SOIL SURVEY OF THE RUSSELL AREA, KANSAS.

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LOCATION AND BOUNDARIES OF THE AREA.

The Russell area consists of a strip 18 miles long, east and west, and 15 miles wide, north and south, and is located almost in the center of Russell County, which lies in the west central part of the State of Kansas. The whole area of 270 square miles is embraced in the Russell sheet, United States Geological Survey, and is a rectangular section, comprising all of townships 14 and 13, and one-half of township 12, ranges 12, 13, and 14 west. It extends to within about 8 miles of the county boundary on both the east and west and to within about 12 miles of the northern and southern boundaries.

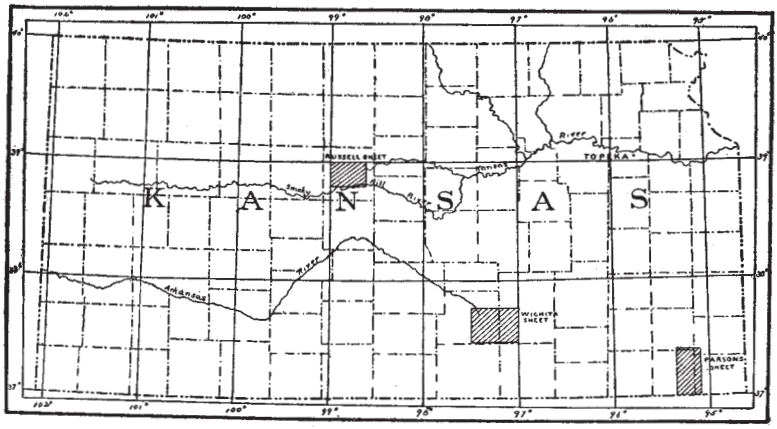

FIG. 45.—Sketch map showing location of the Russell area, Kansas.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Prior to the advent of the Union Pacific Railroad, about 1869, the area under discussion was inhabited only by roving bands of Indians of the Cheyenne and Pawnee tribes, and by a few hunters, who made a living hunting the buffalo and antelope, then plentiful upon the prairies. No attempt at any real colonization was made until the year 1871. In April of that year the first permanent settlement was made by a colony from Green Lake County, Wis., at the place where the town of Russell now stands.

A short time afterwards a second colony, from Ohio, made a settlement a few miles to the east of Russell, and from that time the population steadily increased by the addition of small companies of settlers from Pennsylvania and other eastern States. Between 1870 and 1875 the population had increased from 150 to 1,212.

The county was primarily taken up for the purpose of stock raising, the abundance of water furnished by the two rivers and their small tributaries causing this locality to be excellently fitted for this industry.

The first attempt at farming was made in 1872, when 600 acres were cultivated to wheat, corn, barley, oats, and sorghum. This attempt proved successful, and from that time on the acreage under cultivation gradually increased until in 1875 it had reached 6,407 acres, the greater part of which was devoted to wheat and corn.

In 1877 a large colony of Russians settled in the area, and this was joined by a second colony in the following year. As the population increased the cultivated area was rapidly extended, and the production of wheat began to attract more attention. The uncertainty of a corn crop on the uplands soon caused them to be almost exclusively devoted to the production of wheat, especially as the climatic conditions seemed to be more favorable to the successful cultivation of this crop. The hot winds and drought of the early summer were very detrimental to corn on the uplands, although a good yield was almost always obtained from the bottom lands along the stream courses.

As the cultivation of wheat grew in importance, the number of ranches devoted exclusively to the raising of stock decreased, but this did not lessen the total number of cattle, since each farmer invariably owned a small herd. In 1880 sheep raising began to be an industry, and large tracts of land in the more broken and hilly sections, which offered very poor advantages for cultivation, were devoted to grazing purposes. This industry again gave way to the raising of cattle about 1893, as the latter offered better financial inducements and could be profitably carried on with the expenditure of less time and labor.

In 1882 the total number of acres under cultivation had reached 214,260, and a greater variety of crops were successfully grown. Potatoes, flax, broom corn, Kafir corn, and sorghum, as well as grasses, were cultivated, and there was a large increase in the production of wheat, oats, and corn.

Forestry is now receiving some attention. Walnut, oak, and cottonwood trees can frequently be seen in a flourishing condition.

The whole country is fenced off in sections by means of neat wire fencing, supported by stone posts, which are extensively quarried from the limestone that underlies the area.

