Issued June 10, 1915.

U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF SOILS—MILTON WHITNEY, Chief.

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

SOIL SURVEY OF SAUNDERS COUNTY, NEBRASKA.

BY

A. H. MEYER, E. H. SMIES, AND T. M. BUSHNELL, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND R. R. SPAFFORD, R. R. BURN, AND R. J. SCARBOROUGH, OF THE NEBRASKA SOIL SURVEY.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1913.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE,
1915.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., November 2, 1914.

SIR: During the field season of 1913 a soil survey was made of Saunders County, Nebr. This work was done in cooperation with the University of Nebraska and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area, and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1913, as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

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

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SOIL SURVEY OF SAUNDERS COUNTY, NEBRASKA.

By A. H. MEYER, E. H. SMIES, and T. M. BUSHNELL, of the U. S. Department of Agriculture, and R. R. SPAFFORD, R. R. BURN, and R. J. SCARBOROUGH, of the Nebraska Soil Survey.

DESCRIPTION OF THE AREA.

Saunders County is located in eastern Nebraska, in the second tier of counties west of the eastern boundary. It is bounded on the north and east by the Platte River, on the south by Cass and Lancaster Counties, and on the west by Butler County. From north to south the county is 28 miles wide, and its greatest length from east to west is 32 miles. It comprises 761 square miles, or 487,040 acres. The eastern limit of the county is 24 miles from Omaha, the metropolis of the State; the southern but 14 miles north of Lincoln, the State capital.

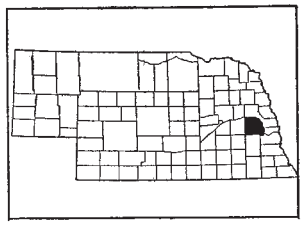

FIG. 1.—Sketch map showing location of the Saunders County area, Nebraska.

Saunders County lies in the Glacial and Loessial and River Flood Plains Provinces. There are three distinct topographic divisions: (1) The uplands, derived from loessial and glacial material; (2) the alluvial terraces, deposited at a time when the streams were flowing at a higher level; and (3) the first-bottom lands, embracing the recent alluvium of the Platte River and its tributaries.

The upland occurs in two distinct areas separated by an old valley of the Platte River, which has been given the name of Todd Valley[1] by Condra. The smaller area, a roughly ovate body about 20 miles long and 6 miles wide, occurs in the northeastern part of the county. At the northern end of this region it grades into a small plain which is an outlier of the Loess Plains proper, so well shown in Butler County on the west. The remainder of the upland east of Todd Valley is rolling to steeply rolling. The slope between the upland and high terraces is fairly gentle, while that between the upland and Platte River first bottoms is very steep to precipitous. As the Platte River elbows around this body of upland it hugs very close to the bluff line, and in places it cuts sharply against the upland region. The highest point of this outlier is 1,360 feet above sea level on the remnant of the Loess Plains, or about 160 feet above the Platte River.

[1] Journal of Geology, June, 1903.

The main body of the upland is west of Todd Valley, occupying the western and southwestern parts of the county, which are rolling to steeply rolling and have a distinct drift-hill topography. Northeast of Prague and north of Malmo this topographic feature gives way to a more gently rolling topography, and the same is true of a zone from 3 to 4 miles wide along Wahoo Creek below Wahoo. To the north of Plasi it merges into a steeply rolling to hilly zone, about 5 miles wide, extending along the western county boundary line. The transition from the upland to the first bottoms of the Platte River varies from a very steep slope immediately west of Morse Bluff to a rather wide dissected zone in the extreme northwestern part of the county. North of Wahoo the transition from the upland to the first bottoms is a very steep slope. Elsewhere there is a rather gentle slope through the second terrace to the first bottoms.

The alluvial terraces or benches of Saunders County may be divided into a higher or second terrace and a lower or first terrace. With the second bench is included Todd Valley, which is practically of the same elevation as the remnants of terrace along the larger streams. This valley varies from 6 to 8 miles in width, and its greatest length is about 30 miles. It leaves the Platte River first bottoms between Morse Bluff and a point where the Chicago & North Western Railway crosses the Platte River and extends in a southeasterly direction for about 20 miles, opening into the Platte River first bottoms again between a point 4 miles south of Yutan and Ashland. Todd Valley has a gently rolling to undulating topography and contains numerous marshy depressions and small knobs. It is evidently an abandoned valley of the Platte, as with the exception of Silver Creek, which may roughly suggest an old channel of the Platte River, there are no streams in the region, though a few large ones from the upland region have sought their way to the Platte River along the edge of this old valley. Where Todd Valley leaves the Platte River Valley proper it is about 60 to 100 feet above the latter, and where it enters again it is from 20 to 40 feet above. The old valley slopes to the southeast and has an approximate gradient of 7 feet to the mile.

The second terraces along the Platte River begin at Leshara and continue as narrow, disconnected areas until Todd Valley is reached. At Leshara they extend back for a distance of 2½ miles along Otoe Creek. About 2½ miles north of Yutan a second terrace leaves the Platte River Valley and joins the terraces along Upper Clear Creek, only to reconnect with the second terraces along the former stream. Another system of second terraces, which are at about the same elevation as those of Todd Valley, exists in the southeastern corner along Salt Creek. Remnant terraces of Todd Valley are found along

Silver Creek and Wahoo Creek, below Wahoo. Above Wahoo definite terraces of the same height as the second benches extend along Wahoo Creek as far back as Weston. Corresponding terraces are found along Oak Creek at Valparaiso, along Rock Creek west of Ceresco, along North Fork Rock Creek about 5 miles east of Ceresco, and along Dunlap Creek and Miller Branch. The first terraces are about 15 to 20 feet above the first bottoms and have a very small distribution in the Platte River and Salt Creek Valleys. In the northwestern part of the county, skirting the bluff line, is a colluvial bench whose front has been cut away by the Platte River. This bench has an appreciable slope toward the latter stream. The next first terrace along the Platte River occurs 3 miles south of Yutan. This bench level also occurs in several places in the southeastern part of the county. The largest of these is found at Ashland and extends along Wahoo Creek for about 3 miles. A number of smaller ones are found along the Salt Creek bottoms and one along the Platte River bottoms in the extreme southeastern corner. An outlier is found about a mile northeast of Ashland and a low bench at the southeast point of Todd Valley about 2 miles north of Ashland. Both the first and second terraces are rather narrow and possess a distinct benchlike topography, though in places streams from the upland have cut drainage ways through them. The higher bench immediately east of Ashland is rather gently rolling and possesses all the characteristics of Todd Valley in having on it poorly drained areas and knoblike elevations.

The first bottoms are rather extensive in Saunders County, covering about one-sixth of the total area. The largest area occurs along the Platte River, varying in width from a fraction of a mile to 4 miles. The next largest area is along Wahoo Creek and its tributaries. A considerable body lies in Salt Creek Valley in the extreme southeastern corner of the county and along the tributaries of this stream in the southern and southwestern parts. The topography of the bottom land is flat, though broken slightly in places by minor depressions, ox-bow lakes, cut-offs, old channels, overflow channels, and sand ridges. In the northwestern corner of the county the Platte River first bottom is about 1,300 feet above sea level, while in the southeastern corner it is about 1,060 feet above, this being the lowest point in the county. The highest points in Saunders County, about 1,620 feet above sea level, are in the western and northwestern part of the upland region. The range of elevation is approximately 540 feet.

