

# SOIL SURVEY OF REDWILLOW COUNTY, NEBRASKA.

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## DESCRIPTION OF THE AREA.

Redwillow County is located in southern Nebraska, adjoining Decatur County, Kans. McCook, the county seat, is 228 miles by rail west of Lincoln. The county is rectangular in outline, its approximate dimensions being 30 miles east and west and 24 miles north and south. The area by planimeter measurement is 711 square miles, or 455,040 acres.

Redwillow County lies in the Great Plains and in the western part of the division known as the loess plains. Topographically it consists of groups of nearly level tablelands with dissected fringes, separated by the valleys of the Republican River, Driftwood Creek, Beaver Creek, and Redwillow Creek, and a few smaller streams.

The largest division of the upland extends across the entire south-central part of the county in a broad belt, south of the Republican Valley and north of Beaver Creek. The next largest division lies north of the Republican River, extending east and west across the county. It is interrupted, however, by the narrow valleys of Redwillow, Coon, and Dry Creeks. Two other small upland divisions, one lying south of Beaver Creek in the southeastern corner of the county and the other forming the divide between the Driftwood and Republican Valleys, complete the upland area. The general surface of the upland appears nearly flat, but in detail it is varied throughout by low, gentle swells.

The table-lands are nearly flat and consist of remnants of the level, extensive loess plains of southern Nebraska, which have not yet been completely dissected by drainage channels. Drainage has been established over the greater part of the surface, but deep ravines have not been cut, nor has a sharply rolling or hilly topography been produced. Only one area of any size remains where the drainageways have not penetrated. This area covers about 4 square miles and occurs in the northwestern part of the county west of Flat Center

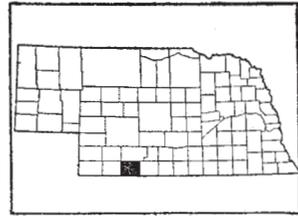


FIG. 39.—Sketch map showing location of the Redwillow County area, Nebraska.

School. Its surface is nearly flat and but slightly modified by a few depressions or basins.

A striking feature of the landscape is the sudden change from the flat or the gently undulating topography of the table-lands to that of the eroded valley and deeply intrenched ravines. Bordering the principal valleys, the descent from the high tables is as a rule of a rounded sloping type. The descent from the level upland to the canyon floors of the smaller streams is frequently a sheer precipice with little or no sloping approach. The tributary heads of the drainage channels are, for the most part, shallow, though often steep-sided, but in their lower courses they break into deeply gullied ravines. Small landslides are a prominent feature, and the slopes often present a succession of projections known as "cat steps," due to successive slides. Where erosion has been severe, the ravines and buttes are almost bare or covered only with a sparse growth of grasses and shrubs. A large part of the valley slopes, however, as well as the narrow bottoms, supports a growth of native grasses.

Terraces and flood plains follow the larger streams, but those along Republican River and Driftwood Creek are most extensive.

The Republican River, traversing the central part of the county from west to east, drains an area of about 500 square miles in the county. Beaver Creek drains all the rest, except about 8 square miles in the northeast corner, which drains east into Medicine Creek, and about 3 square miles in the southeastern corner, which is drained by tributaries of Sappa Creek.

The valley of the Republican River is approximately 30 miles long, but the length of the channel is somewhat greater on account of its broad, sweeping meanders. The stream has a fall of about 270 feet in the county, averaging over  $8\frac{1}{2}$  feet per mile. The valley is deeply entrenched and, in general, is from 2 to  $2\frac{1}{2}$  miles wide. The channel is shallow and relatively wide, and its sandy bed is bordered by low, sandy banks, except where it cuts into prominent bordering terraces, in which case the banks are higher and precipitous. The bottom land lies only 5 to 10 feet above the normal water level and is flat, except where broken by sandy ridges and abandoned overflow channels. Extensive alluvial terraces border the river. Where distinctly defined, they lie well above overflow and in places attain widths of a mile or more. From the point where the river enters the county to the mouth of Redwillow Creek the channel is generally dry during a large part of the midsummer owing to evaporation and diversion of the water for irrigation. Below Redwillow the flow from Redwillow Creek spreads a thin sheet of water over the broad channel, and this, with contributions from springs and seepage, insures a shallow flow to and beyond the eastern limit of the county.

Numerous tributaries empty into the Republican River, the most important of which are Driftwood, Redwillow, Dry, Coon, Ash, and Silver Creeks. Driftwood Creek ranks first in importance and is followed closely by Redwillow. Excepting Redwillow Creek, these streams maintain a flow only immediately after torrential rains or periods of rapidly melting snows.

With the intricate network of tributaries developed by the major streams, drainage everywhere is good, except in the area already mentioned as lying about 8 miles northwest of McCook and in a few small depressions elsewhere on the uplands and in the river valley. The total area of poorly drained lands is small, however.

Parts of the alluvial lands for a distance of 9 miles down the Republican River Valley are under irrigation, the water being diverted from Frenchmen Creek below Culbertson in Hitchcock County and conducted along the south side of the valley. There are possibilities of utilizing some water from Redwillow Creek for small projects farther down the Republican Valley.

Water supplies throughout most of the county are adequate. On the upland, a sandy deposit underlying the loess is the chief source of supply, except in places along the larger valleys, where the water has drained away. Excellent water is obtained from wells tapping this sand deposit at depths of 100 to 300 feet, their depth usually being 140 to 160 feet. In the bottom lands the underlying alluvial sands yield excellent water supplies. Wells on the flood plains range from 8 to 15 feet deep in the Redwillow and from 15 to 30 feet in the Republican and Beaver Valleys. The bench-land wells are 20 to 30 feet deep. Outside of a few bottom-land wells which reach ocherous Niobrara chalk beds and the Pierre shales, water is of good quality and abundant.

Redwillow County has an average elevation of about 2,600 feet above sea level. Its general slope is eastward. The altitude at Perry is 2,534 feet, at McCook 2,506 feet, and at Indianola 2,372 feet, according to the records of the Chicago, Burlington & Quincy Railroad. The elevation of Shippee is given as 2,331 feet, of Lebanon 2,392 feet, of Danbury 2,458 feet, and of Marion 2,501 feet.

Redwillow County was organized in 1873. The earliest settlers came to the county through the efforts of a Nebraska City corporation to organize and settle a county somewhere in the Republican Valley. While the company failed, it initiated immigration. Most of the native American population came from Illinois, though Iowa also contributed largely. A few came from the South and from States east of Illinois. Persons of German extraction predominate among the foreign-born population, particularly among the farmers, though they are not colonized as in some parts of eastern Nebraska. One

settlement of consequence is situated about 5 miles southeast of McCook and another large one lies south of Bartley. McCook has a number of citizens of German-Russian descent, most of whom are in the employ of the railroad, though some are engaged in sugar-beet production in the vicinity of McCook. A few of these have taken up land on the divides in the last few years. In 1910, 7,503 white persons in the county were of native parentage, 2,452 persons were native white of foreign or mixed parentage, and 1,094 were white of foreign birth.

The total population of the county in 1880 is reported as 3,044, all of which is classed as rural. In 1890 this had increased to 6,491 rural and 2,445 urban; in 1910, to 7,291 rural and 3,765 urban; and in 1920, to 7,131 rural and 4,303 urban. In the latter year the rural population, 62.4 per cent of the total, averaged 9.9 persons per square mile. The greater part of the population is in towns in the Republican Valley. The most densely populated area is in the vicinity of McCook, while the southwest corner of the county is sparsely settled. Over most of the county where the farm land is uniform the population is evenly distributed.

McCook, the county seat and principal town, is about 8 miles west of the center of the county. It had a population in 1920 of 4,303. This town is an important railroad point on the main line of the Chicago, Burlington & Quincy Railroad and the shops operated furnish employment for quite a large number of men. Indianola, an important town in the central part of the county, had a population of 742 in 1920; Bartley, 251; Lebanon and Danbury, with populations of 245 and 293, respectively, are situated in the Beaver Valley and are shipping points of local importance.

The main line of the Chicago, Burlington & Quincy between Chicago and Denver and St. Louis and Denver follows the Republican Valley through the county. McCook, Indianola, and Bartley are on this line. The St. Francis Branch of the same system extends through the Beaver Valley and connects with the main line at Orleans, 67 miles by rail east of McCook. Lebanon, Danbury, and Marion are on the branch line. Few parts of the county are more than 10 or 15 miles from a shipping point.

Most of the wagon roads, except in the southwestern part of the county, which is the least accessible, follow section lines. All of them are earth roads. The main highways between towns are generally graded, and, as they are dragged as soon after each rain as the ground permits, have a smooth surface, but some of the minor roads receive very little attention. The Republican River is bridged at 11 places, principally near the towns; and most of the other streams and drainage ways have bridges at necessary points. The

Omaha, Lincoln, and Denver Highway passes east and west through the Republican Valley and is in good condition for both wagon and automobile traffic. A truck line is maintained to North Platte and another line operates between Indianola and Danbury. Telephones and rural delivery routes reach all parts of the county.

The county has a good rural school system of about 80 districts. Several of the rural schools are of the consolidated type. Good grade and high schools are maintained in the towns. Churches are conveniently located throughout the greater part of the county.

The principal local markets in the Republican Valley and vicinity are McCook, Indianola, and Bartley, and in the Beaver Valley, Lebanon, Danbury, and Marion, the latter an unincorporated place. Some products are handled at Cambridge, in the adjoining county to the east. Wheat is delivered to local elevators in all the towns or loaded at sidings at Redwillow and Perry. Sugar beets are shipped from McCook to Grand Island, Hall County, Nebr., and Brush, Morgan County, Colo. There is a local demand for much of the farm products. The outside markets for live stock and other agricultural products are chiefly Denver, 255 miles to the west, Omaha, Lincoln, St. Joseph, and Kansas City. Dairy products are marketed in neighboring towns.

#### CLIMATE.

The climate of Redwillow County, like that of all southwest central Nebraska, is suited to the production of certain grain crops and alfalfa and to live-stock farming. The following table, compiled from the records of the Weather Bureau station at McCook, gives the more important climatic data for the county:

*Normal monthly, seasonal, and annual temperature and precipitation at McCook.*

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1894).	Total amount for the wettest year (1905).
	° F.	° F.	° F.	Inches.	Inches.	Inches.
December.....	27.8	73	-21	0.56	0.60	0.00
January.....	26.6	78	-30	.28	.30	.70
February.....	28.7	80	-38	.58	.40	.94
Winter.....	27.7	80	-38	1.42	1.30	1.64
March.....	39.1	91	-8	.71	.70	1.03
April.....	51.1	98	2	1.90	.36	3.28
May.....	61.8	101	10	2.93	T.	4.99
Spring.....	50.6	101	- 8	5.54	1.06	9.30

*Normal monthly, seasonal, and annual temperature and precipitation at McCook—Continued.*

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1894).	Total amount for the wettest year. (1905)
	° F.	° F.	° F.	Inches.	Inches.	Inches.
June.....	71.9	106	35	3.37	2.97	4.97
July.....	77.4	109	32	2.93	.92	10.86
August.....	75.8	107	35	2.72	1.81	1.40
Summer.....	75.0	109	32	9.02	5.70	17.23
September.....	66.4	103	25	1.77	.33	3.20
October.....	53.8	93	- 1	1.03	.35	1.23
November.....	39.6	85	-14	.53	T.	1.40
Fall.....	53.2	103	-14	3.33	.68	5.80
Year.....	51.6	109	-38	19.31	8.74	33.97

The climate of Redwillow County is characterized by wide extremes in monthly and annual temperature, the winters being long and cold, and the summers short and hot. Low winter temperatures occur as cold waves and blizzards, accompanied by high winds, often of several days' duration. These storm periods were once very destructive to live stock, but better care and protection are now provided and losses minimized. The mean annual temperature as recorded at McCook is 51.6° F. The hottest month is July, with a mean temperature of 77.4° and a maximum of 109° F. The mean temperature for the summer months of June, July, and August is 75° F. December, January, and February have a mean temperature of 27.7° F. The coldest month is January, with a mean of 26.6° F., but the lowest temperature, -38° F., occurred in February.

