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Soil Survey
of
Wilson County, Kansas

By

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and
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Kansas Agricultural Experiment Station

Bureau of Chemistry and Soils

In cooperation with the Kansas Agricultural Experiment Station

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SOIL SURVEY OF WILSON COUNTY, KANSAS

By J. A. KERR, U. S. Department of Agriculture, in Charge, and J. T. WHETZEL and H. W. HIGBEE, Kansas Agricultural Experiment Station

COUNTY SURVEYED

Wilson County is in the southeast part of Kansas in the second tier of counties north of the Kansas-Oklahoma line and in the third tier west of the Kansas-Missouri line. (Fig. 1.) The county is approximately 24 miles square and has a total area of 575 square miles, or 368,000 acres.

The surface features of the county comprise a series of plains crossing the county from north to south, each plain lying higher than the one bordering it on the east. These plains are separated by steep slopes ranging from 100 to 150 feet in height. The present relief was caused by erosion of a series of alternately hard and soft beds of rock. Occasional steep-sided rock-capped mounds or buttes, remnants of the next higher formation, rise from the plains. The formations are nearly horizontal from north to south but have a fairly regular dip toward the northwest, and the plains tend to slope accordingly, so that the western part of the county does not, on the whole, appear much higher than the eastern part. However, it is considerably higher. The eastern and central parts of the county, except for comparatively narrow escarpments, are mainly smooth or gently rolling, and the western part is rather hilly, with many steep stony slopes near the western boundary.

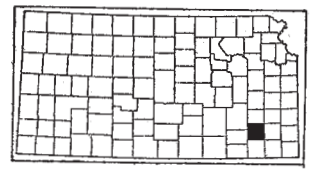

FIGURE 1.—Sketch map showing location of Wilson County, Kans.

The county may be considered as including three principal plains, with a fourth, less extensive and partly merged with the third, on the western border. Each of the three main plains occupies approximately one-third of the county. They are somewhat irregular in outline and extend in a general direction a little west of south.

The lower or eastern plain is gently undulating, with continuous slopes to the streams, which give adequate surface drainage. The slopes are generally more pronounced along the streams. The area north of Pleasant Valley Church is apparently not strictly a part of this plain but occupies a position intermediate between the eastern and central plains. Pleasant Valley is inclosed by low breaks from this plain and by a long narrow mound on the south. South of the mound the land is again gently sloping, but in the extreme southeast part of the county the upland gradually rises to a much greater height, and for some distance back from the streams is very hilly. The breaks on the west border of the plain are not pronounced in the northern part of the county, but farther south and west, where

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they approach or border the bottoms of Verdigris River, they become high, steep escarpments, reaching a maximum height of about 150 feet at Neodesha. The escarpments extend back along Verdigris and Fall Rivers to the northwest for several miles, gradually becoming lower.

The central plain is distinctly a dip plain, sloping to the west or northwest in accordance with the dip of the underlying limestone. The upland is a series of gentle slopes to branching, westward-flowing streams. Along the western border of this plain a belt of comparatively low flat land extends almost continuously across the county from Buffalo to Lafontaine. This belt is a mile or two wide in most places, but between Fall and Verdigris Rivers, north of Fredonia, it is approximately 4 miles wide.

The third plain does not conform closely to the dip of the formations which are of shale with interbedded sandstone not sufficiently thick or hard to be greatly resistant to weathering. This plain is dissected by the two rivers, and numerous small rather direct branches of the rivers have produced rolling areas, with plateau surfaces developed locally at various heights. The escarpment on the eastern border of the plain is in most places low. In the vicinity of Buxton, in the southwest part of the county, lies an extensive area of rather smooth relief.

The fourth plain extends along the western boundary of the county, averaging about a mile in width in the southern part and 2 or 3 miles in the northern part. Its escarpment is high and stony and is marked by a growth of scrub oak. Many stream heads have cut back into the plateau for some distance, so that its outline is rather irregular and the surface mainly rough. The higher land is undulating or rolling.

The elevation at Star School, in the southeast part of the county, is 871 feet above sea level; at Neodesha, 817 feet; 4 miles west of Neodesha in the central plain, 1,018 feet; at Lafontaine, 918 feet; at Buxton in the western plain, 979 feet; and 1 mile northwest of Buxton, 1,059 feet.

Verdigris and Fall Rivers enter the county at the northwest and middle-west borders, respectively, and converge in the southeast quarter. Their flood plains are from 1 to 2 miles wide, except in the limestone area of the central plain, where the streams have formed only narrow, steep-sided valleys for some distance. Numerous branches of these streams extend to all parts of their watersheds, which are rather narrow within the county, some drainage in the northeast and southwest parts being carried by rivers outside the county. Well-defined stream channels extend at fairly close intervals to all parts of the county, although some comparatively small, very flat areas, of which the largest is the flat northwest of Fredonia, are not adequately drained.

The area now included in Wilson County was a part of the Osage Indian Reservation until 1866, when the greater part was withdrawn as trust lands, was surveyed, and offered for sale to settlers. The county was organized by the first legislature in 1855 and included what is now Montgomery County, which was taken away in 1867. The first settlement was made in 1857, and prior to 1866 settlers were few, but by 1870 the county was well settled. The first railway in

the county was constructed along Fall River in 1879. In 1880 the population was 13,775, and 70.2 per cent of the land of the county was in farms. In 1920 the population was 21,157, of which 7,897 was classed as urban. In that year 89.7 per cent of the land was in farms. The population is most dense in the central and eastern parts of the county, where there is considerable industrial development. Much of the land in the western part is best suited for cattle range.

The principal towns are Fredonia, the county seat, and Neodesha which is in the southeast part. Gas and oil were discovered in the early days of the development of the county, and some drilling is still being done. With local gas for fuel, the manufacture of brick, glass, and Portland cement became important industries. A large oil refinery is at Neodesha. The local towns provide good markets for much of the farm products, and the grain crops are marketed at local elevators and mills. Flour mills are operated at Fredonia and Altoona. The principal market for livestock and prairie hay is Kansas City.

The county is well supplied with railroad facilities, lines of the Atchison, Topeka & Sante Fe, the Missouri Pacific, and the St. Louis-San Francisco railroad systems extending through it. The county roads are well maintained. Local deposits of gravel provide good surfacing material, with which the principal highways are graveled.

CLIMATE

Wilson County has a distinctly humid climate. The mean annual rainfall of 37.05 inches is favorably distributed throughout the year, that of the growing season being typical of the Corn Belt in this latitude, especially during the months in which corn requires the largest amount of moisture. During fall and winter the rainfall is light but is sufficient for a good growth of wheat. The mean temperature, as given in Table 1, indicates that the average winters are rather mild and the average summers not excessively hot. However, in all seasons the range in temperature is considerable, with short periods of extreme weather, characterized in summer by great heat, accompanied by dry, hot winds, which wilt growing crops badly, and in winter by temperatures falling below zero for a few days at a time. Light snowfalls are not uncommon, but the snow seldom remains on the ground for a great length of time.

The average date of the last killing frost is April 14 and that of the first is October 16, giving an average frost-free season of 185 days. Killing frosts have been recorded as late as May 9 and as early as September 26. Table 1, compiled from the records of the Weather Bureau station at Fredonia, gives the normal monthly, seasonal, and annual temperature and precipitation for Wilson County.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Fredonia, Kans.*

[Elevation, 864 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1917)	Total amount for the wettest year (1915)
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*
December	35.4	71	−9	1.17	0.41	1.10
January	33.2	74	−21	1.34	.21	2.03
February	35.6	83	−9	1.74	.06	4.75
Winter	34.7	83	−21	4.25	.68	7.88
March	47.2	94	8	2.30	2.51	2.60
April	56.9	95	24	3.48	3.68	6.80
May	65.9	96	26	5.19	4.14	7.06
Spring	56.7	96	8	10.97	10.33	16.46
June	74.6	110	45	5.13	1.92	7.73
July	79.1	111	53	4.07	1.64	6.56
August	78.6	111	44	4.06	6.50	4.37
Summer	77.4	111	44	13.26	10.06	18.66
September	71.5	106	32	3.65	2.15	10.14
October	59.9	95	14	2.99	.65	1.89
November	47.8	86	5	1.93	.22	.21
Fall	59.7	106	5	8.57	3.02	12.24
Year	57.1	111	−21	37.05	24.09	55.24

AGRICULTURE

The agriculture of Wilson County has consisted mainly of general farming and livestock raising. The grazing of cattle was the dominant industry during the earliest years, but this industry did not long continue on a large scale after settlement began. By 1880 about 70 per cent of the area of the county was in farms, and cattle were more generally grazed within fenced pastures in summer and fed largely on prairie pastures in the winter. Corn was the principal grain crop and, with prairie hay for forage, was largely used for winter feed for cattle. According to the census the acreage of the farm crops in 1879 was as follows: Corn 57,525 acres; oats 6,014 acres; wheat 16,342 acres; and hay 21,709 acres. About three-fourths of the land remained in prairie grasses, providing range and hay for livestock. At that time crop production was more hazardous than later. In some seasons hot winds withered the crops, and in others grasshoppers or chinch bugs did great damage. Later the hot winds became much less severe, and the insects did not appear in swarms.

In 1919, the acreage in farm crops was a little less than half the total acreage of the county, the remainder being principally prairie land. On most farms some prairie land has been left for pasture and hay. A large proportion of the upland, especially in the western part of the county, west of Buffalo, Fredonia, and Lafontaine, is not well suited to cultivated crops, and it remains in sod.