Saunders County is drained by three important systems—those of the Platte River, Wahoo Creek, and Salt Creek. The Platte River borders the county on the north and east. It is a broad, shallow, overloaded stream, characterized by numerous sand bars and low

sand islands. Only a small portion of the county drains directly into it. By far the greater area is drained by Wahoo Creek, which extends in a southeasterly direction across the center of the county. The Salt Creek drainage system is confined to the extreme southeastern and southern parts and the southwestern corner of the county. The general direction of the drainage in Saunders County is to the southeast.

The first permanent settlement in the region now embraced in Saunders County was made in 1856 in the vicinity of Ashland. The county was organized in 1867,[1] and after several changes in the boundaries they were fixed as they exist at the present time by an act of the legislature approved in 1875. The county seat was changed from Ashland to Wahoo in 1873. Most of the first settlers came from Illinois, Missouri, Iowa, and the Eastern States. The population increased rapidly between 1865 and 1870, when many German and Swedish immigrants came in. The Germans settled in the northern and northeastern and to some extent in the southern parts of the county. The Swedes settled in the south-central part and the southwest corner. Some Bohemians, who came a little later, settled a portion of the western and northwestern parts. Besides these quite a number are of Irish, English, and American descent. The population of the county increased appreciably until 1900, but between 1900 and 1910, according to the census reports, it decreased from 22,085 to 21,179.

Wahoo, the county seat, with a population of a little over 2,000, lies practically in the geographical center of the county. It is located at the junction of three railroads, in a rich agricultural section at the edge of Todd Valley, and is noted as a distributing point for farm implements and supplies. Ashland, with a population of 1,379, and Cedar Bluffs, population 600, are towns of next importance. There are many small villages situated along the railroads in different parts of the county.

Saunders County is well supplied with railroads, few points being more than 8 miles from a railroad station. The Manhattan branch of the Union Pacific Railroad reaches out from Valley, across the Platte River, traversing the county in a southwesterly direction. From Valparaiso the Central City branch of the same system extends into Butler County. The Chicago & North Western Railway (Lincoln branch) crosses the central part of the county almost due north and joins the Hastings line of the same system at the Platte River railroad bridge. The Hastings line of the Chicago & North Western Railway enters the Platte Valley in the northwestern part of the county and extends eastward until it joins the Lincoln branch.

[1] Bul. of the Bureau of Labor and Industrial Statistics, Lincoln, 1902.

A main line of the Chicago, Burlington & Quincy Railroad crosses the extreme southeastern corner of the county through Ashland, from which point another main line of the same system extends eastward to Plattsmouth. From here also the Schuyler line extends northwest and the Sioux City branch north across the county.

The county has a transcontinental wagon road—the Omaha, Lincoln, and Denver road—which crosses the southeastern corner. Most of the public roads follow section lines or land lines. All are dirt roads, and little attention is given to the upkeep of the minor roads. The more important highways are dragged as soon as the ground permits after each rain, and are thus kept in a smooth condition. There are four long bridges across the Platte River—at Morse Bluff, 5 miles northeast of Cedar Bluffs, Leshara, and Ashland. There are no toll roads, though toll is charged at the Platte River bridge at Ashland.

Direct railroad lines between the county and Omaha and Lincoln make these places the leading markets for the products of the county. Omaha and South Omaha take practically all the general farm products. Omaha, Lincoln, and Fremont furnish good markets for the dairy products.

Rural free delivery routes and telephone lines reach nearly all sections of the county.

CLIMATE.

The mean annual rainfall of Saunders County is 30.21 inches, of which from 75 to 80 per cent occurs during the growing season, from April to September, inclusive. About 47 per cent falls during the three months of May, June, and July, with the maximum during July. The normal precipitation for the driest months—November, December, January, and February—is about three-fourths inch per month.

Most of the rainfall in the summer months comes in the form of thundershowers, and the precipitation is very heavy within short periods of time. Somewhat more than half of the total rainfall of May, June, and July occurs in amounts of 1 inch or more in 24 hours. In a few instances 5 or 6 inches of rain has fallen within 24 hours. The rainfall in May and June is usually well distributed and drought periods during these months are almost unknown. In July the distribution is not quite so favorable, though on the average rain falls about every four days during the months of May, June, and July. During August and September there is considerably less rain than during the three preceding months, and the distribution is not nearly so favorable. Occasionally long droughts occur in the months of July, August, and September.

The average annual snowfall is about 20 inches. The snow seldom stays on the ground long.

The mean annual temperature is 50.9° F. January and February are the coldest months, with a mean temperature of 23.8° F. July is the warmest month, with a mean temperature of 76.2° F., though August is only 1.5° cooler. The coldest day recorded in the county was —33° F. and the warmest day 109° F., at Ashland.

The average date of the first killing frost in the autumn is October 5 and of the last in the spring April 27. The date of the earliest recorded killing frost in autumn is September 12 and of the latest in spring May 19. There is a growing season of 161 days, which is long enough to mature the ordinary farm crops grown in the county.

The prevailing direction of the wind for the average year is from the northwest. During the months of June, July, and August it is from the south or the southeast and from the middle of September to the middle of May from the northwest. Tornadoes, while uncommon, sometimes do damage, as in the case of the one that swept across the county in 1913.

According to the Weather Bureau station at Omaha, the average relative humidity for eastern Nebraska is quite regularly near 70 per cent, although in the afternoons during spring and summer it is sometimes below 20 per cent. The relative humidity is about 17 per cent lower at 8 o'clock in the evening than at 8 o'clock in the morning. On the average there are 170 to 180 clear days and 80 to 90 cloudy days, the remaining days of the year being partly cloudy.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded at the Weather Bureau station located at Ashland, Nebr.

Normal monthly, seasonal, and annual temperature and precipitation at Ashland.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	27.7	69	—26	0.68	0.72	0.50
January	23.9	65	—32	0.59	0.26	0.58
February	23.8	80	—33	0.73	0.72	0.30
Winter	25.1	.....	.....	2.00	1.70	1.38
March	38.2	91	—14	1.14	0.62	2.19
April	52.3	95	12	2.70	2.01	3.15
May	62.6	100	26	4.39	0.92	3.54
Spring	51.0	.....	.....	8.23	3.55	8.88

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

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
June	71.5	104	41	5.01	5.03	4.52
July	76.2	109	49	5.08	0.61	11.79
August	74.7	105	40	4.05	0.12	5.50
Summer	74.1	.....	.....	14.14	5.76	21.81
September	67.2	103	23	2.85	0.52	4.33
October	54.9	97	15	2.23	2.52	6.05
November	38.8	80	−14	0.76	0.25	0.22
Fall	53.6	.....	.....	5.84	3.29	10.60
Year	50.9	109	−33	30.21	14.30	42.67

AGRICULTURE.

The early settlers in the present territory of Saunders County produced only such crops as were required to supply the home needs. Wheat was the first money crop. It was not until 1869 that much corn was produced beyond what was needed for home use. The extension of the Union Pacific Railroad in 1870 through Saunders County gave a great impetus to agricultural development. From that time more attention was devoted to corn, and it soon became the leading money crop. From 1870 to 1880 some broom corn and flax were grown. The latter was soon discontinued, as it was less profitable than other crops. Broom corn never became a very important crop on account of the large amount of labor required in its production.

By 1880 corn had become the most important crop in the county, wheat being a very close second. Immediately after that date spring wheat began to decline in importance and hay became the second crop in point of acreage. Some of the hay was fed at home, but most of it was sold. Oats were not grown very extensively, being chiefly fed on the farms. According to the census of 1880, there were 87,501 acres in corn, 75,676 in wheat, 12,727 in oats, 18.137 in hay, and 2,524 in barley.