The growing of wheat is at present the main industry, and the annual production is steadily increasing.

There has been no appreciable increase in the population during the last few years, but the advancement in property values, the more extensive use of modern farming machinery, and the general prosperity of the farming class indicate the general progress of the country.

CLIMATE.

The climate is mild and healthful, no extremes of either heat or cold being experienced. Occasionally, in summer, hot winds prevail for short intervals, and are more or less harmful to growing crops, but as a rule the steady breezes which sweep over the prairies prevent the heat from becoming oppressive.

The winters are comparatively mild, snow seldom falling until the latter part of December. The coldest months are January and February, and even then it is exceptional when conditions are such as to prevent cattle from feeding in the pastures for any considerable time. Cattle often remain out the whole year with the aid of very little rough feed and grain.

The climate is very dry and windy, but enough rain usually falls during the year, together with the amount of moisture conserved from the winter snows, to be adequate for the crops cultivated.

The following table shows the monthly and annual temperature and precipitation as observed at Weather Bureau stations at Concordia and Eureka Ranch:

Normal monthly and annual temperature and precipitation.

Month.	Concordia.		Eureka Ranch.		Month.	Concordia.		Eureka Ranch.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° *F.*	*Inches.*	° *F.*	*Inches.*		° *F.*	*Inches.*	° *F.*	*Inches.*
January	23.2	0.71	28.2	0.74	August	74.4	2.65	76.2	1.86
February	28.2	.86	28.6	.85	September	67.8	2.45	68.5	1.88
March	39.0	1.59	38.2	.81	October	54.5	2.12	52.6	2.56
April	55.3	2.33	54.0	1.96	November	40.0	.82	38.1	.53
May	62.1	4.04	62.8	2.71	December	33.0	.56	30.8	.64
June	72.3	4.18	73.0	2.52	Year	52.2	25.90	52.3	20.27
July	77.1	3.59	76.3	3.21					

PHYSIOGRAPHY AND GEOLOGY.

A great part of the area surveyed is a broad ridge or table-land, sloping toward the Smoky Hill River on the south and toward the Saline River on the north. This ridge extends through the central part of the area from east to west, and has the appearance of an almost perfectly level and treeless prairie. A few slight elevations give it a gently undulating aspect.

The average elevation of this upland ridge is a little over 1,800 feet above sea level. It slopes gradually toward the Smoky Hill River to the south, and the country is generally quite level, but is occasionally intersected by small arroyos or draws which serve as a means of drainage. To the north the drop to the river is more abrupt and the country is so thickly traversed by deep draws and erosions, which lie between the rounded hills, that a great part of it is in a condition which renders cultivation impracticable. The steepness of the hillsides and the frequent occurrence of draws, whose tributaries branch off at frequent intervals in deep, canyonlike erosions, have caused the soil to be greatly eroded, and as a rule only a thin layer of soil and partially decomposed shale is left above the underlying stratum of limestone.

The southeastern part of the area is the most level, and consequently the least affected by erosion. The draws are shallow, and the valleys are usually wide and productive.

The area is drained by the Smoky Hill and Saline rivers and a few small tributaries of these streams. The rivers flow almost parallel to each other across the area from west to east, the Smoky Hill traversing the extreme southern part of the area, while the Saline crosses the northern part, the average distance between the two being about 11 miles. A few small creeks empty into these streams, flowing between steep banks, their valleys widening out as they approach their outlet and forming rich and fertile bottom lands. These rivers have an elevation of from 175 to 200 feet less than that of the high upland ridges, and their banks are often perpendicular sandstone bluffs from 20 to 30 feet high. These bluffs are formed of the Dakota sandstone, which underlies the Benton group of limestones composing the geological formation of the upland part of the area. This sandstone has the power of absorbing and storing up a large amount of water, and is the main source of the well water and the springs of the area. Springs are frequently found along its junction with the underlying shale.

The series of limestones and shale which underlies the entire upland section belongs to the Colorado division of the Cretaceous period of Mesozoic time, and is known as the Benton group. The strata of this group dip about 5 feet per mile to the east and very slightly to the north.

Occurring just above what is known as the Fence-post limestone, an easily split stratum about 9 inches in thickness, is a bed of fossiliferous shale, which forms by its disintegration a large percentage of the soil in the area. In many places it contains a large number of round or oblong limestone concretions, varying in size from a few inches in diameter to round, wheel-shaped masses, often a foot or more in diameter.

