

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE UNIVERSITY OF NEBRASKA; G. E. CONDRA,  
DIRECTOR, NEBRASKA SOIL SURVEY.

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SOIL SURVEY OF RICHARDSON COUNTY,  
NEBRASKA.

BY

A. H. MEYER, OF THE U. S. DEPARTMENT OF AGRICULTURE,  
IN CHARGE, AND PAUL H. STEWART AND C. W.  
WATSON, OF THE NEBRASKA SOIL SURVEY.

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THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

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[Advance Sheets—Field Operations of the Bureau of Soils, 1915.]



WASHINGTON:  
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1917.

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## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,  
*Washington, D. C., June 1, 1916.*

SIR: Under the cooperative agreement with the State of Nebraska a soil survey was undertaken in Richardson County and completed during the field season of 1915.

The accompanying report and map cover this survey and are submitted for publication as advance sheets of Field Operations of the Bureau of Soils for 1915, as authorized by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

Hon. D. F. HOUSTON,  
*Secretary of Agriculture.*

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# SOIL SURVEY OF RICHARDSON COUNTY, NEBRASKA.

By A. H. MEYER, of the U. S. Department of Agriculture, In Charge, and PAUL H. STEWART, and C. W. WATSON, of the Nebraska Soil Survey.—Area Inspected by THOMAS D. RICE.

## DESCRIPTION OF THE AREA.

Richardson County is situated in the extreme southeastern part of Nebraska, about 54 miles south of the Platte River. It is bounded on the north by Nemaha County, on the east by the Missouri River, which forms the State line, on the south by Doniphan, Brown, and Nemaha Counties, Kans., and on the west by Pawnee County, Nebr. The county is approximately rectangular in shape, with one irregular side, its greatest length from east to west being 36 miles and its width from north to south 18 miles. It has an area of 545 square miles, or 348,800 acres. The northwestern corner of the county is about 70 miles from Lincoln and the southeastern corner approximately halfway between Omaha and Kansas City.

The surface features of the upland, which constitutes far the greater part of the county, are variable, though in general the topography is rolling. In the southwestern and extreme western parts of the county the drainage system is intricate and the surface is marked by numerous steep and precipitous slopes, largely the result of high rock ledges. The steep slopes occur largely along the stream courses of the Nemaha River drainage system. However, there are in this section gently arched divides or plains and gently sloping areas. The remainder of the county, except the bluff zone along the Missouri River, is gently rolling to rolling, with no abrupt slopes. The divides are gently sloping to almost flat, and in a few instances attain the elevation of the original constructional surface of the loess plains. These topographic features occur mainly between the Nemaha and Little Muddy Creek drainage systems, with their best development in Franklin Township. In the eastern part of the county the upland merges through a narrow strip of hilly land into the Missouri River bluff zone, which in some places is  $2\frac{1}{2}$  miles in width. This strip is characterized by V-shaped valleys with a depth of about 350 feet. The roughest and most dissected topography occurs in the northeastern and southeastern parts of the county.

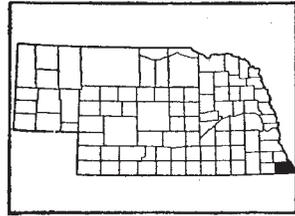


FIG. 1.—Sketch map showing location of the Richardson County area, Nebraska.

There are some alluvial terraces in the county, but they are of very small extent and occur only in the southwestern section. They vary from 5 to 10 feet above the present flood plain of the streams. The terraces are flat, benchlike, and uneroded.

The greater part of the first-bottom land occurs along the Nemaha River and its branches. The Missouri River flows so near the west side of the valley that there is scarcely any first bottom along the course of this stream within the county. The surface of the bottom-land areas is level, except along the Missouri River, where the topography is relieved by low ridges with intervening depressions, sloughs, and ox-bow lakes.

The upland has an average elevation of about 1,100 feet above sea level. The highest point, 1,220 feet, occurs in the northwestern part of the county. The average elevation of the bottom land is about 900 feet above sea level and the lowest elevation is about 850 feet. The general slope of the county is southeastward.

The Missouri River flows along the eastern boundary and receives the drainage of the entire county. The Nemaha River is the only tributary of any consequence, and drains practically all the county. It flows in a southeasterly direction through the area. The North Fork and South Fork of the Nemaha unite at Salem. Muddy Creek is an important branch of this stream. The Nemaha River and its tributary streams are winding and rather sluggish, and have reached base level. The Missouri River is navigable. The streams in this region are not used for power development.

There is a complete system of drainage ways in the county, and adequate drainage is provided for all sections. Springs are numerous in the southwestern part of the survey, and on many farms furnish most of the water for the stock. All the first bottoms are overflowed annually, but rarely are the overflows of a destructive nature, and the water seldom remains more than 12 hours on the surface of the flood plain. However, in the season of 1915, a number of destructive floods occurred, and practically no crops were harvested.

The first permanent white settlements in Richardson County were made in 1855, about a mile north of Falls City, by settlers from Tennessee. The county was created in 1854, and reorganized in 1855 by the first Territorial legislature. When first created the county contained a large part of the area now included in Johnson and Pawnee Counties, but within a few years it was reduced to its present size. Most of the early settlers came from Iowa, Illinois, Missouri, Tennessee, and the New England States. Later some foreigners, including Germans, Swedes, Welsh, Bohemians, Irish, English, and French settled in the county. Less than 8 per cent of the population, however, is of foreign birth.

The total population of Richardson County, according to the 1910 census, is 17,448, of which 81.3 per cent is reported as rural. The density of the population is given as 26 per square mile. The rural population is uniformly distributed throughout the county. There has been a slight decrease in the population since 1900.

Falls City, the county seat, with a reported population of 3,255, is located in the southeastern section at a junction of two railroads, and is a distributing point for farm implements and supplies. Humboldt, Rulo, Stella, Verdon, Salem, Preston, Dawson, and Shubert are other towns of local importance. Strausville is a railroad point. Barada and Nim City are small inland towns.

Richardson County is well supplied with railroads, few points being more than 9 miles from a railroad station, except in the northeastern part of the county, where the greatest distance is about 13 miles. The Missouri Pacific (Omaha and Kansas City line) crosses the county from north to south, giving direct connections with Omaha and Kansas City. The main line of the Chicago, Burlington & Quincy from Denver to Kansas City crosses from east to west, and gives direct access to the markets of Lincoln, Denver, and Kansas City. The Nebraska City line of the same system extends northward from Salem and terminates at Nebraska City. From Rulo the Atchison and Rulo Branch extends southeastward into Kansas. The Chicago, Rock Island & Pacific (Horton Branch) touches the extreme southwestern corner of the county.

There are many excellent graded roads through the county, including the Omaha-Kansas City Highway. Most of the roads follow section or land lines. All the roads are of earth, and little attention is given to the minor roads. The more important highways are dragged as soon as the ground permits after each rain. There are no toll roads.

Kansas City, St. Joseph, and Omaha constitute the principal markets for the county. Some dairy products are shipped to Lincoln. Most of the cattle are shipped to St. Joseph and Kansas City, and some to Omaha. In the local towns there is a small demand for dairy products, berries, and vegetables.

Rural mail delivery and telephone lines reach practically all parts of the county. Most of the public schools are well kept, and are accessible to all communities.

#### CLIMATE.

The mean annual rainfall of Richardson County is 32.71 inches, the highest mean annual precipitation recorded in the State of Nebraska. From 75 to 80 per cent of the rainfall occurs during the growing season, from April to September, inclusive. About 45 per cent falls during

the months of May, June, and July, with the maximum during July. December, January, and February are the driest months, with a total precipitation of 2.53 inches.

Most of the rainfall in the summer occurs in the form of thunder showers, and the precipitation is very heavy within short periods of time, ranging from 1 inch to 6 inches in single storms. Something over one-half the rainfall of May, June, and July occurs in quantities of 1 inch or more in 24 hours. The rainfall in May and June usually is well distributed, and droughts in these months are practically unknown. In July the distribution is not quite so favorable, though on the average rain falls at least once every four days during the months of May, June, and July. During August and September the precipitation is lighter and less favorably distributed. Periods of drought, of only occasional occurrence, are chiefly confined to July, August, and September. The average annual snowfall is about 20 inches. Little snow falls before December or after March.

The mean annual temperature is about 53° F. January and February are the coldest months, with an average temperature of about 27°. July is the warmest month, with an average of 77°. The lowest temperature recorded at Dawson and Falls City, Nebr., is 30° below zero, and the highest 111° F. The average date of the first killing frost in the fall is October 8, and of the last in the spring April 24. The date of the earliest recorded killing frost in autumn is September 12 and of the latest in spring May 27. There is an average growing season of about 170 days, which is sufficiently long for the maturing of all the ordinary farm crops.

The winds are prevailing from the northwest. During the months of June, July, and August, however, they are mainly from the south and southeast. The average velocity of the wind at Omaha is about 9 miles per hour. In storms winds of 30 to 50 miles per hour are common. Tornadoes are of rare occurrence.