The early methods of farming practiced in the county were very crude and wasteful, no attention being given to the proper cultivation of crops, seed selection, crop rotation, or fertilization. As a result the soil became impoverished and crop yields declined. When the reduction in yields and the cause thereof became apparent the

system was gradually improved, until at the present time the farmers give more attention to crop rotation, exercise considerable care in the selection of seed, and increase the nitrogen content of the soil by sowing alfalfa and other legumes.

As in eastern Nebraska generally, grain growing is the chief type of farming followed in Saunders County, although dairying and the raising of hogs and other live stock are not by any means neglected. Corn, oats, wheat, wild hay, alfalfa, and clover are the principal crops grown and rank in acreage in the order given.

Although the production of corn has decreased since 1900, owing to the increased production of small grains, hay, and alfalfa, it is still by far the most important crop of the county. According to the census, 177,454 acres were devoted to this crop in 1909, as against 213,281 acres in 1899. It is grown on all the soil types of the county, doing best on the silt loam soils, although fair returns are obtained from lighter textured soils. The ordinary yields for 1909 were slightly more than 32 bushels to the acre. Both the yellow and white dent varieties are grown.

Most of the corn is listed, some is check rowed, and in a few cases it is "double listed" with good results. The loose lister machine has only been used to a small extent.

At present the greater part of the crop is sold, although a large and increasing percentage is fed to hogs and beef cattle. On farms with silos a large part of the corn is cut for silage, otherwise only the grain and the finer parts of the stalk are utilized. Ordinary field corn is used for ensilage, but it is planted thicker than usual and is harvested about the middle of September. It is the general practice to pasture corn land after the ears have been removed. On many fields corn is grown four or five years in succession and in some cases 20 years or more.

The growing of oats is steadily increasing. In 1909 there were 68,468 acres devoted to the production of this crop. It does well on all the tillable soil types except on the bottom lands, where it is apt to lodge. Kherson oats, a very short, stiff-strawed variety, have given excellent results on the bottom lands. The ordinary yield is only 24 bushels per acre—much below what it should be with proper farm management.

As a rule oats follow corn in the rotation and are very seldom sown more than one year in succession. Most of the crop is fed to horses and other live stock, though part of it is sold.

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 replaced the spring varieties, owing to the fact that it is a better yielder, can be sown in the fall, a time of the year when it does not interfere with other farm labor, and ma-

tures before the dry weather and hot winds come on. It is grown with profit on all the soil types except the more broken areas of the Knox silt loam, the Shelby loam, light-colored phase, and the Lancaster fine sandy loam, which are too steeply rolling for grain production. As a rule, wheat is grown 2 to 4 years in succession following oats. Where corn is cut for silage wheat follows corn and does excellently. It is strictly a cash crop, and is usually sold directly from the thrashing machine. According to the census, there were 45,799 acres devoted to wheat in Saunders County in 1909.

The acreage of wild hay in the county is quite large, owing to the extensive areas of unreclaimed bottom land. Most of the wild hay is grown on the Platte River, Wahoo, and Salt Creek bottoms, and in depressed areas of Todd Valley; only a few acres of upland remain in virgin prairie. Within the last few years a good deal of land has been reclaimed by ditching and tiling, and consequently the acreage of wild hay has been considerably reduced. There is no doubt that in a few years most of the wild hay land, except on the lower lands along the Platte River, will be broken up and devoted to the production of farm crops. The ordinary yield of hay for the county is 1½ tons per acre. Most of the crop is stacked in the fields, and if intended for market is pressed into bales and hauled to town as soon as time permits. If kept for feed it is usually hauled from the stacks as needed. A number of farmers living on the upland own small hay lots on the bottom land, and where such is the case most of the hay is fed to live stock. In 1909 there were 27,987 acres in wild, salt, or prairie grasses.

The growing of alfalfa has passed beyond the experimental stage, and this promises to be the principal hay crop of the future. In 1909 there were 3,312 acres in alfalfa, while in 1899 there were only 67 acres devoted to the crop. It does excellently on the upland and well-drained bottom lands, 3 and some times 4 cuttings being obtained each year, with a yield ranging from 3 to 5 tons per acre. Alfalfa is chiefly grown on the Marshall, Shelby, and Waukesha silt loams and the higher lying areas of bottom land. Most of the crop is fed to cattle and horses, and some is used as hog pasture. It is usually sown after a wheat crop and is left in the same field from 5 to 7 years.

Very little clover is grown in the county, owing to the fact that it has been almost impossible to obtain good seedings. On the average very little rain falls from the middle of July to the middle of September, and on this account the delicate clover plants are subjected to extremely hot winds and sometimes to long droughts after the nurse crop has been removed. If rain falls at the critical time immediately after the cutting of the grain, clover does well and produces from 1½ to 2½ tons per acre. As a rule clover and timothy are sown together

in the proportion of 1 to 2. For the last 4 years the crop has been practically a failure. According to the census, there were 957 acres in clover, 655 in millet and Hungarian grasses, and 203 in other tame grasses in 1909.

The less important crops of Saunders County are potatoes, barley, rye, sorghum, and buckwheat. Most farmers plant a few potatoes, but as a rule not enough for home consumption. In 1909 the average yield of potatoes was 95 bushels per acre. Barley and rye were rather important crops in 1879, but in 1909 the acreage had dwindled to 110 and 441 acres, respectively. Only a few acres are devoted to the production of buckwheat and sorghum, and they scarcely deserve mention.

A small acreage in the Platte River bottoms is devoted to the production of seed crops. Pumpkins and sweet-corn seed are grown with profitable results on the Cass very fine sandy loam. Pumpkins yield ordinarily 300 pounds of seed per acre and sweet corn 20 to 25 bushels. These are produced on contract. In Douglas County, where the soils are quite similar to those of Saunders County, the seed industry has been extensively developed on the Platte and Elkhorn River first bottoms.

The trucking industry in Saunders County has not been given much attention, owing to the distance from markets. Some vegetables are grown on a commercial scale around the cities and villages of the county.

Most of the farms have small orchards containing apple, plum, and pear trees, which, when properly cared for, produce a fairly good quality of fruit. Usually, however, the orchards are neglected and many of them die. A few vineyards were seen during the progress of the soil-survey work, and where the air circulation and the slope of the land were favorable profitable crops were grown.

Dairying, in conjunction with general farming, is gradually being extended. There is very little pure-bred dairy stock in the county, though the graded Holstein is coming more into favor. Most of the farmers keep scrub dairy cows of Shorthorn breeding. The average number of cows per farm is about 6, while on a few farms as high as 15 are kept. Most of the cream is separated on the farm. The surplus cream is shipped to Omaha, Fremont, or Lincoln, or is marketed in the home towns. The average price obtained for butter fat in the summer is 25 to 28 cents per pound and in the winter 30 to 32 cents per pound. A few farmers ship their milk to Omaha.

There are only a few large herds of beef cattle in Saunders County, and most of these are on the poorly drained areas of the bottom lands. Some farmers have obtained profitable returns from the feeding of beef cattle purchased at stockyards. A few head are sold every year from most farms. More of the beef cattle are of Shorthorn breed

than any other, though a number of herds of polled cattle were seen during the survey.

A great deal of attention is paid to the breeding of farm and draft horses. Nearly every farmer raises one or two colts a year and in this way supplies his own work stock and frequently has a team to sell. The Percheron is the favorite breed, although quite a few Clydesdales are to be seen. Some mules are raised also.