Although the industrial development of the county has provided an increasing market for dairy and poultry products, considerable quantities of grain have always been sold as cash crops; in fact, on many farms, not only on the river bottoms but also on the uplands, grain has been the principal source of income. The fertility of the upland has been reduced by continuous cropping to grain, and it is now generally recognized that a more systematic rotation of crops, including a legume, is advisable. It is also recommended that more livestock be carried and the manure applied to the land. Alfalfa is now grown to some extent on many upland farms for feeding dairy cattle. On a few farms some commercial fertilizer is used.

The types of farming practiced at present differ somewhat according to character of the soil. The most productive soils are in the river bottoms. On these, corn, wheat, and alfalfa are the principal crops, with prairie hay on poorly drained areas. Much of the grain is sold. On many farms the adjoining upland is best suited to pasture, and cattle are pastured there in summer and fed in the bottoms throughout the winter. To a considerable extent the pastures are operated independently, cattle being bought in the spring and marketed in the fall. Local farmers sell some grain and forage to the cattle owners. Hog raising is also engaged in on these farms.

On the uplands throughout the eastern part of the county diversified farming is practiced. Corn, kafir, wheat, oats, and prairie hay are the principal crops. On soils naturally suited to alfalfa, a considerable acreage is grown. A few head of dairy cattle and hogs are carried, but commonly not enough to use all the grain produced.

Dairying is the main source of income on many farms, from which milk is sold to supply the local demand, and a few farmers sell milk and cream to local creameries or stations. Ordinarily, however, only from two to five milk cows, with young animals in proportion, are carried.

Corn is the leading grain crop of the county. In 1919 corn was grown on 19,451 acres and kafir on 7,847, the acreage in that year being unusually small. In 1924 the reported acreage of corn was 45,014 acres and of grain sorghum, 18,965 acres. On bottom lands and also on many upland farms some corn is marketed. Good yields range from about 40 bushels on fertile bottoms to 20 bushels on uplands.

Kafir is grown on a large acreage on upland farms. The proportion of kafir and corn grown varies according to the type of soil, but corn is grown on a considerable acreage where kafir outyields it, because the corn is less expensive to harvest and is preferable for sale or for feed. On most farms the kafir is cut with a binder, and the fodder is cut for winter feeding, but a considerable acreage is headed, and cattle are allowed to run in the stalk fields for a time.

Milo and feterita are grown by a few farmers, but the total acreage is small. Some sorghum is also grown for forage, but Blackhull and Pink varieties of kafir are the standard grain sorghums grown. The crop is commonly grown on the same land for several years, as the first crop of other grain following kafir is generally poor.

Wheat is commonly grown on both bottom and upland farms. The acreage has varied considerably from time to time, reports for census years ranging from about 9,000 to 17,000 acres until 1919, when, because of the World War, it was increased to 58,617 acres. Spring wheat has been grown and its culture was resumed to some extent during the war, but ordinarily only winter wheat is grown, as it matures before the droughty periods ordinarily occur and is therefore a more satisfactory crop than corn on shallow but fertile soil. To some extent, it is desirable to grow wheat in large fields, as wheat harbors chinch bugs and adjoining fields are infested after harvest. Hard wheat is grown to a considerable extent on the uplands, but the soft varieties do better in the bottoms. Yields ordinarily range from 10 to 20 bushels in the uplands and from 20 to 30 bushels on bottom land or on specially fertile upland.

A small acreage of oats is grown for feed on most farms. Yields are variable, as the crop requires good moisture conditions at heading time to produce well, but it matures fairly early and generally yields well on both bottoms and uplands.

The acreage of alfalfa increased from 1,559 acres in 1899 to 15,107 acres in 1919, but has decreased considerably since. It is grown principally on the bottom soils and on Summit silty clay loam. On these soils it requires no special preparation and thrives well, from three to five cuttings being obtained, with total yields of 4 or 5 tons to the acre. On the upland soils having acid surface soils it is grown without liming on land manured each year. Liming is recognized as advisable and is coming into practice. The crop is generally baled in the field, even for home use. The weather conditions are generally favorable for curing the hay, so that it can be dried in the swath into good condition for baling.

Prairie hay was harvested from 28,664 acres in 1919, yielding 35,202 tons. The hay for home use is cut from comparatively small fields reserved for this purpose, and as a cash crop it is cut from large bodies of claypan or shallow soils and from low bottoms. On such soils, land in virgin prairie is valued at a higher price than land in cultivation. The hay from the uplands is finer than that from the bottoms, and that from limestone soils is considered more nutritious than that from the Bates soils. The grasses are species of Andropogon. On the uplands only one cutting is generally made, in July. The later grass growth may be pastured or cut, but over a period of years the single cutting has proved most profitable. Two cuttings are generally made in the bottoms. A common practice is to burn over the meadows in spring to remove any stubble or dead growth. The mowed lands are almost free of weeds, in contrast to many adjoining weedy pastures.

Silage crops were grown on 1,360 acres in 1919, the yield being 7,304 tons. Corn, kafir, and sorgo are cut for silage which is used on dairy farms and for wintering beef cattle. Coarse forage was grown on 8,414 acres in 1919, yielding 18,467 tons. Sorgo and, to some extent, kafir are fed in this way.

Flax has been grown on a small acreage, decreasing from 6,094 acres in 1889 to 1,776 acres in 1919. The acreage was increased to 6,346 in 1924. Flax is said to produce best on land not long under cultivation.

Clover and timothy, grown separately or mixed, were grown on a total of 542 acres in 1919, whereas in 1909 timothy had been grown on 1,576 acres, clover on 1,382 acres, and timothy and clover mixed on 8,000 acres. The yields reported were all a little more than a ton to the acre. Alfalfa has almost supplanted these hay crops, although a few fields of both red and alsike clover were seen on the uplands.

At the taking of the 1920 census, the numbers of the important livestock in the county were as follows: Horses, 9,467; mules, 1,895; beef cattle, 14,593; dairy cattle, 9,875; sheep, 2,028; and swine, 14,724. There were 174,756 chickens.

Beef cattle are bred to some extent, but a large proportion of the cattle are shipped in from southern ranges in the spring, carried through one or two grazing seasons, and marketed at Kansas City in the fall.

For the most part the crops of the county are not suited to any especially advantageous short rotation, because the most effective rotation includes a hay crop at short intervals. Here much of the hay is cut from the permanent prairie grasses, and alfalfa is the common tame hay. These, together with the forage from kafir and sorgo, fill the requirements for hay and forage. The alfalfa stands are left for several years, ordinarily as long as they are good. Following alfalfa, very good crops of grain are obtained for several years, and where a large proportion of the land is well suited to alfalfa, some farmers plow down good stands after two or three years in order to rotate crops; but where only a part of the farm is naturally well adapted to alfalfa or where land must be limed and manured for it, the other fields are used for grain crops.

Fertilizer was used on only 16 farms in the county in 1909 and on 90 farms in 1919, the expenditure for fertilizer in that year amounting to $10,772. Some farmers use lime in preparing acid soil for alfalfa, and some use small applications of phosphatic fertilizer on wheat.

Most farms are equipped with good buildings and machinery. Three-horse or four-horse implements are used to a considerable extent, and tractors are used on the larger farms. Hay is harvested with a minimum of labor, being commonly baled from the windrow. Wheat is generally cut with tractor-drawn binders and threshed from the shock on the larger farms. At present a few farmers are trying small combines.

Labor was hired on 70.5 per cent of the farms of the county in 1919, the average labor expense on each farm being $416.74. In 1909, under more normal conditions, labor was hired on 38 per cent of the farms, at an average expense of $135.07 a farm. At present, on most farms, the work is ordinarily done by members of the family and by exchange of labor, and the comparatively small requirement for hired labor is fairly well supplied.

The average size of farms was 173.9 acres in 1920. There is a considerable range in size of farms in the county, especially in the amount of pasture land included. The usual size is between 80 and 160 acres. The 1920 census reported that 56.8 per cent of the farms were operated by owners, 42.7 per cent by tenants, and 0.5 per cent by managers. Tenancy is mainly on the share system, the

owner commonly receiving half the wheat and a third of the other crops.

The bottom lands and the Summit soils are the most productive and valuable lands of the county. In their present unleveed condition, the river bottom lands vary in value according to extent of overflow, so that the Verdigris soils are more desirable, but the comparatively high-lying Osage soils are also valuable land. Large rolling areas of the Summit soils have been worn to a silty clay texture and are in a comparatively poor state of cultivation. Present values of the bottom lands and the better Summit soils range from $60 to $100 an acre; of the upland soils with friable subsoils, such as the Labette and Crawford soils, from $40 to $75; of the Gerald and Cherokee soils from $30 to $50; of the shallow Bates soil and the stony Summit and Crawford soils, all of which are pasture land, from $15 to $30.

SOILS

The soils of Wilson County have been identified as members of a number of soil series most of which are known to occur in other parts of the United States. Each soil series consists of one or more soils. The soils within a series differ from each other in the texture of the surface soil, but are essentially alike in other respects.

In the following pages the various soils of Wilson County are described in detail and their agricultural adaptation is discussed; the accompanying map shows their distribution, and Table 2 shows their acreage and proportionate extent.