The relative humidity is quite regular, the average for the year being about 70 per cent. The humidity is about 17 per cent lower at 8 o'clock in the evening than at 9 o'clock in the morning. On the average there are 170 to 180 clear days and 80 to 90 cloudy days during the year, the remainder being partly cloudy.

The following table, compiled from the records of the Weather Bureau, gives the normal monthly, seasonal, and annual temperature at Dawson and precipitation at Dawson and Falls City.

*Normal monthly, seasonal, and annual temperature at Dawson and precipitation at Dawson and Falls City, Nebr.*

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1901).	Total amount for the wettest year (1902).
	° F.	° F.	° F.	Inches.	Inches.	Inches.
December.....	29.7	67	-15	0.73	0.53	1.38
January.....	28.4	66	-23	.75	.55	.84
February.....	25.8	70	-30	1.05	.81	T.
Winter.....	28.0	70	-30	2.53	1.89	2.22
March.....	41.3	95	- 2	1.69	2.08	1.25
April.....	52.8	96	10	2.88	1.46	1.05
May.....	63.4	94	24	5.17	5.29	5.34
Spring.....	52.5	96	- 2	9.74	8.83	7.64
June.....	72.5	104	40	4.36	2.46	6.73
July.....	77.0	111	44	4.73	1.22	12.51
August.....	76.7	105	45	3.86	2.52	3.44
Summer.....	75.4	111	40	12.95	6.20	22.68
September.....	69.1	100	27	3.34	2.31	3.97
October.....	57.5	96	21	3.04	3.89	3.79
November.....	42.5	80	- 8	1.11	1.08	2.76
Fall.....	56.4	100	- 8	7.49	7.28	10.52
Year.....	53.1	111	-30	32.71	24.20	43.06

#### AGRICULTURE.

Richardson County originally was covered with a luxuriant growth of prairie grasses, with marginal areas of timber along the streams. The first settlers located along the edges of first bottoms, where there was an abundant supply of fuel.

During the first few years vegetables, corn, and wheat were grown for the subsistence of the family. As claims were permanently located and conditions became more stable, the farmers began to break the prairie land for the more extensive production of corn and wheat, with some oats for stock feed. A wide variety of vegetables was grown. Some hemp was produced, but this crop was soon abandoned. No clover, timothy or bluegrass was grown while the country was agriculturally new. Up to about 1874 the farmers produced spring wheat and corn as their main cash crops, and some oats, winter wheat, rye, barley, buckwheat, and flax. Very few cattle and hogs were raised. The yields reported by the early settlers were in many cases higher than at present, but with poor methods of farming the yields soon decreased. The prices of crops were very low and as a result the farmers generally were poor.

Wheat and corn continued the important cash crops, but within the last 20 to 25 years agricultural conditions have gradually improved and to-day most of the farmers are thrifty and prosperous. The dairy industry, the raising of hogs and cattle, and the feeding of beef cattle have no doubt been important factors in this progress, but the improved conditions are due chiefly to better methods of handling the soil.

In 1879 corn was the most important crop in the county. The 1880 census reports 86,766 acres in corn and 31,579 acres in wheat. Oats are reported on about 6,000 acres, and barley on something over 3,000 acres. Hay was cut from a total of 15,492 acres. After 1880 spring wheat declined in importance, as owing to the poor yields of this crop it was found more profitable to grow corn. The chinch bug, the grasshopper, and growing wheat continuously on the same land for many years in succession were the main causes for the poor yields of this crop. Hay was an important crop, and some rye, buckwheat, and tobacco were grown. The orchard products were valued at \$9,328, and market-garden crops at \$51,960.

By 1890 the area in corn had increased to 115,785 acres and the area in oats to 21,826 acres. Wheat is reported in the census of 1890 on only 10,223 acres. Hay was grown on 27,024 acres, rye on nearly 2,000 acres, and barley on less than 500 acres. Potatoes are reported on nearly 1,500 acres. Market-garden products and small fruits had a total value of only \$2,075.

From 1889 to 1899 there was a steady advance in the acreage of all the staple crops. In the 1900 census about 130,000 acres are reported in corn, 29,000 acres in oats, and 20,000 acres in wheat. Of the hay crops, wild grasses, reported on about 18,000 acres, tame grasses on about 10,000 acres, and alfalfa on nearly 1,000 acres were the most important. The acreage in rye, barley, and buckwheat was small. There were about 250,000 apple trees in the county, nearly 100,000 grapevines, and about 75,000 peach trees. Of the live-stock products, animals sold and slaughtered were valued at \$1,167,490, dairy products at \$65,474, and poultry at \$94,896. From 1899 to 1909 there was an increase in the number of acres of wheat and a decrease in the acreage of other crops, especially corn.

At present the production of grain is the chief type of farming in Richardson County, though dairying and the raising of hogs and other live stock are important industries. Corn, oats, wheat, timothy and clover mixed, alfalfa, and wild grasses are the chief general farm crops. The tendency is to grow less corn and more wheat and leguminous crops.

Corn is by far the most important crop in acreage, and is the principal money crop. The 1910 census reports corn on 103,386 acres. There are about 2 acres of corn to every acre of all other cereals com-

bined, even though the acreage has declined considerably in the last decade. About one-half the total area of improved farm land in Richardson County is devoted to the production of corn. The crop is grown on practically all the soil types of the county, but does best on the Marshall silt loam. The average yield for the county is about 30 bushels per acre. Reids Yellow Dent and Iowa Silver Mine are the most popular varieties. About 85 per cent of the corn is listed, some is check-rowed, and in a few cases the crop is double-listed. Most of the corn is sold, though a large part is fed to hogs and beef cattle. It is the general practice to pasture the corn lands after the ears have been removed. There are only a few silos in the county.

Oats rank second in acreage to corn, and the area in this crop seems to be increasing steadily. In 1909 there were 25,093 acres in this crop. Most of the crop is fed to horses and mules; the remainder is sold largely in local markets, though some is shipped to Kansas City. White and Green Russian, Kherson, and Swedish Select are the principal varieties grown.

The third crop in importance is wheat. The census of 1910 reports 21,871 acres devoted to this crop. About 1895 the State experiment station demonstrated the superior qualities of a variety of Russian winter wheat known as Turkey Red, and this has almost entirely displaced the spring varieties formerly grown, as it produces better yields, can be sown in the fall, a time of the year when it does not interfere with other farm labor, and matures before the season of dry weather and hot winds. Wheat is strictly a cash crop, and most of it is sold directly from the thrashing machine to local elevators. Most of it is shipped later to Kansas City. A small proportion of the crop is stored in farm elevators or granaries, and held for higher prices. Scarcely any wheat is grown for home use, the flour used in the county being shipped in. The value of cereal crops is reported in the 1910 census as \$2,346,787, and of other grains and seeds as \$10,348.

Timothy and clover mixed is the most important hay crop. It is reported in the census of 1910 on 11,329 acres. During the progress of the survey excellent stands of this crop were seen, though it is reported that in dry years the crop is not nearly as good. In dry seasons considerable difficulty is experienced in obtaining a good seeding of clover. There are reported 4,799 acres in timothy alone, 3,306 acres in clover alone, 7,703 acres in wild grasses, 290 acres in millet and 161 acres in other tame grasses. Some red-clover seed and timothy seed are produced. Ordinarily clover yields 2 to 4 bushels of seed an acre and timothy, 4 to 8 bushels. Practically all the hay is fed to work stock and cattle, with a small part sold in local towns and some hay shipped to outside markets. Large quantities of hay are imported from the West.

The growing of alfalfa has passed beyond the experimental stage, and this promises to become the principal hay crop of the county. In 1909 there were 7,722 acres in alfalfa. The crop does well both on the upland and on the well-drained bottom-land soils, 3 and sometimes 4 cuttings being obtained each year, with a total yield ranging from 3 to 5 tons per acre. Most of the crop is fed to cattle and work stock, and some is used as hog pasturage. Alfalfa hay is not shipped out of the county, except from a few farms where it is the main cash crop. It is sent chiefly to Kansas City and St. Joseph, and sells for \$12 to \$15 a ton. The total value of hay and forage crops is reported in the census of 1910 as \$532,519.

The less important crops of Richardson County are potatoes, barley, rye, kafir, sorghum, and buckwheat. Potatoes are reported in the 1910 census on 940 acres. The production is inadequate to meet the local demand.

Trucking receives but little attention, owing to the distance from large markets. Some vegetables are grown on a commercial scale near the cities and villages of the county. The 1910 census reports the value of vegetables produced in the county in 1909 as \$83,682.

Most of the farmers have small orchards of apple, plum, peach, and pear trees. These fruits do well when properly cared for, but owing to lack of care the trees in most orchards are gradually dying and less apples are produced now than 10 years ago. There are several commercial orchards in the county, mainly in the vicinity of Falls City and Shubert. Though the bluff zone of the Missouri River is admirably adapted to apples, it has few commercial orchards, owing to the fact that it is too far from railroad points. In the vicinity of Shubert the apples are sold through the Central Fruit Growers' Association; in other localities they are sold direct by the producer. Most of the apples are shipped to points in western Nebraska, Kansas, and South Dakota.