There are only a few flocks of sheep in the county. The raising of hogs is the most important live-stock industry. Nearly every farmer fattens from 30 to 50 hogs a year. On a few farms all the corn produced is fed to hogs. Usually the profit in pork production is good. Duroc Jersey, Poland China, and Chester Whites are the leading breeds, though there are very few pure-bred herds.

Practically every farmer in the county keeps a small flock of chickens ranging from 40 to 150 in number, and on many farms, especially in the western part of the county, there is also a small flock of ducks and geese. Leghorn, Barred Rock, Rhode Island Red, Orpington, and Wyandotte are the important breeds. The high prices of eggs and dressed poultry have made poultry raising very profitable.

Very little attention has been paid to the adaptation of crops to soils, though there is a tendency to correct this defect in farm management. Practically all of the general farm crops common to this region are grown upon most of the soil types.

Definite systems of rotation are followed by only a few progressive farmers. The general tendency is to keep the land in corn for 2, 3, or 4 years, following it with 1 year of oats and from 1 to 3 years of wheat. Occasionally the wheat land is seeded to clover for 2 years, when it is planted to corn. It is not unusual to plant corn or wheat on the same field for 15 years or more. Of late alfalfa has been quite extensively introduced into the rotation. It usually occupies the land from 5 to 7 years. A good rotation followed to some extent is: Corn, 2 years; oats, 1 year; wheat, 1 to 2 years; and clover and timothy, 2 to 3 years. Owing to the great difficulty experienced recently in getting a stand of clover, it has been dropped from the rotation and alfalfa is taking its place. On farms where there is no permanent pasture clover and timothy are usually pastured the second year.

Not enough attention is given to the proper cultivation and fertilization of most of the crops in the county. Stubble is almost universally plowed in the fall either for winter wheat or corn. Corn land is usually listed and sometimes double listed, where corn succeeds corn. If it is put into oats the land is either disked twice or the oats are sown between the rows and covered with a cultivator. Variations and modifications of the above practices are very common.

The barnyards are usually cleaned twice a year—in the fall and in the spring. As a rule the manure is put on the wheat land, though some is used on corn land. The plowing under of green crops is not practiced, nor are commercial fertilizers used to any extent. According to the census report, the expenditure for fertilizers in 1909 was but $296.

As a rule, the farm improvements in Saunders County are good. The farm buildings, especially the houses, are painted and kept in good repair, and in general the farmstead gives the impression of thrift and prosperity. Most of the fences are of barbed wire. Woven-wire fences are also encountered. Hedges are common on the farm boundaries. Most of these consist of Osage orange, and black locust is also used.

Farm labor is rather scarce, especially during the harvest season, although enough help is usually obtainable to do the farm work. The usual wage paid is $25 to $35 a month, with board and washing. Most of the laborers are hired from April 1 to December 1, though a large number of farmers are beginning to employ labor by the year, because by so doing it is easier to get efficient men. The daily wage for transient labor during the harvest time ranges from $2 to $3 per day, with board. Most of the work, however, is done by the farmer and his family, and it is not uncommon to see women and children doing the lighter work in the fields.

There are approximately 464,526 acres in farms in Saunders County, of which 433,119 acres are improved. The average size of farms is 166.1 acres.[1] Since 1880 the average size of farms has increased 32.1 acres. Only 61.1 per cent of the land is operated by the owners, the remainder being largely worked by tenants. Both the cash and share systems, as well as a combination of the two, are practiced, the share system being the more prevalent. Cash rents vary from $3 to $6 per acre for general farming, depending on the kind of soil. On the reclaimed muck soils $10 an acre is obtained. In case of share renting, the owner gets two-fifths of the crops produced, the tenant furnishing all implements and stock. Where land is rented on half shares the owner furnishes all tools and the work stock. In the combination system of cash and share renting the permanent pasture and land not used for crops are rented for cash and the grain and hay land on shares. In each system of renting the tenant is required to deliver the grain at the elevator.

In 1900 the average value of all farms and improvements except buildings was $33 per acre, and in 1910 it had risen to $89 per acre. Farm land ranges in value from $30 to $200 an acre, depending on the kind of soil, improvements, and location.

[1] Each tenancy is tabulated as a farm by the census.

SOILS.

Upon the basis of physiographic position the soils of Saunders County may be divided into three groups—upland, terrace, and first-bottom soils. The upland group embraces the Knox, Marshall, Shelby, and Lancaster series; the terrace group the Waukesha, Sioux, and Scott series; and the first bottoms the Cass, Wabash, and Sarpy series and Riverwash.

In texture most of the upland and terrace soils are silty, while those of the bottom lands vary from a loose, incoherent sand to heavy clay. With the exception of the Knox and Lancaster series, the Shelby loam, light-colored phase, and recently deposited soils along the Platte River, the soils are dark in color and contain a relatively large quantity of organic matter.

In connection with the origin of these various types of soil the structure and geology[1] of the county are of interest. The upland was originally covered with a fairly thick mantle of Plains loess, which through a long period of erosion has been almost worn away. Few remnants of this covering are left in the county. The largest of these is found northeast of Cedar Bluff on an outlier of the upland region. A few caps are also encountered southwest and northwest of Prague. Where typically developed the loess was mapped as the flat phase of the Marshall silt loam. The areas where erosion has removed considerable of the original loess but which still retain loess characteristics have given rise to the Marshall and Knox series. Along the bluff line of the Platte River the loess has been modified by material blown upon it 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 impregnated with lime and blotched with iron stains.

Below the Plains loess lies the weathered phase of the Kansan drift, which has given rise to the Shelby silt loam type. It is rather difficult to differentiate between the loess and the weathered phase of the Kansan drift. The latter is a yellowish or pale-yellow to light-gray, smooth, silty material, containing numerous lime concretions and iron blotches. It has a vertical structure and is practically stone free, though searching will disclose a few large sand grains and small cobblestones. The soil derived from the weathered phase is heavier in texture, breaks down into granules, and does not stand up in vertical banks nearly as well as the soils derived from the true loess. In the fourth foot of the subsoil there is no apparent difference, except for occasional stones between the two formations. There is no line of demarcation between the loess and weathered drift, and

[1] Unpublished manuscript of Dr. G. E. Condra.

they grade imperceptibly into each other. As a result large areas of loesslike material which possess both the characteristics of loess and drift are encountered, and such areas were mapped as the soil which predominated. The drift which gives rise to the Shelby silt loam occurs in the southwestern and western part of the county. The areas in which the loess characteristics predominate occur northeast of Malmo and on the upland belt along the Wahoo Creek below Wahoo. On the other upland areas there are only small spots which show drift characteristics.

Below the Loveland (weathered) phase of the Kansan 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. Undoubtedly the weathered phase has been so much altered by wind action that it has lost much of its drift characteristics and has assumed more of the properties of the loess. The Kansan sheet is distinctly till and consists of a heterogeneous mass of clay, silt, sand, gravel, and bowlders. The upper oxidized zone varies in color from yellowish brown or brown to reddish brown. Below the oxidized zone the drift sheet changes to a light-gray or pale-yellow color and has numerous iron stains. This drift sheet has given rise to the Shelby loam.

The Aftonian material lies below the Kansan drift and consists largely of stratified sand and gravel with a few bowlders. It crops out in a number of places in the county. In the southeastern corner of the county it produces a small area of fine sandy soil which is included with the Lancaster fine sandy loam.

