of about 15 inches. It is rather heavy, but has excellent tilth and is easily cultivated, except when very wet or dry. The subsoil to a depth of 36 inches consists of a compact and rather heavy brown or yellowish silt loam, and occasionally of a brown silty clay.

The Wabash silt loam is found as long, narrow strips in the creek valleys and along the outer edge of the river valleys. The larger areas are located along Fancy, Swede, Mill, Tuttle, Wild Cat, Deep, and McDowell creeks and their tributaries. Narrow areas of the type occur near Manhattan and on each side of the Kansas, Big Blue, and Republican river valleys. The type is well distributed throughout the entire county.

The Wabash silt loam occupies a rather low position in stream valleys and along gentle slopes. In the former position its surface is very nearly level or gently sloping. It occurs as first bottom, lying from 4 to 20 feet above the smaller streams, and, in the river valleys, as second bottom, rarely ever lying next to the river, and then from 20 to 40 feet above the river bed. The type is seldom overflowed and only in small areas and for short periods. It is fairly well drained naturally and practically none of it requires artificial drainage.

This type is largely a water deposit and can be classed as an alluvial soil. It was laid down when the region was covered with glacial waters. On the slopes and in some of the draws this material is covered with what Robert Hay^a has called loess. The surface soil consists in large measure of material from the neighboring hills, and this process of formation still continues.

The second-bottom areas of this type occurring in the river valleys occupy a bench from 6 to 10 feet higher than the other bottom soils. This would seem to indicate that all the river valleys were at one time composed of this material and that a considerable part has since been removed.

The natural growth on this type consists of prairie grass and some timber, mainly elm, box elder, walnut, oak, etc. Most of the type is in cultivation. It is especially adapted to the production of corn and alfalfa, care being used to have the alfalfa on gentle slopes where drainage is good. Besides corn and alfalfa, some wheat, oats, sorghum, Kafir corn, and native grasses are grown. A few fields of bluegrass have been sown on this type, but good results have not been obtained in all cases, owing to climatic conditions.

Corn is the most important crop and yields from 30 to 75 bushels per acre, 40 to 45 bushels being an average yield in ordinary sea-

^a A Geological Survey of Fort Riley Military Reservation and Vicinity.

sons. Alfalfa, a very important crop on this type, yields 3 to 5 cuttings a year and averages about 1 ton per acre for each cutting. The average annual yield is probably 3 or 4 tons of cured hay per acre. Wheat yields from 20 to 35 bushels per acre, with an average of about 25 bushels. Oats yield from 30 to 60 bushels per acre, but the soil is so rich in organic matter that grain grows too rank and is apt to lodge, and the Wabash silt loam is not a favorite soil for this or the other small grains. The native grasses yield from 1 to 2 tons of hay per acre. Sorghum and Kafir corn also make large yields on this type. It produces good fruit, such as apples, peaches, plums, cherries, grapes, and berries, besides all kinds of vegetables. Fruit and vegetables are grown only in a small way, principally for home consumption and the local markets.

The land is cropped constantly, but as yet the yields have not diminished greatly, although no fertilizer and very little manure is used. The soil is naturally rich in organic matter, which may account for its continued productiveness. Corn is often cropped year after year on this type, and no system of rotation is used. On some farms corn has been grown continuously for fifteen or twenty years on the same land, but it is generally conceded that the yields of such land are diminishing. It is now becoming a practice to change the crops often, but no fixed system of rotation is used. By a rotation of corn, wheat or oats, and alfalfa the soil could be maintained in a very high state of productiveness for an indefinite period.

The Wabash silt loam has an average value of \$40 to \$75 an acre, while in the river valleys and near the railroads and towns it brings as high as \$100 an acre.

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

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>				
15798, 15800	Soil.....	0.0	0.6	0.3	1.7	10.2	68.6	17.8
15799, 15801	Subsoil.....	.0	.3	.3	1.1	7.5	70.5	19.9

LAUREL SILT LOAM.