Distribution of rainfall is important, as the precipitation consists mainly of local showers, and is extremely variable. These rains are frequently in the form of thunderstorms and are sometimes torrential, and hail occasionally does serious damage over local areas. Droughts rarely occur in May and June, but during July and August the rainfall is frequently light and unfavorably distributed. The greatest uncertainty is during July, when deficiency may injure the sorghum and corn crops. The mean annual rainfall is 19.31 inches, of which 80 per cent comes during the growing season, from April to September, inclusive. Three-fifths of this falls during May, June, and July, with June as the wettest month. The driest year on record was 1894, with only 8.74 inches of precipitation, and the wettest year, 1905, with 33.97 inches.

The average date of the first killing frost in the fall is October 1 and of the last in the spring May 10. The date of the earliest recorded killing frost in the fall is September 18 and of the latest in the spring May 21. There is an average growing season of about 144 days, which is long enough to mature the ordinary farm crops. The grazing season usually lasts from about May 1 to November 1 and occasionally longer.

The prevailing wind is from the northwest, but during the summer winds from the south and southwest are most common. High winds are frequent, but tornadoes are of rare occurrence. The winds are valued as a source of power for pumping, but are disadvantageous in that they accelerate evaporation from soil and plants, particularly when strong and hot. The relative humidity is low.

As most of the tillable land is fertile, climate is a controlling factor in production. The relatively low rainfall results in smaller yields than those of eastern Nebraska, but with good methods farming has yielded fair average returns. The disadvantages of altitude and a short growing season are met by the use of hardier and earlier, though possibly less productive, varieties of crop plants. While trees will grow on the uplands, it is difficult to keep them alive, and there are few in existence at present.

#### AGRICULTURE.

Cattlemen were the first settlers to make use of the agricultural resources of Redwillow County. A large open range, supporting a variety of nutritious grasses, supplied good summer and fair winter pasturage, while the rough, broken canyons afforded excellent shelter from storms. The range was never developed, however, on as large a scale for cattle production as in the neighboring counties and other parts of western Nebraska.

The earliest settler came to the county in 1871. He was followed shortly by an exploring party sent out by a Nebraska City company which had incorporated with a capital of \$100,000 for the purpose of organizing and settling a county in the Republican Valley. The project failed as far as organization went and the company dissolved. In 1872 settlements began in earnest, and heavy immigration ensued the following year. Grasshoppers appeared in numerous swarms in 1874, and, consuming all the green crops, caused considerable suffering. The construction of the railroad up the Republican Valley in 1879 brought in large numbers of new settlers, and the completion of the line to Denver and the establishing of a land office at McCook in 1883 resulted in the rapid settlement taking place from 1885 to 1887. Following this period came a series of dry years, culminating in the disastrous droughts of 1893 and 1894. This caused a marked de-

crease in population, but had the present dry-farming methods been understood at that time it is probable that the agricultural development would not have been as seriously arrested. The general financial depression of the entire country had likewise brought low prices for all farm products. Later, conservation of soil moisture by cultivation, adoption of proper crop varieties, and combined stock and grain farming largely overcame adverse climatic conditions and development was renewed. The Kincaid Act, which increased the homestead to 640 acres and made it profitable to acquire land adapted only to grazing, did much to bring in new settlers and to improve the farming conditions in the county.

The following table, giving the acreage and production of the principal crops of the county, as shown by the census reports of 1880, 1890, 1900, and 1910, shows the general progress of agriculture during that period of 30 years:

*Acreage and production of principal crops as shown by the census reports, 1880-1910.*

Crop.	1880		1890		1900		1910	
	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>	<i>Acres.</i>	<i>Bushels.</i>
Corn.....	2,269	54,412	46,226	898,566	80,023	1,152,560	85,746	441,057
Oats.....	51	1,284	6,134	87,642	886	6,640	3,322	70,612
Wheat.....	717	6,443	16,155	160,691	45,720	198,270	71,517	746,736
Rye.....	231	2,321	2,801	29,915	3,941	26,540	1,198	10,757
Barley.....	16	298	12	146	590	5,820	7,618	121,046
Potatoes.....		1,565	1,311	85,979	626	29,022	1,034	47,103
						<i>Tons.</i>		<i>Tons.</i>
Sugar beets.....							17	92
Sorghum.....					25		53	70
Alfalfa.....					8,047	15,325	10,159	9,391

Almost 91 per cent of the area of Redwillow County in 1910 was included in a total of 1,187 farms, a large part of which is now under cultivation. The general type of agriculture consists of combined stock and grain farming, with the production of some dairy products. The principal crops are corn, wheat, barley, sorghum, oats, alfalfa, wild hay, sugar beets, and rye.

The following table shows the acreage and average yields per acre of corn, wheat, and other important crops for the years 1913-1918, according to the annual report of the Nebraska State Board of Agriculture:

*Acres and average yields per acre of crops in Redwillow County for the years 1913-1918.*

Crop.	1918		1917		1916		1915		1914		1913	
	Acres.	Average yield per acre.										
		<i>Bush.</i>										
Winter wheat..	83,978	6	48,162	.....	82,228	19.5	69,034	17.8	88,996	14	76,018	6.6
Spring wheat...	231	6	123	.....	533	13.2	2,075	11.4	5,255	8.6	4,124	5
Corn.....	78,200	16	74,084	8	80,244	12	14,641	29.5	62,409	19	76,803	1.3
Barley.....	12,548	13	11,085	15	6,552	29.3	7,609	31.8	11,287	19.3	7,096	7.5
Sorghum.....	10,315	.....	9,301	.....	6,183	.....	7,220	.....	6,970	.....	7,653	.....
Oats.....	5,461	15	5,659	21	6,012	33.4	3,618	41.7	6,932	14.1	7,255	14
Rye.....	1,824	12	876	11	491	21.8	1,256	23.9	1,079	11	530	10
Potatoes.....	666	87	637	55	527	85.5	638	103.5	750	128	763	43
		<i>Tons.</i>										
Alfalfa.....	4,234	3.2	4,615	2.5	5,543	3.3	5,526	3.3	6,845	3	7,529	2.3
Wild hay.....	4,135	.3	3,404	.3	3,071	.9	4,175	1.4	5,309	1.2	22,045	.8
Millet and Hungarian grass..	1,933	.....	3,156	.....	2,590	.....	2,732	.....	3,204	.....	3,040	.....
Sugar beets....	960	.....	699	.....	368	.....	730	.....	727	.....	657	.....

Corn ranks first among the grain crops. In 1918 the area in corn was 78,200 acres, yielding 16 bushels per acre, or a total of 1,251,200 bushels, valued at \$1,626,560. Corn is grown with success on every soil in the county, the yields varying mainly with climatic conditions, but the crop seems to be better adapted in the long run to the sandier soils, which are more drought resistant. Hot, dry winds and low rainfall in some years cause considerable injury to the crop, and when combined with a short growing season and cool nights at critical periods the kernels are likely to be soft and immature. The early settlers paid no attention to climatic adaptation of seed sown, and their success was only partial on this account, but hardier, fairly early, acclimated varieties have been introduced and are giving much better results. The stalks and ears of these new varieties are smaller than those of varieties grown in eastern Nebraska, but a matured crop is nearly always assured. Silver Mine, Flower Corn, Squaw Corn, and Reid's Yellow Dent were earlier introduced and now seed from each crop is saved for the succeeding one, though little attention is given to the finer points of seed selection. A "calico" variety is popular in some parts of the county, where it is held to be as early as the white varieties and earlier than Reid's Yellow Dent. White varieties produce the better yields, but are of quality inferior to the yellow. Some farmers grow corn successively on the same ground for years with little appreciable decrease in yield, but the rotation in general use consists of two years of corn followed by wheat, or two

years of wheat by one of corn, the former being the better. The crop is fed to hogs, cattle, and horses, being generally husked from the standing stalks. Pit silos are coming into general use, and the corn not husked or cut for fodder and much of the soft corn is used for silage.

Wheat is the principal money crop. At the present time winter wheat is grown almost exclusively. In 1918 the acreage was 83,978 acres. The yields are largely dependent on climatic conditions and therefore vary considerably from year to year. The average for the county is between 8 and 10 bushels per acre, although in 1916 it was 19.5 bushels. The acreage in 1918 was over thirteen times greater than in 1890, but only twice as large as in 1900. Winter wheat has attained practically the same acreage as corn.

Most of the wheat is grown on the heavy upland silt loams. There are also large acreages on the sandy soils, though there is danger of crop damage as a result of drifting by the strong winds in spring and fall. Winter wheat is preferred to spring wheat, as the former benefits by the rainfall of fall and winter and ripens early, avoiding the hot winds and low rainfall in summer. Most of the crop is headed and thrashed from the stack, though some prefer binding and thrashing from the shock. A part of the crop is used locally, but most of it is shipped to outside markets. Turkey is the principal variety grown.

Barley ranks third in importance among the grain crops. From 16 acres in 1880, 12 acres in 1890, and 590 acres in 1900, the acreage increased to 7,618 in 1910, and to 12,548 in 1918. This is more than double the acreage in oats. In the last six years the yield per acre has ranged from 7.5 bushels to 31.8 bushels, the maximum occurring in 1915, a year of ample rainfall. While barley seems to be hardier than oats, considerable damage is caused by grasshoppers, which clip the heads. Very little of the crop is marketed.

Oats rank next to barley in acreage, the average area planted in the years 1913 to 1918, inclusive, approximating 6,000 acres. This is almost twice as large as the acreage of 1910. The yields ranged from 14 to 41.7 bushels per acre, with the maximum as with barley in 1915. On irrigated land yields of 50 bushels per acre are reported. In general, the crop is less profitable than other grains, but it is valuable in rotations. It is included as a source of feed principally for horses. Oats may follow corn when it is desired to change the field to wheat the succeeding season. It is rarely grown two successive years on the same land. The crop does not withstand droughts as well as other grains, suffers some damage from the hot summer winds, and, like barley, is damaged by grasshoppers. The crop is usually cut with a binder and thrashed from the shock.

Sorghum is the chief forage crop. It is grown on nearly every farm in the county, except on the more valuable irrigated land, where alfalfa displaces it. At present it ranks fourth in acreage among the cultivated crops. The census of 1910 gives the small acreage of 53 acres as compared to 10,315 acres in 1918. The yield of cured forage varies from 1 to 5 tons per acre, and occasionally more. Sorghum belongs to a group of plants that become temporarily dormant in dry periods, and it is therefore very drought resistant as well as extremely productive. The best quality of feed is produced if the crop is cut when the earliest heads begin to mature. Most of it is fed with corn and oats. Its feed value compares favorably with any of the prairie hays, except the buffalo grass and grama grass.

Following severe droughts, caution should be exercised in using the crop as a green feed, as it may be poisonous, and the green aftermath of the fall is likewise injurious, so that stock should not be turned out to graze upon it. Sorghum consumes large quantities of moisture, and should not be grown on the same land in consecutive years. Black and Amber cane are planted, the latter being considered a sure crop.

Alfalfa, the principal leguminous crop in the county, is almost wholly confined to the subirrigated bottoms along Beaver and Redwillow Creeks and to the irrigated benches of the Republican Valley. On account of its value for stock feeding it is one of the most important forage crops produced. The crop occupied a total area of 4,284 acres in 1918, with a yield of 3.2 tons per acre. The acreage has decreased since 1910 when more than 10,000 acres was in this crop. The crop does well, giving 3 or 4 cuttings each season. Occasional difficulty is experienced in obtaining good stands, and the grasshopper and the variegated cutworm may injure the crop, the latter, eating the young shoots of the second crop, being especially harmful. Alfalfa has not proved very profitable on the uplands, although a few farms have obtained fair yields by planting in rows and cultivating the crop as in growing corn. It does best in deep, fertile, well-drained soils high in lime, and with an abundant supply of moisture. Rainfall is the controlling factor in the uplands of Redwillow County.