The lowermost drift sheet, underlying the Aftonian, consists of a blue clay containing numerous small pebbles and a considerable number of bowlders. It is exposed only in deep-cut banks.

Below the thick covering of mantle rock is the Dakota formation of the Cretaceous age, the bedrock of the area. It consists of rusty colored sandstone and locally of shale. The Dakota sandstone is exposed in the southeastern corner of the county and along North Fork Rock Creek and gives rise very locally to the Lancaster fine sandy loam. This formation rests upon the Pennsylvanian beds of the Carboniferous age, which are exposed in the bluff zone in the extreme southeastern corner of the county. It consists of beds of limestones and shales.

The bench soils of Saunders County consist of first and second terraces. The second terrace includes Todd Valley and is of later age than that of the Plains loess, while the first terrace is of still more recent origin. Along the major streams and Todd Valley the valley loess, varying in thickness from less than a foot to about 30 feet, is underlain by a basal material consisting of light-gray alluvial

sand and gravel. From the loess covering is derived the Waukesha silt loam and the Scott silt loam, while from the basal material is derived the Sioux fine sandy loam.

In the upland region the cross-section of the alluvium shows largely stratified clays and silts, owing to the uniformity of wash, though in places it has received wash of coarser material from the Kansan drift. On the Platte River bottoms and at the mouth of Salt and Wahoo Creeks the upper part of the alluvial deposits consists largely of alternate layers of stratified clays, silt, and different grades of sand and the lower portion of alternate layers of sand and gravel, with an occasional layer of clay. The alluvial deposits in the upland region and in Todd Valley have given rise to the Wabash series, and the alluvium along the Platte largely to the Cass series and to a smaller extent to the Sarpy and Wabash series and Riverwash.

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

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Shelby silt loam	133,120	27.3	Riverwash	3,584	0.7
Marshall silt loam	114,112	23.7	Wabash clay	3,328	.7
Flat phase	1,216		Sarpy fine sand	2,880	.6
Waukesha silt loam	103,936	21.3	Scott silt loam	2,496	.5
Wabash silt loam	64,640	13.8	Sioux fine sandy loam	2,432	.5
Colluvial phase	2,176		Cass loam	1,472	.3
Shelby loam	16,320	3.6	Wabash loam, colluvial phase	704	.1
Light-colored phase	1,024		Lancaster fine sandy loam	512	.1
Cass fine sandy loam	14,016	2.9	Muck	512	.1
Cass very fine sandy loam	7,232	1.5			
Cass silt loam	6,272	1.3	Total	487,040	
Knox silt loam	5,056	1.0			

MARSHALL SERIES.

The Marshall soils are dark brown to black, overlying yellowish-brown subsoils, usually calcareous. This series includes the dark-colored loessial soils occurring along the Missouri River in a belt about 50 miles wide extending from western Missouri northwestward. 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.

MARSHALL SILT LOAM.

The soil of the Marshall silt loam is a dark-brown to black, moderately heavy silt loam, 12 to 15 inches deep, underlain by a brown or yellowish-brown very heavy silt loam, which, at a depth of 20 to 24 inches, rests on a yellow, very compact silty clay loam. At 30 to

36 inches a yellow mottled with light-gray silty clay is encountered, though it is not uncommon for the yellow color to extend to a depth of 26 to 40 inches. At depths ranging from 32 to 40 inches the subsoil becomes looser and appears more like a silt loam again. The subsoil is highly calcareous, the lime existing chiefly in the form of concretions varying in size from that of a small pebble to that of a hen's egg. Faint markings of yellowish or brownish iron oxide occur in the 3-foot section, becoming very pronounced at greater depths. A high percentage of organic matter gives this soil its characteristic dark color. The depth of the soil is variable and depends upon its topographic position. On rather flat divides it is usually 15 to 18 inches deep, while on the sharp divides, shoulders of hills, and along gullies it is only 6 to 8 inches deep and often the yellowish-brown subsoil is exposed. On slopes the soil becomes darker in color and deeper, and at the foot it is not uncommon to find it extending to a depth of 24 to 40 inches. Included with this type are small, narrow strips of colluvial material occurring along intermittent streams, which were not extensive enough to map. It also includes along shoulders of hills and along small gullies spots of Knox silt loam, which were likewise too small and patchy to justify mapping. As erosion goes on the tendency will be to remove more of the dark soil and increase the extent of the Knox silt loam.

The Marshall silt loam differs from the Knox silt loam in that it has a darker color, a higher organic-matter content, and a smoother topography. Both soils have the vertical structure and extremely smooth feel which are so characteristic of loess soils.

The Marshall silt loam is derived from the eroded Plains loess which at one time capped the entire county. The area southeast of Wahoo is really a transitional area between the Shelby silt loam and the Marshall silt loam, being mapped as the latter because it possesses the stronger loessial characteristics. The other areas, except locally and along the edge of the Shelby silt loam, do not possess any strong glacial characteristics. Owing to the difficulty of distinguishing between the loess and loesslike drift, it was exceedingly difficult to draw a satisfactory boundary line between the Shelby silt loam and the Marshall silt loam, and small areas of Marshall silt loam occurring in the Shelby type or vice versa could not be shown.

This type is next to the Shelby silt loam in extent in Saunders County. The largest area occurs in the northeastern part of the county, where it forms practically the only soil on the upland outlier. The next largest area is found in the northwestern part of the county, and another large one occurs along the south side of Wahoo Creek, below Wahoo. The small area occurring in the extreme southeast corner of the county joins the Marshall silt loam in Cass County, where it forms the most extensive soil type.

The topography of this type varies from gently rolling to steeply rolling. West and northwest of Prague it is steeply rolling, while the remainder of the northwestern area and the area in the northeastern part of the county are rolling to very rolling. The rest of the type is gently rolling to rolling. In general the slopes along streams are rather steep, while the divides are gently sloping. Erosion has become a serious factor on many of the farms on this type.

The Marshall silt loam originally supported a thick matting of prairie grasses common to this section, but now only a few small, scattered patches remain.

About 96 per cent of the type is under cultivation, the remainder being in farmsteads and roads. This type is the most important corn-producing soil of eastern Nebraska. About one-half of it is in corn, the rest being largely in oats and wheat, with some alfalfa. Ordinarily it produces 35 to 45 bushels of corn per acre, and in favorable seasons, with proper cultivation, much higher yields. Oats do well, the ordinary yield being about 35 bushels per acre. Only about one-eighth of this type is at present devoted to wheat, but the acreage is being rapidly extended. Wheat produces ordinary yields of 20 to 30 bushels, and as high as 40 bushels are sometimes obtained. The acreage of clover, timothy, and alfalfa is very small. Owing to the unfavorable moisture conditions, it has been difficult to get a good stand of clover during the last few years. In favorable years clover produces from 1½ to 2 tons per acre. Alfalfa does splendidly on this type, yields of 3 to 4 tons per acre from 3 cuttings being usually obtained. The tendency on the Marshall silt loam is to grow less corn and more wheat and leguminous crops, and to raise more live stock.

The usual rotation followed on farms of this type is 2 to 3 years corn, 1 year oats, and 1 to 2 years wheat, returning to corn. Occasionally the wheat field is sowed to alfalfa, in which case it is usually left in that crop from 5 to 7 years, when it is generally put back to corn. Most of the farmers do not follow any definite rotation, but leave the same field in corn or wheat for 4 or 5 years.