Apples of the better grades are stored in Omaha for shipment at the time of greatest demand. The culls are made into cider and vinegar, and bring from 20 to 30 cents a hundred pounds. Graded apples sell for an average of \$2.50 a barrel. The principal varieties of apples grown are the Ben Davis, Winesap, Jonathan, Mammoth Black Twig, Missouri Pippin, Grimes, York Imperial, Gano, Duchess, and Wealthy. There are approximately 800 acres in commercial apple orchards. Only a few pears are produced commercially. The value of all orchard products, including small fruits and nuts, is given in the 1910 census as \$54,212. The number of apple trees is given as 175,179, with about 67,000 peach trees and about 35,000 grapevines.

Dairying is receiving increased attention. Most of the farmers keep dairy cows, chiefly Shorthorn grades. The number of cows

per farm varies from 3 to 10, with upward of 40 on the dairy farms in the vicinity of Falls City. A few farmers keep no dairy cows. Most of the dairying is carried on during the summer months, and in the winter not enough milk and butter is produced for home use. Most of the cream is separated on the farm. The surplus cream is shipped mainly to St. Joseph, and some is sent to Lincoln, Omaha, and Kansas City. The local creamery at Falls City handles a small part of the cream. Some butter is made on the farms and sold at local markets. The average price obtained for butterfat in the summer is 25 to 28 cents per pound, and in the winter 30 to 32 cents. The 1910 census reports the total value of all dairy products, excluding home use, as \$124,021. The number of dairy cows on farms reporting dairy products is 6,726.

There are some herds of beef cattle, mostly on the farms in the southwestern part of the county, on areas of Rough stony land. The cattle are mainly of Shorthorn and Hereford breeding, though there are some herds of Polled Durham. A number of farmers feed one or two carloads of cattle, obtained from stockyards, with good returns. In other cases a few head are fattened on the farm each year, and sold when prices are most favorable. Most of the beef cattle are marketed in St. Joseph and Kansas City. The 1910 census reports 19,246 other cattle and 1,219 calves sold or slaughtered.

Considerable attention is being paid to the breeding of farm and draft horses. Nearly every farmer raises one or two colts each year, and some as many as six. In this way the farmers supply their own work stock, and occasionally have a team to sell. The Percheron and Clydesdale are the favorite breeds. About one-fourth to one-fifth of the colts are mules. The census of 1910 reports a total of 1,848 horses and mules sold.

There are only a few flocks of sheep in the county, though some sheep are shipped in from Kansas City for feeding. There is one large goat ranch, carrying about 1,000 head, in the northeastern part of the county, on the Knox silt loam. The 1910 census reports 6,960 sheep and goats sold or slaughtered.

The raising of hogs is the most important live-stock industry. Nearly every farmer fattens from 25 to 30 hogs each year, and some as many as 150. On tenant farms not nearly so many hogs are kept, which is also true of other live stock. Pork production is profitable, though cholera is prevalent and reduces the profits considerably. Most of the hogs are marketed in St. Joseph and Kansas City, and some in Omaha. Nearly every farmer butchers enough hogs to supply the home with meat the year round. Poland China, Duroc Jersey, and Berkshire are the leading breeds, though there are very few registered herds. According to the 1910 census 46,982

hogs were sold or slaughtered in 1909. The total value of all animals sold and slaughtered is reported in the 1910 census as \$1,875,319.

According to the same authority the total value of poultry and eggs is \$240,815. Practically every farmer keeps a small flock of chickens, ranging from 40 to 150. Most of the eggs and poultry are handled by the two poultry establishments at Falls City. The dressed chickens are shipped mainly to Buffalo and New York. About 32 carloads of chickens and 90 carloads of eggs are shipped out of Falls City each year.

Considerably more attention is paid to the adaptation of crops to the different soils than 10 years ago. The farmers realize that the Marshall silt loam and Carrington silt loam are best suited to corns, wheat, oats, and grass. They recognize that the Knox silt loam and steep slopes of the Shelby loam are best suited to alfalfa and for use as pasture. The Wabash soils are generally recognized as well adapted to corn and less well suited to the small grains, and the same is known to be true of the other bottom-land types. The topography of the Rough stony land makes it suitable only for grazing.

The stubble land generally is plowed in the fall either for winter wheat or corn. Corn land usually is listed and sometimes double listed where the crop succeeds itself. If the field is put in oats, it is either double disked or the oats are sowed broadcast between the rows of corn. Variations and modifications of the above practices are common. It is necessary to exercise considerably greater care in the preparation of the seed beds on the heavier types of the county. A little barnyard manure is used. It is applied to corn or as a top-dressing for winter wheat. As a rule the barnyard is cleaned twice a year, but on many farms a large part of the manure is wasted. Green manuring is not practiced and scarcely any commercial fertilizers are used. According to the census of 1910, the total expenditure for fertilizers in this county in 1909 was only \$626, only six farms reporting their use.

The farm buildings, especially the houses, usually are well painted and kept in good repair. There are many large, modern houses in the county. The barns are usually small, but as a rule are substantial and well kept. Hedge fences, established before the introduction of barbed wire, are common. Most of these consist of Osage orange. Most of the cross fences and some boundary fences are of barbed wire, though woven wire is coming into more general use.

The work stock consists mainly of medium-weight draft horses and mules. There are only a few gasoline tractors in the county. On

most farms the 4-horse hitch is used. The farm equipment consists of gang or sulky plows, disk harrows, straight-tooth harrows, drills, listers, corn planters, mowing machines, cultivators, rakes, hay loaders, stackers, binders, and wagons. Thrashing machines are favorably distributed for use by the farmers in all sections immediately after harvest.

Definite systems of rotation are followed by only a few progressive farmers. The general tendency is to keep the land in corn 2 or 3 years or even longer, following with 1 year of oats, and from 1 to 3 years of wheat. Occasionally the wheat land is seeded to clover for 2 or 3 years, and then planted to corn. Of late alfalfa is taking the place of clover, and occupies the land from 7 to 10 years or longer. On farms where there is no permanent pasture clover and timothy fields usually are pastured the second year.

There is an adequate supply of farm labor, but it is rather difficult to secure efficient help. The usual wage paid is \$20 to \$35 a month, with board and washing. Most of the laborers are hired from March 1 to October 1 or December 1, though a few farmers employ labor by the year, because it is easier in this way to get efficient men. Where they are hired only to October 1 the laborers are paid additional rates of 3 to 3½ cents a bushel for husking corn. The daily wage for transient labor during harvest time ranges from \$2 to \$3 per day, with board. The farmers are beginning to hire married men with their families, and the owners furnish them with tenant houses, milch cows, chickens, gardens, and fruit. Under this plan the wages range from \$30 to \$40 a month. Most of the farm work in the county, however, is performed by the farmers and their families. The expenditure for labor in 1909 was \$314,735.

Most of the farms in Richardson County contain 160 acres. There are a few as small as 80 acres, and several ranging from 400 to several thousand acres. According to the 1910 census, about 95 per cent of the area of the county is in farms, and of the land in farms 86 per cent is improved. The average size of the farms is 157.9 acres. About 53 per cent of the farms are operated by the owners and practically all the remainder by tenants. Both the cash and share systems of renting, as well as a combination of the two, are practiced, the share system being most popular. Cash rents vary from \$3 to \$6 an acre for general-farm land, depending largely on the character of the soil. Under the share system the owner receives two-fifths to one-half the products of the farm when the tenant furnishes all implements and stock. Where the land is not so productive the owner furnishes one-half the work stock and tools and there is an equal division of crops. In the combination system of cash and share renting the permanent pastures and lands not used for crops are rented for cash.

The value of farm land in Richardson County ranges from \$20 to \$200 an acre, depending on the nature of the soil, the topography, improvements, and distance from railroad points. The lowest priced land is in the bluff zone of the Missouri River, and the highest priced in the vicinity of Falls City. In the 1910 census the average value of farm land is reported as \$80.71.

#### SOILS.

Upon the basis of physiographic position, the soils of Richardson County may be divided into three groups, upland, terrace, and first-bottom soils. The upland group embraces the Marshall, Grundy, Knox, Carrington, and Shelby series, and Rough stony land; the terrace group includes the Waukesha series; and the first-bottom group the Wabash, Cass, and Sarpy series and Riverwash.

Practically all the soils are derived from transported material, except most of the Rough stony land. The upland originally was covered with a thick veneer of plains loess, which has been almost entirely removed by erosion. Where erosion has progressed enough to give rise to a rolling topography, as in the eastern part of the county, the loess subsoil as well as soil is loose and friable. Along the bluff line of the Missouri the loess has been modified by material blown from the sand and silt bars of the river. The loess beds vary in color from yellow or pale yellow to light gray, and are always more or less calcareous and blotched with iron stains. It is thought by the State survey that the plains loess was laid down in sluggish waters as outwash from the glaciers to the north.