TABLE 2.—*Acreage and proportionate extent of soils mapped in Wilson County, Kans.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Bates loam	32,448	10.7	Summit silt loam	6,528	4.1
Deep phase	7,104		Shallow phase	8,640	
Bates silt loam	11,648	5.3	Cherokee silt loam	12,864	5.5
Deep phase	7,616		Shallow phase	7,424	
Bates fine sandy loam	3,072	3.7	Parsons silt loam	56,768	15.4
Stony phase	10,816		Parsons silty clay loam	5,760	1.6
Bates shale loam	16,640	4.5	Riverton silt loam	1,856	.5
Labette silt loam	24,896	6.8	Riverton gravelly silt loam	1,920	.5
Crawford silt loam	21,760	6.3	Verdigris silt loam	24,384	6.6
Shallow phase	1,408		Verdigris fine sandy loam	6,144	1.7
Crawford stony silt loam	3,776	1.0	Osage silty clay loam	20,544	5.6
Crawford fine sandy loam	576	.2	Osage silt loam	5,696	2.2
Crawford loam	1,088	.3	Poorly drained phase	1,344	
Crawford clay	512	.1	Shallow phase	896	
Summit silty clay loam	22,400	8.0	Heavy-subsoil phase	384	
Shallow phase	6,848		Osage clay	5,568	1.5
Summit stony silty clay loam	22,400	7.8	Mine dumps	128	.1
Slope phase	6,144		Total	368,000	

BATES LOAM

The surface soil of virgin Bates loam is brown loam or fine sandy loam moderately darkened with organic matter. At a depth ranging from 8 to 14 inches this material passes into the friable granular heavy loam, fine sandy clay, or very fine sandy clay subsoil which is buff, greenish yellow, or reddish yellow. The color in this layer may be uniform or it may be considerably mottled with reddish yellow, light red, or dark green, according to the rock from which the sub-

soil material is derived. Much of the shale rock is of a dark-greenish cast, whereas the more sandy rock being porous, tends to oxidize to a somewhat reddish color. Some shale is distributed throughout the subsoil, and at a depth ranging from 15 to 30 inches the soil is underlain by noncalcareous shale and sandstone.

Both surface soil and subsoil are strongly acid. The dark color of the surface soil is ordinarily much less pronounced than in soil derived from calcareous rocks and is less persistent under cultivation. The surface soil is characteristically shallow both in level areas and on slopes.

The underlying rock ranges from silty or clayey shale to porous fine-grained sandstone. Much of it is of intermediate texture and has a considerable content of very fine sand. The layers of shale and sandstone are so closely interbedded that the overlying soil is somewhat variable in texture and thickness. On level areas most of the underlying rock is sandstone, and the soil is loam or fine sandy loam. On gentle slopes most of the sand is very fine.

Bates loam occurs extensively throughout the western part of the county and in the southeast corner, occupying smooth or gently rolling areas. Probably three-fourths of it is in native prairie grasses and is used mainly for pasture. Some large holdings include 1,000 or more acres of this and associated soils. The grass on this noncalcareous soil is of the same general type (Andropogon) as that on the calcareous soils in this county and Greenwood County, but it is considered by cattlemen to be less nutritious, although no difference is recognized on hay markets. The stand of grass varies, because of overgrazing of some tracts, but generally about 3 acres of pasture are required for each steer. Thin cattle from the southern ranges gain about 300 pounds in a season when pastured on this land. The grazing season lasts from April until frost occurs in the fall, approximately six months.

On manured pasture land, such as bedding ground and small farm pastures, considerable bluegrass grows, together with thin stands of Lespedeza. Some abandoned farm lands furnish weedy pasturage which slowly reverts to the native grasses.

A considerable acreage of native grasses is cut for hay which yields from one-half to three-fourths ton to the acre in dry seasons and a ton or more in good seasons. Usually only one cutting is made, some time in July. A later cutting may be taken, but in the long run the single cutting gives the largest yield.

The farmed land largely represents the smoother, less shallow, and to a considerable extent the more sandy areas of this soil. Soil 2 feet deep appears to stand drought nearly as well as deeper soil. Yields vary widely, depending on many conditions. In general yields of kafir range from about 20 to 40 bushels to the acre, corn from 15 to 25 bushels, and wheat from 12 to 20 bushels, and oats produce about 25 bushels. Some Sudan grass is grown and is said to produce good yields. Red clover was formerly grown to some extent. Alfalfa yields well without liming on land manured yearly. On most farms grain crops have been grown almost continuously for years, consequently the land has gradually become less productive and even on gentle slopes is susceptible to washing.

To prevent erosion, a hay crop is needed for rotating. Some land, which was originally rather shallow and rolling, has been abandoned.

On some small farms truck farming and orcharding are carried on. The common truck crops, potatoes and especially melons, do well on comparatively fresh or manured land. In the more rolling areas, the high locations are of some advantage in reducing the danger of untimely frost, and a few farmers have well-kept orchards of Winesap and Ben Davis apples and Elberta peaches.

Bates loam, deep phase.—The deep phase of Bates loam is similar to the shallower soil except that the subsoil is free or nearly free of shale and the depth to bedrock is greater, in most places at least 3 feet. Some areas of the deeper soil occur in situations similar to those in which the shallow soil commonly occurs. Typically, however, soil of the phase occupies lower, graded slopes and benches along the valleys. The greater depth is apparently the result partly of deeper weathering and partly of the accumulation of colluvial or outwash material from the hills. At the mouths of many ravines are large deposits of friable fine sandy loam outwash, very deep near the ravine and thinning out toward the sides and down the slope. Between ravines the surface soil in many places is rather sandy owing to material washed down the slopes.

Numerous so-called "alkali" spots occur throughout this soil. In such spots, the soil material beneath a thin loose surface layer is very dense and heavy and in places continues to a depth of 10 feet. It is alkaline in reaction to or nearly to the surface. In dry weather white material forms on the surface of bare spots and impure crystals, mainly lime sulphate or gypsum, are scattered throughout the clay. Numerous iron concretions and some lime are present. The native grasses grow fairly well on these spots, and alfalfa makes some growth, but the spots are very droughty and almost untillable, so that most cultivated crops make little growth.

About two-thirds of the land is under cultivation, mainly to corn, kafir, and oats. Kafir yields from 20 to 40 bushels to the acre, corn from 15 to 30 bushels, oats from 20 to 40 bushels, and wheat from 12 to 20 bushels. Alfalfa yields fairly well on land which is manured annually. Much of the land has been farmed almost continuously to grain crops for years, and yields are becoming lower.

BATES SILT LOAM

The surface soil of Bates silt loam typically consists of an 8 to 12 inch layer of dark-brown silt loam underlain by friable granular yellow or greenish-yellow silty clay loam. At a depth ranging from about 12 to 24 inches this material is underlain by thin-bedded dark olive-green and yellow noncalcareous shale.

This soil occurs in association with Bates loam in the western part of the county and is fairly extensive. Agriculturally, no marked distinction can be made between the silt loam and the loam, their use and productiveness varying similarly according to the depth of soil, topography, and years of use. However, the lighter texture of the loam affords somewhat better moisture conditions, other things being equal. A large proportion of the silt loam is on slopes, which are occupied mainly by native prairie grass.

Bates silt loam, deep phase.—Bates silt loam, deep phase, closely resembles typical Bates silt loam, but the subsoil of the deep phase, below a depth of 15 or 20 inches, is finely mottled with red, olive-green, and light-gray material, together with a few small dark-brown concretions. At a depth of about 3 feet this is underlain by yellow and gray rather compact clay or, less commonly, by non-calcareous shale. In most places the bedrock lies at an undetermined depth. Some areas of this soil along Verdigris River, near Farmdale and across from Altoona, may be from alluvial deposits. The soil occurs in smooth areas in association with other Bates soils. Under tillage the color of the surface soil is not so dark as that of Labette silt loam. Both surface soil and subsoil are acid. In some places the substratum is alkaline. In some areas the subsoil shows a slight tendency toward compaction.

This soil is regarded as a fair farm soil and is mainly under cultivation. Corn ordinarily yields from 20 to 35 bushels to the acre, oats from 20 to 25 bushels, wheat from 12 to 15 bushels, and kafir from 20 to 40 bushels. Sweetclover and alfalfa require liming for good growth, though they may be grown on manured land without liming. Areas remaining in the native prairie grasses provide good pasturage or give good yields of hay.

BATES FINE SANDY LOAM

The surface soil of Bates fine sandy loam consists of a layer of dark-brown fine sandy loam, well darkened with leaf mold in the topmost part and somewhat darkened to a depth of 3 or 4 inches, passing into light-yellow or somewhat grayish-yellow light fine sandy loam which extends to a depth ranging from 10 to 18 inches. It is underlain by yellow friable fine sandy clay. At irregular but slight depths the soil is underlain by brown soft porous sandstone. The soil is strongly acid throughout.

This soil occurs mainly in one area including several square miles on a high plateau in the west-central part of the county. The land is undulating. Most of this land is in forest consisting of scrub oak, blackjack oak, and a variety of white oak, but a few small areas have been cleared for farming. The less shallow soil produces fair crops of corn, kafir, and oats, but some of the cleared land has been abandoned, as the soil is not well suited to farming. The forest growth is too stunted to make good timber. The land is of little value except for the few gas wells on it.

Bates fine sandy loam, stony phase.—The surface soil of Bates fine sandy loam, stony phase, is loose yellowish-brown or brown fine sandy loam, somewhat darkened with leaf mold in the topmost layer. Below a depth ranging from about 3 to 6 inches is yellow, pale-yellow, or reddish-yellow fine sandy loam or sandy clay. Bedrock of reddish-brown, brown, or gray noncalcareous sandstone lies at a slight depth. Rock outcrops are common, and fragments of rock are scattered over the surface. This soil occurs extensively in the extreme western part of the county and to some extent in the southeastern part, occupying high steep escarpments. In places it occupies part of the adjoining plateau, and here the soil is very shallow rather than stony. At the breaks are occasional ledges or

cliffs 8 or 10 feet high. Nearly all the land supports a rather heavy forest growth of stunted oak, but some of the steeper stony land is in grass. The land is nonagricultural and is of little value as forest land.