As a source of stock feed wild hay ranges next to alfalfa. From 3,000 to 4,000 acres have been cut annually in recent years. This is but two-fifths of the acreage reported in 1910. The yield averages 1 ton or more per acre. The native bluestem and wheat grasses yield fair crops of very good feeding value. The individual areas cut for hay are small, but one or more are included in each farm. They lie principally in the flat canyon floors or on their slopes, although many are situated on the unbroken upland or in the

stream valleys. Practically all the hay produced is used on the farm.

On irrigated lands the sugar beet is the most important crop. Its production is confined to lands in the Republican River Valley, between the western boundary of the county and a point 9 miles east. While but 17 acres are reported in the 1910 census, the area increased to 730 acres in 1915 and to 960 acres in 1918. The yields range from 10 to 22 tons per acre, with an average of about 13 tons. The tops are used locally for stock feed.

Minor crops of the county include rye, millet, Hungarian grass, kafir, and potatoes. Millet, Hungarian grass, and kafir lead in acreage. The total acreage of rye is small, though it is a valuable crop in rotations and makes excellent early feed for cattle before native grasses are fit for use. Sudan grass, grown to a small extent, gives good results and probably could be more extensively used for forage. Potatoes and vegetables are grown mainly for home use, and watermelons, cantaloupes, tomatoes, cabbage, and other truck crops are grown on a small scale to supply local market demands.

There are a few small orchards of apples, cherries, and other fruits scattered over the county, but, excepting cherries, the fruits are unprofitable, owing to unfavorable climatic conditions. Late spring frosts prevent the setting of fruit, and severe winters and droughts injure the trees. There is one large orchard in the Republican Valley south of McCook which apparently is succeeding. The orchards receive little attention. Other small fruits are unprofitable without irrigation. Wild plums and wild grapes are the chief native fruits.

As is the case throughout most of west-central and western Nebraska, the raising and feeding of live stock, generally combined with grain farming, is an important industry. According to the 1910 census, the value of all live stock and live-stock products sold was only about 10 per cent less than the value of all other crops combined. In 1918 there were in the county 4,919 milk cows, 19,298 other cattle, 11,772 hogs, 8,449 horses, 1,207 mules, and 7,253 dozen poultry. Only a few sheep are kept on the farms or ranches, the maximum number in recent years being 2,740 in 1915. The animals might be successfully run on stubble fields. Sheep raising is at low ebb at present (1919).

Most farmers keep a number of cattle which are mostly sold as feeders, but there are a few farmers in the county who feed for market on a large scale. The cattle are comparatively free from disease. As a rule, pasturage on dead grasses during the winter has been supplanted by feeding during the severe seasons. There are a few herds of pure-bred beef cattle, and the introduction of pure-bred bulls has improved the quality of the stock generally in recent years. The most popular breeds are Hereford, Shorthorn, and Polled Angus. Beef

cattle in the county in 1918 had a value of \$1,350,860. There are several dairy herds in the county consisting mostly of grades, but the industry receives marked attention only in a few instances. Holstein of the milk breeds, and Red Poll, Durham, and Shorthorn of the dual-purpose breeds, are the most popular. Dairying has proved a valuable adjunct on most of the farms where it has been undertaken. The use of pure-bred herds would materially increase the returns from this industry.

Hogs are raised on a small scale on many farms, though the low market prices of the past season has somewhat discouraged those engaged in the industry. The animals are generally fattened on corn or fed alfalfa on the irrigated and subirrigated farms. Nearly every farm has a flock of poultry, but few engage in poultry raising as a specialty. Small numbers of turkeys, geese, and ducks are raised as well as chickens.

The raising of mules and horses, principally of the draft type, is an industry of some importance. Most of the farmers raise their own work stock and often have a few animals to sell. The type of horse has been improved from the western broncho. The Percheron is recognized as the best breed for local use.

Sparse growths of willow, cottonwood, elm, ash, box elder, and hackberry flourish along the principal streams. The uplands are dotted with timber claims of ash, box elder, and honey locust, but owing to unfavorable moisture supply none of them have become more than patches of bushes.

The Russian thistle and dwarf sunflower are abundant, and other noxious weeds are widely distributed over the county. The sand bur is locally troublesome. The loco weed is occasionally encountered in pasture lands.

Chief among the destructive insects is the locust, commonly called grasshopper. The insect first attacks the wheat and barley, preferring the latter grain. It has but little effect on the first crop of alfalfa, but vigorously assails the young second growth. After the grain harvest it infests the cornfields. The insect breeds and feeds on weeds along the roadside, and the young brood generally consumes the weeds before it encounters the cultivated crops. Destruction of the weeds is a step toward eradication of the pest. The total damage done in Redwillow County in 1918 by these insects is estimated at \$150,000, and losses of individual farms range from \$1,000 to \$1,500. In 1919 the cutworm caused great destruction in the cornfields, appearing when the young plants first developed and necessitating replanting in some cases two and three times, occasionally the entire crop being destroyed. The variegated cutworm occasionally injures alfalfa by eating the young shoots.

The staple crops are grown on all the different soil types and on about the same proportional acreage, with one or two exceptions. Little wheat is raised on the subirrigated bottoms, but most of the alfalfa is confined to the irrigated or subirrigated land, being substituted for sorghum of the dry-farming areas. Production of sugar beets is carried on only under irrigation. As a rule, the heavier and deeper soils are recognized as better adapted to the production of general farm crops when moisture is plentiful. Under the average prevailing conditions, the "hard" lands are believed to be best suited to the small grains and forage crops, and the sandy lands to such crops as rye, corn, and potatoes. In a season of ample precipitation, on the other hand, the yields of cereal crops are larger on the hard lands than on the sandy lands. Fields on northern slopes are considered better for corn and on southern slopes for wheat, but the matter of situation is disregarded by most farmers. In dry seasons corn and other crops produce better yields on the rounded slopes and valley sides than on the flatter uplands. No farming is done on the eroded canyon slopes, which are suitable only for grazing. The wet bottom lands are used for pasture and hay production. Alfalfa is especially adapted to terrace soils where suitably irrigated.

Owing to the low rainfall and its variable distribution from year to year, certain cultural methods not practiced in more humid parts of the country are necessary to success. On the unirrigated lands, dry-farming methods are uniformly carried out. As loose a surface mulch as possible, without pulverizing the soil, is maintained in order to conserve moisture, somewhat cloddy or rough surface being preferable to prevent the soil from blowing. Cultivation follows a rain to restore the mulch and in periods of long drought fields are often cultivated between rains. As a rule, the ground for small grain is not fall plowed. Old land is usually plowed every third or fourth year. The field is generally disked, and where wheat follows small grains the seed is commonly drilled in without previous preparation. Wheat is often seeded between corn rows with a one-horse drill before harvesting the corn. New land is plowed for small grain either with heavy teams or tractors and double disked to fill up all interstices in the furrow slices. The seed is sowed with a drill. Some land is summer fallowed.

Corn land is disked early in the spring, usually between March 15 and April 15. On corn or grain stubble the crop is usually planted with a lister, using approximately 1 bushel of seed per acre. Corn is harvested about October 15, a large part being cut for fodder or ensilage, especially if the season is droughty and the grain fails to mature. Thinly planted corn commonly gives the largest yield. As a rule, seed is not carefully selected, and the yields could be increased by giving more attention to this matter.

Three methods are practiced in planting wheat. (1) When the stubble is clean, the field is listed, the soil thrown back with a double-row weeder, and the seed drilled in with a 4-horse drill; (2) when the stubble is not clean, the ground is fall plowed; (3) when grain follows grain in consecutive years, the land is commonly disked and the seed put in with a disk drill. The crop is harvested between June 24 and July 15, July 1 being the average date. Most of the wheat is headed and stacked, although many farmers prefer binding and thrashing from the shock. It is considered best to head the larger fields, as the wheat is less likely to bleach than when shocked.

Sorghum is planted in rows closer than corn. Occasionally the seed is broadcast. It is cultivated like corn and harvested with a corn binder. Most of it is fed from the shock.

Oats and rye are for the most part planted with a drill, though a part of the acreage is seeded broadcast. Rye furnishes excellent grazing in early spring, before the pasture grasses are available. Barley and oats should be sown early.

On the irrigated lands of the Republican Valley farming methods are quite thorough. The chief crop is sugar beets, with alfalfa, corn, and wheat of secondary importance. The Wessel is the variety most commonly planted. The seed bed is prepared by plowing and harrowing, and the seed is planted from May 10 to June 10. During dry years it is frequently difficult to obtain a stand, owing to "crusting in" or "spoiling." If before planting the seed is soaked for 48 hours or until sprouts appear the danger of "crusting in" is materially reduced. The seed is planted in rows about 20 inches apart. From 15 to 20 pounds of seed per acre are used. After 2 or 3 leaves appear the field is blocked and thinned with special knives. All seedlings except the hardiest are removed and weeds are pulled at the same time. The crop is cultivated 3 times and hoed twice, after which the land is prepared for irrigation. Harvesting, which begins about October 1, consists in lifting, pulling, topping, and piling the crop. The beets then are hauled to the dump, screened, and shipped in open cars.

On the whole farm improvements are good, and practically all places are equipped with some modern labor-saving machinery. The fences are of barbed wire and in fair condition. The buildings are generally adequate and in good repair. In 1918 there were 265 gas engines, 22 gasoline tractors, 360 silos, 728 cream separators, and 618 automobiles in the county. The work stock commonly consists of heavy draft horses or mules.

Few follow a very definite rotation, as occasional extremely drougthy seasons make precise adherence to a definite plan practically impossible. The most common plan is to change from two

years of wheat to one of corn. Oats, rye, and barley have no regular place in rotations. The more progressive farmers recommend two years of corn followed by one of wheat. On many farms, both corn and wheat succeed themselves for a series of years.

No commercial fertilizers are used and but little of the manure produced on the farms is applied to the land. Unless manure is thinly spread, the crops tend to "burn."

Efficient farm labor is rather scarce, but usually there is sufficient help available to supply the necessary labor during harvest seasons. Much of the farm work is performed by the farmer and his family, except during the harvests. Most of the farm laborers are American, but there are a few of German and Russian descent. In 1919 men hired by the year were receiving \$50 to \$75 a month with board, day labor \$3 to \$5 a day and board, and harvest hands commanded \$5 to \$7 a day. These wages are higher than normal on account of the shortage of help since the war. Some farmers and ranch owners employ entire families, giving in addition to the wages the use of a house, garden, cows, and chickens. Contract labor is employed in beet production.

In 1918, according to State reports, the county had 176,160 acres of unimproved and 258,751 acres of improved land. The farms included 382,651 acres, of which 214,351 acres were under cultivation. The total of irrigated land was 2,738 acres. The average farm contained 321 acres.

Only 46 per cent of the farms are occupied by owners. Most of the tenanted farms are rented on shares, the owner receiving one-third of the crop delivered at the elevator and the tenant furnishing seed, labor, and equipment.

According to the census, the assessed value of farm land increased from \$7.84 in 1900 to \$27.40 per acre in 1910. The value of all farm property was \$12,640 per farm, of which 76.4 per cent was invested in land, 10 per cent in buildings, 2.2 per cent in implements, and 11.3 per cent in stock. In 1880, the average farm was worth only \$955, 54 per cent being in land, fences, and buildings, 5.5 per cent in machinery, and 40.4 per cent in stock. In 1919 the selling price of farm land outside the irrigated sections ranged from \$15 to \$100 an acre; irrigated land was held for about \$300 an acre. The price for most of the land suitable for dry farming is between \$35 and \$60 an acre.