Owing to its friable structure, freedom from stones, and silty texture, this soil is very easy to handle and can be cultivated under a wide range of moisture conditions. It is somewhat easier to handle than the Shelby silt loam, owing to the fact that it is lighter in texture. The 4-horse hitch is usually used for tillage operations. Only a small amount of barnyard manure is applied to this soil, and no commercial fertilizers are used. Owing to its high organic-matter content, vertical structure, and silty texture, it has the power to resist prolonged droughts, provided the proper attention is given to the conservation of soil moisture.

Under the present system of farming the efficiency of the soil is gradually decreasing and only by a proper system of crop rotation and farm management can this be stopped.

Land of the Marshall silt loam type ranges in value from $125 to $175 an acre, depending upon location and improvements.

Marshall silt loam, flat phase.—The soil of the Marshall silt loam, flat phase, consists of a dark-brown, moderately heavy, smooth silt loam, with an average depth of 15 to 18 inches. It is underlain by a yellowish-brown or brownish-yellow, heavier and more compact silt loam to silty clay loam. At 30 inches the color of the subsoil changes to a yellow mottled with light gray. The lower subsoil is slightly stained with yellow iron oxide and is highly calcareous. As the color indicates, this phase is high in organic matter.

This phase is very limited in extent, occupying only 1.9 square miles, and occurs about 2 miles northeast of Cedar Bluffs.

The flat phase of the Marshall silt loam differs from the typical soil in that it occupies high, flat, plateaulike country and has a deeper surface soil. The streams have not cut back into it, but they are close enough to provide adequate drainage.

The native vegetation and utilization of this phase are the same as in the case of the typical soil. Owing to its flat topography it is better for farming purposes than the typical soil and higher yields are obtained.

The price of land of this phase also ranges from $125 to $175 an acre.

Knox Series.

The Knox soils are light brown, overlying subsoils of light-brown to yellowish-brown color. They are derived from thick deposits of loess occurring in a broad belt along both sides of the Missouri River from western Missouri northward. They are closely associated with the Marshall soils. The topography is gently undulating to rolling, and surface drainage is generally good.

KNOX SILT LOAM.

The soil of the Knox silt loam is a yellowish-brown, light-brown, or buff-colored heavy silt loam, from 6 to 8 inches deep. The subsoil is a compact, light-brown to pale-yellow heavy silt loam to silty clay loam. The soil is rather low in organic matter and lime concretions and reddish-yellow iron stains are common throughout the soil section. On the lower slopes and draws, where there is a higher content of organic matter, the soil is a dark-brown silt loam varying in depth from 10 to 30 inches and is underlain by a yellow, more compact, and heavier silt loam.

A rather important textural variation occurs in this type on the points of hills and at the heads of gullies in the extreme south-

eastern corner of the county, where the soil, to a depth of 36 inches, is a yellow to pale-yellow coarse silt loam to very fine sandy loam, including small spots of sandy loam. There is no apparent change in color or texture throughout the 3-foot section. The soil on the lower slopes and draws is typical, though slightly modified by the lighter textured wash from the higher points. The above description also applies to the area in section 29, Clear Creek Precinct.

The Knox silt loam occupies 7.9 square miles and occurs entirely as a bluff zone, varying from one-sixteenth of a mile to 1½ miles in width, between the Marshall silt loam and the bottom lands. The largest area occurs in the northwestern part of the county. Other areas are found in the vicinity of Ashland and northwest of this place, and northeast of Cedar Bluffs.

Owing to its location, the type is extremely dissected by short streams which have cut back into it. The valleys are distinctly V-shaped and the divides are very sharp. The soil is well drained and very much subject to erosion.

Originally practically all of the Knox silt loam was timbered, though about 50 per cent of it is now cleared. The chief growth on the upper slopes and crests of hills was scrub bur oak and sumac, and on the lower slopes bitter hickory, box elder, and ash, with a few scattered black walnut trees.

Most of this type is used for pasture, though a small portion is devoted to the production of alfalfa, corn, wheat, and oats. Alfalfa does well and is really the only profitable cultivated crop produced on this soil. Yields of 2 to 3 tons per acre are obtained. In the eastern part of Douglas County apples, grapes, and small fruits are very profitably produced on this soil.

Land of the Knox silt loam type ranges in value from $50 to $80 an acre, depending on location and improvements.

Shelby Series.

The soils of the Shelby series are brown to dark-brown in color, overlying brown, yellowish-brown, or faintly reddish-brown sandy clay subsoils. They are derived from the Kansan drift. The topography is usually rolling.

Only the loam and silt loam of the series are developed in Saunders County.

SHELBY SILT LOAM.

The soil of the Shelby silt loam consists of a dark-brown or dark grayish brown, heavy to extremely heavy silt loam, 8 to 15 inches deep. The soil carries a rather high percentage of clay, and as a result breaks down into angular granules. The subsoil is a light-brown or yellowish-brown compact silty clay, which at about 24 inches

merges into a more compact silty clay of a yellow color slightly mottled with gray. At depths ranging from 30 to 40 inches the subsoil becomes looser in structure, has a pale-yellow or yellow color mottled with light gray, and again takes on the character of a smooth silt loam.

There is an accumulation of clay in the second and third foot of the soil section deposited by percolating waters. When exposed in banks the first 3 feet of the soil section has a granular structure and below that a vertical, flakelike structure. As the color indicates, the soil is high in organic matter. The subsoil is highly calcareous and the lower portion is faintly marked and streaked with yellowish and brownish iron stains. The depth of the soil and also the color vary considerably. On rather broad divides the soil is dark brown in color and about 15 inches deep, while on narrow, crestlike divides the soil has been largely removed and a brownish or yellowish-brown silty clay is exposed. On shoulders of hills and along gullies the soil is also a very thin, medium-brown, heavy silt loam 4 to 6 inches deep. In places the subsoil is exposed, but downward along the slopes the soil becomes deeper and darker in color. At the foot of the slopes it is a dark-brown to black heavy silt loam, varying in depth from 20 to 40 inches. None of these minor variations were large enough to indicate on the soil map. Within the type there are also narrow strips of colluvial material along the intermittent streams.

Along North Fork Rock Creek there are numerous spots where the typical soil is underlain by a brownish silty clay loam to silty clay which, at any point from 20 to 30 inches, grades into a reddish-yellow silty clay. The Dakota sandstone lies very close to the surface and is often encountered in the 3-foot section. Locally, in small spots along gullies, steep slopes, and where erosion has been severe, it is not uncommon to encounter the Kansan drift material proper at 24 to 30 inches. In such places the soil is a dark brownish gray, extremely heavy silt loam, about 10 inches deep, underlain by a yellowish-brown, stiff, compact silty clay which at 30 inches turns into a light-gray mottled with brown and yellow gritty clay. The subsoil is highly calcareous. The nearness of the Kansan drift to the surface varies, and where freshly exposed it has a reddish-brown color. Where these areas were well developed they were mapped as Shelby loam. Small areas of the Marshall silt loam are also included in the type, but owing to the close association of the two soils such areas could not be mapped. On the average the silty covering over the Kansan drift proper is 10 to 20 feet deep.

The Shelby and Marshall silt loams are very similar in this county, differing mostly in point of origin. The Shelby silt loam is derived from the weathered phase of the Kansan drift, whereas the typical Marshall is derived from the Plains loess. The Shelby silt loam

also contains a few pebbles and cobblestones. There is also a slight difference in structure and texture between the two types in that the Shelby silt loam breaks down in granules as a result of a higher clay content, while the Marshall silt loam breaks down to a fine powder. They also differ in that the Shelby silt loam does not stand up nearly as well in vertical banks. These two types are very similar in color of soil and subsoil, organic-matter content, lime content, iron stains, in structure where there has been no granulation of clay particles, drainage, topography, and agricultural value. They grade imperceptibly into each other, and in places the boundary line was more or less arbitrarily drawn.