BATES SHALE LOAM

The surface soil of Bates shale loam is mainly dark reddish-brown or chocolate-brown silt loam or loam, passing, at a depth ranging from 4 to 8 inches, into lighter reddish-brown friable silty clay loam. The bedrock, which lies at a slight depth, consists of interbedded brown noncalcareous fine-grained sandstone and shale and reddish-brown calcareous shale, with a little limestone. Fragments of the red shale are scattered throughout the soil and over the surface. The topmost part of the surface soil is generally acid, but at a slight depth the soil is alkaline.

Bates shale loam is rather extensive. It supports a good growth of the native prairie grasses and, in connection with adjoining Bates soils and shallow or stony Summit soils, is used for grazing cattle. The grasses on the Bates soils are not considered so nutritious as those of the same species on the calcareous soils.

LABETTE SILT LOAM

The surface layer of Labette silt loam typically consists of dark-brown silt loam, which passes at a depth ranging from 8 to 14 inches into yellowish-brown or light-brown friable silty clay loam, and this layer, in turn, grades abruptly into the friable silty clay subsoil, which is finely mottled with brown, yellowish-brown, and reddish-brown spots. The material breaks on exposed banks into a mass of small somewhat rounded particles which are dark brown on the outside and reddish brown or rust brown on the inside. The clay is of good structure, crushing easily into fine fragments when moist and not becoming unduly hard or cracking to any extent when dry. Numerous small dark concretions are scattered throughout the subsoil. The clay becomes heavier with depth, and the gray spots increase somewhat in number. At a depth of 3½ or 4 feet the clay is very plastic and sticky, and is mottled gray and greenish yellow. Bedrock of limestone generally lies at a depth of 4 feet, but in a few places it occurs at a depth of 3 feet or less.

This soil is closely associated with the Crawford and Summit soils, grading into the Crawford on the one hand and the Summit on the other. The surface soil and upper part of the subsoil are somewhat acid in reaction, in places at least, but below depths of about 2½ or 3 feet the material is neutral or alkaline. Even though the subsoil is rather dense in places, there is no marked evidence of excessive accumulation of water-soluble salts, such as is met with occasionally in soils having dense, impervious subsoils. As a matter of fact, drainage of this soil is characteristically good.

Labette silt loam is moderately extensive, occupying gently rolling areas scattered throughout the greater part of the county. It is a good general-farming soil and nearly all the original prairie land has been broken. Corn is grown on a larger acreage than kafir. Corn ordinarily yields from 20 to 30 bushels, kafir from 25 to 40 bushels, wheat from 15 to 25 bushels, oats from 20 to 40 bushels, and

prairie hay from three-fourths to 1 ton or more to the acre. The soil is physically well suited to alfalfa which is grown in a small way on manured land. The calcareous content of the lower part of the subsoil is beneficial to this crop, but liming is advisable.

Small areas of soil, whose general characteristics are essentially identical with those of Labette silt loam, occur as benchlike formations along the sides of the Fall River Valley west of Fredonia. The surface soil contains a little more sand than the typical Labette soil, and the subsoil contains a small amount of gravel but not enough to make it droughty.

CRAWFORD SILT LOAM

The surface soil of Crawford silt loam consists of dark-brown silt loam passing at a depth of 8 or 10 inches into less dark chocolate-brown silt loam which in turn grades, at a depth ranging from 10 to 14 inches, into reddish-brown or brownish-red friable silty clay. In places the lower part of the subsoil contains spots of yellowish-brown clay which are not caused by ground water but by fragments of partly decomposed rock. In most places the limestone bedrock lies less than 6 feet below the surface and in some places less than 3 feet. Immediately above the limestone rock is, in most places, a thin layer of rather plastic clay. The red clay subsoil breaks into a mass of small angular or subangular particles which are red on the outside and rust red on the inside. It contains numerous dark-colored concretions of iron or manganese oxide. The clay is slightly plastic when wet, and when moist crushes easily to fine granules, but on drying it becomes hard and has some tendency to crack, though not so much as the claypans.

Both surface soil and subsoil are acid in reaction to a greater average depth than the Labette soil, and even very close to bedrock there may be little or no alkaline soil.

This soil occurs rather extensively throughout the central part of the county and in small scattered areas throughout most of the county. The areas are smooth or gently rolling and drainage is good. About three-fourths of the land is under cultivation, and general farming is practiced. Corn, the principal crop, yields from 20 to 35 bushels to the acre; kafir from 25 to 40 bushels; wheat from 12 to 20 bushels; and oats from 20 to 35 bushels. Alfalfa is grown to some extent on manured land, and yields of 2 or 3 tons to the acre are obtained for a few years, after which the crop tends to thin out. It is said that clover and cowpeas do well.

Crawford silt loam, shallow phase.—Crawford silt loam, shallow phase, differs from typical Crawford silt loam only in depth to bedrock which in most places lies from 12 to 24 inches below the surface. This shallow soil commonly occurs on level areas as well as on slopes. Most of it remains with its native growth of prairie grasses and is used for pasture or hay land. Yields ranging from one-half to 1 ton or more of hay to the acre are obtained. Where the soil is farmed, larger proportions of kafir and wheat are grown than on the typical soil. In seasons of well-distributed rainfall crops produce nearly as well as on the deeper soil, but in dry seasons the growth is spotted.

CRAWFORD STONY SILT LOAM

Crawford stony silt loam consists of a 6 to 10 inch surface layer of chocolate-brown or dark-brown silt loam which grades into chocolate reddish-brown friable clay. The clay is moderately plastic when wet and crumbles easily into fine fragments when slightly moist. The bedrock consists of interbedded white limestone and calcareous shale or of dark limestone. The white limestone weathers deeply along the seams, forming detached masses with rounded and pitted surfaces. In many places the rock has almost completely weathered, and in other places numerous rocks project above the surface.

This soil is closely associated with the stony and shallow Summit soils, the soils of each series, as mapped, commonly including areas of the other. Crawford stony silt loam occurs where the white limestone is at or near the surface, and patches of the darker Summit soils occur where other beds outcrop. The Crawford soil is inextensive and occurs in the central part of the county in smooth or gently rolling areas which extend for considerable distances back from the breaks to lower levels.

The greater part of this stony land is used for pasture. Where the land has been overgrazed sumac and rockweed are common, but rockweed has not spread so badly on the Crawford as on the Summit soils. Most of the soil is too stony to be cultivated. Some of the less stony soil is used for hay land, and it produces from one-half to 1 ton of hay to the acre. The mowed land is practically free of weeds.

CRAWFORD FINE SANDY LOAM

The surface soil of Crawford fine sandy loam consists of dark reddish-brown fine sandy loam, passing at a depth ranging from 10 to 15 inches into heavier, lighter-colored fine sandy loam or fine sandy clay which is underlain by white limestone between depths of 30 and 40 inches. Both surface soil and subsoil are acid. The soil is derived from red noncalcareous sandstone interbedded with limestone, the depth of the sandstone being generally only a foot or two.

This soil is very inextensive in the county. Most of it, in connection with other soils, is in pasture, but some is under cultivation to general farm crops. Moisture conditions are good, and the land produces well.

CRAWFORD LOAM

Crawford loam has a surface soil of reddish-brown loam or fine sandy loam, somewhat darkened with organic matter, passing at a depth ranging from 8 to 12 inches into chocolate-red silty clay loam which abruptly grades into friable chocolate-red silty clay.

This soil is derived from fine-grained sandstone and shale overlying or interbedded with white limestone. In places the soil to a depth of 3 feet is apparently derived altogether from the noncalcareous rock, the underlying limestone affecting the soil only so far as its solution modifies structure and oxidation. In most places, however, the limestone is reached at a depth ranging from 2 to 4 feet, and the soil material is probably derived in part from calcareous rock, there being little residue from the sandstone except in

the surface soil, so far as is indicated by texture. The surface soil and subsoil are strongly acid, as is typical of the Crawford soils.

Crawford loam occurs in a number of small areas southeast of Fredonia, occupying gentle slopes which apparently conform to the rock structures. Part of the land is in the original prairie grasses, but most of it is under cultivation. Moisture conditions are good, and corn, kafir, and alfalfa do well.

CRAWFORD CLAY

Crawford clay typically consists of very dark-brown or dark chocolate-brown clay, passing at a depth of 4 or 6 inches into chocolate-red clay. The upper part of the surface soil ranges from acid to alkaline, but at a slight depth the soil is uniformly alkaline and contains small lime concretions.

The soil is inextensive in the county. A number of small areas occur in the extreme northwest part, occupying strips of land of irregular width on hillsides. The soil is derived from Indian-red shale and limestone. The soils with which it is associated are largely shaly or stony calcareous soils with rolling relief. The land supports a good growth of the native grasses and is used mainly for grazing cattle. A few fields are under cultivation. The soil is naturally well suited to alfalfa, and this crop is grown on a large part of the farm land. Corn also does well.

SUMMIT SILTY CLAY LOAM

The surface soil of Summit silty clay loam is dark, almost black, silty clay loam, the basic color of the soil particles being obscured by a covering of organic matter. At a depth ranging from 6 to 10 inches this material passes into dark clay which grades into yellow clay with a greenish or olive cast. The upper part of the subsoil is darkened to a depth ranging from 1 to 18 inches and generally contains some concretions of lime and iron oxides. Typically the clay is well disintegrated to a considerable depth, but in places bedrock of limestone is reached at a depth of about 3 feet.

The surface soil is heavy, rarely approaching silt loam in texture except where there has been some colluvial accumulation. It tends to grade into silty clay on slopes. In cultivated fields it is mellow and friable. In most places the subsoil is granular in structure, but in places along divides and on slopes, it is rather heavy and tough. When moist the material crumbles to fine granules.