#### SOILS.

The development of the soils of Redwillow County has taken place under the influence of a climate that can best be described as sub-humid.

On the basis of their origin and processes of accumulation, the soil materials of Redwillow County are classified into two general

groups: (1) loessial material, and (2) alluvial, or stream-deposited material, the former occupying the upland and the latter the terraces and first bottoms along the rivers and smaller streams.

Before erosional agencies had dissected it the territory included in the county consisted of a smooth upland plain, whose surface was covered with a massive deposit of loess. Technically this material consists of a buff-colored silt with smaller amounts of clay, very fine sand, and fine sand. Locally it is often called "yellow clay," though the percentage of clay is relatively small. The material is remarkably uniform in texture and has a tendency to a columnar structure, which shows itself on steep banks and the sides of deep cuts. In an undisturbed deposit the material is coherent, but it reduces readily into a loose, silty powder. In places accumulations of particles of white carbonate of lime give it a splotched appearance, while in other places there are pockets of sand or remnants of old soil lines. Some volcanic ash occurs in the lower part of the formation. Owing to the porous nature of the loess, rainfall is rapidly absorbed, except on the steeper slopes. Under the influence of soil-producing agencies the loess has given rise to soil series differing markedly from one another in spite of an almost uniform parent material. Thus, the changes which have taken place in the weathering in eastern Nebraska have resulted in series described as the Marshall, the Knox, or the Grundy, depending upon the natural forces operating in each case. In Redwillow County the agencies acting have produced the Holdrege and Colby series.

The origin of the loess deposit, which covers more than one-third of Nebraska, has been much disputed among geologists, but doubtless the source of the materials varies widely in different parts of the State. The probability of this difference is strongly suggested by a comparison of the loess of eastern Nebraska adjacent to the Missouri River and the loess of Redwillow County. The former shows abundant evidence of wind action, the deposits probably having been blown from the adjacent large valley bottoms. The mantle loess of Redwillow County presents no such evidence, the uplands being fully as old or older than the present valleys of the Republican River and Beaver Creek, while the valley of the Platte River lies too far to the north to be considered a source of much material. In the case of the Republican River, broad, sweeping curves high in the upland point to the ancient sluggish meandering of the stream during the time of early activity and seems to indicate that the present valley has been incised subsequently to the deposition of the loess. The State surveys at present offer two possible sources for the origin of the loess: (1) That it is a silty material deposited by sluggish streams flowing in a general southeasterly direction, or (2) that it represents the breaking down of a massive sandy deposit into silt through the long-continued

action of physical and chemical forces. Provided the latter be true, deposits of various kinds may develop loessial characteristics when subjected to the proper soil-forming agencies. To what extent, then, the terraces of the Republican, as typically illustrated at McCook, should be classed as true loessial material is not clear. State surveys have differentiated these bench materials from the upland formation and designated them as terraces of valley loess.

Climate has influenced the soil formation of the extensive upland loess in the county and accounts for the wide difference in the soil section of this area as compared with more eastern counties of the State. Large quantities of unleached mineral matter, combined with a high organic content and a favorable texture and structure, has resulted in a fertile soil. Primarily, a drier climate has produced a more shallow weathered zone and distinctive vegetation—dissimilarities which have yielded material differences in the decomposition of the soil-forming minerals and their chemical properties. The weathered portion of the loess modified by organic matter varies from 10 to 24 inches in thickness, depending upon the character of the land form. Where the surface is nearly level the weathered zone extends to greater depths; where eroded, the surface materials have been more rapidly leached or partly removed. The dark color is due to the incorporated organic matter. Owing to a lower rainfall, the limy concretions are formed nearer the surface than in the loessial areas of eastern Nebraska and often give the zone a splotched appearance.

Directly under the loess is a sand deposit, into which the loess grades in places. The exact relationship of this material to the overlying loessial formation is not clearly understood, but it is generally believed to be of early Pleistocene age. It outcrops prominently in some of the valley sides and canyons and is the chief source of water supply of the upland wells. While not extensively exposed, it probably underlies the loess formation throughout the county, as well records everywhere show its presence.

This sandy deposit lies unconformably upon beds of Tertiary age, identified as the Ogallala formation by the State survey. Prominent exposures of these rocks occur in most of the larger valleys and in the lower courses of most of the canyons where not covered by creeping of the overlying silt and sand. They are locally known as mortar beds. These beds are made up principally of deep beds of limestone, usually sand and soft lime and sandy lime, and the formation is strikingly without uniformity in character, containing interbedded deposits of clay, sand, gravel, and lime, in no perceivable order. The Ogallala is easily eroded, but it has confined the streams to narrower valleys than the loess cap.

The alluvial and colluvial soils occupy broad terraces and flood plains. The deposits are mainly sands and silts, occasionally associated with thin local beds of clay. They comprise materials washed down from the adjacent uplands and from the more elevated regions to the west. The terraces along the stream valleys represent the oldest alluvial deposit in the county and comprise beds of silt, fine sand, and very fine sand which have been subjected to considerable weathering since their deposition. The structure and zonation are loessial in character in many places. The first bottoms, or flood plains, are of more recent origin and, in places, still in the process of formation. They occur along both sides of the Republican River, and Beaver and Redwillow Creeks. They are generally sandy in texture, and, for the most part, adequately drained, on account of the open, porous nature of the soil and subsoil materials.

According to the scheme of classification, the soils are grouped into series on the basis of similarity in color, structure, origin, mode of formation, topography, and drainage. Each series includes one or more soil types, the type being determined by texture, which depends upon the relative percentages of the various sized particles of which it is composed. The soil type is the unit of mapping.

The upland soils of the county, included in the Holdrege and Colby series, have been developed from loess; the terrace soils, correlated with the Bridgeport and the Hall series, and the first-bottom soils, classed in the Laurel and Lincoln series, are derived from the loess or other upland materials reworked and deposited by streams.

The Holdrege series includes types with dark-brown surface soils 12 to 18 inches deep, with the granular structure of typical soils in subhumid regions. The color becomes lighter with depth and finally grades into a pale yellowish gray, the color of the calcareous parent loess, from which these soils are derived. Both soil and subsoil are friable throughout. The subsurface layer appears heavier than the soil, but no hardpan has developed. Lime carbonate first appears in the zone of color transition, and the material effervesces freely with acid in the lower part of the 3-foot section. The soils of this series differ from those of the Colby series in the greater depth and darker color of the surface and upper subsoil layers. One type, the silt loam, is mapped in Redwillow County.

The types included in the Colby series have ashy-gray to brownish-gray surface soils which grade abruptly into light-yellowish or whitish, floury, highly calcareous subsoils. They are derived from loess and have an open structure. The topography varies from comparatively level to sharply rolling. The drainage is good. The material in the surface zones has been considerably weathered and slightly modified by wind action. In this survey only the silt loam

and silty clay loam of the series, the former with a broken phase, are encountered.

The Bridgeport series consists of types with brown to grayish-brown soils that normally become lighter in color with depth. In many places, however, there is little change in color or texture within the 3-foot section. The lower subsoil is calcareous. Drainage is everywhere good. The materials forming the Bridgeport series are either alluvial sediments brought down from higher lying regions to the west and intermingled with colluvial material from the adjoining uplands, or, according to the State geological survey, are valley loess. Surface drainage is not well established, but the open subsoil promotes internal drainage and the surplus water passes off in this way. The topography is flat or slopes gently toward the streams. In this county the Bridgeport sandy loam, fine sandy loam, and very fine sandy loam are mapped.

In the Hall series are included types of dark-brown to dark-gray soils overlying heavy compact subsoils, in many places with indications of hardpan development. In the lower part of the section the materials become more friable, somewhat lighter in color, and slightly calcareous. The soils are developed on terraces above overflow and are adequately drained. In Redwillow County the Hall series is represented by the very fine sandy loam and silt loam.

The surface soils of the types included in the Laurel series are gray to yellowish gray and the subsoils light gray or lighter. In most places the texture of soil and subsoil is identical, but in some of the coarser types the subsoil becomes slightly lighter than the soil. The topography is flat to gently undulating. Most of the series is subject to overflow. Both soils and subsoils are characterized by a high lime content. The types occur on the flood plains of the streams and are composed of reworked sediments washed from the loess, the Loup Fork beds, and the older rocks to the west. The Laurel loamy fine sand, fine sandy loam, and very fine sandy loam are mapped in Redwillow County.

The Lincoln series includes types with dark-colored—dark-brown, or dark-gray—soils and light-colored subsoils. The topography is generally flat, but sufficiently well drained for agriculture. The soils are not calcareous, but the subsoils have a high lime content. These soils are of alluvial origin and confined to the first bottoms. The series is represented in the county by one type, the silty clay loam.

In the following pages of this report the various soils of the county are described in detail and their relation to agriculture discussed. The distribution of the various soils is shown on the soil map accompanying this report, and the table following gives the name and the actual and proportionate extent of each:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Holdrege silt loam.....	271,104	59.6	Bridgeport fine sandy loam.....	2,432	0.5
Colby silt loam.....	11,840	24.5	Laurel loamy fine sand.....	1,408	0.3
Broken phase.....	99,776		Hall very fine sandy loam.....	1,152	0.3
Bridgeport very fine sandy loam..	38,400	8.5	Hall silt loam.....	640	0.1
Laurel very fine sandy loam.....	13,696	3.0	Bridgeport sandy loam.....	384	0.1
Laurel fine sandy loam.....	6,016	1.3			
Colby silty clay loam.....	4,224	0.9	Total.....	455,040	.....
Lincoln silty clay loam.....	3,968	0.9			

HOLDREGE SILT LOAM.

The surface soil of the Holdrege silt loam is a brown to dark-brown, friable, smooth silt loam, 12 to 18 inches deep, changing to ashy-gray or pale yellowish gray, calcareous silt loam subsoil. The material of the lower subsoil is generally lighter in texture than the material above and continues below the 3-foot section, the substratum consisting of a light yellowish gray or light buff colored loess of great thickness. The material is spotted with accumulations of white carbonate of lime particles.

Though it is, on the whole, remarkably uniform in texture and color over large areas, the type presents some variations. On ridges, slopes, or near canyons, the soil may be lighter in color than typical, and near the crests of many local divides clay concentration and leaching have produced knolls of heavier textured reddish-brown soils which are too inextensive to map separately, though in reality a different soil. In other places the soil is quite dark and appears much heavier than it really is.

In a few places small depressions occupied by the Scott silty clay loam occur. The soil in these areas consists of 16 to 18 inches of a dark-brown compact silty clay loam, underlain by an ashy-gray silt loam material identical in color, texture, and structure to the surrounding Holdrege. The soil is very sticky and plastic when wet, and hard and brittle when dry. In a dry condition the soil has a pronounced bluish gray cast.

The type is quite uniform in texture. It occurs in sinklike depressions in a few scattered places on the undissected upland. The areas are small in size, the largest occurring one-half mile west of the Flat Center School.

After heavy rains water stands on the surface for a few days to a week or two. The type has no agricultural value at present, and is best used for grazing and hay production. Smartweed is a characteristic growth.

The Holdrege silt loam is the most extensive and one of the most uniform agricultural soils in the county. It extends in broad bodies between major drainage ways across the entire county. It occupies the highest positions, being widely distributed over the greater part of the tillable upland plains, where it represents the original constructional surface of the loess plain. Most of the type occurs on smooth ridges and hills with gentle slopes and has a generally undulating surface.

Drainage is adequate, except for a small area in the northwestern part of the county, in T. 4 N., R. 30 W., where the only outlet for the run-off is into small depressions. Elsewhere the surface is intercepted at frequent intervals by vertical-walled canyons, where the drop from the smooth Holdrege silt loam is often a steep precipice with little or no sloping approach.