The Shelby silt loam is the most extensive type in the county, and occurs almost entirely as a large connected body in the southwestern and western part of the county. It is more or less interspersed with Shelby loam.

This type is rolling to steeply rolling and is thoroughly drained. In the southwestern corner of the county it occurs mostly on the high divides which have a roughly concave configuration. In general the slopes are steeper along the larger drainage ways and the divides of the type as a whole are gently sloping, though there are a number of sharp crests. Erosion has become a rather serious factor on this type. Many large gullies with subsidiary laterals are cutting back into the soil. It was reported by farmers during the progress of the soil survey that a large number of Kansan drift areas had been exposed within the short period of 50 years. With proper tillage and crop rotation this soil, owing to its rather high organic-matter and clay content, is very retentive of moisture. Under the same farm management it apparently will stand drought longer than the Marshall silt loam.

Originally the Shelby silt loam was covered with native prairie grass, but only a few small remnants of pasture land remain.

About 93 per cent of this type is in cultivation, the remainder being in permanent pastures, farm lots, and public roads. Corn is by far the most important crop and when properly tilled and rotated does well on this type. It produces yields of 30 to 40 bushels per acre, though as high as 60 bushels are often obtained. Oats rank second in acreage, but though admirably adapted to the soil are not a very profitable crop. The ordinary yield of oats is from 25 to 30 bushels per acre. Wheat does well on this soil and the acreage is being gradually extended. Yields of 20 to 25 bushels are obtained. Very little land is devoted to the production of clover, timothy, and alfalfa. Owing to the unfavorable moisture conditions of the last few years it has been almost impossible to get a good catch of clover and as a result farmers have stopped growing it. Alfalfa

has taken its place and promises to be an ideal hay crop on this soil. As a rule three cuttings per season and sometimes four are made, with an average yield of 3 tons. The tendency is to grow less corn and more wheat and leguminous crops, which involves the keeping of more live stock. A few potatoes are grown, but not nearly enough for home consumption. Where properly cared for they do well, but most farmers give them very little attention.

No definite rotation is followed, except by a few farmers who cultivate their own land. The general tendency is to keep the land 2 to 4 years in corn, 1 year in oats, 1 to 2 years in wheat, and then back to corn. Occasionally it is seeded to clover or alfalfa, being usually left in the latter crop for 5 to 7 years. It was not unusual during the survey for farmers to report that they had had a certain field in corn or wheat for 5 to 10 years.

Most of the Shelby silt loam is either plowed or listed in the spring. The farmers avoid plowing in the fall because of the tendency of the soil to drift. This soil is somewhat harder to handle than the Marshall silt loam, and owing to the higher clay content it can not be cultivated under quite as wide a range of moisture conditions. When plowed too wet it bakes and forms clods which are rather difficult to break. Small checks and cracks are formed at times on this type, but not enough to cause any serious loss of moisture by evaporation. Manure is usually applied to this soil twice a year, in the spring and fall, either as a top dressing on the winter wheat or on stubble fields. Where used as a top dressing on winter wheat an increase in yield of 5 bushels per acre is usually obtained. This soil is gradually becoming less productive, owing to the improper methods of farming practiced.

The Shelby silt loam is valued at $90 to $150 an acre, depending on improvements.

SHELBY LOAM.

The soil of the Shelby loam to a depth of 6 to 10 inches consists of a dark-brown to dark grayish brown loam to silty loam containing a rather high percentage of fine sand. This is underlain by a brownish-yellow or reddish-brown clay loam which, at 15 to 18 inches, merges into a gritty clay of a drabbish color, mottled with yellow and brown. The color of the subsoil usually changes to a light gray mottled slightly with reddish yellow or brown at 30 inches or deeper. Where the subsoil is looser and has been more thoroughly oxidized the reddish-brown color continues to a depth of 40 inches. The subsoil is very compact and occasionally so pebbly as to be impenetrable by an auger. The soil is fairly high in organic matter and the subsoil is highly calcareous. The lime exists chiefly in the form of concretions, specks, and to some extent as small pebbles. Black iron oxides and other oxidized iron concretions are plentiful in the subsoil. The soil

of this type contains a rather large quantity of pebbles and a few bowlders, though on most fields there are not enough to prevent cultivation.

This soil is rather variable in texture. On steep slopes, sharp ridges, shoulders, and places where erosion has been severe the subsoil is exposed with about a 2-inch veneering of brown or reddish-brown friable clay loam. The subsoil is a brown to reddish-brown gritty clay loam to clay, underlain at about 20 to 24 inches by a mottled light-gray and yellow gritty clay. Pebbles, cobblestones, and a few bowlders are numerous on the surface and throughout the soil section. The variation is called "gumbo" by farmers. A large number of these spots were encountered in the Shelby silt loam and to some extent in the Marshall silt loam, but they were too small to indicate as a separate type. Within the areas of Shelby loam there are numerous small spots of Shelby silt loam and also areas modified by wash from the generally higher-lying areas of the silt loam. The Shelby loam has a high stone content, while the Shelby silt loam is practically stone free. They also differ in the texture of the soil, and especially in that of the subsoil, which is very heavy and compact in the loam. The reddish tinge in the color of the subsoil is a distinguishing characteristic of the latter type.

The Shelby loam occurs mostly in the southwestern corner of the county along the slopes of Oak and Rock Creeks and their branches. There are also numerous small areas throughout the upland types of the county.

Physiographically this type usually occurs along steep slopes of drainage ways between the Shelby silt loam on the higher land and the Wabash silt loam on the bottom land, though occasionally it occupies high knolls and sharp crests of hills. The drainage is thorough, though the subsoil retains moisture remarkably well on account of its high clay content. Locally there are poorly drained spots in this type where seepage water issues along the lower slopes. Erosion has become the most serious problem in farming this soil. Gullies 10 to 15 feet deep with numerous tributaries are very common. The Shelby loam is not so drought resistant a soil as the Shelby silt loam, except where it receives seepage water.

The native vegetation of the Shelby loam includes the prairie grasses common to this section. Along the larger drainage ways the lower slopes are usually timbered with bur oak, etc.

About 40 per cent of this type is under cultivation and the remainder is largely in permanent pasture and hay land. A small portion is still in native prairie grasses. This type produces fairly good yields of the staple crops, including corn, oats, wheat, and alfalfa. Corn yields 15 to 25 bushels, oats 20 to 30 bushels, wheat 15 to 20 bushels, and alfalfa 2½ to 3½ tons per acre. A few farmers

produce enough sorghum to supply sirup for home use. Not nearly enough potatoes are grown to supply the home demand.

No definite system of rotation is followed on this type. The farming practices are about the same as on the Shelby silt loam. Owing to the larger quantities of stony material in this soil it is not quite so desirable as the Shelby silt loam. It can not be cultivated under as wide a range of moisture conditions as the latter type, and if plowed too wet it bakes and forms clods that are very difficult to reduce. Checks and cracks are very common in the soil, especially on the heavier spots. As a whole this type requires heavy draft horses and strong farm equipment. The soil is given liberal applications of barnyard manure only about every 5 or 6 years and no commercial fertilizers are used.

The average price of land, including farm buildings and improvements, ranges from $50 to $80 an acre.