This soil is calcareous, with considerable variation in degree of alkalinity. Ordinarily the surface soil and upper part of the subsoil are somewhat acid, but at a slight depth the subsoil becomes neutral and at a greater depth becomes alkaline. The surface soil is neutral or alkaline in many places on lower slopes and on benches at the foot of slopes where there is a tendency toward seepiness, consequently the soil is somewhat slow in drying out in spring.

Summit silty clay loam occurs extensively throughout the central and eastern parts of the county, both on the higher plateaus and on gentle slopes at the foot of the escarpments. On the plateaus the soil is generally underlain by limestone at a depth ranging from 2½ to 4 feet, and in the lower situations it is generally underlain to a con-

siderable depth by disintegrated material. Some of the soil material in these valleys is doubtless colluvial material from the escarpments, but the lime content is probably derived from calcareous shales or is the result of the movement of soil moisture.

The soil is naturally strong and productive, and nearly all of it has been broken and put under cultivation, mainly to corn, wheat, oats, and alfalfa. Corn yields from 30 to 50 bushels to the acre, wheat from 15 to 30 bushels, and alfalfa from 3 to 5 tons. The soil is well suited to alfalfa, and a considerable acreage is grown. Following alfalfa the crops produce much better than on land continuously used for grain production.

Summit silty clay loam, shallow phase.—The shallow phase of Summit silty clay loam is similar to the deeper typical soil, except that the limestone bedrock occurs at a depth ranging from 1 to 3 feet. The surface is mainly free of stones, but some stony soil is included in mapping.

This soil occurs in numerous small areas both on slopes and on level surfaces. The greater part of it is left in the native prairie grasses most of which are cut for hay and yield from three-fourths to 1 ton to the acre. The soil is inherently rich, and cultivated crops yield as well as on the deeper soil in good seasons. However, crops have a tendency to start off well but make little growth in dry weather. Wheat is a more reliable crop than the other grains, as it matures before the hottest summer weather.

SUMMIT STONY SILTY CLAY LOAM

Summit stony silty clay loam typically consists of dark dull-brown silty clay loam overlying bedrock of limestone at a depth ranging from 6 to 24 inches. In detail the areas thus classified vary from rock with little or no soil covering to the shallow phase of Summit silty clay loam interspersed with occasional patches of Crawford stony silty clay loam and the shallow phase of Crawford silty clay loam. The soil lacks the characteristic reddish cast of the Crawford soils, and the variations are too numerous and irregular to be taken account of in mapping stony pastures. This soil is derived from interbedded layers of platy limestone, calcareous shale, and the white, more massive limestone associated with the Crawford soils. The very shallow soil is calcareous; the deeper areas may be acid to a slight depth.

The soil occurs extensively through the central part of the county, occupying plateau positions near the escarpments to the river and creek valleys. Small areas are scattered over the eastern part and on the infrequent limestone developments of the western part. The relief is mainly level or gently rolling.

The soil was originally covered with a good growth of grasses, but most of the land has been overgrazed so that the stand is thinned and pastures are infested with rockweed which even chokes out the grass in places. The less stony patches are mowed, and these are free of rockweed, but most of the land is too stony to mow, and no method of eradicating the rockweed has been found. It is said that cattle thrive better on these limestone pastures than on non-

calcareous pasture land, though the grasses are of about the same varieties, mainly big and little bluestems.

Summit stony silty clay loam, slope phase.—The soil material of the slope phase of Summit stony silty clay loam is similar to that of the level areas, except that it tends to be somewhat more highly calcareous. The underlying material is partly disintegrated to a greater depth than in level areas where solid limestone is reached at a slight depth. On the slopes much of the underlying material is shaly limestone or calcareous shale, and the surface rock ranges from blocks of solid limestone to small rounded and pitted pieces of shaly limestone. Some Ellis shaly silty clay loam, overlying beds of shale, is included with this soil in mapping.

This sloping soil occurs on the escarpments in the central and southern parts of the county. Generally a rock ledge or cliff, from 10 to 15 feet high, is at the edge of the plateau, and below this the slopes are steep. Very few large rock masses have fallen from the cliffs, and most of the slopes are less stony than might be expected. However, the soil is rather shallow, and considerable quantities of small stones are on the surface of most areas.

The land is used only for pasture. In addition to the prairie grasses, there is considerable bush growth on much of the soil, and a few clumps of locust, oak, and other trees. The land has been overgrazed, and pastures are poor.

SUMMIT SILT LOAM

Summit silt loam consists of a layer of very dark-brown silt loam, passing at a depth ranging from 8 to 14 inches into friable greenish-yellow silty clay loam or silty clay. The surface soil and upper part of the subsoil are acid, and the lower part of the subsoil is alkaline. The soil is less typical of the Summit soils in this respect than is the silty clay loam member. The surface soil tends to be less dark, owing to deeper leaching, and the soil more nearly resembles Labette silt loam in stage of maturity. The areas are gently rolling, and drainage is good. The agricultural use of this soil is similar to that of the Labette soil.

Summit silt loam, shallow phase.—Summit silt loam, shallow phase, has a surface soil of very dark-brown silt loam, passing at a depth ranging from 6 to 10 inches into olive-green or greenish-yellow friable fine-granular silty clay somewhat speckled with reddish brown and containing some small iron concretions. The surface soil ranges from acid to alkaline, but the subsoil is uniformly alkaline and passes at a depth ranging from 3 to 4 feet into olive-green calcareous shale. The soil material is less changed from its original form and structure than in most of the Summit soils. On the slopes of some escarpments the soil contains many shale fragments.

This soil is inextensive. It occurs on gentle or moderate slopes at the base of escarpments throughout the south-central, central, and northeast parts of the county. Surface drainage is good, although in spots there is some seepage.

This is a productive soil, but it is subject to considerable erosion when in cultivation, partly on account of its position and partly

on account of its fine-granular structure. It is farmed to the same crops as the typical silt loam. Alfalfa does especially well and is grown extensively, as it holds the soil.

CHEROKEE SILT LOAM

The surface soil of Cherokee silt loam is grayish brown to a depth of 6 inches and is underlain by light-brown or slightly grayish-brown silt loam a few inches thick, below which is tough dark-brown very heavy clay which breaks into small cubical blocks. This material, in turn, is underlain by mottled yellow and gray clay, heavy and compact but appreciably less dense and easier to dig than the heavy clay above it.

The soil contains some salts, generally in too small amounts to be recognized in the soil, or even at the surface in dry weather, but frequently recognizable as an efflorescence from the subsoil in road cuts. These salts occur in larger amounts in spots and are locally called alkali, although they are not the salts known as alkali in arid regions but are predominantly gypsum, with small proportions of other salts such as chlorides.

In virgin prairie the surface soil when moist shows considerable darkening with organic matter, but under cultivation it appears throughout to have a remarkably small organic-matter content for a prairie soil, except in places where the slope affords a better supply of moisture. In places the surface soil dries out more quickly and has a more brownish color, owing to slight irregularities of slope or depth of silty soil, but these factors have little or no effect on the gray lower layer.

The surface soil becomes gray or at times almost white in dry weather, and for this reason the soil is commonly called gray-ash land. The change is more than the usual graying of soils in dry weather and is evidently partly due to the accumulation of gypsum carried up by moisture and deposited throughout the upper 3 or 4 inches of soil.

The claypan material is tough and plastic when wet, but at intermediate moisture stages it may be fairly easily broken into small pieces. When very slightly moist it seems hard on account of its density, and when dry it is very hard. It shrinks on drying and splits vertically. In prairie it can be dug out easily when dry in pieces about the size of a brick. This breaking and probably the lines of weakness along which it may be broken when moist are apparently mechanical and are probably influenced by the numerous small iron concretions scattered throughout the clay.

The clay is generally of a yellowish-brown color somewhat darkened or in places almost obscured by organic matter. The surface soil and all the claypan except the base are strongly acid. The base of the claypan is alkaline in places, but this apparently has no beneficial effect on the structure.

The underlying rock lies at an undetermined depth, and the soil material is weathered deeply and greatly transformed. It is probably derived from somewhat calcareous shale or shales including some calcareous beds. In some areas the lower part of the heavy clay layer and the upper part of the substratum vary in their re-

action but the variation is of little importance at this depth and under a claypan.

Cherokee silt loam occurs in a number of fairly extensive areas in the northeast part of the county and on the lowlands north and south of Fredonia. It occupies very gentle slopes and flat land. Little of the soil except the shallow phase is without perceptible slope, but the slope, although sufficient to prevent water standing on the surface, is not sufficient to provide effective drainage within the surface soil. Underdrainage is very slow, consisting merely in the absorption of water in the claypan and heavy substratum. However, the claypan, which constitutes the subsoil, is not impervious or even approximately so. The absorption of occasional heavy rains in summer is promoted to some extent by the vertical cracking of the clay.

Moisture conditions are inferior, and the soil is more or less droughty, but the surface soil retains an excess of water in wet weather, as evidenced by the occurrence of the light-gray silt layer directly overlying the clay.

About three-fourths of the total area of Cherokee silt loam remains in prairie sod and is used for pasture and hay land. Yields of hay range from one-half to 1 ton to the acre. Where this soil is farmed kafir is the principal grain crop and ordinarily yields from 20 to 30 bushels to the acre. Oats and wheat maturing before the dry spell of summer also yield well, oats from 15 to 40 bushels, and wheat from 10 to 20 bushels.

Cherokee silt loam, shallow phase.—The surface soil of the shallow phase of Cherokee silt loam consists of ash-gray silt loam from 5 to 10 inches thick grading abruptly into a dark yellowish-brown or almost black tough dense claypan. At a depth ranging from 2½ to 3½ feet this passes into somewhat friable clayey material, mottled yellow and white. In prairie areas the surface soil appears very light gray or almost white at times in the summer. In cultivated fields it is very light gray at the surface and below that fairly dark gray. The surface soil and the upper part of the claypan are strongly acid to some depth, but in places the claypan becomes alkaline at a depth of 3 feet. Soil of this phase represents an extreme of the typical soil in density and thickness of the claypan and in the content of salts.