About 75 per cent of this soil is under cultivation, the remainder being used for the production of hay or as pasture land. While the Holdrege silt loam is hardly more than half as productive as the principal upland soils of eastern Nebraska, which receive ample rainfall, its natural fertility is slightly greater. During favorable seasons, when precipitation is adequate, crop yields are often more than double.

The Holdrege silt loam originally supported a thick growth of grasses and was extensively used for grazing, although not to the extent that it was in neighboring counties or in other parts of western Nebraska. There are still many small tracts of the original prairie sod. Buffalo grass is the dominant growth, with small admixtures of grama, bluestem, western wheat, wire, and other species, which furnish excellent hay and pasturage, especially on areas where there is sufficient moisture present to keep the buffalo grass green. Western wheat grass is the preferred hay grass. Pastures are open from May 1 to January 1, when the snowfall is light. They are at their best in June. In August they become drier, but will continue to support cattle as long as the weather is favorable. Pasturage on dead grasses in winter has been supplanted to a great extent by production of forage crops. The type was originally treeless, but there are scattered woodlots of ash, box elder, honey locust, and cottonwood, relatively extensive in the order named.

Winter wheat and corn, occupying about an equal acreage, are the most important crops. During the last five years, according to the annual report of the Nebraska State Board of Agriculture, wheat and a part of the corn produced have constituted cash crops. Sorghum is the important forage crop, and with the unsold corn is fed to stock on the farms. Oats, barley, millet, kafir, and Sudan grass occupy a large combined acreage. The soil is well adapted to general farming, and in normal years yields are usually fairly good.

Wheat, one of the chief crops, yields from 0 to 65 bushels, its average being close to 10 bushels per acre; corn produces an average of 12 bushels per acre, though yields of 60 to 65 bushels are occasionally obtained. Sorghum cut for forage returns from 1 to 3 tons per acre, and ordinarily yields 20 to 25 bushels when grown for grain. Oats yield from 5 to 40 bushels, and occasionally 50 bushels, averaging about 12 bushels. The yield of millet hay is about 2 tons per acre, and of Sudan grass 1 to 2 tons per acre. Kafir yields 1 to 2 tons of forage or 10 bushels of grain. Barley does well, but on account of grasshoppers is not planted extensively. The yields of this grain range in normal years from 10 to 25 bushels per acre. Some alfalfa is raised in an experimental way. The yields on this type are dependent upon the moisture supply.

Oats and barley, owing largely to the greater profitableness of the other grains, are of secondary importance and used as stock feed, while the entire hay crop is fed in the county. Experiments in the introduction of suitable tame grasses are being conducted by a few progressive farmers.

Beef and dairy cattle and hogs are raised as important auxiliaries to crop production. Only a part of the cattle are fattened, the greater number being sold as feeders. Good dairy herds are maintained on some of the farms, while there is scarcely any farm that has not a cow or two for dairy production.

Where wheat stubble is clean winter wheat is listed and drilled with a four-horse drill, but when not clean the ground is generally plowed. In this condition it has a tendency to blow, however. Where wheat follows corn many farmers plant on the unplowed ground without even removing the cornstalks, using a one-horse drill. Land for corn is disked and double disked early in the spring and planted with one or two row listers. Both corn and wheat frequently succeed themselves for several years. Farm tractors are being introduced on some of the farms.

The extremely favorable physical structure of this type makes farming operations possible under a wide range of moisture conditions. It retains moisture well, however, and where properly tilled it withstands drought for long periods. No commercial fertilizer is used, but some manure is applied to the fields.

There are a few orchards on this soil, but for the most part the climatic conditions are unfavorable for fruit growing. Cherries and apples are more resistant than peaches, which readily winterkill. Some small fruit is produced.

The selling price of the Holdredge silt loam varies from \$30 to \$75 an acre, the price depending mainly upon the improvements and the distance from markets or shipping points.

Under the present system of grain farming land of this type tends to diminish in productiveness. By systematic rotation of crops and application of barnyard manure—the latter must be applied carefully in this region—the supply of organic matter can be satisfactorily maintained. Where the acreage of Colby silt loam, broken phase, in a farm is large enough to supply the needed grazing land it would be profitable to cultivate the greater part of the smooth or Holdrege soil instead of utilizing it for pasture.

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

*Mechanical analyses of Holdrege silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
373001.....	Soil.....	0.0	0.0	0.1	1.5	34.5	48.8	15.2
373002.....	Subsoil.....	.0	.0	.0	1.2	43.6	41.0	14.5

COLBY SILT LOAM.

The surface soil of the Colby silt loam is an ashy-gray to brownish-gray calcareous silt loam 8 to 10 inches in depth. The upper subsoil is of similar or slightly lighter color, though identical in texture and structure. A lower subsoil zone, encountered at depths of 12 to 15 inches, consists of a light-yellow or yellow silt loam, with an open and friable structure. It has the characteristic smooth, floury feel of the loess material from which it is derived, and grades with depth into the very light colored, unweathered parent loess.

The type presents variations. On several rounded ridges, principally along the Republican Valley, the ashy-gray surface material extends to depths of 15 inches or more before grading into the lighter colored subsoil. In other small, irregular areas the surface soil is very shallow, the grayish-white subsurface material being encountered within a few inches of the surface.

The Colby silt loam occurs adjacent to the valleys and canyons in places where erosion has smoothed the abrupt drop from the Holdrege silt loam to the deep U-shaped valleys. It also flanks the more open valleys of Coon Creek, Ash Creek, and other drainageways. The topography is gently sloping to undulating and in places gently rolling. The drainage of soil and subsoil is adequate to thorough, though the subsoil retains moisture remarkably well, insuring a higher production than on the more valued Holdrege silt loam during seasons of subnormal rainfall.

The native vegetation of the Colby silt loam consists chiefly of prairie grasses. On rolling areas subject to erosion bunch grass

predominates; on the smoother areas buffalo grass is the important grass. Areas too small for cultivation produce good growths of bunch grass for hay. Where the surface is disturbed and not farmed sunflowers and wire grass take possession of the land. From 6 to 8 acres are considered sufficient to support one horse or cow, where supplemented with feed during the winter months.

The Colby silt loam, with its broken phase, is second in extent among the soils of the county. About 85 per cent of the type is under cultivation. Wheat and corn are the principal crops, with sorghum of secondary importance. Taking the yields of a series of years, wheat averages 8 or 10 bushels per acre, though 30 or 40 bushels are obtained in exceptionally favorable seasons. In some years, on the other hand, production falls so low, though this is unusual, that individual crops are not harvested. Corn ranks close to wheat in acreage. Ten or twelve bushels per acre represent the average return over a period of years, but the range is equally as great as in the case of wheat, with a reported maximum yield of 60 bushels under favorable rainfall conditions. Corn for silage gives about 5 tons per acre. In dry seasons the Colby silt loam makes the best corn land on the upland, its power of retaining moisture being unsurpassed by any other type in the county. Sorghum gives good yields of forage, from 1 ton to 3 tons per acre, with an average of 2 tons. Kafir forage averages 1 to 2 tons and milo about 2 tons per acre. Oats, though a minor crop, are grown with success. The yields range from 5 to 40 or even 50 bushels per acre and averaging about 12 bushels. Barley is more difficult to grow on account of grasshoppers. Yields average about 15 bushels per acre, though as much as 60 bushels has been obtained.

Owing to its friable silty character, this soil is very easily handled and can be cultivated under a wide range of moisture conditions. Where the land is disked before listing for corn, it withstands drought well. Occasionally it is plowed, but only when absolutely necessary, as the soil drifts when thoroughly broken. No commercial fertilizer is used, but manure is applied carefully by the more progressive farmers.

Land of the Colby silt loam sells for \$30 to \$60 an acre, the price depending on the improvements and nearness to the towns or shipping points.

Under a system of grain farming without rotations, including leguminous crops, this soil tends to decrease in productiveness, owing to its naturally low content of organic matter and its porous nature, which permits the leaching of plant food. Cultural methods should be improved with the view of remedying this deficiency.

*Colby silt loam, broken phase.*—The Colby silt loam, broken phase, includes extensive areas of badly eroded stream slopes and bluffs

occupied by the loess formation, with the exception of included stream valleys and several small areas that have escaped excessive erosion. The land is unsuited for agriculture. It not only borders the main valleys, but includes the tributary canyons and gullies cut through the loess and into the underlying Tertiary limestones, which outcrop conspicuously along the slope. The surface material consists of a gray silt loam beneath which, at depths varying from 5 to 15 inches, is a pale-yellow silt loam grading into the unweathered loess. The subsoil is highly calcareous, a property which is first developed in the transition zone between soil and subsoil.

The topography of this phase is rolling to rough and escarped with numerous steep slopes and precipitous bluffs. All parts of the type are dissected by intermittent streams which have cut deep, abrupt, perpendicular-walled valleys into the originally level upland surface. The surface now consists of an intricate succession of steep ravines 75 to 100 feet deep in their lower parts.

The Colby silt loam, broken phase, is one of the more extensive soils in Redwillow County. Large, irregular bodies are distributed over the entire county, except in a district covering a few square miles lying about 8 miles northwest of McCook. The areas are larger and more numerous in the southwestern part of the county below Driftwood Creek.

Owing to the steepness of the slopes, drainage over most of the area is excessive. The land is used almost exclusively for grazing and hay production, the only tillable areas being composed of remnants of other types, too small to separate on the map, and the canyon floors; and as these are subject to the effects of torrential rainfall, their utilization for crop production is very small. Landslides are common, and the slopes often present a succession of steps known as catsteps, due to these slides.

Where erosion has been severe the slopes are almost bare of vegetation or support sparse growths of pasture grasses, weeds, and shrubs. Much of the area supports good stands of nutritious grasses, including little bluestem (*Andropogon scoparius*) or bunch grass, buffalo grass, wire grass, and June grass.

The eroded catstep areas are covered principally with sparse growths of little blue stem or bunch grass. The location of this species here indicates the presence of a higher moisture content than in the areas supporting buffalo grass, which possesses greater drought resisting qualities. This difference in moisture requirement causes the buffalo grass to tend to crowd out the little bluestem in periods of low rainfall, while, in periods of increased precipitation, the more luxuriant growth of bluestem shades and drives out the buffalo grass. Bluestem, where the land is level enough to allow cutting, makes excellent hay.

The buffalo grass is patchy and occurs in flat or less severely eroded depressions included in the type, where the drainage is sufficient to keep out little bluestem. It has a very high feed value.

Intermediate between little bluestem and buffalo grass in moisture requirement conditions is the wire grass, which occurs with buffalo grass in small areas on the canyon slopes. When pasture has been overgrazed, wire grass has a tendency to take possession of the land, but it has little or no value as feed and is hardly touched by cattle.

On the valley floors there is an abundant growth of June grass, which is cut for hay. This grass grows to a height of almost 3 feet when mature, and yields from one-half to 2 tons per acre. Cutting should begin not later than August 1, as the grass ripens early. The hay has moderate feed value.

In places the yucca or soapweed is commonly found in small patches or eroded areas that are dry. Owing to deep root penetration it is enabled to grow high on the slopes, and it is capable of withstanding hot winds and other adverse conditions. Bordering the cultivated fields, where surface water has washed the soil into the adjacent canyons, sunflower and ragweed have invaded the heads of the small tributary canyons, as well as the lower floors, where the rapid flow of the water has been obstructed and caused deposition. Loco weed grows in places.

Native trees occasionally occur in some of the canyons—the ash hackberry and cottonwood—particularly near the lower courses and the elm where moisture is plentiful. Where the underlying bedrock outcrops, scrubby growths of cedar and plum have gained a foothold, the high lime content of the soil being favorable to these species. A few wild grapevines grow in some of the wooded areas.