Only two remnants of the original constructional surface remain, and they are located in the northwestern part of the county. Owing to the flat to slightly undulating topography in that section, the clay has not been carried away by rain waters, but has been washed down into the subsoil, forming a hardpanlike layer.

Below the plains loess lies the upper or weathered phase of the Kansan drift, which is very similar to the loess. The material is yellowish brown or pale yellow to light gray, and is smooth and silty, and contains fewer lime concretions than the loess. It also contains some sand and a few small pebbles, which are absent from the loess. In a vertical section there is no well-defined line of demarcation between the loess and the weathered drift. However, the loess has a more decided tendency to weather in perpendicular walls than the drift. The soil derived from this phase of the drift has a heavier and more compact subsoil than that derived from the eroded loess.

Below the weathered phase of the drift is the Kansan drift proper. There is a sharp line of demarcation in color and texture between these two divisions. The upper part of the Kansan drift is thoroughly

oxidized, showing that it has been subjected to weathering. The Kansan sheet is distinctly till, and consists of a heterogeneous mass of clay, silt, sand, gravel, and bowlders. The upper part of the till varies in color from yellowish brown or brown to reddish brown, and the lower part from light gray to pale yellow, with numerous iron stains.

Below the Kansan drift lies the Aftonian material, which consists largely of stratified sand and gravel, with a few bowlders. This does not occur as a continuous stratum, but as sand or gravel trains. The material outcrops west and northwest of Humboldt and northeast of Salem. It has given rise to local sandy spots in the drift soils.

The lowest drift sheet, the Nebraskan, consists of blue clay, containing small pebbles and large numbers of bowlders. It is exposed only in deep-cut banks. It may be seen north of Rulo and also west of Rulo in the railroad cut.

The loess and drift beds lie on a very uneven surface of bedrock belonging to the Pennsylvanian division of the Carboniferous System. In many places the streams have cut through the loess and drift and exposed large areas of bedrock. Most of these are in the southwestern part of the county. In the northern and eastern parts of the county, the mantle of rock is from 50 to 100 feet deep, with only local outcrops. The upper layers of the bedrock consist of well-defined beds of shale and limestone; in places the shale is wholly composed of clay and in other places it grades into sandstone. The rocks dip northwestward in the southeastern corner of Richardson County, then flatten out to near Salem, beyond which they are nearly level in an east-west section, remaining so to a north-south line just west of Humboldt. Between this line and Table Rock there is a sharp rise of the beds amounting to about 400 feet, and some of the formations exposed in the eastern part of the county are again brought to the surface. The most important rocks are the Cottonwood, Falls City, Aspinwall, Tarkio, Preston, Fargo, Burlington, and Rulo limestones.

The lower limestones named above outcrop near Rulo and in an anticline southwest of Humboldt. The limestones are of use for building purposes, and are of value in road making. There are about 35 square miles of bedrock exposed, giving rise to a thin, stony soil, seldom more than 2 to 10 inches deep.

The terraces of Richardson County are very inextensive. The material forming them consists largely of silt, known in the State of Nebraska as valley loess. It was deposited at a time when the streams were flowing at a higher level. The material was largely derived from the plains loess and finely divided drift débris.

The main areas of alluvial soils occur along the Missouri and Nemaha Rivers, with small areas widely distributed throughout the county. They are of recent origin and are constantly receiving additional sediments from the overflow waters of the streams. The material along the Missouri River represents waste mainly from the glacial and loessial Rocky Mountain and Great Plains provinces. The soils along the other streams represent reworked and deposited loessial and glacial material.

The Marshall series includes types with dark-brown to black surface soils and a lighter, yellowish-brown subsoil. This series comprises the dark-colored upland loessial soils which predominate in the prairie region of the Central West. The soils are characterized and distinguished from those of the Knox series by the large quantity of organic matter in the surface soil. The topography is level to rolling. The series is represented in Richardson County by a single type, the silt loam.

The soils of the Grundy series are dark brown to black to an average depth of about 8 inches. The soil becomes somewhat heavier with depth, more rapidly as it approaches the subsoil. The transition from soil to subsoil, however, is not abrupt. The upper subsoil is mottled, heavy, and rather plastic when wet and hard when dry. The mottling consists of dark drab and yellowish brown. This layer is 6 to 10 inches thick and passes gradually into material of somewhat lighter color and texture. As a rule the mottlings are not well defined in the lower subsoil. This series is derived by thorough weathering from silty material overlying the Kansan drift. The silt loam is the only representative of this series in the county.

The Knox soils are prevailing light brown and the subsoil is light yellow or light grayish yellow. These soils occur mainly in the central prairie States. They are derived from loessial deposits. The loessial covering where the Knox series is found is always thick enough to form a subsoil as well as a surface soil, the deeper lying glacial till being far enough from the surface to have no marked influence on the general character of the soil. The topography is gently undulating to rolling, and the surface drainage is generally good. The silt loam is the only member of the Knox series encountered in Richardson County.

The Carrington soils are derived through weathering of glacial till, with little or no modification from loessial deposits. The series is developed in the central and western prairie region and consists mainly of prairie soils. The soil generally is black, ranging in some cases to dark brown. The subsoil is lighter colored, generally light brown or yellowish. The topography is gently undulating to rolling, though some areas are nearly flat. In Richardson County only the Carrington silt loam is recognized.

The soils of the Shelby series are dark brown to brown; the subsoil is a yellow, reddish-yellow or light-brown, tenacious, sandy clay. These soils are derived from the Kansan drift. Only the Shelby loam is mapped in Richardson County.

The surface soils of the Waukesha series are dark brown to black, and the subsoil is yellow. These soils occur in areas of deep glacial drift. They are derived from water-assorted glacial débris deposited on broad filled-in valleys or as outwash plains and terraces. The topography is mainly flat to undulating. Drainage is good.

The Wabash soils are prevailing black, ranging to dark brown, and contain a high percentage of organic matter. The subsoil is brown or brownish gray. These soils occur in the first bottoms of streams in the central prairie States. They extend for long distances along the Mississippi River. The material is derived principally from the loessial and associated soils of the region. The Wabash areas are flat and poorly drained.

The surface soils of the Cass series are dark brown to black. The subsoil is lighter in color and in texture. These soils are alluvial, and are most extensively developed in the bottoms along the Mississippi and Missouri Rivers and their tributaries. They occur in association with the Sarpy soils, occupying, however, areas which are somewhat less well drained, being subject to overflow. Between the high stages of the streams the drainage is good.

The soils of the Sarpy series range from light gray to dark brownish gray or nearly black. They differ from the Wabash soils in having loose, silty or fine sandy subsoils, distinctly lighter in texture than the surface soils. The material is alluvial in origin. Owing to their low position these soils are subject to overflow, although the nature of the soil and subsoil is such that drainage is thorough to excessive between flood stages of the streams. In general the topography is flat.

The following table gives the name and actual and relative extent of each soil type mapped in Richardson County:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Carrington silt loam . . . . .	162,624	46.5	Riverwash . . . . .	1,664	0.5
Wabash silt loam . . . . .	68,288	19.6	Waukesha silt loam . . . . .	1,152	.3
Marshall silt loam . . . . .	57,472	16.5	Sarpy very fine sandy loam . . . . .	960	.3
Rough stony land . . . . .	17,408	5.0	Cass clay . . . . .	512	.1
Wabash silty clay loam . . . . .	13,568	3.9	Grundy silt loam . . . . .	320	.1
Knox silt loam . . . . .	12,864	3.7	Sarpy silt loam . . . . .	256	.1
Shelby loam . . . . .	8,576	2.5			
Wabash clay . . . . .	3,136	.9	Total . . . . .	348,800	.....

## MARSHALL SILT LOAM.

The Marshall silt loam is a dark-brown, moderately heavy silt loam, 8 to 15 inches deep, having a decidedly smooth feel. It grades through a thin brown layer of silt loam, about 4 inches thick, into yellowish-brown material, the color changing with increasing depth to yellow. As a rule the color of the subsoil is uniform, though occasionally the lower part is slightly mottled with light gray and streaked with rusty iron stains. The subsoil is open and friable and becomes more so with depth; as a rule the fourth foot is highly calcareous, the lime occurring chiefly in the form of concretions. As the color indicates, the soil is high in organic matter.

The depth of the soil is variable, and depends upon the topographic position. In the flatter areas and on the gently arched divides it is 15 to 18 inches deep, while on the shoulders of hills and along gullies the depth is only 6 to 8 inches, and often the yellowish-brown subsoil is exposed. On the lower parts of slopes the soil is darker in color and deeper, owing to the deposition of colluvial material, and at the foot it is commonly 24 inches or more in depth. Included with this type are small, narrow strips of colluvial material, occurring along intermittent streams. Where the Marshall silt loam gives way to the Knox silt loam, small spots of the latter type are included. In general, the color of the Marshall silt loam is lighter where the type adjoins areas of the Knox silt loam.