Land of this kind is flat. The soil is subject to drought, and it is said that in summer the rainfall is never too much for good results, little excess water being retained in this depth of silt. About three-fourths of the phase is in prairie some of which is used for pasture. Hay is commonly harvested once, in July, and yields from one-half to 1 ton to the acre. The common cultivated crops are kafir, cane, and oats. In good seasons kafir yields from 20 to 30 bushels to the acre. Some kafir is drilled in for forage. The soil is difficult to work, and some land that is plowed is not used for crops.

PARSONS SILT LOAM

The surface soil of Parsons silt loam is light-brown or dark-brown silt loam. At a depth ranging from 8 to 12 inches this passes into a heavy dense claypan which is underlain at a depth of 2½ or 3 feet by mottled yellow and gray less dense clay.

The surface soil is darker than that of Cherokee silt loam and lacks some of the light-gray layer overlying the clay. Typically the transition from silt to dense clay is abrupt, with only a thin layer of transitional soil of silty clay loam or clay texture. This is apparently owing partly to the comparatively slight depth of surface soil and in places to the more sloping relief but may be considered as indicating a less fully developed claypan. The claypan is yellowish brown, being darkened with organic matter. The color varies considerably at close intervals, without apparent consistent differences in density or thickness of the claypan. On the average the claypan is not so thick or so dense as that of Cherokee silt loam, and the substratum is less compact. As in the Cherokee soil small amounts of salts are generally present, sufficient in places to be recognized as efflorescence in road cuts. The gray appearance of the surface soil on drying is probably partly owing to deposition of salts near the surface.

The surface soil and the upper part of the claypan are strongly acid, and the base of the claypan and the substratum are neutral or alkaline. The soil is apparently derived from shales which are at least partly calcareous. Places in the Parsons soil marked by unusually large amounts of salts and with maximum intensity of hardpan may be considered the same development as the alkali or slick spots in the friable upland soils. The claypan is heavy dense clay, which is tough and plastic when wet, somewhat crumbly when moist, rather hard when slightly moist, and very hard when dry. It contracts on drying, forming numerous vertical cracks. On sloping cuts the cracking makes a diagonal pattern like that of chicken wire. The claypan is not impervious or even approximately so. It constitutes the subsoil and is the principal source of moisture, which it absorbs and gives up slowly. Dry soil absorbs water rapidly because of the cracks to the lower part, and it is possible that these cracks also hasten the drying out of the soil.

About two-thirds of this soil remains in native prairie grass and is used for pasture and meadow. Where the land is cultivated general farming is practiced, the principal crops being kafir, corn, oats, and wheat. Yields vary somewhat according to the length of time the soil has been farmed. The darker phases of soil are somewhat more productive. Kafir yields ordinarily from 25 to 40 bushels, corn from 18 to 25 bushels, oats from 25 to 45 bushels, wheat from 10 to 18 bushels, and prairie hay from three-fourths to 1 ton to the acre. A small acreage of alfalfa is grown on manured land on some farms, but its growth is limited by the moisture supply, so that yields are comparatively small. Sweetclover is a common roadside growth, especially on exposed calcareous material, but it is little used as a farm crop. In order to grow sweetclover successfully on this soil, the land must be limed.

This soil is somewhat darker in color and has a somewhat less heavy claypan than the Parsons soils in Labette and adjoining counties in the southeast part of the State. More careful examination in the future may disclose that this is a different soil and should be given an independent status. However, it has the same general characteristics as the Parsons soils.

PARSONS SILTY CLAY LOAM

The surface soil of Parsons silty clay loam typically consists of a layer of very dark-brown or nearly black silty clay loam, passing at a depth ranging from about 6 to 12 inches into very dark-brown heavy tenacious clay. At a depth ranging from 30 to 40 inches this material is underlain by mottled yellow or greenish-yellow and gray less heavy clay. The surface soil and upper part of the subsoil may be acid to a slight depth, but the greater part of the subsoil and all of the substratum are alkaline. The surface soil becomes gray to a slight depth when dry. The subsoil shows some brown iron stains.

The subsoil may be regarded as a claypan, being approximately as heavy and intractable as that of Parsons silt loam. This heavy layer exists in spite of a fairly high lime content. In some places it shows a coarse granular structure. In most places it is plastic when moist and very hard when dry. Even when moist it is rather tenacious, breaking out in large blocks. It cracks considerably on drying, mainly along vertical lines.

This soil may be regarded as a very dark phase of the Parsons soils, having been developed from especially calcareous material or under moisture conditions which maintain a content of lime nearly to the surface.

The soil is inextensive, occurring mainly in the northeast part of the county in level areas. Most of the land is in native-grass pasture as it is difficult to cultivate. One field of alfalfa was seen. It is usually necessary to apply lime and phosphate to this soil before a successful stand of alfalfa can be obtained. The land is hard to plow, except at a certain stage of moisture content, and cultivated crops are difficult to grow for this reason.

RIVERTON SILT LOAM

The surface soil of Riverton silt loam typically consists of dark chocolate-brown silt loam, passing at a depth of about 3 or 4 inches into reddish-brown silt loam. At a depth ranging from 8 to 12 inches this passes into reddish-brown friable silty clay loam containing some rounded chert gravel, and at a depth between 2 and 3 feet it is underlain by gravel with the interstices filled with clay. The soil material is acid throughout.

This soil is inextensive, occurring mainly as small isolated areas at the summits of elevations, some of them far from the present courses of the rivers. The beds of somewhat rounded chert gravel are conclusive evidence that the overlying soil is transported, but the exact origin of these beds is not known at the present time. The gravel beds are not thick but furnish a convenient supply of gravel for surfacing roads, and pits have been opened in many places. The soil is fairly suitable for general farming, but little of the typical soil is farmed. Areas near the river south of Fredonia lie at a lower level, from 20 to 40 feet above the bottoms. Such areas have little gravel beneath them and overlie limestone at a slight depth. They are closely associated with areas of Crawford silt loam, and this soil closely resembles the Crawford soil in appearance and use.

RIVERTON GRAVELLY SILT LOAM

Riverton gravelly silt loam typically consists of a surface layer of dark-brown silt loam, passing at a depth ranging from about 8 to 12 inches into reddish-brown or chocolate-brown friable silty clay loam or silty clay. Both surface soil and subsoil contain considerable rounded chert gravel. Below a depth ranging from 2 to 3 feet the material consists of mottled greenish-brown and reddish-brown granular clay which is free of gravel. Most of the soil overlies calcareous formations, and in many places limestone bedrock occurs at a depth between 3 and 4 feet.

This soil occurs in small areas at the summits of elevations lying at various altitudes in the uplands. Some areas are far from the rivers. The soil is mainly a shallow residue of transported material overlying residual soil. Some areas are apparently almost altogether residual, with the gravel content occurring mainly in the surface soil.

The more gravelly areas are not farmed, but they make good pastures. In some places the material has been used for road building. Some of the less gravelly land is farmed. The soil is variable, more or less nearly approaching Labette silt loam in characteristics. The gravel are small and do not interfere with cultivation except in spots, and the soil is fairly productive.

VERDIGRIS SILT LOAM

The surface soil of Verdigris silt loam is dark-brown or yellowish-brown silt loam. Where the deposits contain a large proportion of clay, the subsoil is, typically, yellowish-brown silty clay loam somewhat mottled with rust brown. Some layers may be dark, somewhat grayish-brown, silty clay loam or silty clay, but the yellowish material in the lower part of the subsoil is sufficient to indicate effective underdrainage. The surface soil and upper part of the subsoil are acid, and in places the lower part of the subsoil is nearly neutral.

On the better-drained bottoms of the small creeks the soil varies somewhat according to the source of the material and the extent to which it is subject to overflow. Verdigris silt loam from the Bates upland soils is apparently somewhat less productive than that derived partly from limestone.

This soil occupies a belt of land next to the river. It is the highest-lying land of the bottoms, considerably less subject to overflow than the Osage soils, and, largely on that account, is most desirable farm land. To some extent the Verdigris soil represents the wooded bottoms, the Osage soils the prairie bottoms. The original timber, practically all of which has been cut, was mostly oak, walnut, hackberry, and sycamore. The principal crops are corn, wheat, and alfalfa. Alfalfa requires no lime or special treatment, but yields and endures well. Three or four cuttings are obtained, with a total yield of 4 or 5 tons to the acre. Following alfalfa, the grain crops yield especially well for several years. Average corn yields are between 40 and 60 bushels, wheat about 20 bushels, and oats about 40 bushels. Maximum yields are considerably higher.

VERDIGRIS FINE SANDY LOAM

The surface soil of Verdigris fine sandy loam is yellowish-brown fine or very fine sandy loam somewhat darkened with organic matter. At a depth ranging from about 10 to 15 inches this layer passes into brownish-yellow fine sandy loam or friable fine sandy clay. The soil is strongly acid throughout.

This soil occurs mainly along the streams flowing from the uplands occupied by soils of the Bates series in the western part of the county, and a few small areas lie along the rivers. The creek bottoms do not slope away from the stream, but tend to slope toward it, with some terrace or colluvial soil nearest the hills. The creeks in many places have a narrow inner bottom capable of carrying ordinary high water, and the land in general is much less subject to overflow than the river bottoms.