The Colby silt loam, broken phase, is devoted exclusively to pasture. In connection with the adjacent areas of level land it is peculiarly adapted to stock raising, as the canyons insure protection for cattle during the winter and pasturage during the greater part of the year. When winter fed 7 to 10 acres will support one steer, pasture being open from May 1 to October 15. Grade Hereford and Shorthorn are the principal beef types, though there are considerable numbers of Aberdeen Angus cattle. Most of the dairy cows are Shorthorn and Holstein grades.

Land of this phase sells for \$15 to \$25 an acre. It is almost always included in sales of adjoining level areas.

Overgrazing and fires are the two important destructive agencies to be guarded against in the efficient use of this soil.

#### COLBY SILTY CLAY LOAM.

The surface soil of the Colby silty clay loam to a depth of 6 to 12 inches is a brown to grayish-brown sticky silty clay loam. The soil

is heavy and tough, though plastic, when wet, is hard and brittle when dry, and has a granular structure. At a depth of 8 to 12 inches the soil passes abruptly into a loose, floury, ashy-gray silt loam. The subsoil material closely resembles the characteristic whitish subsoil of the Rosebud series, but is different in origin, being derived from loess.

In places the soil is slightly lighter both in color and texture than as described, but the difference was not great enough to warrant separation of such areas. Near the margin of the areas of the type there is more or less variation in texture, the silty clay grading into the Holdrege silt loam or the Colby silt loam.

The Colby silty clay loam is an upland soil and one of the less extensive soils of Redwillow County. It is unevenly distributed over the county, but occurs mainly in the southwestern part of the county. A very typical area occurs 1 mile north of McCook. The topography is rolling, the type being developed mainly adjacent to rough, broken canyon areas near the confluence of drainage ways and on slopes leading into the canyons. Surface drainage and underdrainage are adequate to excessive, the latter condition existing in areas on the steeper slopes.

Owing to its small extent the Colby silty clay loam is not important in the agriculture of the county. About 50 per cent of it is under cultivation and the rest is used for grazing. Buffalo grass and June grass constitute the chief vegetation. Small amounts of wild rye and western wheat grass are encountered, particularly where the surface has been broken and then allowed to revert to pasture.

It is a very good corn soil and, on account of its power to retain moisture, the yields surpass in average and dry seasons those of the more extensive upland type—the Holdrege silt loam. From 10 to 15 bushels per acre is the average yield over a series of years, but occasionally the yield amounts to 35 or 40 bushels. Wheat and oats do well, though the soil apparently gives better results with corn. Wheat yields range from 5 to 25 bushels, and the yield of oats from 10 to 35 bushels per acre. The acreage of small grains has been greatly reduced in recent years, owing to the better results obtained with corn. Sorghum is a popular forage crop, the Black Amber being a preferred variety. Sorghum is one of the more certain crops, and rarely fails to yield from 2 to 5 tons per acre. Prairie grasses occupy about one-half the acreage of the Colby silty clay loam. Hay from these grasses returns from  $\frac{3}{4}$  to  $1\frac{1}{2}$  tons per acre. It is of good quality, and especially valuable where the percentage of buffalo grass is high.

The selling price of Colby silty clay loam ranges from \$30 to \$50 an acre, the price depending largely upon state and character of improvements and the drainage conditions.

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

*Mechanical analyses of Colby silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
373003.....	Soil.....	0.0	0.0	0.1	1.5	41.0	41.7	15.6
373004.....	Subsoil.....	.0	.0	.0	1.9	48.1	39.4	10.9

BRIDGEPORT SANDY LOAM.

The Bridgeport sandy loam, to an average depth of 12 to 15 inches, is a brown to yellowish-brown, mealy, sandy loam containing various amounts of coarse sand. The subsoil is a light-brown loamy sand or sand, which becomes lighter and more yellowish in color with depth. The first few inches of the surface soil is relatively dark, owing to a higher content of organic matter. Neither the soil nor subsoil appear highly calcareous. The type is more subject to wind erosion than the other members of the Bridgeport series, no doubt as a result of its relatively lower percentage of clay and organic matter.

The Bridgeport sandy loam is of small extent. It occurs on the terraces of both the Republican River and Beaver Creek. A typical area is mapped about 2 miles southwest of Bartley. The surface is smooth to hummocky. Drainage is generally excessive, owing to the porous subsoil. The type consists of alluvium deposited at an earlier stage in the river's work of carving its valley. The sediments have in places been considerably reworked by the wind. The type at present is not subject to overflow. Though most of it is under cultivation, the Bridgeport sandy loam is not important, on account of its small acreage in the county. Corn and sorghum are the principal crops. Sand burs and the Russian thistle are troublesome weeds. The native vegetation in the pasture areas consists of June grass and sand grass.

Land of this type generally occurs in such small areas that it is sold in conjunction with the surrounding types. It will produce good crops under proper cultivation, but, as with the Laurel sandy loam, care must be taken to check drifting.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Bridgeport sandy loam:

*Mechanical analyses of Bridgeport sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
373013.....	Soil.....	2.4	14.6	12.4	22.8	29.6	11.5	6.7
373014.....	Subsoil.....	1.6	14.5	12.6	23.3	35.1	8.8	4.1

BRIDGEPORT FINE SANDY LOAM.

The Bridgeport fine sandy loam consists of a gray to brownish-gray fine sandy loam, 12 to 15 inches deep, underlain by a lighter colored brownish sandy loam which continues throughout the 3-foot section without change of texture, but becomes lighter in color with increasing depth. Owing to a higher content of organic matter, the surface 6 inches is usually darker colored than the subsurface layer of the soil. The texture of the surface soil varies somewhat from place to place owing to variation in the proportions of fine sand and silt. The subsoil, which is calcareous, is in places slightly compact.

This type occurs in irregular areas along the Republican River. There is also an area on Redwillow Creek north of Redwillow and another on Beaver Creek northeast of Lebanon. One of the more typical areas is situated in sec. 29, T. 3 N., R. 28 W.

The Bridgeport fine sandy loam, like the Bridgeport very fine sandy loam, has a flat to gently sloping surface, but owing to the open structure of the materials and to the relatively elevated position above the stream bed, drainage is good.

The total acreage of the Bridgeport fine sandy loam in Redwillow County is small, yet the type is important on account of its productiveness. Practically all of it is under cultivation, the proportion in crops being higher than in the case of any other of the soils. The principal crops are corn, wheat, and sorghum. Some barley and oats are produced, and potatoes are grown for home consumption. The soil drifts to a slight extent when left uncovered, and for this reason is seeded to small grain as early as practicable.

The methods of cultivation are the same on this type as on the Bridgeport very fine sandy loam, and the yields approximate those obtained on the heavier soil. Corn ordinarily yields about 15 bushels per acre, though 50 bushels have been obtained in favorable years. Wheat returns from nothing to 25 bushels, with an average of 8 or 10 bushels for a series of years. Sorghum is grown only for

roughage, of which 1 to 3 tons per acre may be reasonably expected. Barley, when not destroyed by grasshoppers, yields 5 to 50 bushels, and oats 0 to 40 bushels, depending on the season. The higher yields stated are exceptional.

No definite rotation is practiced. Corn usually follows a small grain and is listed, as the moisture conditions are better than when planted in a level seed bed. The small grains usually are drilled in on old stubble or corn land. In periods of drought the type gives better yields of corn than the Bridgeport very fine sandy loam, as it is more retentive of moisture.

The land of this type is held at \$50 to \$75 an acre, the price depending mainly upon location with respect to markets and upon the character of the improvements.

With proper care, the Bridgeport fine sandy loam is a good farming soil. It drifts more freely than the Bridgeport very fine sandy loam, and it should not be left without protective covering longer than is absolutely necessary. Its productiveness could be increased by the more general use of cultural methods designed to conserve moisture. Applications of stable manure help to check drifting and at the same time increase the supply of organic matter. More thorough preparation of the seed bed for small grains is advisable. In growing corn and other tilled crops, too much attention can not be given to the maintenance of a surface mulch.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of Bridgeport fine sandy loam:

*Mechanical analyses of Bridgeport fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
373011.....	Soil.....	1.0	9.8	8.7	19.5	42.0	15.6	3.5
373012.....	Subsoil.....	1.3	5.7	6.6	21.4	49.7	11.1	4.2

BRIDGEPORT VERY FINE SANDY LOAM.

The Bridgeport very fine sandy loam, to a depth of 10 to 15 inches, is a loose, mellow, friable, very fine sandy loam, brown to light grayish brown in color, excepting the immediate surface, which is considerably darker than the bulk of the soil on account of a large content of organic matter. At a depth of 10 to 15 inches, which marks the upper limit of the subsoil, the material becomes lighter in color, a trifle coarser in texture, and highly calcareous.

Small areas of fine sandy loam are mapped with the type, their small size not warranting separation on the map. The type is not

so subject to wind erosion as the Bridgeport fine sandy loam, as the larger content of organic matter, very fine sand, and silt gives the heavier soil greater coherency.

There are some slight variations in color in the soil section. Along the Republican River the soil is fairly typical in this respect, except included colluvial slopes leading from the upland to the terraces and flood plains, which, as a rule, are lighter in color. There are numerous other areas, particularly on the lower terraces of the Republican River and Beaver Creek, which show very little color change within the 3-foot section, though the subsoil may be slightly coarser than the soil. The absence of distinct zones here is probably due to recent deposition, the material having as yet not leached sufficiently to produce a color change.

The Bridgeport very fine sandy loam occurs in irregular bodies scattered over both the low and high terraces and the colluvial slopes of the Republican River and Beaver, Driftwood, Redwillow, and Coon Creeks and other large tributaries of the river. The type generally lies a little above the Bridgeport fine sandy loam, though in many cases there is no difference in elevation. The areas vary in size from a few acres to several square miles. One of the largest lies along the Republican River in T. 3 N., R. 30 W., another in the Driftwood Valley in T. 2 N., R. 30 W., and a very typical, though much smaller, area is mapped north of Redwillow in T. 3 N., R. 28 W.

The Bridgeport very fine sandy loam is composed of deposits laid down by the streams when they flowed at a higher level than at present. It represents material brought down from the adjoining uplands and from regions to the west. These deposits have been slightly modified by addition of materials through colluvial wash and through deposition of wind-blown silt and sand.

The areas have an almost flat surface, but slope very gently toward the main streams and are marked by occasional slight depressions and low hummocks due to wind action. Drainage is adequate; and even were the surface channels lacking, the porous subsoil and substratum would allow the escape of surplus water downward. The line of demarcation between the Bridgeport very fine sandy loam and the Laurel types is topographic, and not always definite in places, the slopes being so gentle and the transition so gradual that the placing of the boundary line is more or less arbitrary. There is, however, a distinct difference in age, and this is apparent at a greater distance from the boundary lines in these localities. Along Driftwood Creek, Republican River, and Beaver Creek there is often a series of benches lying one above the other. The soils of these are all mapped as the Bridgeport very fine sandy loam, there being no difference to warrant separation on a topographic basis alone.

Owing to its large extent, the Bridgeport very fine sandy loam is an important agricultural soil. About 95 per cent of it is under cultivation and about 10 per cent of the cultivated area is irrigated. Corn and wheat are the principal crops on the dry-farmed area and are the principal sources of income. Sugar beets, corn, wheat, alfalfa, and potatoes are important irrigated crops, with oats and barley of secondary importance. All the corn, oats, barley, and alfalfa produced is fed to stock on the farm or sold locally for feed. Sugar beets are hauled to the dump, where after screening they are loaded into open cars for shipment to the sugar factories at Brush, Colo., and Grand Island, Nebr.

The area not cultivated is used for hay production or as pasture. Many nutritious grasses, including buffalo grass, the predominating type, western wheat grass, and grama grass grow on this soil.