SOILS.

The soils of the area are very uniform in occurrence, and the relation of the topographic features of the area to the location of the different types is very noticeable.

The following table shows the extent of each of the five types found in the area:

Areas of different soils.

Soil.	Acres.	Per cent.
Sedgwick clay loam	91,648	53.0
Benton loam	35,456	20.5
Sedgwick sandy loam	24,064	13.9
Waldo loam	12,864	7.4
Lincoln sandy loam	8,832	5.1
Total	172,864	

SEDGWICK CLAY LOAM.

The extent of area, level topography, relative amount under cultivation, natural productiveness, and recognized adaptability to crops grown are features which combine to make the Sedgwick clay loam the most important type of the area.

For the first 12 inches the soil consists of a dark-brown to black silty loam, containing a large percentage of organic matter, but becoming lighter in color and slightly heavier with depth. It is underlain at from 12 to 36 inches by a heavy silty loam of a light-brown color having a slight clay content, but still retaining its silty nature. This soil, when dry, becomes very compact and shows a slight tendency to crack. When plowed in this condition it becomes cloddy, and unless exposed for some time to sun and rain is difficult to reduce to good tilth. Kept in a good state of cultivation it is quite retentive of moisture, but a crop which matures later than July generally suffers from the droughts frequent at that time of the year.

The Sedgwick clay loam covers the entire central part of the area, extending uniformly and in an unbroken area from the extreme western boundary to the eastern. It is also found on the high uplands north of the Saline River and south of the Smoky Hill River, but the rough and broken topography in these sections of the area prevents it from covering any large extent of territory. As the streams are approached, a few small isolated areas occur on gradual slopes at a lower elevation than that at which the greater part of this soil occurs.

Where this type has been extensively developed the country presents a flat or gently rolling surface, broken only occasionally by narrow depressions, which seldom reach sufficient depth to be classed as draws or arroyos. In the more broken and hilly sections, where deep draws exist, it is found occupying the broader ridges between them, which have not suffered excessive erosion. The surface of the

soil thus located is generally level, with the exception of a slight slope toward the draws on each side.

The elevation of from 100 to 200 feet above the level of the rivers insures to the uplands good natural drainage. Small creeks and deep draws extend from the uplands to the rivers, furnishing adequate means for carrying off the excess water. Artificial drainage is never needed, very few places occurring where water stands, even in times of the heaviest rains.

The Sedgwick clay loam has its origin in the decomposition of a fossiliferous shale containing thin layers of limestone and limestone concretions. The underlying shale is close textured, and as it is approached the soil becomes stiffer and more impervious.

This is the principal wheat soil of the area and it is devoted almost exclusively to the cultivation of this crop. Under the present methods of cultivation the general average yield is about 15 bushels per acre, but when the soil is carefully prepared and proper methods are used to conserve moisture an average of 18 or 20 bushels has been continuously obtained. It has been made to produce as high as 40 bushels per acre in a good season, under thorough cultivation. Corn is by no means a certain crop, its success depending on the amount of rainfall during the growing season, but in a wet year an average yield of 10 or 12 bushels per acre is realized. Kafir corn and cane are often cultivated for forage crops.

This type of soil is best adapted to crops which mature early, as it does not retain and give up enough moisture in an ordinary dry season for the thorough maturing of any of the late summer crops.

The following table shows the texture of typical samples of this soil:

Mechanical analyses of Sedgwick clay loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
9896	1½ miles N. of Bunkerhill.	Dark silty loam, 0 to 14 inches.	2.73	0.00	0.50	0.44	1.52	9.66	78.70	8.92
9771	2½ miles W. of Russell.	Dark silty loam, 0 to 12 inches.	1.75	.00	.64	.48	1.94	11.82	73.60	11.50
9894	3 miles NE. of Russell.	Dark-brown loam, 0 to 14 inches.	3.21	.00	.44	.62	2.90	10.14	74.22	11.70
9897	Subsoil of 9896.....	Brown loam, 14 to 36 inches.	1.13	.00	.34	.60	2.66	4.86	80.40	10.80
9772	Subsoil of 9771.....	Brown silty loam, 12 to 36 inches.	.26	.00	.36	.44	2.10	10.28	71.26	14.80
9895	Subsoil of 9894.....	Loam, 14 to 36 inches.	1.64	.00	Tr.	.40	1.80	4.10	76.92	16.20

The following sample contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 9772, 1.06 per cent.