This soil is not so fertile as Verdigris silt loam. Although it is predominantly a prairie soil, plowed fields do not appear very dark. In places there has been considerable deposit from the recent washing of cultivated fields. This is a good farming soil and is nearly all in cultivation. Corn is the principal grain crop, yielding ordinarily from 25 to 40 bushels to the acre; oats yield from 30 to 40 bushels; and wheat is grown to some extent, yielding from 15 to 20 bushels. Some fairly good stands of alfalfa were seen on the very acid areas, but the crop is not extensively grown, as it does not yield or endure so well as on soil derived partly from limestone.

OSAGE SILTY CLAY LOAM

The surface soil of Osage silty clay loam typically consists of very dark-brown or almost black heavy silty clay loam. It is underlain at a depth of about 6 or 8 inches by very dark-brown silty clay or clay which, at a depth ranging from 30 to 36 inches, passes into dark-grayish silty clay or clay. The soil color is effectively obscured by the dark organic content, even when the soil is dry. Some small iron concretions occur throughout the subsoil, and some indistinct brown mottles may be caused by iron stains.

This is the most extensive soil in the river bottoms of the county, occupying the lower situations back from the rivers. The surface is almost flat, but as a general rule a slight slope toward drainage ways near the upland provides surface drainage. The land is subject to overflow, which may not occur for a period of several years or may occur several times in one season. Underdrainage is apparently limited to the absorption of excess moisture by the clay of the substratum. The soil is capable of holding comparatively large amounts of moisture without becoming water-logged, and during the growing season moisture conditions are on the whole very favorable. There may be wet seasons when the land can not be cultivated as well as is desirable, but crops grow well at such times. This soil is among the last to show effects of drought. It seems probable that this soil and the river-bottom soils in general are to some extent supplied with moisture from considerable depth.

The surface soil and upper part of the subsoil are ordinarily approximately neutral, and the lower part of the subsoil is alkaline.

Where small streams flow in from shallow limestone uplands the surface soil may be alkaline.

The lime content gives the soil good structure. When in good tilth it can be plowed with 2-bottom plows drawn by five horses or the equivalent, and in ordinary seasons cornfields are fairly easily kept in good shape. It is a productive soil, and corn, wheat, and alfalfa are the principal crops. Corn yields ordinarily from 40 to 60 bushels to the acre; oats, from 35 to 50 bushels; wheat, from 20 to 30 bushels; and alfalfa, from 3 to 5 tons. Maximum yields reported are about 80 bushels of corn, 90 bushels of oats, and 47 bushels of wheat. Alfalfa is grown extensively. The stand remains good for 10 or 12 years, but it is usually plowed under sooner, as other fields are seeded, in order to rotate crops. After alfalfa, wheat is usually grown for several years and is in turn followed by corn.

OSAGE SILT LOAM

The surface soil of Osage silt loam typically consists of very dark-brown silt loam, which passes at a depth ranging from 6 to 10 inches into dark-brown silty clay loam containing some small iron concretions and in places some mottles of yellow and gray. At a depth ranging from 24 to 36 inches the material gives way to dark-gray or mottled gray and yellow clay.

This soil occurs mainly in narrow strips on the river bottoms between areas of Verdigris silt loam and Osage silty clay loam. The transition from one soil to another is gradual. As the land slopes away from the river, this soil lies at an intermediate elevation and is somewhat less subject to overflow than Osage silty clay loam. Although the lime content is variable, this soil tends to be more acid in the surface soil and subsoil than Osage silty clay loam. However, alfalfa does well. The land is farmed much like the silty clay loam and approximately the same yields are obtained, but as it is somewhat easier to work and less subject to overflow it is considered more desirable land.

Osage silt loam, poorly drained phase.—Osage silt loam, poorly drained phase, consists of brown or dark grayish-brown silt loam, passing at a depth ranging from 8 to 12 inches into gray or mottled gray and yellow silty clay loam or silty clay. The lower part of the subsoil is heavy plastic clay, mottled gray and buff or reddish yellow, becoming predominantly gray at a depth of about 3 feet.

This soil is not extensive. It occupies flat, poorly drained bottoms along the local streams, the largest area being on Sandy Creek. Most of the land supports a growth of rather coarse prairie grasses. Some of the browner soil has been ditched, and good yields of corn are obtained.

Osage silt loam, shallow phase.—Osage silt loam, shallow phase, typically consists of black silt loam, passing at a depth ranging from 8 to 14 inches into dark-gray silty clay loam or clay. At a depth ranging from 12 to 36 inches the soil is underlain by limestone bedrock.

This soil occurs in narrow bottoms along small streams in the limestone uplands, mainly in the central part of the county. It is subject to overflow, which keeps the soil moist throughout most of the year.

The land supports a good growth of native grasses or bluegrass and is used for pasture.

Osage silt loam, heavy-subsoil phase.—The heavy-subsoil phase of Osage silt loam typically consists of nearly black silt loam, passing at a depth of 8 or 10 inches into nearly black silty clay which is underlain at a depth of about 24 inches by gray or dark-gray tough clay.

This phase of soil is inextensive. The principal area is in the Verdigris River bottom at Farmdale. This area adjoins the upland and extends out to Snake Creek which drains the Bates and hardpan soils.

When fairly moist the soil gives little evidence of poor structure and granulates fairly well, but when dry the surface soil assumes a grayish cast as in the hardpan soils of the uplands, and the subsoil becomes very tough. When the soil is in the right moisture condition it plows fairly well, but it becomes harder than the typical bottom soils when dry. Early-maturing crops do better than kafir or corn. In good seasons wheat has produced as much as 25 bushels and oats 40 bushels to the acre. The soil is about neutral, and alfalfa does fairly well, though not so well as on the other dark soils.

OSAGE CLAY

Osage clay has a surface soil of very dark-brown almost black clay, passing at a depth of about 6 inches into very dark-brown clay which is underlain at a depth ranging from 30 to 36 inches by bluish-gray clay. The basic color of the surface soil and subsoil is effectively obscured by the dark organic content. Even when dry the subsoil is very dark. Some brown color may be due to iron stains which are a common feature in poorly drained soils.

This soil occupies the lowest situations in the river bottoms and is comparatively inextensive. The largest area lies between Snake Creek and Verdigris River. In this area the soil is somewhat acid to a depth ranging from 18 to 24 inches and becomes neutral or alkaline below that depth. The upper part of the subsoil, though acid, shows a good granular structure. In other areas adjoining the limestone uplands the soil may be highly alkaline to the surface in places. A few small areas adjoining hardpan flats and containing some soluble salts were included with this soil in mapping.

Almost all the land is in native prairie grasses. The hay is somewhat coarser than upland prairie hay, but not objectionably so. Yields of 1 or 2 tons to the acre are obtained. Hay is considered the most satisfactory crop, as it is not damaged or drowned out by the overflows.

MINE DUMPS

A few very small areas are indicated on the map as mine dumps; but since these have little or no agricultural value at the present time, they do not require discussion.

RECOMMENDATIONS FOR THE USE AND IMPROVEMENT OF WILSON COUNTY SOILS

The maintenance of a good sod on grazing land is recognized as an important problem. The original stand of grass in Wilson County is said to have been heavy and clean, but at present the

growth varies considerably. Much of it has been overstocked until it is thin and weedy, and in the forested hill region a scant timber growth has spread considerably. Mowed land on all the various soils is practically free of weeds, and mowing is apparently the best method of control where practicable. Limestone land too stony to mow, where the rockweed has come in very badly, presents a special problem. At present the most obvious way of keeping a good stand of grass is through moderation in grazing.

In the uplands the system of growing a large acreage of corn as a cash crop is being modified. The system is logical on virgin prairie land, but the drain on the fertility of the soil and the reduction of organic content through clean cultivation leads to reduced yields. Sufficient livestock should be carried to consume all the roughage grown and a large part of the grain. The manure should be protected from leaching and applied to the fields within a reasonable time. Alfalfa is considered the most desirable legume. Sweetclover may be grown on many of the bottom soils, and if applications of lime and phosphate are made it can be produced on many of the upland soils. Experiments indicate that applications of phosphatic fertilizer to wheat and alfalfa may be profitable on all but the most productive soils.

SOILS AND THEIR INTERPRETATION

This general region is designated as the Osage prairies. Certain stony or shallow soils and the best-drained soils in the river bottoms were covered, under natural conditions, with forest, most of which was rather scrubby, otherwise both uplands and bottoms were essentially treeless and were covered with a good growth of grasses. The virgin soils are darkened, in widely varying degree, with organic matter from this source, the principal causes of variation being moisture conditions and the lime content of the parent material. The characteristically shallow, strongly acid Bates soils are darkened in a patchy way, commonly not enough to obscure the rock color, and to a depth of only a few inches. Erosion from smooth areas is not sufficient to account for this. Where the soil is somewhat deeper owing to colluvial action, in places where there is some tendency to seepage and along hedge rows, the soil is darker. The similarly shallow but alkaline Summit soil is much darker. The normally matured soils differ in darkness of color apparently in accordance with lime content or degree of acidity. Where limestone occurs at a slight depth, the slopes below are unusually dark. Over claypan the drainage conditions tend to produce gray soils. Ordinarily, the flatter the land and the greater the depth of silt over the pan, the more pronounced this effect becomes.

Labette silt loam may be regarded as the typical normally developed soil of the county. A representative profile is as follows: A, from 0 to 8 inches, dark-brown silt loam; B_1, from 8 to 12 inches, friable yellowish-brown or light-brown silty clay loam; and B_2, moderately friable clay, finely mottled or specked with buff, reddish brown, yellowish brown, and greenish yellow, with some small rust-brown concretions. The clay becomes heavier with depth. The surface soil and upper subsoil layer are acid, and the lower subsoil layer is generally neutral or alkaline.