The Marshall silt loam differs from the Knox silt loam in having a higher content of organic matter. It is very difficult to draw a definite boundary line between the two soils, because of their patchy occurrence where they unite. In texture and structure the two soils are similar. Both have the vertical structure and extremely smooth feel characteristic of loess soils.

The Marshall silt loam occurs as a belt about 6 miles in width in the eastern part of the county, running parallel with the Missouri River bluff. On the east it gives way to the Knox silt loam, and on the west to the Carrington silt loam.

In general the topography is rolling. Where the type adjoins the Knox silt loam, it is steeply rolling, and where it adjoins the Carrington silt loam it occupies rather gently sloping divides. In the vicinity of Zion Church and in the area south of Preston the soil has a gently undulating surface. The drainage is good and the physical condition of the soil is such that it withstands protracted droughts. Where the slopes are steep there is considerable wash, though less than would be expected on such slopes on account of the favorable texture and structure of the soil. The type lies at an elevation of 880 to 1,160 feet above sea level.

The Marshall silt loam originally supported a thick growth of the prairie grasses common to this region, but very little of the native

sod remains. Approximately 95 per cent of the type is under cultivation. It is considered by farmers the best upland corn soil of eastern Nebraska. About one-half the farm land is devoted to the production of this crop, and the remainder is largely in wheat and oats, with some clover and timothy and alfalfa. In average seasons corn yields 30 to 40 bushels per acre, and occasionally as much as 60 bushels. Oats rank second in acreage, and ordinarily yield 30 to 35 bushels an acre. The acreage in wheat is being gradually extended, as the crop has proved very profitable. Yields of 20 to 30 bushels an acre, and sometimes as much as 40 bushels per acre, are obtained. Clover and timothy and alfalfa are the principal hay crops, though some millet and sorghum are grown.

In wet seasons clover does well, but in dry seasons it is difficult to get a stand. In view of this fact, alfalfa is coming more in favor, even though it does not fit nearly so well in the crop rotation. In favorable seasons clover yields  $1\frac{1}{2}$  to 2 tons per acre, while alfalfa yields 3 to 5 tons. Small patches of barley and rye also are produced. About one-half the corn crop and all the wheat are sold. The remainder of the corn is largely fed to hogs. The oats and hay produced are chiefly fed to the work stock. The present tendency on the Marshall silt loam is to grow less corn, more wheat, and more leguminous crops, and to keep more live stock.

In the vicinity of Shubert there are a number of commercial apple orchards. The apple does especially well on this type.

At present no definite rotations are followed on this type. The general practice is to keep the land in corn from 2 to 3 years, oats 1 year, and wheat 1 year, returning the field to corn. Occasionally the wheat field is sowed either to clover and timothy or to alfalfa. Tenant farmers pay less attention to the rotation of crops, and often use the same field for corn or wheat 4 or 5 years in succession.

This soil is friable, silty, free from stones, and very easy to handle. It can be cultivated under a wide range of moisture conditions, without clodding or baking badly on drying. Though the natural productiveness of the type is high, it responds readily to good methods of cultivation, fertilization, and the growing of leguminous crops. Only small quantities of barnyard manure are applied, and no commercial fertilizer is used.

The value of the Marshall silt loam ranges from \$100 to \$200 an acre, depending on location, improvements, and the condition of the land.

The Marshall silt loam is a very productive soil and it is only in cases where the same fields have been devoted to the same crops for a series of years that the soil has materially deteriorated in productiveness. Deeper plowing is needed on most farms, and though the type

is high in organic matter, it is advisable to rotate the cereal crops with leguminous crops every 4 or 5 years in order to keep up the organic-matter content. On steep slopes where erosion is a serious factor the type should be kept in cover crops as much as possible. The Marshall silt loam is well suited to the production of apples on a commercial scale, and within reasonable distances from railroad points this industry might be profitably extended.

#### GRUNDY SILT LOAM.

The surface soil of the Grundy silt loam is a dark-brown, heavy silt loam, about 15 inches in depth. It passes rather abruptly into a very compact, plastic silty clay of drab color, mottled with yellowish brown. When dry the upper part of the subsoil is tough and decidedly granular. Below 24 to 30 inches the color as well as the texture becomes lighter and the structure is more friable. As a rule the mottlings are not so conspicuous in the lower part of the subsoil. The soil is high in organic matter, and as a rule lime concretions are encountered in the lower part of the subsoil. The upper subsoil layer is locally called "hardpan."

This soil is very similar to the extensive areas of Grundy silt loam mapped in Gage County, Nebr. It appears heavier than that mapped in Seward and Polk Counties, but not quite so heavy as that in Gage County.

The type is very inextensive; it occurs as two small areas in the northwestern part of the county, which extend into Nemaha County. It occupies a high, slightly undulating divide which undoubtedly represents the original constructional surface of the loess plains. The type is well drained in normal seasons. In wet seasons the drainage is somewhat deficient on account of the hardpan layer and in very dry years the soil is rather droughty for the same reason.

The agriculture on the Grundy silt loam is the same as that on the surrounding Carrington silt loam. The land is valued at \$150 to \$200 an acre.

#### KNOX SILT LOAM.

The surface soil of the Knox silt loam is a yellowish-brown, light-brown or buff-colored, friable, smooth silt loam, from 6 to 8 inches deep. It is underlain by a brownish-yellow or yellow, open, loose, friable silt loam. Light-gray mottlings and yellowish-brown or reddish iron stains are frequent in the lower subsoil, and often occur throughout the substratum. Lime concretions are very common in the subsoil. The soil varies considerably with difference in topographic position. On the sharp divides and upper steep slopes a light yellowish gray variation with numerous lime concretions occurs. Where erosion has been very severe, the surface has a whitish appearance. On the tops of divides or on the lower slopes of hills and in forested areas the

soil is brown, and in places approaches a dark-brown color. In the timbered areas the color is due largely to leaf mold, which would soon disappear with cultivation. The soil has a vertical and open structure, a characteristic of the Missouri River bluff loess. The typical soil contains very little black organic matter.

The Knox silt loam is rather inextensive in this county, having a total area of 20.1 square miles. It is confined to the Missouri River bluffs. It is best developed in the northeastern and southeastern parts of the county.

This soil has an extremely dissected topography and is thoroughly drained. The valleys are V-shaped, with very steep slopes, and are 200 to 300 feet deep, but steplike slopes are very conspicuous features in some places. The hills are usually rounded, a characteristic of loess soils. Along the Missouri River the slopes are extremely steep to precipitous. The type is subject to severe erosion, though since the subsoil is of practically the same character as the surface soil, the washing away of the surface material does not greatly change the character of the type nor render it useless for agriculture.

Practically all this type originally was forested. The chief growth on the upper slopes and crests of the hills was hazel brush, sumac, and scrubby bur oak, and in the draws elm, oak, hickory, bitter hickory, basswood, box elder, ash, and some black walnut, with an undergrowth of hazel brush, prickly ash, and dogwood. At least 50 per cent and probably more of the type is still forested, though it is slowly being cleared.

Owing to the steep slopes the growing of small grains is impracticable. Some oats and wheat, however, are grown where the topography is more favorable. Oats constitute the most important grain crop, and are used largely for feeding work stock. Oats yield an average of 25 bushels per acre, and wheat 16 to 18 bushels. At present corn is the principal cereal and is mainly a cash crop. On the lower slopes, and where there is sufficient organic matter, it does well and yields from 20 to 40 bushels per acre. On the high crests and steep slopes the growing corn has a yellowish appearance and makes a stunted growth unless heavily manured. Alfalfa is grown very extensively and promises to become the leading cash crop. It does well, owing to the thorough drainage and favorable distribution of lime. On some farms it is produced extensively, and is baled and shipped to St. Joseph or Kansas City. Ordinarily alfalfa yields 3 to 4 tons per acre per season. Clover and timothy do well, but it is difficult to get a stand in dry years. Sweet clover grows luxuriantly on this type, and is found along roads and in uncultivated fields, but the crop is not utilized. Apples and small fruits are grown to a small extent. The type is too far from railroad points for the successful production of fruit on a commercial scale.

Owing to its dissected surface the type is hard to manage, notwithstanding its loose structure and favorable texture. As very little live stock is kept on this soil, very little barnyard manure is applied. Commercial fertilizers are not used.

This type is valued at \$20 to \$75 an acre, depending largely on the proportion of land suitable for cultivation.

For the improvement of the Knox silt loam it is necessary to handle it with considerable care in order to prevent erosion and gullyng. The type should be kept in pasture as much as possible, the cultivated areas should be plowed deeper, and more organic matter should be incorporated with the soil. Where sufficient barnyard manure is applied, crops do as well as on the Marshall silt loam. As the timber is very stunted, the forested areas should be cleared and used for pasture or seeded to alfalfa. Grass crops do well, and dairying and stock raising should prove profitable on this type. With proper attention the commercial production of apples should meet with success, where transportation and market conditions are favorable.