BENTON LOAM.

The surface soil of the Benton loam, ranging in depth from 3 to 12 inches, is a light-brown to grayish silty loam, often having small argillaceous shale and limestone fragments scattered through it and lying on its surface. The soil grades quickly into a light-colored subsoil, which is almost wholly made up of partially decomposed shale, mingled with which occurs a small quantity of limestone fragments in various stages of degradation. At a depth of from 25 to 36 inches the rotten shale and limestone in the subsoil often appear as soft, chalky particles, causing the color to become lighter. Owing to its general porosity and chalky nature, the subsoil retains and gives up but little moisture for the growth of crops.

The Benton loam is found where the country is cut by small streams and draws. It follows the immediate course of these very closely, and extends both along their steep banks and usually some distance back upon the ridges, which slope gently toward them.

The topography is naturally rough and broken, and the general appearance of the country is that of a gently sloping table-land, intersected by a great number of deep erosions, which gradually deepen and widen as they near the rivers, their banks becoming almost perpendicular walls from 50 to 75 feet high. These draws afford excellent drainage, but as they have deepened and widened the ridges between have decreased in extent, and the upper soil has been eroded and washed down into them. The location of this soil is not such as to allow it to conserve moisture and withstand drought, as water falling on the ridges soon finds its way into the neighboring draws. On the more level ridges the soil is deeper, but on the steeper slopes near the draws it is often so shallow as to expose the white shale and limestone which underlie it. Thus small areas that have the characteristics of a stony loam are sometimes encountered, but these are not of sufficient extent, nor of frequent enough occurrence, to be recognized as a distinct soil type of the area.

The Benton loam is a residual soil, being derived from the fossiliferous layers of shale and limestone in the upper series of the Benton group, but in a more imperfect state of decomposition than that of the main upland type. These shale beds and limestone strata disintegrate rapidly where the topography is such as to expose them to the action of the atmospheric agencies, but erosion has prevented the soil from accumulating to any great depth.

The most of the territory covered by this soil type is devoted exclusively to pasture, an abundance of native grasses being found on it. At the present time the production of cultivated crops is attempted only in a few instances, as the other types offer so many more advantages for cultivation. On a few of the more level slopes Kafir corn and sorghum have been cultivated with success. The type is well

adapted to stock raising, as the numerous draws furnish protection during the winter, and the grass on the slopes insures pasturage the greater part of the year. The value of this land ranges from $5 to $10 an acre, according to the location.

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

Mechanical analyses of Benton loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
9761	8 miles SE. of Russell.	Light-brown loam, 0 to 8 inches.	1.56	2.16	4.26	6.26	9.86	17.66	34.70	24.94
9763	6 miles SW. of Russell.	Light-brown loam, 0 to 8 inches.	5.51	1.28	4.60	6.42	9.20	12.28	28.16	37.80
9762	Subsoil of 9761.....	Loam, 8 to 36 inches.	1.42	2.10	3.44	4.50	8.84	12.92	26.68	40.72
9764	Subsoil of 9763.....	Light-brown loam, 8 to 36 inches.	.66	1.86	7.50	6.74	8.46	9.40	22.40	43.38

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 9761, 54.28 per cent; No. 9762, 62.10 per cent; No. 9763, 47.89 per cent; No. 9764, 32.29 per cent.

SEDGWICK SANDY LOAM.

Among the upland types the Sedgwick sandy loam ranks in agricultural value between the Sedgwick clay loam and the Benton loam. In parts of the area it suffers the same topographical disadvantage as does the Benton loam, but where it occupies more level areas it is successfully cultivated to a greater diversity of crops than either of the other upland soils. The depth of the soil varies from about 10 to 15 inches, and is a light gray to grayish-brown sandy loam, the sand content of which ranges from a medium to fine grade. Occasionally on rounded knobs and small ridges there is a large proportion of waterworn pebbles scattered on the surface and mixed with the finer sand. These pebbles range in size from coarse sand particles to fragments an inch or more in diameter. These areas, however, are of infrequent occurrence and of small extent.

From 10 to 36 inches the subsoil differs little from the soil, except that the sand content increases and the color becomes lighter with depth. Rounded quartz pebbles are also frequently encountered in the subsoil.

The location of this soil is usually in the vicinity of the rivers, and rarely extends more than a few miles north or south from these streams. The largest unbroken area is situated north of the Smoky Hill River, south of Bunkerhill, and covers about 5 square miles.