The texture of the Laurel silt loam is somewhat variable. The typical soil consists of 12 to 15 inches of a brown or gray silt loam, underlain to a depth of 36 inches by a gray silt loam subsoil. This is a river bottom type, and as the river is approached the soil becomes lighter in color and contains an appreciable quantity of very fine sand. Nearest the river the soil may consist of a gray colored, very

light textured silt loam, containing considerable very fine sand. Here the subsoil also contains more very fine sand. In low places the soil sometimes consists of a rather heavy brown silt loam and is underlain by a gray light silt and very fine sand. This type gradually merges into the Laurel fine sandy loam as the river is approached, and no sharp line of demarcation is to be found. Small areas of sandy material are scattered throughout the areas of the Laurel silt loam in the vicinity of the river. The soil is of excellent tilth and, excepting the heavier spots, may be cultivated at any time.

Areas of this type are located in the bottoms of the Kansas and Big Blue rivers. It forms continuous or broken strips along these streams, but reaches only a short distance up their tributaries. In the bends of the larger creeks small areas containing from one-half to 2 or 3 acres are sometimes seen, but it was not found here in areas large enough to be shown on the map.

While, on the whole, the Laurel silt loam has a level topography, during overflows the soil is shifted and washed somewhat in places and, on the lighter phases, the wind has blown the soil about considerably, so that in many places the surface is somewhat uneven. Generally the surface is well drained, and none of the areas require artificial drainage. The texture of the type is such that any surplus water passes downward easily.

The Laurel silt loam is an alluvial soil and owes its origin to the deposition of silt and very fine sand from the overflow waters of the rivers. These overflows do not occur very often, and a number of years may pass without any. Nearly all the type is cultivated, except along the edges of the streams, where there is a natural growth of forest trees, such as elm, cottonwood, walnut, and hickory.

The type is adapted to a large number of crops, but is probably best adapted to the production of corn, alfalfa, and potatoes. Besides these crops, oats, sorghum, Kafir corn, vegetables, apples, peaches, small fruits, berries, and grapes are grown. Corn yields at the rate of 40 to 80 bushels per acre, 60 bushels being considered a very good crop. Alfalfa is usually cut four times and yields about 1 ton of cured hay per cutting. Wheat yields about 20 bushels per acre and has been known to yield 35 bushels. Oats yield from 25 to 40 bushels. Only a small acreage of wheat and oats is planted on this type, as the straw makes a very rank growth and is apt to lodge. Sorghum and Kafir corn do well. Irish potatoes yield from 100 to 200 bushels, according to the season. Vegetables do quite well on this type, but on the whole it is too heavy for melons and other vine crops. All kinds of fruit do quite well, some thriving small orchards being located on this soil. Owing to its light texture and ease of cultivation, this soil will withstand drought quite readily. It is a favorite with farmers and increases the value of adjoining types.

Little of it is for sale, and its value ranges from \$60 to \$100 an acre, according to location and improvements. Railroads run near this type all through the county and doubtless the value of the land is much enhanced by their proximity.

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

Mechanical analyses of Laurel silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>				
15802, 15806	Soil	0.0	1.0	0.5	4.9	15.9	66.6	10.2
15803, 15807	Subsoil .....	.0	.3	.4	2.4	10.9	77.5	7.9

WABASH SILT CLAY.

The Wabash silt clay consists of from 2 to 12 inches of dark-brown or black heavy silt loam, resting on a subsoil of black or brown very waxy and tenacious clay, which extends to a depth of 36 inches. In many places the soil is quite shallow, not being more than 2 or 3 inches deep. The type is not an easy soil to cultivate, for when wet it is rather adhesive, and if plowed in that condition it breaks into heavy clods which prevent thorough cultivation for a long time, while if allowed to dry out entirely without cultivation it becomes so compact that cultivation is very difficult. The type is locally known as "gumbo."