In the dry-farmed areas corn yields from 5 to 65 bushels of grain, the average for a series of years being low—from 12 to 15 bushels per acre. The yield of corn when cut for ensilage is 3 to 5 tons per acre. Wheat yields as much as 35 bushels per acre in exceptionally favorable seasons, but averages only 10 or 12 bushels over a period of years. Sorghum is an important forage crop, yielding from 1 to 4 tons per acre when cut for fodder and from 10 to 15 tons when used for silage. Black and Orange are the popular varieties. Barley and oats ordinarily return an average of 10 or 15 bushels per acre for a series of years. Under dry farming alfalfa yields are not large, averaging somewhere between one-half and 1 ton per acre during dry years. Unless the moisture supply is ample only one cutting is possible. In the more favorable seasons the total yield may reach 2 or 3 tons per acre. Potatoes are produced only for home consumption.

Under irrigation, sugar beets, the leading cash crop, yield from 10 to 22 tons, averaging 13 tons per acre. Wheat produces 20 to 60 bushels, with an average of 35 bushels per acre; corn, 20 to 90 bushels, with an average of 50 bushels per acre; and potatoes yield 150 bushels and occasionally as much as 300 bushels per acre; oats yield ranges to 65 bushels, the average falling close to 50 bushels. Excessive heat and attacks by grasshoppers, which cut off the heads, makes the crop somewhat uncertain. Little barley is produced, but the average yield is about 40 bushels per acre. Only a small acreage of sorghum is planted, as the irrigated land is considered too valuable for the production of this forage crop.

In a small way truck gardening is important on the irrigated section, tomatoes, melons, and cabbage being grown. Cherries, apples, and a few other orchard fruits do well, but fruit-growing is not an important industry.

The Bridgeport very fine sandy loam, owing to its mellow condition, is easily handled under a wide range of moisture conditions. Beets are planted from March 10 to June 10, depending upon the season. The Wessel is the preferred variety. The seed is soaked for 48 hours or until germination begins, when it is planted in rows 20 inches apart in seed beds carefully prepared by plowing and harrowing. Growth starts quickly unless the soil is in too dry a condition, which causes "crusting in" or "kinking." Contract labor is employed for blocking and thinning. After the crop is cultivated three times it is irrigated. Harvesting takes place about October 1, the beets being pulled, topped, and piled by hand labor. Freezing and thawing are the only injuries the crop may suffer. The sand bur and bindweed are often troublesome. The tops are valuable as feed for milk production as well as for fattening beef cattle.

Corn is listed after double disking in early spring. Both white and calico varieties are planted, but a Minnesota variety is preferred in some irrigated sections. In preparing the land for wheat it is flooded about October 1, plowed, harrowed, and leveled, and the seed sown with a press drill.

Irrigated land of this type is valued at \$300 an acre; the nonirrigable land varies from \$50 to \$100 an acre, depending upon location, topographic position, and improvements.

The Bridgeport very fine sandy loam is naturally productive and remarkably retentive of moisture. The soil readily works up into a good tilth. Overcropping and failure to maintain a sufficient supply of organic matter may cause the yields to decrease in time. Under irrigation farming on this type is exceedingly profitable.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of Bridgeport very fine sandy loam:

*Mechanical analyses of Bridgeport very fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
373007.....	Soil.....	0.0	0.8	1.2	4.0	57.1	32.6	4.6
373008.....	Subsoil.....	.0	1.3	1.4	5.0	62.1	25.5	4.9

HALL VERY FINE SANDY LOAM.

The Hall very fine sandy loam consists of 10 to 12 inches of a light-brown to grayish-brown uniform very fine sandy loam, passing gradually into a darker colored subsoil, usually a dark-brown to dark-gray very fine sandy loam. This material, at a depth of 20 to 24 inches, is moderately compact, yet friable in structure, and rests upon a heavy dark-brown to almost black silty clay loam locally referred

to as hardpan or gumbo, in places streaked with drab, which continues throughout the 3-foot section. Both soil and upper subsoil are uniformly fine in texture and contain a high percentage of silt and very fine sand. The immediate surface soil of this type has a high content of organic matter and appears almost black when wet.

The Hall very fine sandy loam occurs in small, widely separated areas, the largest lying 3 miles southwest of Indianola, in the Republican Valley. One of the most typical areas is situated about 4 miles southwest of Indianola. Smaller areas occur on the terraces of Redwillow and Driftwood Creeks.

The surface of this type is flat or slopes gently toward the first bottoms. Natural drainage is sufficient for agricultural purposes, though the heavy impervious lower subsoil tends to retard the escape of water downward. The area lies well above overflow.

While this is a productive soil, it is not an important farming type, for its total extent is small. Practically all of it is under cultivation. Corn, sorghum, alfalfa, and wheat are the principal crops. Yields show wide variations from year to year. The estimated average yield of corn is 15 bushels per acre; of wheat, 10 to 12 bushels; of sorghum, 2 tons; and of alfalfa, 1 ton. Alfalfa does not seem to do well on account of the heavy lower subsoil, which interferes with root penetration. The soil has a loose loamy structure and is easily cultivated.

Land of this type sells for \$65 to \$90 an acre, depending upon location and improvements.

#### HALL SILT LOAM.

The Hall silt loam consists of a dark-brown or dark-gray silt loam, underlain at a depth of 10 or 12 inches by a very dark brown to nearly black heavy, sticky silty clay loam or clay loam which continues to the lower part of the 3-foot section, where it rests upon material slightly lighter in color and coarser in texture. The surface soil is smooth and friable and high in organic matter and is readily broken into a good tilth. While the surface soil shows a low lime content, the lower subsoil effervesces freely with acid. Color and structure are fairly uniform throughout the different areas of this type.

The total extent of this type is small. It occurs in irregular shaped bodies on the first and second terraces of the Republican River and the Driftwood and Beaver Creeks, where it is closely associated with the Bridgeport very fine sandy loam. The topography is flat or slopes gently toward the main axis of the stream. The type is well drained and lies well above overflow.

The principal crops are corn, wheat, alfalfa, sorghum, and sugar beets. Dry-farmed corn and wheat in seasons of moderate rainfall

give average yields from one-third to one-half larger than the Bridgeport very fine sandy loam. Alfalfa and sugar beets are produced chiefly under irrigation and give as large returns as on any other of the irrigated soils. Potatoes do not do so well as on the sandier types. Small areas not under cultivation are used as pasture.

The price of this land varies from \$50 to \$300 an acre, depending upon location, improvements, and irrigation facilities.

In the following table the results of mechanical analyses of samples of the soil and subsoil of the Hall silt loam are given:

*Mechanical analyses of Hall silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
373018.....	Soil.....	0.0	0.2	0.1	0.7	37.0	41.8	20.3
373019.....	Subsoil.....	.0	.1	.1	1.8	23.4	50.7	23.9

LAUREL LOAMY FINE SAND.

The Laurel loamy fine sand, to a depth of 8 to 10 inches, is a brown or light-brown loose, friable, loamy fine sand containing varying quantities of sand, coarse sand, and gravel. The upper 6 inches of the soil is considerably darker than the lower portion on account of a higher content of organic matter. The soil passes abruptly into a gray or light-gray loamy sand or fine sand having a yellowish tinge. In places the subsoil contains small quantities of fine gravel and in other places irregular strata of loamy sand or coarse sand. Included with the type are small areas of fine sandy loam, sandy loam, and Riverwash, too small to be shown separately on the map.

In this county the Laurel loamy fine sand occurs only in the Republican Valley, where it forms irregular strips adjacent to the channel of the river, principally within the inner curve of the broad, sweeping meanders. A typical area is mapped about 1½ miles east of Bartley. The soil consists of alluvium washed from the adjacent uplands and of sediments brought from greater distance. It occupies a low position in the first bottom and is subject to overflow. The surface is flat to hummocky, but owing to the open, porous nature of both soil and subsoil, drainage is generally adequate.

Probably one-half of this type is under cultivation, the rest being in pasture or used for the production of hay. It is not an extensive soil, but is important agriculturally on account of its great moisture-retaining power. The soil, when not properly handled, drifts more than any other type in the county. Yields are slightly lower than those obtained on the other members of the Laurel series. Corn is

the principal crop. Cottonwood, ash, and box elder find congenial conditions on this soil.

Land of this type ranges in price from \$35 to \$50 an acre, depending on nearness to markets and improvements.

Moisture conditions on this soil favor the production of corn, which does well, even in seasons of low rainfall, but a proper rotation and cultivation of crops should be practiced to prevent blowing and to obtain maximum yields. Thin stands of corn, during droughty seasons, are able to survive much better than corn grown on the heavier types.

As land of this type ought not be plowed oftener than necessary, corn should be kept clean of weeds, so that small grains may be drilled in directly on the stubble. The seed is best planted in east-to-west listed furrows to further prevent damage from blowing. Small grain sowed in strips along the cornfields will check drifting of bare cornfields in early spring. After rains, when the corn is young, going over the surface with a harrow tends to form clods and prevent blowing which otherwise might injure the small plants.

In plowing, the soil should not be pulverized, but left as turned up. Manure, straw, or other soil-binding materials could be profitably applied. Rye is better adapted to this sandy type than wheat, as it stands the winter better, and on account of its extensive root system is anchored more securely in the soil. Rye furnishes excellent early spring feed for cattle before the native pastures are fit for use, provides good bedding, and is desirable in a crop rotation.

#### LAUREL FINE SANDY LOAM.

The Laurel fine sandy loam is a light-brown to gray fine sandy loam to a depth of 15 inches, underlain by a gray sandy loam containing a considerable quantity of coarse sand and small gravel. It is quite uniform in color, but varies in texture, particularly near streams, from a light loam to a sandy loam. The soil is rather high in organic matter, and when wet appears dark gray, especially in poorly drained areas. The subsoil varies more than the surface soil, but is friable and calcareous, often with a yellowish tinge, and in places becomes mottled with iron stains; in places it has a streaked appearance as a result of the concentration of white lime-carbonate particles. Strata of fine sand may occur throughout the 3-foot section.

This type occupies large areas in the first-bottom of the Republican River and of Beaver and Redwillow Creeks. It is subject to occasional overflow and to deposition of some sediment, particularly along Redwillow Creek. The topography is flat to gently undulating, and in places drainage is poor, though generally sufficient to

allow the production of certain crops. Along the Republican River the surface is billowy and marked by the remnants of abandoned channels of the river. The type lies from 3 to 15 feet above the normal water level in the streams.

The Laurel fine sandy loam is an important first-bottom soil in Redwillow County, and about 85 per cent of it is under cultivation. The rest has value as hay and pasture land. The native vegetation includes big bluestem, "salt grass" (*Distichlis* sp.), switch grass (*Panicum virgatum*), and scattered patches of western wheat grass. Sedges, slough grass, and rushes are common in the wet areas near streams. There are large amounts of carex in the low places subject to frequent overflow, and salt grass predominates where the soil is higher lying and drier, which conditions assist the rise of the salty materials to the surface. Sand reed-grass is found on the more elevated parts of the type, where the moisture supply is scant. It is probably best to keep enough cattle in the pasture to consume the carex and salt grass before they toughen, but the pastures must not be overgrazed. The chief tree growth is cottonwood and willow.

Alfalfa is the most important and profitable crop on this soil, though corn occupies an acreage nearly as great. Barley, oats, sorghum, potatoes, and wheat are secondary crops. The type is best adapted to alfalfa and other hay and forage crops. It maintains a better grass growth than the upland or terrace types, grasses flourishing even in the driest years. It yields from one-half to 2 tons of hay per acre. Owing to natural subirrigation, alfalfa does exceptionally well. The Beaver Valley at one time was the leading alfalfa section of the county. Alfalfa appears to do best where the water table lies 5 to 6 feet below the surface and the subsoil is not too wet. From 3 to 4 cuttings a season are possible, the total yield ranging from 2 to 4 tons, depending upon the amount and distribution of moisture. Corn yields range from 10 to 70 bushels per acre, averaging about 25 bushels. The great variation is due in some instances, especially along Redwillow Creek, either to overflow or to low rainfall. Barley, in some years, has produced 40 to 60 bushels, oats 40 to 50 bushels, and wheat 40 bushels, but these yields are very exceptional. Wheat grows too rank in wet seasons. Sorghum is a successful crop, yielding 1 to 4 tons of forage per acre. While millet does well, little is sown. Land of this type sells for \$65 to \$150 an acre, the price depending upon the location, topographic position, and improvements.