The surface of the sandy loam areas, especially along the Saline River, is very rough. Occupying, as this type does, the lower slopes of the hills and the rounded knobs between them and the bottom lands, it is intersected by the many arroyos or draws that extend to the rivers. The areas along the Smoky Hill River are generally of a more rolling nature, the draws are shallower and less numerous, and the country gradually becomes more level to the eastward, especially on the north side of the river.

A great part of this soil originates directly from the Dakota sandstone, which outcrops along the lower slopes of the hillsides and caps the summits of the low ridges and knolls, but in many instances it is found at such an elevation above the sandstone that it can not be influenced by this formation. These areas are supposed by geologists to have been deposited by early floods, which brought down large amounts of material from the western mountains. The abundance of waterworn pebbles which are often found on the ridges indicates that, at least in part, this soil was deposited by water at an early date, before the rivers had cut down their channels to their present level.

Where the surface is level or gently rolling, fair yields are obtained of every crop adapted to the climatic conditions of the area. It is always more productive in a wet season, since it does not seem to withstand the effects of drought as well as the heavier soils. In seasons of much rainfall it oftens produces a wheat crop equal to that of the Sedgwick clay loam. On the level areas wheat yields range from 10 to 15 bushels per acre, and corn produces about 15 bushels. Oats, Kafir corn, and sorghum are also cultivated with much success. The rougher and more hilly sections are mainly used for pasture and for the production of such forage crops as Kafir corn and sorghum. The cultivation of melons and potatoes has been attempted on this soil with good results.

The Sedgwick sandy loam warms up earlier in the spring and can be plowed sooner after rains than the other upland soils. The sand content also prevents it from baking into hard clods. It is therefore well adapted to crops requiring intertillage.

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of Sedgwick sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
9773	6 miles SW. of Russell.	Brown sandy loam, 0 to 12 inches.	1.53	1.54	6.32	8.94	16.64	28.74	28.94	8.44
9777	12½ miles NE. of Russell.	Brown sandy loam, 0 to 12 inches.	.96	.90	6.88	11.54	18.90	27.08	25.70	8.64
9775	8½ miles SE. of Bunkerhill.	Brown sandy loam, 0 to 12 inches.	1.21	.40	9.12	10.92	18.82	20.36	28.14	12.00
9774	Subsoil of 9773....	Yellow sandy loam, 12 to 36 inches.	.21	1.20	5.24	5.72	10.78	26.84	37.80	11.80
9778	Subsoil of 9777....	Gray sandy loam, 12 to 36 inches.	.56	1.68	12.02	13.72	18.36	16.98	21.70	14.80
9776	Subsoil of 9775....	Brown sandy loam, 12 to 36 inches.	.55	2.52	12.56	9.92	13.08	15.80	23.12	22.60

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 9773, 6.37 per cent; No. 9774, 5.81 per cent; No. 9777, 5.08 per cent; No. 9778, 5.70 per cent.

LINCOLN SANDY LOAM.

The Lincoln sandy loam is the most important type of alluvial soil in the area. It covers the largest acreage of any of the lowland types and is the typical sandy bottom soil of the Saline and Smoky Hill rivers. The soil from 0 to 15 inches is a sandy loam, the color varying from light gray to brown, in proportion to the amount of organic matter present. The subsoil is usually of a lighter color, the sand content being greater than that of the soil, though it still contains a small amount of silt and organic matter.

This soil occurs along the low, flat areas bordering the rivers on each side, except in a few localities where the bluffs rise perpendicularly from the channels of the streams. These channels have been cut down to a depth of from 5 to 10 feet below the average elevation of the Lincoln sandy loam, protecting it from overflow as well as affording excellent drainage. Many of the broad, flat areas lying in the bends of the rivers offer excellent opportunities for the practice of irrigation on a small scale. The streams furnish an abundance of water at all times, and the porosity of both soil and subsoil would allow the seepage water to return to the neighboring stream without the aid of artificial drainage. Limited experiments in the valley of the Saline River have shown that the irrigation of this land is beneficial to the crops and can be successfully accomplished at no great cost.

The soil is alluvial, being formed from material held in suspension by the streams and deposited along their courses. It owes its sandy

nature to the wearing away of the Dakota sandstone in the formation of the river valleys.