The Wabash silt clay is not an extensive type in Riley County. The two largest areas consist of a strip near the foot of the bluffs along the Big Blue River north of Manhattan and a strip at the foot of the bluffs along the Kansas River west of Zeandale. The type occupies a low flat position on a bench or second bottom, which lies 10 feet above the first bottom—the same bench on which the Wabash silt loam is found. One or two small areas were found in the first bottom. The type is rather poorly drained as a whole, but the most of it is cultivated without artificial drainage, and a few areas are drained by open ditches. Owing to the flat surface and low position of this type, and also to its very impervious subsoil, water stands on the surface for some time after rains unless removed by ditches.

This type owes its origin to water-deposited material, principally clay and silt. It occupies a position at the foot of the high bluffs, and its formation is due largely to wash from the uplands. Very little of the type is overflowed at the present time. It is probable that the soil was formed when the river bed was at a much higher level than at present and when the valleys were overflowed from bluff to bluff and there was a wide expanse of quiet waters.

All of the Wabash silt clay is in cultivation, except a few small areas covered with prairie grass. It is well adapted to grass and where well drained to alfalfa. The crops grown are corn, alfalfa, wheat, oats, Kafir corn, sorghum, and grass. Corn yields at the rate of 40 to 60 bushels per acre. Alfalfa yields from three to five cuttings a year and produces from three-fourths to 1 ton of cured hay per cutting. Wheat yields from 20 to 25 bushels per acre and oats from 25 to 40 bushels. Little grain is grown on this type, as the straw makes such a rank growth that it frequently lodges. Sorghum and Kafir corn yield well. Native grass yields from 1 to 1½ tons of hay per acre. This soil is very strong and productive and is rich in organic matter. No commercial fertilizer or manure is used. It is considered a valuable soil by the farmers and ranges in price from \$60 to \$100 an acre.

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

Mechanical analyses of Wabash silt clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>				
15810	Soil	0.0	0.9	1.1	2.8	2.6	67.9	24.6
15811	Subsoil .....	.0	.4	.9	3.6	.9	59.9	34.4

LAUREL FINE SANDY LOAM.

The Laurel fine sandy loam is a type of soil which has very little uniformity in texture. It consists of quantities of sand and silt which have been washed together by floods and mixed in varying proportions.

In places the soil consists of 0 to 36 inches of fine and medium sand mixed with enough silt to give it a loamy texture. Again, it may occur as 0 to 12 inches of gray fine sandy loam, underlain by brown silt and sand. Sometimes it consists of 8 to 12 inches of sandy material which has been washed by the river onto the Laurel silt loam, in which case the subsoil to a depth of 36 inches consists of a brown or black heavy silt loam. In all cases the soil is loose and easily cultivated, and its sandy texture allows of the ready conservation of soil moisture by cultivation.

The type is located in the bottoms of the Kansas, Big Blue, and Republican rivers. The largest areas are in the Kansas River bottoms near Manhattan. Smaller areas of the type are found in the Big Blue River bottom, usually inside of the larger bends.

The Laurel fine sandy loam lies in a nearly level position. Areas that have been washed by the overflow waters and blown about by the wind give the type an uneven and irregular surface in places. Surface drainage is fairly good, and the loose texture of the soil and

subsoil allows a ready downward percolation of water, so that the type does not require artificial drainage.

The Laurel fine sandy loam is an alluvial soil and owes its origin to the deposition of transported sand and silt from rather freely flowing water. The process is continued during the infrequent floods which occur in these rivers. The last flood, in 1903, formed considerable of this soil by depositing the sandy material on what was at that time Laurel silt loam. These sandy deposits were made to a depth of from a few inches to several feet and little uniformity is to be found in the soil section.

The greater part of the soil is cultivated, but where uncultivated there is a natural forest growth of cottonwood, elm, walnut, etc. The lighter phase is especially adapted to melons, sweet potatoes, and other vine crops. The heavier phase, especially where the subsoil is a black or brown silt, is especially adapted to corn and Irish potatoes. The type as a whole is a good truck soil.

The crops grown at present are corn, alfalfa, potatoes, melons, and vegetables, together with smaller quantities of wheat, oats, Kafir corn, and sorghum. In the vicinity of Manhattan considerable trucking is done. The crops grown for local market and for shipment consist of sweet potatoes, melons, Irish potatoes, and smaller quantities of other vegetables.