#### CARRINGTON SILT LOAM.

The soil of the Carrington silt loam consists of a dark-brown, heavy silt loam, 8 to 15 inches deep. In the flatter areas the soil is darker and approaches a black color. The soil carries a higher percentage of clay than the Marshall silt loam, and as a result breaks down upon drying into angular granules instead of a fine powder like the Marshall silt loam. The subsoil is a yellowish-brown or light-brown, very compact silty clay, with a decided grayish cast. Below 24 to 30 inches the subsoil is lighter in color, and the gray appears as light-gray mottlings. In the lower part of the subsoil bright yellowish brown iron stains are common. In places there is a layer of material between the soil and subsoil, from 2 to 4 inches in thickness and consisting of a brown, heavy silt loam, heavier than the surface soil. There is a pronounced difference between the soil and subsoil in texture, but the change is not abrupt, except in the flatter areas. The subsoil is moderately plastic when wet, though when dry it is very hard and compact and difficult to break down between the fingers. At 30 to 40 inches the subsoil is likely to be looser in structure and lighter in texture. The soil is high in organic matter.

There are a number of patches of heavy soil in the Carrington silt loam, known locally as "gumbo spots." In these places the soil is a dark-brown, heavy silty clay loam, 8 to 12 inches deep, with a grayish cast at the surface. The soil has numerous cracks and is extremely difficult to handle. The subsoil is a drab, plastic silty clay, mottled with yellowish brown. The drab becomes lighter, changing to light gray, and the mottling decreases with depth. Lime and iron concretions are numerous in the lower subsoil. Crops do not mature in these spots.

In the gently undulating region in Franklin Precinct there is a variation of this type marked by a "hardpan" layer. This is similar to the flat phase of this type mapped in Gage County, Nebr. It consists of a dark-brown, heavy silt loam, 12 to 15 inches deep, underlain abruptly by a rather tough, black clay. The material is extremely difficult to penetrate with a soil auger and is decidedly plastic. At 20 to 24 inches the subsoil changes to a drab silty clay, mottled with yellowish brown. The lower part of the subsoil is not so compact and heavy as the upper layer.

On shoulders of hills and moderately steep slopes the soil is not so deep and is usually lighter in color than typical. In places the subsoil is exposed, but downward along the slopes the soil becomes deeper and darker in color, and at the foot of the slopes it is a dark-brown to black, heavy silt loam from 20 to 40 inches deep. The type also includes narrow strips of colluvial material along the intermittent streams. The variations of this type are not sufficiently extensive to be shown on the soil map.

The Carrington silt loam differs from the Marshall silt loam in origin, texture, and structure. The Carrington is a glacial soil, while the Marshall is a loessial soil, free from stones. The Carrington soil, and particularly the subsoil, is heavier than the Marshall silt loam. These soils also differ in that the Carrington silt loam does not stand up so well in vertical banks as the Marshall silt loam. Even with these differences, the types grade into each other so that the boundaries are difficult to establish and are more or less arbitrary.

The Carrington silt loam is the most extensive type in the county, and covers about two-thirds of the western upland region. It is more or less broken with areas of Rough stony land and Shelby loam.

This type is gently rolling to rolling and is thoroughly drained. West and northwest of Humboldt, where it is associated with the Shelby loam, it occupies the gentler slopes and the divides. It has a similar topography in the southwestern part of the county, where most of the steeper slopes are occupied by Rough stony land. The gently undulating areas are confined to the divide between the Nemaha River and Muddy Creek, which extends from Falls City northwestward into Nemaha County. Other areas with a gently undulating surface occur south of Falls City. It is only on the steeper slopes that there has been any serious erosion. With proper tillage and crop rotation this soil, owing to its rather high organic-matter content, is very retentive of moisture.

The type originally was prairie. About 95 per cent of it is now in cultivation, the remainder being in permanent pastures and farm lots. Corn is the most important cash crop, though a large part of the corn produced is fed to hogs. About one-third of this soil is in this crop, and the yields average about 30 bushels per acre, though

much higher yields are obtained with careful cultivation. Oats rank second in acreage to corn and yield from 30 to 40 bushels an acre. The oats are largely fed to work stock. Wheat is strictly a cash crop, and is receiving increased attention. Ordinarily, yields of 20 to 25 bushels per acre are obtained. Clover and timothy are grown more extensively than alfalfa, though alfalfa is becoming more popular. Clover and timothy do well in wet years, though in dry years considerable difficulty is experienced in getting a stand. In favorable years yields of  $1\frac{1}{2}$  to 2 tons per acre are obtained. Some timothy and clover are grown alone for seed with very profitable returns. Alfalfa does well, and three to four cuttings per season are made, with a total yield of 3 to 5 tons per acre. The tendency on this type is to produce less corn and more wheat and alfalfa and to keep more dairy cows and other live stock.

A few potatoes are grown, but scarcely enough to supply the home demand. Some sorghum is produced for sirup. There are only a few commercial orchards on this type; they give profitable returns, though the trees do not do so well as on the Marshall silt loam.

The general practice on this type is to keep the land 2 or 3 years in corn, 1 year in oats, 1 or 2 years in wheat, and in every second or third rotation to grow clover and timothy. The land is usually kept 2 or 3 years in clover and timothy and 7 to 10 years or longer in alfalfa.

The 4-hitch team is used almost entirely in the preparation of the seed bed on this type; gang plows generally are used for turning the soil. Owing to its stone-free nature, favorable topography, silty texture, and granular structure, this type is very easy to handle. When plowed too wet it bakes and clods. Only small quantities of barnyard manure are applied, and no commercial fertilizers are used.

The price of farm land on the Carrington silt loam varies from \$100 to \$175 an acre. In the vicinity of the towns this land is held for \$200 an acre.

On most farms deeper and more thorough tillage of this soil would prove beneficial. Leguminous crops should be grown in order to keep up the organic-matter content of the soil.

#### SHELBY LOAM.

The surface soil of the Shelby loam is a dark-brown to brown loam, with an average depth of about 8 inches. The subsoil is a yellowish-brown sandy clay loam, which becomes lighter in texture with depth. Below about 30 inches the material is almost yellow. In the northwestern part of the county and other localities where the Aftonian material is near the surface, the subsoil is considerably lighter in texture and the surface soil is often a sandy loam. This variation, however, is too patchy to be shown on the soil map. In

places the subsoil has a reddish tint, which is due to the color of the original material and not to oxidation. The content of organic matter is moderately high. The subsoil contains considerable gravel and rock débris. Gravel is usually scattered over the surface, and a few boulders are present, though in most fields these are not sufficiently numerous to prevent cultivation.

The Shelby loam occurs as small areas scattered throughout the Carrington silt loam type. It is best developed west and northwest of Humboldt in the Long Branch drainage basin. The type usually occurs along the steep slopes between the Carrington silt loam on the higher land and the Wabash silt loam in the bottom land. The drainage is thorough, and is excessive in local spots where the Aftonian sands lie near the surface. Where the subsoil is typical the soil withstands drought well. The type is subject to destructive erosion, gullies 10 to 15 feet deep, with numerous branching laterals, being very common.

The Shelby loam is derived from the Kansan drift sheet, but is more or less influenced by the wash from the silty upland soils. The large boulders and pebbles on the surface and the gritty or sandy clay subsoil distinguish it from the Carrington silt loam.

The native vegetation on the Shelby loam consists of the prairie grasses common to this region. Along the drainage ways a large part of the type is forested. About 40 per cent of the Shelby loam is under cultivation, and the remainder is largely in permanent pasture, with some hay land. No farms are composed entirely of this type. The yields of crops are lower than on the Carrington silt loam, though the same crops are grown. Corn yields 15 to 35 bushels, oats 20 to 25 bushels, wheat 15 to 20 bushels, and alfalfa  $2\frac{1}{2}$  to  $3\frac{1}{2}$  tons per acre.

No definite crop rotation is practiced on this type. The general methods are about the same as on the Carrington silt loam. Owing to the steeper surface and the larger quantity of stony material present, this soil is much less desirable than the Carrington silt loam, with which it is closely associated. When cultivated too wet, the Shelby loam clods and bakes, and large checks and cracks form. A heavy farm equipment is required in cultivating this type, except in the sandy spots. Only small quantities of manure are applied, and no commercial fertilizers are used. Land values on this type range from \$50 to \$90 an acre.

For the improvement of the Shelby loam considerable care is necessary to prevent gullying on the steep slopes. The steep areas should remain in permanent pasture or cover crops as much of the time as possible. The content of organic matter should be maintained by turning under green crops and growing leguminous crops.

## WAUKESHA SILT LOAM.

The Waukesha silt loam consists of a dark-brown, smooth, friable silt loam, having an average depth of about 18 inches. The soil passes through a brown, heavy silt loam into a brownish-yellow silt loam which is heavier and more compact than the surface soil. The subsoil becomes lighter in color with depth, being yellowish in the lower part. The substratum is open and very friable, and the material in the fourth foot is calcareous. The soil section of the Waukesha silt loam is similar to that of the Marshall silt loam. As the color indicates, the Waukesha silt loam is high in organic matter.