This type of soil is recognized as best adapted to corn and alfalfa, being esteemed about equal to the Waldo loam in the production of these crops. However, on account of its loose, sandy texture, crops are more subject to injury by drought than are those cultivated on the Waldo loam.

Kafir corn and sorghum do well on this soil and are widely grown. The average yield per acre of corn is 25 or 30 bushels, and of alfalfa 4 or 5 tons. Wheat is seldom cultivated on this soil, the other types being recognized as much better adapted to it.

The following table shows the texture of the soil and subsoil of this type:

Mechanical analyses of Lincoln sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
9769	8½ miles NE. of Bunkerhill.	Fine sandy loam, 0 to 15 inches.	0.39	Tr.	1.26	5.86	43.80	30.68	11.50	6.50
9767	7½ miles SW. of Russell.	Gray sandy loam, 0 to 15 inches.	4.48	0.10	.88	1.28	25.38	40.44	22.38	8.92
9765	5½ miles SE. of Bunkerhill.	Sandy loam, 0 to 15 inches.	1.39	.30	1.52	3.10	37.54	26.34	19.60	11.44
9770	Subsoil of 9769.....	Gray sandy loam, 15 to 36 inches.	.27	Tr.	1.10	3.90	29.00	36.40	19.70	9.44
9768	Subsoil of 9767.....	Gray sandy loam, 15 to 36 inches.	2.94	.00	1.22	1.46	17.58	39.42	30.10	9.68
9766	Subsoil of 9765.....	Gray sandy loam, 15 to 36 inches.	.67	.00	1.16	5.34	41.32	24.04	17.26	10.14

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 9765, 25.99 per cent; No. 9766, 24.38 per cent; No. 9767, 8.88 per cent; No. 9768, 4.97 per cent; No. 9769, 18.19 per cent; No. 9770, 16.23 per cent.

WALDO LOAM.

The surface soil of the Waldo loam consists of a brown or grayish-brown silty loam, having an average depth of about 12 inches, and sometimes containing a small amount of fine sand. It grades into a subsoil of about the same nature, but of a lighter color, and becoming slightly stiffer as its depth increases.

The Waldo loam is found along small creeks, and here and there along the Smoky Hill and Saline rivers, generally where these creeks or draws enter the valleys. Narrow areas also extend some distance up the more important of the draws.

The topography of this type is comparatively level, the gradual slope toward the streams being scarcely noticeable. The elevation above the adjacent streams is sufficient to admit of good natural drainage, artificial drainage never being necessary in a season of average

rainfall; neither is it subject to overflow, as the streams rarely leave their narrow channels, even in times of heaviest rains.

The material from which the soil is formed is derived mainly from the erosion of the limestone and shale of the surrounding uplands. The loose soil has also been washed down from the steep hillsides into the creeks and draws, and deposited along them. Near the rivers, where occasional outcrops of limestone occur along the bluffs, a small amount of fine sand has become mixed with this material.

When properly cultivated, wheat often yields from 18 to 20 bushels per acre; the average yields, however, covering wet and dry seasons, range from 12 to 15 bushels. During a wet season wheat has a tendency to produce a large amount of straw and very little grain. Corn yields on the average 25 or 30 bushels per acre, but much larger yields are often obtained. Oats are not extensively grown, but 20 to 25 bushels per acre have been produced. Alfalfa is quite successfully grown, and produces an average yield of 4 or 5 tons per acre. Sorghum and Kafir corn are extensively grown for forage and winter feed for cattle, and produce yields which show the type to be well adapted to these crops. This type is also the principal source of native hay in the area, and yields an average of from 1½ to 3 tons per acre.

The Waldo loam is an alluvial soil, well adapted to general agricultural purposes. Its location protects the crops from the hot winds which often damage those on the uplands, and the texture enables it to withstand drought better than the sandy loam along the rivers. It seems well adapted to any of the general farm crops grown in the area. Its value is about $20 per acre.