Corn yields at the rate of 25 to 50 bushels, alfalfa from 2½ to 4 tons, wheat from 15 to 20 bushels, oats from 25 to 40 bushels, Irish potatoes from 75 to 150 bushels, and sweet potatoes from 75 to 200 bushels per acre. Apples, pears, peaches, plums, cherries, grapes, and berries do well on this soil. Melons and cantaloupes also do well and are grown to a considerable extent.

This land is a good truck soil, but needs plenty of rain for the best results, as it dries out quickly. It is not naturally a very strong soil, and for general farming it soon deteriorates if not cultivated carefully. No fertilizer and little manure of any kind is used. This type is not a favorite with the farmer who wishes to grow grain, but in the vicinity of railroads and towns, where it is used for trucking, it is valued quite highly, being held at from \$50 to \$75 an acre.

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

Mechanical analyses of Laurel fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>				
15786, 15788	Soil	0.1	1.6	2.4	17.8	22.9	47.6	7.0
15787, 15789	Subsoil .....	.1	.5	.8	14.6	24.7	51.4	7.2

LAUREL FINE SAND.

The Laurel fine sand consists of several feet of medium and fine sand, which has been deposited by swiftly flowing waters inside the river bends and near the river banks. In some areas it contains a small quantity of silt, which makes it somewhat loamy. In places along the Big Blue River considerable coarse gravel and small stones are scattered throughout this soil. The sand grains are waterworn and rounded or subangular. This type is found in several small areas in the bottoms of the Kansas and Republican rivers, only a small acreage occurring in the Big Blue River bottoms.

The Laurel fine sand is located at a slight elevation above the river bed. Its surface is rolling, and in large areas it is blown up into dunes. Very little of it is cultivated. In the more loamy areas it produces fairly good yields of watermelons, and corn will yield from 10 to 20 bushels per acre. Kafir corn and sorghum grow moderately well. Most of the type is left to be covered with grass, which prevents drifting. Large numbers of cottonwood trees spring up on this sand and grow rapidly. The type is considered of little or no value and depreciates the value of farms on which it exists. Numbers of wild-plum trees grow on this sand, and it is possible that small fruits would do well on the better phases of the soil. Owing to its slight extent in the county it is not an important soil type.

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

Mechanical analyses of Laurel fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>				
15784	Soil	0.0	2.2	11.5	61.9	15.5	6.3	2.2
15785	Subsoil .....	.0	2.3	13.0	64.9	15.2	2.9	1.7

SUMMARY.

Riley County is located in the northeastern part of the State of Kansas near the geographical center of the United States.

The topography in the southern and eastern parts of the county consists of river and creek valleys, with rough, steep, and stony walls, and with some low uplands which are very rolling. In the central-western and northern parts of the county the topography consists of broad very rolling prairies into which reach the various larger creeks of the area.

The elevations range from 1,000 feet in the valleys to 1,400 feet in the highest uplands. The climate of Riley County is favorable to

agriculture. The summers are long and warm, and the winters have few periods of excessive cold, snow rarely accumulating to a depth of more than a few inches. Droughts and hot winds are of infrequent occurrence, and the average yearly precipitation of 30.36 inches is usually well distributed throughout the growing season.

The area is thoroughly drained by the Kansas, the Big Blue, and the Republican rivers and their numerous tributaries.

The population of the county is about 14,000, and is uniformly distributed over the high rolling prairies and in the valleys. The population in the rugged areas is very sparse. According to the biennial report of the Kansas State Board of Agriculture, in 1904 nearly 54 per cent of the area of Riley County was in cultivation—counting land where prairie grass was fenced—and over 32 per cent of the county was devoted to cultivated crops.