The deep Bates silt loam is similar in profile to the Labette soil, though it is derived from approximately noncalcareous rocks. Both soils have been leached to an acid condition throughout the surface soil and upper part of the subsoil, becoming about neutral in the lower part of the subsoil. The principal distinction is that in places the Labette soil approaches the characteristics of the Summit soil, and the surface soil is rather dark, whereas the Bates soil averages less dark.

The Crawford soils differ from the Labette primarily in the red color of the subsoil. The Crawford soils have developed from material accumulated through the decomposition of limestone in place and in situations where drainage is rapid, giving opportunity for oxidation. In the Labette soil, heavy plastic clay intervenes commonly between the surface soil and the bedrock, the parent material of the Labette soil being somewhat heavier than that of the Crawford, owing mainly to derivation from impure and somewhat shaly limestones. Greenish mottlings in the lower layers of both soils are manifestations of incomplete oxidation.

The Riverton soils, though derived from alluvial material, are very similar to the Crawford. The oxidation in these soils is due to the presence of gravel in the subsoil, which provides for rapid drainage and thorough aeration.

The Summit soils typically occur out from the foot of calcareous slopes to drainage ways, beyond which other soils occur. The abundance of lime concretions in obviously seepy places in the Summit soils is an extreme phase of this condition. Typically, the surface soils of the Summit soils are very dark. The B horizon also may be very dark to considerable depth, whence it passes into olive-yellow clay. The underlying rock is olive yellow also.

Although normally developed soils occur rather extensively, claypan soils have perhaps more generally been formed wherever the land is fairly level and where the rather heavy disintegrated material is deep. An unusually large amount of gypsum, with small amounts of associated salt, is apparently present in most of the shale of the region. In this region leaching is not so complete, or at least not so deep, as seems typical of regions having so much rainfall. This is illustrated by the neutral or alkaline reaction common in the Labette soil and found in some of the deep phase of Bates silt loam. Thin layers of gypsum are seen here and there in roadside cuts, and it seems that the claypan soils generally contain some salt. Following rain, a roadbed through dark claypan frequently shows gray patches spotted with concretions, though a fragment of the clay remains black on drying. A test indicates a conspicuous surface efflorescence on Summit soil to be nearly all gypsum. It seems probable that the very gray color observed at times in the topmost part of the surface soil is owing, at least in part, to the deposition of salts.

The character of the claypan as a development, rather than as a native characteristic of the material, is better illustrated in the alkali or hardpan spots which occur in the upland soils. Many of these spots occur along inconspicuous drainage ways, indicating their origin. Some occupy small depressions called buffalo wallows. Small seepy areas are rather common in most shale soils, not only

here but throughout the humid region. Accumulations of gypsum and lime concretions occur in the dense clay of these spots; the clay is generally alkaline to the surface, and efflorescence of gypsum is not uncommon. So far as could be determined from road cuts, the tough dense clay extends down to bedrock. In most places some soil, either residual or colluvial, overlies the clay. The color of the clay tends to correspond fairly closely to that of the surrounding soil. It seems evident that these spots are caused by minerals brought in by infiltrating waters. The claypans are developed from both calcareous and noncalcareous soils, or soils of minimum calcareous content. The yellowish-brown tobacco-colored pan is apparently related to the less-calcareous soils, Bates for instance; the Parsons soil is related to the Summit soil and is probably a development from it. Some of the claypan soils in the county have developed from alluvial material on terraces. These could not be separated satisfactorily, as there is no evidence, other than topography and position, to indicate origin. Probably much of the soil adjacent to the rivers, including the large area northwest of Fredonia, is derived from alluvium. These areas are so flat and so little above the level of the flood plain that it would seem that the alluvium with which they were presumably covered at the close of deposition could scarcely have been removed. The variation in the soil of these flats is similar to that of higher flats, and the question of origin of the deposits is immaterial. Above the claypan, wherever the silt surface soil is deep enough and the slope slight enough to result in the soil being saturated for a long time, the material tends to become gray. The upper part is less affected, and except in very flat places it has a brownish color. The soil directly overlying the claypan is light gray.

Cherokee silt loam has the thickest silty horizon overlying the claypan, and has a gray layer over the heavy claypan. The silty surface layer in the Parsons soil is thinner than in the Cherokee, occurs in somewhat undulating areas, and has no gray layer overlying the claypan. The surface soil is darker than that of the Cherokee soil and the transition from silt to claypan is not so abrupt.

Soils of the Verdigris and Osage series are the most extensive alluvial soils in the county. The Verdigris soils represent the better-drained alluviums. The relationship of the soils of these two series is best illustrated in the river bottoms, where the Verdigris soils represent the higher-lying lighter-textured material along the natural level of the stream. The Verdigris soils here are fairly dark, though not so dark as the Osage soils. The most significant difference is that the lower subsoil layer of the Verdigris soils is yellow, whereas, at a depth of about 3 feet, the Osage soils become gray clay. This signifies the difference in underdrainage. The Verdigris soils are somewhat acid. The Osage soils are alkaline in the lower part of the subsoil, and the surface soil ranges from somewhat acid to alkaline, varying somewhat with the nature of the local wash, especially in places where small streams emerge into the larger stream valleys.

Ordinarily no tendency toward development of an unfavorably tough subsoil is apparent in the alluvial soils. However, at Farmdale, the soil within the loop of Snake Creek extending about 2 miles downstream, shows a slight tendency to a heavy subsoil. The sur-

face soil has a somewhat grayish cast on drying. The two patches of Osage clay lying nearest the upland, just below this area, contain salts in recognizable quantities. When moist, the soil appears typical of the Osage soils, but on drying the unfavorable structure is apparent. The soil is recognized as of inferior productiveness. Part of this bottom is rather high.

SUMMARY

Wilson County is in the southeast part of Kansas and has an area of 575 square miles. The surface features consist of a series of smooth or gently rolling plains, separated by prominent escarpments. Two rivers flow through the county, and their branches extend to nearly all parts, and the upland region is well drained.

The population in 1920 was 21,157, of which 62.7 per cent was rural. The local towns, in which manufacturing of importance is carried on, provide local markets for considerable quantities of farm products. The principal market for livestock, grain, and hay is Kansas City. The county is well supplied with railway facilities.

The climate is humid, with a mean annual rainfall of 37.05 inches, favorably distributed throughout the year.

The soils of the county may be grouped and summarized as follows:

The upland prairie soils having friable subsoils and derived from noncalcareous rock are represented by the Bates soils. They are characteristically shallow and their principal utilization is as pasture.

Upland prairie soils having friable subsoils and derived from calcareous rock are the Labette, Crawford, and Summit soils. They constitute good general-farming land, except the shallow or stony phases, which are used for pasture.

The claypan soils are the Cherokee and Parsons soils. The Cherokee soil is largely used for pasture and hay, and the Parsons soils constitute fairly productive general-farming land.

The terrace soils are represented by soils of the Riverton and Labette series and are fairly productive general-farming soils.

The first-bottom soils are the Verdigris and Osage soils. They constitute very fertile farm land, naturally well suited to alfalfa. The poorly drained phase of Osage silt loam is used chiefly for pasture and hay land.

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[PUBLIC RESOLUTION—No. 9]

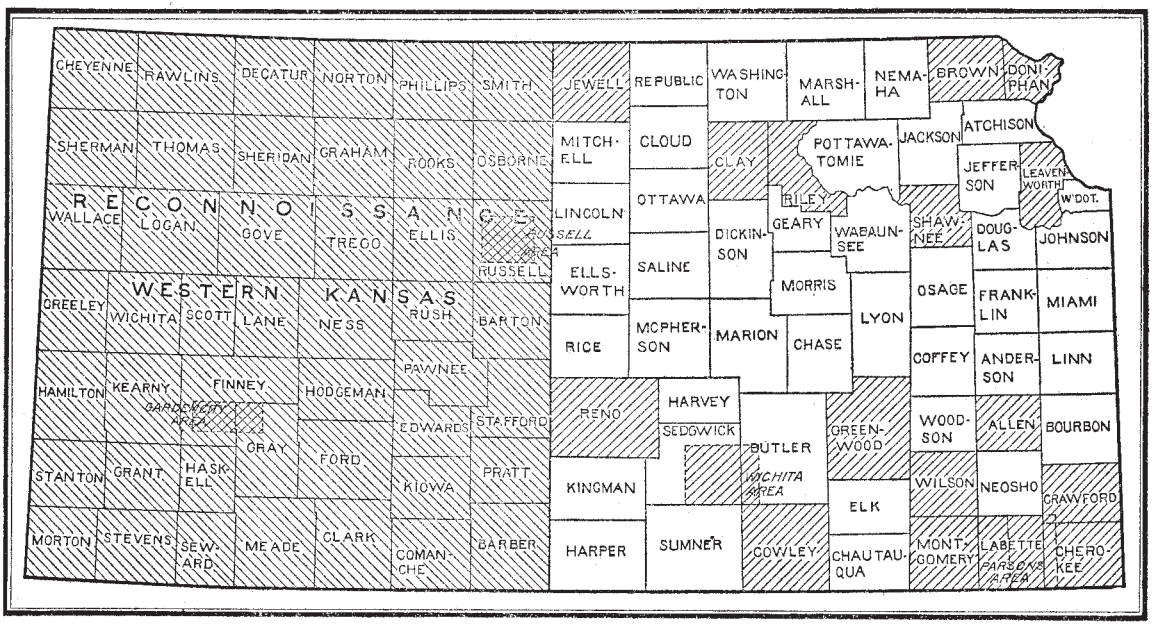
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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

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

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Kansas, shown by shading

U. S. GOVERNMENT PRINTING OFFICE: 1931

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