The following table shows the texture of the soil and subsoil of this type:

Mechanical analyses of Waldo loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.5 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
9781	7 miles SE. of Russell.	Brown silty loam, 0 to 16 inches.	2.74	Tr.	0.84	1.12	6.28	13.86	66.60	10.50
9785	7⅛ miles NE. of Bunkerhill.	Brown loam, 0 to 14 inches.	4.11	.00	1.44	3.18	17.10	17.18	49.40	11.48
9783	5⅛ miles SE. of Bunkerhill.	Silty loam, 0 to 12 inches.	1.62	Tr.	.36	1.20	8.54	7.34	59.16	23.40
9782	Subsoil of 9781.....	Brown silty loam, 16 to 36 inches.	1.31	.12	.86	1.10	5.00	12.92	68.30	11.32
9784	Subsoil of 9783.....	Loam, 12 to 36 inches.	.81	.00	.72	1.34	5.50	7.14	63.86	21.26
9786	Subsoil of 9785.....	Brown silty loam, 14 to 36 inches.	.28	Tr.	.76	1.32	8.98	11.54	52.54	24.60

The following samples contained more than one-half per cent of calcium carbonate ($CaCO_3$): No. 9781, 2.77 per cent; No. 9782, 2.89 per cent; No. 9783, 4.10 per cent; No. 9784, 6.31 per cent; No. 9785, 8.30 per cent; No. 9786, 25.42 per cent.

ROCK OUTCROP.

There are strips along the banks of the draws where the lands are either too steep and rocky to be of any agricultural value, or consist of layers of limestone and shale from which the soil has been entirely eroded.

These areas were too narrow to be accurately shown on a map of the scale used in the survey, and for this reason they have not been separated.

AGRICULTURAL METHODS.

Up to this time the agriculture of the Russell area has been extensive rather than intensive, and the soils have not had the care and attention which their natural productiveness deserves.

In an area where the conservation of moisture is a very important matter at certain critical periods of the growing season the value of thorough and proper preparation of the soil and of frequent and careful cultivation should be fully understood. The farmers are overlooking this most important feature of successful agriculture.

Up to the present time there have been three different methods of wheat culture in vogue in this section—"volunteer," drilling in on the stubble of the preceding crop without any preparation of the soil whatever, and plowing and preparing the soil in the ordinary way.

In the "volunteer" method, which is but little used at present, the crop was produced from the growth of what wheat was scattered on the ground in harvesting. In wet years good stands have thus been gotten with no labor or expense of plowing, harrowing, and drilling, and as high as from 15 to 30 bushels per acre have been grown by this method. The uncertainty connected with it, however, has caused it to be generally discontinued.

The second method—that of drilling in the crop without any preparation of the soil—is still a quite common practice among the farmers, and in a dry season, having an open, dry winter, often produces the best crop; but in a wet season it has been found to be a failure. Where this system is practiced the stubbles should always be burned before drilling, and the soil should be plowed every other, or each third, year at least, or a disk harrow should be used every year. With these precautions this system is considered almost as good as any.

The best method, however, consists of plowing the soil to a depth of 4 or 5 inches very early after harvest and allowing it to lie thus exposed until sufficient rain has fallen to soak it well; then it should be thoroughly harrowed. It would be well to harrow after each rain of any consequence, if possible, till it is time to sow the crop; then a large amount of moisture would be stored up and the soil would be in the best condition to retain it. Frequently such extreme methods

are uncalled for, as a sufficient rainfall is present for all practical purposes; but to always insure the best crop the preparation of the soil can not receive too much attention. In connection with this the crop should be sown from the 10th to the 30th of September, as it then takes good root and makes a thrifty growth. There is thus very little danger of "freezing out," and a good yield of wheat of fine quality is practically assured. As much as 40 bushels per acre have been grown by this method, whereas by the ordinary method of plowing late, carelessly preparing the soil, and leaving it loose and cloddy the same soil in the same year produced only from 12 to 18 bushels. The average yield of wheat under ordinary methods as now practiced in the area, taking one year with another, is conservatively estimated at from 12 to 15 bushels per acre, while by better methods the average yield would run as high as from 18 to 20 bushels. This should be sufficient to encourage the farmers of the area to pursue better and more careful methods.

AGRICULTURAL CONDITIONS.

The area surveyed embraces a section of country suited to two distinct branches of agriculture. The greater proportion lying between the Saline and Smoky Hill rivers, being but slightly rolling and well adapted to cultivation, constitutes an area in which wheat is grown almost exclusively. In the vicinity of the rivers, creeks, and large draws the country is too rough to permit of this, but is well suited to grazing. While almost every farmer keeps some live stock, the larger herds are found in the rougher sections. Wheat growing is generally considered the more profitable of the two industries, and it is to the success of this that the county owes its present prosperous condition.