The principal products of the county are corn, alfalfa, wheat, oats, Kafir corn, sorghum, millet, prairie hay, apples, grapes, berries, peaches, sweet and Irish potatoes, melons, and other vegetables. Considerable stock is raised, consisting principally of beef cattle, hogs, and horses. Cattle and sheep are shipped into the county to be fattened for market. Poultry and poultry products are an important item. Cream separated by small hand separators on the farms is shipped to Topeka and some western towns. Kansas City is the principal market for the county, but some truck products are shipped to western towns. The most of the corn, alfalfa, prairie hay, sorghum, and Kafir corn is utilized in the county for feeding purposes. Some grain is shipped out of the county in years of very good crop yields.

No fixed system of crop rotation is followed. The farmers are beginning to plow their land more frequently, and the practice of listing land year after year without plowing is disappearing. Most farmers try to change the crops grown on the land every year or two and to plow the land at least once every three years. This often leads to a rotation of corn, oats, and wheat. No commercial fertilizers are used, and only a few farmers utilize barnyard manure. Labor is scarce and high. From \$20 to \$25 a month is usually paid for hands the year round, and during harvest \$1.50 to \$2 a day is paid. Corn husking is paid for at the rate of 3 cents per bushel, including board.

Where the surface soil has not been removed by erosion the Oswego silt loam is a very valuable soil type and is especially adapted to wheat and oats. It produces good yields of corn, alfalfa, sorghum, Kafir corn, millet, and prairie hay and is utilized for these crops more extensively than for small grain, owing to the fact that large numbers of stock are raised and fed in the county. Kafir corn is

grown largely on the eroded areas of the type where the surface soil is quite shallow or entirely absent. The areas of this eroded phase are kept in prairie grass to a great extent. The soil is valued at from \$25 an acre for the poorer phases to \$50 an acre for the better phase.

The Rough stony land is uncultivable and is utilized for pasture land. It is valued at about \$15 to \$20 an acre.

The Marshall silt loam is a good soil for small grain, corn, and alfalfa, and the yields obtained are about the same as on the Oswego silt loam, or possibly a little higher. The type is well located with reference to railroad facilities, and is valued at from \$40 to \$60 an acre.

The Wabash silt loam is a very productive soil and is especially adapted to corn and alfalfa. It is used, however, for all the other crops produced in the area. Small grain does well, but is apt to make a very rank growth and lodge. The type is valued at from \$40 to \$75 an acre.

The Wabash silt clay is the only soil in the area which is in a poorly drained condition. It is easily drained by ditching, and produces excellent alfalfa when drained. It is good for corn and other crops, but is often difficult to cultivate when wet or very dry. Small grain does well, but often lodges. The type is valued at from \$50 to \$75 an acre.

The Laurel silt loam, a river-bottom soil, is very productive and is valued highly by the farmers. All the general farm crops are produced on it, but corn and alfalfa do best. Good yields are obtained, the soil is very easily cultivated, and overflows are very rare. The price of the land depends upon its location, and ranges from \$60 to \$100 an acre.

The Laurel fine sandy loam is utilized for corn, alfalfa, trucking, and general farm crops, good yields being obtained. It holds moisture well, and in the vicinity of Manhattan, Ogden, and Zeandale is used largely for truck gardening. Sweet and Irish potatoes, melons, and cantaloupes are the principal truck crops. The type is valued at from \$40 to \$60 an acre.

The Laurel fine sand is simply waterworn quartz sand washed onto the banks of the river during floods. A slight quantity of organic matter is found in the older areas and these sometimes produce fairly good watermelons, and the more loamy phases sweet potatoes. It drifts into dunelike mounds and is valued at a very low figure. No large areas of the type are found in the county.

The transportation lines passing through the county are the main line of the Union Pacific, the main line of the Chicago, Rock Island and Pacific, the Leavenworth, Kansas and Western, and the Manhattan and Blue Valley railways, the latter being a branch of the Union

Pacific. These lines give adequate railway service to all parts of the county, excepting the extreme northwestern part. The county roads are fairly well kept and except when wet are very good. In the broken and stony areas the roads are very rough and grades are often quite steep. Abundant material for improving the roads is found in the large quantities of limestone in the county, but this is utilized very little for this purpose. The roads are worked regularly and good road machines are used.

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