The Laurel fine sandy loam is an excellent agricultural type. As alfalfa and hay are dependable crops, it is well suited to general farming and dairying, particularly along the Beaver and Redwillow Creeks, where it is often part of farms that include adjacent upland

areas, which are used for pasture. The hay and corn produced are generally fed to stock on the farm, but some of the alfalfa is sold locally. No definite rotation is practiced. As the type is subject to inundation and deposition of fresh materials, productiveness is indefinitely maintained even under ordinary agricultural methods. Weeds are often troublesome.

LAUREL VERY FINE SANDY LOAM.

The surface soil of the Laurel very fine sandy loam to a depth of 10 to 15 inches is a light-gray or light grayish brown very fine sandy loam. The upper subsoil is a light-gray, calcareous very fine sandy loam, often with a yellowish tinge and occasionally stained with granular particles of oxide of iron. With increasing depth it becomes lighter in color, grading at 24 to 30 inches into a very light colored material. The upper 6 inches of the surface soil is high in organic matter. The subsoil is highly calcareous.

There are numerous variations from this typical description. In many places adjacent to the stream the soil material is nearly uniform in texture throughout the 3-foot section, though the subsoil is lighter in color. Included with the type are small areas in which the lower subsoil and substratum contain considerable coarse sand and small gravel. The soil when wet may appear dark gray, especially in poorly drained areas where organic matter tends to accumulate. In places the surface approaches a loam and in spots a silty very fine sandy loam. While the surface soil is uniform over large areas, the lower subsoil is here and there slightly mottled by brownish iron stains, or is streaked with whitish concentrations of carbonate of lime or other soluble salts. Alkali accumulated from sheet water often appears on or near the surface in poorly drained areas.

The Laurel very fine sandy loam occurs in irregular strips in the first bottom of the Republican River and Beaver and Redwillow Creeks. One small area is mapped in the Driftwood Creek Valley. The topography is level to gently undulating and in places hummocky. The type is imperfectly drained, but can generally be cropped.

This type generally borders on the channels of the main streams. It consists of recent alluvium, and in places is in the process of formation at the present time. It is subject to overflow and receives additional sediments with each flood.

The Laurel very fine sandy loam is the most extensive bottom land soil in the county. About 75 per cent is under cultivation, the rest being used for hay and pasture land. The wild grasses include big bluestem, salt grass, switch grass (*Panicum virgatum*), carex, sand

reed-grass, and patches of western wheat grass. The big bluestem forms a characteristic sod and yields excellent hay. Carex is found in low places subject to frequent inundation, and, like salt grass, is eaten only sparingly by cattle when other grass is available. There are good growths of cottonwood and willow along the streams and some elm, ash, and box elder.

Corn, sorghum, alfalfa, and wheat are the leading crops, corn and alfalfa being the most important and profitable. Barley, oats, potatoes, and rye are secondary crops. The type is well adapted to hay production, as grasses make a better growth than on the upland soils and flourish in even the driest years, yielding one-half to 2 tons per acre. Alfalfa does exceptionally well, owing to natural subirrigation, and makes the best growth where the water lies 5 to 6 feet below the surface. Where the subsoil is too wet the plants soon die out. Alfalfa yields 2 to 4 tons of hay per acre from 3 to 4 cuttings, depending upon the season. Corn yields 10 to 70 bushels per acre. Sorghum is a dependable crop and often yields 3 and 4 tons of dry forage per acre; barley produces from 10 to 50 bushels per acre; oats, 10 to 50 bushels; potatoes, 50 to 150 bushels; and rye, 10 to 30 bushels per acre. Millet and kafir yield well, but their total acreage is small.

Hogs are raised quite extensively, alfalfa being an important feed in their ration. Dairying is practiced in a small way. The cream is shipped to outside markets.

Land of the Laurel very fine sandy loam sells for \$65 to \$150 an acre. Improved farms bring \$100 to \$175 or more an acre, the price depending upon the location, topographic position, and improvements.

This is one of the most productive soils in the county. It is well suited to general farming and dairying, and in many places it is included in farms comprising slope land and canyon areas suitable for pasture. Occasional overflows tend to maintain the productivity. Weeds are troublesome, being difficult to eradicate on account of moisture conditions favoring their rank growth and persistence.

The following table gives the results of mechanical analyses of samples of soil and subsoil of the Laurel very fine sandy loam:

*Mechanical analyses of Laurel very fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
373024.....	Soil.....	0.2	0.9	1.0	4.8	43.5	37.7	12.0
373025.....	Subsoil.....	.2	1.8	1.7	5.3	45.6	36.8	8.4

## LINCOLN SILTY CLAY LOAM.

The Lincoln silty clay loam, one of the heaviest bottom soils in the county, consists of 10 to 12 inches of heavy dark-brown to almost black silty clay loam, grading into yellowish-brown very fine sandy loam, which becomes lighter in color with increasing depth. When wet the soil is sticky and plastic, and in this condition is very difficult to work, but owing to the presence of large quantities of organic matter proper cultivation gives a mellow seed bed. When properly worked the soil holds moisture well, but it bakes and cracks after rains if allowed to become too dry before cultivation is resumed.

The Lincoln silty clay loam is an inextensive type occurring in narrow strips along the Republican River, Redwillow Creek, and Beaver Creek. One of the most typical bodies lies about one-half mile north of Redwillow School and another extensive, though not so typical, body is situated about 2 miles east of McCook.

On account of its flat surface, the type is not as rapidly drained as other valley types, but drainage is in general sufficient to allow the land to be used for crops. This is an alluvial soil in which most of the material has been deposited by quiet backwaters. It is still subject to frequent overflows.

Corn and alfalfa are the principal crops, to which the soil is well adapted. Corn produces from 15 to 75 bushels per acre, averaging between 25 and 30 bushels. Because of difficulty in handling the land and of the tendency to bake, it is occasionally hard to get a good stand of corn, but once a stand is obtained a crop is comparatively certain. Alfalfa affords 3 and occasionally 4 cuttings a season, yielding a total of  $2\frac{1}{2}$  to  $3\frac{1}{2}$  or 4 tons per acre. It does best where the water table does not lie too near the surface. On this type cattle and hog raising are profitable industries, as the soil is productive and the streams, except Beaver Creek, at all times furnish a water supply. Small acreages of wheat, sorghum, and oats are planted and good yields are obtained.

Where too wet to farm the land is valuable for the production of hay. The pasture grasses include the big bluestem, Indian grass (*Sorghum avenaceum*), switch grass, and in wet places abundant growths of slough grass. The bluestem is cut for hay. Adjacent to the streams are good growths of ash, elm, and cottonwood.

The land is held at prices ranging from \$75 to \$175 an acre, depending on location and improvements.

On account of its high productiveness it should be profitable to tile and drain the areas of this type too wet for cultivation. More care is required in handling this soil than the sandier types on account of the tendency to bake and crack.

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

*Mechanical analyses of Lincoln silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
373026.....	Soil.....	0.0	0.6	1.2	7.6	32.6	39.0	19.1
373027.....	Subsoil.....	.0	.1	.2	3.6	60.7	28.9	6.6

#### SUMMARY.

Redwillow County is in southern Nebraska. It lies in the physiographic province known as the High Plains, in the dissected part of the loess region. The surface consists of groups of nearly level dissected tables separated by the broad, deep valleys of the Republican River, Driftwood Creek, and Beaver Creek, and the narrower valley of Redwillow Creek.

Loess covers the entire upland area of the county and is the most extensive soil-forming material in the county.

The elevation of the county ranges between 2,300 feet in the valleys to over 2,700 feet on the uplands.

The drainage is effected mainly by Republican River and Driftwood, Beaver, and Redwillow Creeks, with their intermittent tributaries.

The county had a total population of 11,434 in 1920, or an average of 15.9 persons per square mile. About 62.4 per cent of these are classed as rural. The county was organized in 1873. McCook is the county seat, with a population of 4,303, and including the suburban, of nearly 6,000.

Excellent transportation facilities are afforded by the main lines of the Chicago, Burlington & Quincy Railroad between Denver and Chicago and Denver and St. Louis. The St. Francis branch of that road follows the Beaver Valley and connects with the trunk line at Orleans. The main highways are graded and kept in good condition. The Omaha, Lincoln, and Denver Highway parallels the Republican River.

Telephone lines and rural mail delivery reach all sections, and the county has a good rural school system. Denver, Lincoln, St. Joseph, Omaha, and Kansas City are the chief markets. Much produce is in demand at local towns.

The climate is suited to the production of certain grain crops, alfalfa, and live stock, but is characterized by wide extremes in temperature, the winters being long and cold and the summers short and hot. The mean winter temperature is 27.7° F. and the mean summer temperature 75° F. The mean annual precipitation is 19.31

inches, 80 per cent of which occurs during the growing season, which is relatively short. Summer droughts are frequent, and crops are curtailed for lack of moisture when the rainfall is below normal.

In the dry-farming areas agriculture consists of grain farming combined with stock raising. Intensive cropping under irrigation is carried on in a small way in the Republican Valley. Corn is the principal cultivated crop, and is followed closely by wheat, the cash crop, these grains occupying almost equal acreages. Barley and oats are valuable crops, but are subject to injury by grasshoppers. Sorghum and alfalfa are the chief forage and hay crops. Alfalfa is produced principally on the naturally subirrigated bottoms and the irrigated lands of the Republican Valley. Wild hay is an important source of cattle feed. Sugar beets are the most important of the crops produced under irrigation. Vegetables and potatoes are raised for home consumption and local markets. There is an abundance of nutritious pasture and hay grasses, principally buffalo grass and bluestem. Orchard fruits, as a rule, do not succeed. Native trees are confined to the valleys.

Stock raising is an important adjunct to grain farming. Grade, Hereford, and Shorthorn cattle are the principal beef types. Most of the farms raise hogs and poultry and maintain dairy cows.

The staple crops are grown on all the soil types. Dry-farming methods prevail, but indefinite crop rotations are followed. A little manure is applied, but quickly "burns out." Most of the crops are well suited to the soils, but yields are irregular, as rainfall is the controlling factor. Farm equipment is generally adequate.

Land values range from \$6 to \$15 an acre for rough grazing land to a maximum of \$300 an acre for irrigable farms, including water rights.

The soils of the county are loessial and alluvial in origin. The upland soils and some of the terrace soils (according to the State survey) are derived from loess. The former are identified as the Holdrege and Colby series; the latter are correlated with the Bridgeport and Hall series. The bottom-land soils comprise the members of the Laurel and the Lincoln series.

The Holdrege silt loam is the most extensive upland soil in the county. It is deep, productive, and fertile. Corn, wheat, and sorghum are the principal crops.

The Colby soils are chiefly used for grazing and hay land, but the smoother types are very suitable for general farming and are practically as productive as the smoother Holdrege.

The Bridgeport is the most extensive terrace series in Redwillow County. Its section is similar to the Holdrege, but it is of lighter texture. It is an important agricultural soil in the county, and some of it is under irrigation.

The Hall soils are desirable terrace soils, but their small extent makes them relatively unimportant in the county.

The Laurel series is the chief bottom-land group. These soils are used for crop production, as well as for grazing and hay lands. Most of them are well drained, but they are naturally subirrigated to a small extent. They are productive and desirable soils and in part under irrigation.

The Lincoln silty clay loam is closely associated with the Laurel. It is excellent for corn and alfalfa, being naturally subirrigated, and makes excellent wild hay land.

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