During the past few years the prosperity and thrift of the area have been very noticeable. Lands which were either homesteaded or bought at a low price have increased greatly in value. There has been a rapid development generally, which has placed most farmers in a good position financially. However, a large percentage are still paying for land recently bought, and as a result have but little ready money. A large proportion of the most prosperous are Germans or Russians. These farmers have, as a rule, large families, which enables them to farm a large acreage at little expense for labor. Their mode of life is simple and inexpensive, and the most of their income is invested in land or improvements.

Every section of land is neatly fenced with barbed wire, supported by stone posts. The farm dwellings, many of which are commodious two-story structures, are mostly built of stone. The barns also are generally built of stone, but are small and less modern, being intended only for the stabling of a few horses or cows, while the agricultural

implements are allowed to remain unsheltered during the entire year. A few cheaply built sheds for cattle are to be seen in the grazing districts.

Farms sell for from $8 to $25 an acre. The cheaper land lies in the rough or grazing section, and is valued at from $8 to $10 an acre. The upland farms sell at from $20 to $25 an acre, while the bottom lands have an average value of $20. The latter lands are valuable, in connection with the grazing lands, for the production of alfalfa, corn, Kafir corn, and sorghum forage, to which they are well adapted.

The farmers have generally taken advantage of the homestead law, or former low prices of lands, and now own their farms. The man who depends entirely upon renting is practically unknown. Formerly farmers rented large tracts in addition to the land they owned, but as the country has become more thickly settled this practice has become less prevalent, so that now comparatively little land is rented. However, some farmers continue this practice of renting, and pay from one-fourth to one-third of the crop, delivered at the elevator, for the use of the land. One-third is the rent generally given where it is within reasonable distance of a market, but where so situated that a long haul is necessary only one-fourth of the crop is paid to the landlord.

The average-sized farm in this section ranges from 320 to 350 acres, while there are a few ranches and wheat farms which greatly exceed this. On the whole, the farms are too large for the general good, or for securing the greatest possible output from the area. Farming such large areas has given rise to great carelessness in the preparation and cultivation of the soil.

The agriculture of the area is responsible for the labor conditions peculiar to it. The greater number of farmers, being engaged in the production of wheat, need laborers only in the harvesting, thrashing, and seeding seasons. About the only demand during the remainder of the year is for a few hands on the ranches. These conditions necessitate transient labor. About harvest time a large number of men usually come to this part of the State, many of whom find employment till colder weather sets in, in November and December. Usually these men have proved to be trusty and efficient laborers. There is usually a good demand for harvest hands at $2 a day and board. A scarcity of men and a good crop have often caused $2.50 and $3 a day to be paid, and in some instances more. However, $2 is the customary wage, and in no case is it lower than this. About the same is paid during the thrashing season. The ranchmen pay a farm hand by the year from $20 to $25 a month, but they have much difficulty in procuring men under this system.

Wheat and cattle constitute the principal products of Russell County. Most farmers formerly gave their attention to either one or the other

exclusively, but there is now a tendency to combine the two. There is an advantage in this, as one can generally be relied upon as a source of income when the market price of the other is low. Farmers raising cattle also find that wheat produces valuable pasturage, and that it is possible to allow it to be grazed over in the fall, if the wheat has a good start, and still harvest a good crop. Comparatively few hogs are raised, and still fewer sheep at present. The latest reports show about 4,000 hogs and 300 sheep in the county, whereas the number of cattle is about 11,000.

During the last year the hand separator system of dairying has been introduced, and is growing quite rapidly. There are no creameries in operation in the county, but much cream is being shipped to St. Joseph and Wichita. The value of the cream shipped during the first seven months of the operation of this system was $8,169.

Throughout the entire area, to restate the soil conditions, certain soil types are almost wholly devoted to the production of certain crops. The stiffer upland soil is recognized as the best wheat land, while the bottom soils are invariably cultivated to corn, alfalfa, Kafir corn, and sorghum. Kafir corn and sorghum also seem to do well on the uplands. The rougher sections of country, where the soil is shallow and the topography such as to interfere with cultivation, are utilized as pasture lands for the herds of cattle, the growth of buffalo and other native grasses causing them to be excellently adapted to this branch of agriculture.

The Union Pacific Railroad passes through the area and affords the only means of transportation for its products. The facilities furnished are good, except occasionally during a short period in the thrashing season, when great quantities of wheat are to be marketed in a short time.

The cattle and a large part of the wheat of the area are shipped to Kansas City. The remainder of the wheat is shipped to different points in the State which have milling industries of some importance.

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