In extent the Waukesha silt loam is very unimportant, having a total area of only 1.8 square miles. It occurs as small, isolated areas along the streams of the county.

This type occupies distinctly benchlike areas, modified to some extent by stream erosion. The terraces are from 10 to 15 feet above the present flood plain. The Waukesha silt loam is well drained and withstands drought over long periods.

Originally this soil was covered with a luxuriant growth of prairie grasses. Nearly all the type is now under cultivation to the staple crops commonly grown in the county. No farms consist entirely of this type. Corn yields 25 to 45 bushels, oats 35 to 40 bushels, and wheat 20 to 30 bushels per acre. Leguminous crops receive little attention.

The methods of cultivation, rotation, and fertilization are similar to those on the Marshall and Carrington silt loams. The productive capacity of this soil has been somewhat impaired by the failure to grow clover and alfalfa.

The value of farm lands on the Waukesha silt loam varies from \$150 to \$200 an acre.

For the improvement of this soil there is a general need for more thorough cultivation and the growing of leguminous crops to maintain the organic-matter content.

## WABASH SILT LOAM.

The soil of the Wabash silt loam is nearly black, and to an average depth of about 20 inches consists of a heavy, smooth silt loam. This is underlain by a slightly heavier and more compact silt loam, which usually is somewhat lighter in color, though it is not uncommon to find little difference in color or texture in the 3-foot section. In places, usually along the edge of the bottoms, the subsoil is a black, compact silty clay. Lime concretions and also iron stains are common in the lower part of the subsoil. In poorly drained situations the lower subsoil usually is gray, mottled with yellowish brown. A high content of organic matter is characteristic of the surface soil of this type. In sec. 24, T. 1 N., R. 17 E., and sec. 19, T. 1 N., R. 18 E.,

there is a variation of the Wabash silt loam, characterized by the admixture of large quantities of sand. Otherwise the soil is similar to the main type. The higher sand content has given it a somewhat more friable structure.

This type is the most important bottom-land soil in the county and has a total area of 106.7 square miles. It occupies the first bottoms along the Nemaha River and its North and South Forks, Muddy Creek, and along the smaller streams of the county.

The surface is generally flat, with only slight topographic relief where old cut-offs occur. Originally the drainage of this type was poor, but by clearing and straightening the channels of streams the drainage conditions have been very much improved. About 60 miles of ditches have been constructed. Practically all the type is subject to overflow in the spring.

Along the stream channels the type originally was forested with elm, box elder, willow, cottonwood, ash, linden, hackberry, bitter hickory, and black walnut, and a large part of this timber remains. Other parts of the type support a luxuriant growth of marsh grasses. About 60 per cent of this soil is devoted to the production of staple crops, and the acreage in cultivation is rapidly being extended. Corn is the dominant crop, and there are about 6 acres of corn to 1 acre of wheat and oats combined. Higher yields of corn are obtained on this land than on any other soil in the county. The yields ordinarily range from 45 to 55 bushels per acre, but with good cultivation in favorable seasons as much as 90 bushels has been obtained. About one-half the corn is fed and the remainder is sold. Where this soil has been devoted to the production of corn for a number of years, and is well drained, wheat does well, producing from 25 to 30 bushels per acre. Wheat, however, is not grown extensively. Kherson oats do fairly well, yielding from 30 to 40 bushels per acre. The long-straw varieties are likely to lodge. On farms that do not include some upland not enough oats are grown for the feeding of work stock. In well-drained areas alfalfa does well, although very little of this crop is grown. A large area of the type is hay land and pasture. Wild hay yields from 1 to 2 tons per acre. Owing to the fact that this type affords good pasturage and produces good yields of hay, the raising of beef cattle has been more extensively developed than on the upland. No crop rotation is practiced, owing to the high natural productiveness of the soil. In many cases it is reported that fields have been in corn continuously for 10 years or longer. Occasionally is corn alternated with oats or wheat.

The flat topography, silty texture, and desirable structure of this soil make it very easy to handle. In the spots of heavier material there is a tendency for the soil to form hard lumps when cultivated too wet. No barnyard manure or commercial fertilizers are used.

The Wabash silt loam ranges in value from \$125 to \$175 an acre, depending on location and drainage conditions.

The important problem confronting the farmers on this type is that of drainage. The installation of a standard drainage system to remove the excess soil moisture as well as the overflow water is needed. In the better drained situations ditches would serve the purpose, while in the low, poorly drained areas tiles should be laid about 3 rods apart.

#### WABASH SILTY CLAY LOAM.

The soil of the Wabash silty clay loam is a black silty clay loam, ranging from 12 to 15 inches in depth. It grades into a hard, compact silty clay, which does not smooth out, but breaks into small aggregates when crushed between the fingers. The subsoil becomes heavier and denser with depth. At 24 to 30 inches the material is lighter in color, being dark drab, mottled slightly with yellowish brown. The soil as well as the subsoil has a granular structure, a characteristic of soils consisting largely of clay. Locally this type is called "gumbo." The soil is very high in organic matter.

The Wabash silty clay loam is an extensive bottom-land type. It has a total area of 21.2 square miles, and occurs in the first bottoms of the Nemaha River and the North and South Forks of this stream.

The topography is flat to slightly depressed. The drainage is very poor, owing to the impervious character of the subsoil. The type is subject to annual overflow.

The original growth on this type consisted of slough grasses and water-loving plants. Most of the type is in hay land and pasture; about 20 per cent of it is under cultivation. Corn, wheat, and Kherson oats do well, except in wet years. Corn yields 40 to 50 bushels per acre, wheat about 30 bushels, with a maximum of 45 bushels per acre, and Kherson oats about 30 bushels per acre. This soil is particularly well adapted to wheat, owing to its heavy texture. In dry seasons a fairly good quality of wild hay is produced on this type, yielding from 1 to 2 tons per acre, though in wet years the hay is too coarse to be of much feeding value. In very wet seasons crops are practically a failure because of the frequent overflows. Owing to the abundance of pasturage and hay, more live stock is kept on farms of this type than on the upland.

The Wabash silty clay loam is much harder to handle than the Wabash silt loam. Under favorable moisture conditions it granulates and works up into a mellow seed bed, but when worked too wet it bakes and forms intractable clods. The type receives no fertilization of any kind.

This land is valued at \$25 to \$80 an acre, depending largely on the drainage conditions.

The establishment of efficient drainage by supplementing the present ditches with tiles about 3 rods apart is necessary over a large part of the type.

#### WABASH CLAY.

The Wabash clay is a black, waxy, plastic clay, 15 to 18 inches deep, underlain by a dark slate colored subsoil of the same texture. The subsoil becomes lighter in color with depth, and below 30 to 36 inches is gray, mottled with bright yellowish brown. Small iron and lime concretions are encountered in the subsoil. Both soil and subsoil have a granular structure and are very high in organic matter. The soil checks and cracks considerably during periods of dry weather. The Wabash clay is similar to the Wabash silty clay loam, except that it is heavier in texture.

This type is relatively inextensive, and is confined to the southeastern part of the county. It occurs in the first bottom at the mouth of the Nemaha River.

The Wabash clay has a flat to depressed topography and is very poorly drained. The type has been provided with several ditches, although additional laterals are needed to remove the surface water. It is subject to annual overflows, which usually occur early in the spring. It is sometimes inundated in the growing season.

The Wabash clay is largely utilized for pasture land. In dry seasons it furnishes good pasturage, but during wet seasons or when overflows occur little or no pasturage is available. About one-half the cultivated area is in wheat, which in dry seasons produces from 30 to 40 bushels per acre. Corn does well, but is less extensively grown than in former years. It yields from 30 to 45 bushels per acre. The soil is too rich for the production of oats. Wild hay yields from 1 ton to 1½ tons per acre. The hay is mainly fed. Most of the stock raised on this type consists of beef cattle, few dairy cattle being kept.

This is the most difficult soil in the county to handle, and a heavy farm equipment is required. When cultivated too wet it forms clods, though under favorable moisture conditions the soil works up into a mellow seed bed. No fertilizers are used.

The value of this land ranges from \$20 to \$60 an acre, depending mainly on drainage conditions.

This type requires the same treatment as the Wabash silty clay loam. It is greatly in need of drainage.

#### CASS CLAY.

The surface soil of the Cass clay is a dark-drab to black, sticky clay, 6 to 10 inches deep. It is underlain by a drab or gray clay, faintly mottled with brown and rusty brown. In places the mottling is reddish yellow. Below 24 to 30 inches a yellowish-gray mottled with reddish-yellow very fine sandy loam is encountered. This type dif-

fers from the Wabash clay in that it has a sandy subsoil. The soil is high in organic matter.

The Cass clay is inextensive in this county, having a total area of less than 1 square mile. It is encountered in the Missouri River first bottoms, occurring north of Rulo and in the northeastern part of the county.

The surface is generally flat, with a few meandering sloughs. Owing to the underlying light-textured material, this type possesses fair drainage. The sloughs occasionally are inundated.

Practically all this type is reclaimed. It is largely devoted to the production of corn, wheat, oats, and alfalfa. Corn is by far the most important crop, and yields from 40 to 50 bushels an acre. Oats do fairly well, but are likely to lodge. Wheat does well, yielding about 30 bushels per acre. Alfalfa is grown quite extensively with seasonal yields of 3 to 6 tons an acre. Owing to the natural productiveness of this soil, the rotation of crops receives little attention, and the fields usually are planted in corn until an appreciable reduction in crop yields takes place, when some small grain crop is substituted for a few years. Corn, wheat, and alfalfa are cash crops.

This type is difficult to handle, although easier than the Wabash clay. A heavy farm equipment is required for thorough tillage. No barnyard manure is applied and no commercial fertilizers are used.

The Cass clay is valued at \$60 to \$100 an acre, depending on the extent to which it is subject to erosion by the Missouri River.

As on all bottom-land soils there is a general need for the practice of crop rotation on this type.

#### SARPY VERY FINE SANDY LOAM.

As it occurs in Richardson County, the Sarpy very fine sandy loam consists of a light-brown to brown very fine sandy loam to a depth of 10 to 15 inches, containing an appreciable quantity of coarse silt. This is underlain by a yellowish-gray, lighter textured very fine sandy loam which contains but little silt or clay. Below 24 inches the subsoil is mottled with light gray and shows bright yellowish brown iron stains. The low percentage of organic matter is indicated by the light color of the soil.

This type is very inextensive, occurring as small areas in the Missouri River bottoms. It lies usually about 8 feet above the normal flow of the stream. The surface is generally flat, though marked by slight ridges. Between stages of high water, the drainage is good; at high stages of the stream the low areas are overflowed.

The greater part of this type is under cultivation, and is almost entirely devoted to the production of corn. In seasons of favorable rainfall corn does well, yielding from 25 to 35 bushels per acre. Some wheat and oats are grown. Wheat yields 15 to 20 bushels, and oats

30 bushels an acre. Potatoes of good quality are produced on this soil, though the crop is grown only to supply the home demand. Some alfalfa is grown and does fairly well.

The Sarpy very fine sandy loam works up into a very mellow seed bed and can be tilled under any moisture conditions as long as there is no water standing on the surface. Small quantities of manure are added to the reclaimed areas; no commercial fertilizers are used. Land values range from \$30 to \$80 an acre.

For the improvement of the Sarpy very fine sandy loam it is recommended that green crops be turned under to increase the organic-matter content.

#### SARPY SILT LOAM.

Areas of the Sarpy silt loam are indicated on the soil map by inclusion symbols in the Sarpy very fine sandy loam color. The soil of the Sarpy silt loam is a light-brown to brown silt loam, 12 to 15 inches deep, containing a high percentage of very fine sand. The subsoil is a yellowish or brownish-gray very fine sandy loam with streaks of coarser as well as heavier material. The change in color between the soil and subsoil is not marked by a distinct line, although as a rule the lower subsoil is a shade lighter in color and streaked with rusty-brown iron stains. The soil is not nearly so high in organic matter as the Wabash silt loam.

This soil occurs in a single small area east of Rulo in the Missouri River bottoms; it covers 256 acres.

The type is flat, but owing to its sandy subsoil it is well drained between stages of high water. It lies about 8 to 10 feet above the normal level of the river. Owing to the high water table, it is very drought resistant.

Practically all this type is under cultivation, being devoted mainly to corn. This crop does well, yielding from 40 to 50 bushels an acre. Some alfalfa is grown, and this is a very profitable crop.

The value of land of this type ranges from \$80 to \$100 an acre, depending on the extent to which it is subject to erosion by the Missouri River.

For the improvement of the Sarpy silt loam the incorporation of organic matter is needed. Liberal applications of manure should be made.

#### ROUGH STONY LAND.

The areas mapped as Rough stony land consist of land too stony and rocky to permit cultivation. The soil is seldom deeper than 8 inches, and over large areas the bedrock is exposed. What little soil has remained is chiefly a black silt loam to silty clay, underlain by rotten limestone or shale of the Pennsylvanian formation which

vary in color from white to red. In local spots the soil contains some sand and is a loam in texture. Considerable coarse material, such as boulders and gravel, is scattered over the surface. It is probable that most of the soil is derived from the bedrock and not from glacial débris.

Rough stony land is rather extensive in this county. It occurs as small areas mainly in the southwestern part of the county, scattered throughout areas of the Carrington silt loam.

The topography is broken and marked by an intricate drainage system. Along streams the slopes frequently are precipitous. The areas mapped include rock bluffs along streams and occasional low knobs in the higher lying land.

Along the drainage ways most of the Rough stony land supports a scrubby growth of bur oak. The other areas support a fairly luxuriant growth of the prairie grasses common to the region.

This land is used only for grazing. Beef cattle, mainly Herefords, are raised, and are sold chiefly in Kansas City and St. Joseph. Land values range from \$10 to \$40 an acre.

#### RIVERWASH.

Riverwash, as mapped in Richardson County, comprises mainly areas of mud, silty flats, and sand bars in the Missouri River. The material is very light colored and ranges in texture from a clay to a fine sand. A large part of the Riverwash supports a growth of young willows, and is in the transitional stage from Riverwash to soil of the Sarpy series.

There are 2.6 square miles of Riverwash in this county. The surface is only a few feet above the normal level of the river, and the areas are overflowed with slight rises of the stream. The Riverwash changes with each overflow and even during the normal flow of the stream the outlines of the areas are constantly changing. The new deposits are considerably modified by wind action, and in stormy days form dust clouds.

#### SUMMARY.

Richardson County lies in the extreme southeastern corner of Nebraska, bordering the Missouri River. It has an area of 545 square miles, or 348,800 acres.

The topography varies from gently unquating to steeply rolling or broken, though most of the area is rolling. The elevation of the county above sea level ranges from 850 to 1,220 feet. The greater part of the area lies between 1,000 and 1,100 feet above sea level. The general slope of the county is southeastward. All sections are provided with adequate surface drainage by a complete system of drainage ways belonging to the system of the Nemaha River, an important tributary of the Missouri.

According to the census of 1910, Richardson County has a population of 17,448 of which 81.3 per cent is classed as rural. The principal town is Falls City, the county seat. The transportation facilities, except in the northeastern corner of the county, are good. In general, the county is provided with excellent dirt roads. Kansas City, St. Joseph, and Omaha are the principal markets. All parts of the county are provided with rural mail delivery and telephone service and good schools.

The climate of Richardson County is pleasant and is well suited to agriculture. There is an average growing season of about 170 days. The mean annual precipitation is about 33 inches, and the mean annual temperature about 53° F.

Grain farming is the main type of agriculture. Corn, oats, wheat, timothy and clover mixed, alfalfa, and wild grasses are the principal crops, ranking in acreage in the order named. The raising of hogs and beef cattle and dairying are important industries. The farm buildings are substantial and the surroundings present an appearance of thrift and prosperity.

Systematic crop rotations are not practiced. Only small quantities of barnyard manure are applied, and scarcely any commercial fertilizers are used. There is an abundance of farm labor, but it is hard to obtain efficient help. Most farms consist of 160 acres, though the average size is reported in the 1910 census as about 158 acres. About 53 per cent of the farms are operated by the owners, and practically all the remainder by tenants. About 95 per cent of the area of the county is reported in farms and of the land in farms 86 per cent is reported improved. The value of farm land ranges from \$20 to \$200 an acre. Land is rented mainly by the share system. Cash rents range from about \$3 to \$6 per acre.

The county lies almost entirely within the Glacial and Loessial region, with only a small area belonging to the River Flood Plain province. The soils of the Glacial and Loessial region are derived from the weathering of the loess and drift. The loess material has given rise to the Marshall, Grundy, and Knox soils and the drift to the Carrington and Shelby soils. The second bottoms are occupied by the Waukesha soil. The recent deposits along the streams are classed with the Wabash, Cass, and Sarpy soils, and Riverwash.

Small areas closely associated with the drift have been formed through the disintegration of the shales and limestones of the Pennsylvanian formation. This material is classed with Rough stony land.

The Marshall silt loam is one of the extensive soil types in Richardson County. It is well suited to the production of corn, oats, wheat, and hay. The utilization of the Grundy silt loam is similar to that

of the Marshall. The Knox silt loam is chiefly devoted to corn and alfalfa, as it is too hilly for the production of the small grains.

The Carrington silt loam is by far the most extensive and important type of soil in the county. This soil, together with the Marshall silt loam, dominates the agriculture of the county. The Shelby loam and Rough stony land are best used for pasture.

The Waukesha silt loam is well adapted to corn, oats, and wheat.

The bottom-land soils are best suited to corn, though considerable hay and some wheat and oats are produced.



[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



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