Shelby loam, light-colored phase.—The Shelby loam, light-colored phase, to an average depth of 6 inches consists of a yellowish-brown or brown heavy loam containing a rather high percentage of gravel. The subsoil is a light yellowish gray, gritty clay, mottled with yellow, which at 24 inches becomes light gray mottled with yellow. The subsoil is very compact and tenacious and contains a high percentage of lime in the form of concretions, specks, and a few pebbles. As the color indicates, this type is very low in organic matter. Gravel, cobblestones, and bowlders are thickly scattered over the surface and throughout the soil section, and the soil is in many places too stony to admit of cultivation.

Where the drift material has been more thoroughly oxidized the soil is underlain with a reddish-brown, gritty clay loam to clay, which immediately passes into a reddish-yellow color. At 20 inches the subsoil becomes so gravelly and full of bowlders that it is impossible to penetrate it with the soil auger. Sometimes there is merely a slight suggestion of red and the predominating color of the subsoil is brown or brownish yellow. Areas which conform to the above description are found in Newman, Oak Creek, Chapman, and Rock Creek Precincts, and in section 23, Richland Precinct. The areas in the latter location are rather shallow, and Dakota sandstone outcrops on them. The remainder of the areas in Richland Precinct have a very gravelly subsoil, with numerous bowlders and cobblestones, which are poorly rounded and crudely stratified. The areas in sections 9 and 33, Rock Creek Precinct, consist largely of brownish, crudely stratified sand beds with a fine sandy loam soil.

The Shelby loam, light-colored phase, differs from the typical soil in that it has a higher stone content and a light-colored surface soil. Both soils are typically derived from the Kansan drift sheet, though some stratified sand beds and gravel of the Aftonian sheet are

included. This phase is of rather small extent and occurs largely in the southwestern part of the county as small scattered areas, though the largest is found in the northwestern corner along the lower slope of the bluff line.

This soil occupies steep slopes along drainage ways and knoblike hills on the upland proper. Owing to its stony and gravelly subsoil, it is well drained, except on lower slopes where it receives seepage water.

Where the soil has a high stone content it is not very retentive of moisture, but where the stones are fairly well imbedded with clay it stands drought for a fairly long time.

Most of this type is still in a rather scanty growth of prairie grasses, though a small portion has been broken and seeded to alfalfa. Where the soil is rather retentive of moisture alfalfa does fairly well. By far the greater part of this type is utilized for pasture. It furnishes a fairly good growth of grasses in the spring, but during the hot and dry weather of summer these usually turn brown and lie dormant until the next spring. A few of the gravelly areas supply gravel for cement sidewalks and concrete blocks. Land of this phase is valued by farmers at $40 to $60 an acre.

Lancaster Series.

The soils of the Lancaster series are dark brown to brownish gray, and the subsoils yellow to gray. The series is residual from sandstone or derived from sand beds of both glacial and eolian origin. The topography is rolling to hilly, and the soils are thoroughly drained and are not retentive of moisture.

Lancaster fine sandy loam.

The Lancaster fine sandy loam consists of a grayish-brown to brownish-gray fine sandy loam, with an average depth of 10 inches, underlain by a yellow, sticky fine sand which at 30 inches merges into a very fine sandy loam. It is not uncommon to find no difference in texture in the subsoil. The soil is low in organic matter and rather leachy. A few bowlders and pebbles occur in places. The Dakota sandstone outcrops in a number of places, and also the Pennsylvanian rocks. There are small spots of very fine sandy loam included with this type.

This type covers only 0.8 square mile and is confined to the southeastern corner of the county. It occupies a very steep and rather dissected topography along the bluff line of Salt Creek bottom. It is thoroughly drained and very unretentive of moisture, except on the lower slopes, where it often receives seepage water.

The Lancaster fine sandy loam typically is derived in situ from the Dakota sandstone, though in this county it is only very locally derived from that source and largely from the sands underlying the loess. The sand is both glacial and wind blown. At the head of a deep gully in section 11 on the Cass County line a clean-cut bank shows a deep bed of stratified sand which shows distinct cross bedding. This material undoubtedly belongs to the Aftonian glacial sheet.

The native vegetation consisted largely of scrub oak.

About 80 per cent of this soil in section 11, Ashland Precinct, is devoted to the production of staple crops, corn, oats, and wheat. About 5 acres of it have been utilized for grape growing with good results. Crops suffer extremely during droughts, and only in wet years are profitable yields returned. The remainder of the type is largely in pasture, and a part of it is occupied by the town of Ashland. As farm land it is valued at $60 to $100 an acre, depending largely on its topography and ability to withstand drought.

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

Mechanical analyses of Lancaster fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
371147	Soil	0.2	4.6	14.0	31.6	17.6	25.0	6.8
371148	Subsoil	.3	8.4	18.0	32.8	19.2	17.0	4.5

WAUKESHA SERIES.

The surface soils of the Waukesha series are dark brown to black, and the subsoils are yellow and as heavy as or heavier than the soil. They are derived from water-assorted glacial debris deposited in broad filled-in valleys or as outwash plains and terraces. The topography is mainly flat to undulating. Drainage is good.

WAUKESHA SILT LOAM.

The soil of the Waukesha silt loam is a dark-brown heavy silt loam which extends on the average to a depth of 12 to 15 inches. It is high in organic matter and has a very smooth, velvety feel. The subsoil is a yellowish-brown, compact silty clay which at 20 inches becomes very compact and grades into a yellow color. At a depth of 30 to 40 inches the subsoil becomes looser in structure and again takes on the texture of a heavy silt loam, possessing a yellow color mottled with light gray. It is not uncommon to encounter a light

yellowish gray or yellow subsoil mottled with gray immediately below the surface soil. The silty subsoil extends ordinarily to a depth of 10 to 20 feet, where the basal material, consisting of light-gray stratified sands and gravels, is encountered. The soil varies in depth with its topographic position. On the knoblike elevations it is somewhat lighter in color than the average and about 8 to 10 inches deep, while on slightly depressed or flat areas it is a very dark brown silt loam about 15 to 20 inches deep. The subsoil is highly calcareous, the lime existing in concretions, and is faintly blotched or marked with yellowish and brownish iron stains. This type has a vertical structure like the Missouri bluff loess, but is considerably heavier in texture. Along the Platte River in the northern part of the county, owing to its greater relief, the soil is somewhat lighter in color. Numerous areas of Scott silt loam too small to map were encountered in this type.

Within this type there also occurs small areas, known as "gumbo" spots, varying from 10 to 50 feet in diameter and consisting of heavy, rather indurated dark-brown silty clay, 10 to 12 inches deep, underlain by a brownish-yellow, extremely compact silty clay. Soil of this phase checks and cracks considerably, and is very difficult to handle. The crop growth is very stunted on such spots, which makes them very easily recognized.

The soil sections of the Waukesha silt loam and the Marshall silt loam are similar in color, structure, and texture. They differ in that the Waukesha silt loam occupies an old undulating to gently rolling valley with numerous marshy depressions and knoblike elevations or distinct benchlike strips along stream courses, with hardly any drainage development, whereas the Marshall silt loam occupies higher rolling to steeply rolling land dissected by numerous streams.

Small areas of the type that vary from the typical soil are found along smaller streams and as far as is known are not underlain by basal sands, the fluvial silt lying directly on the glacial debris. This phase is very limited in extent and occurs as first terraces or second bottoms along the Wahoo Creek above Wahoo, along Dunlap, Oak, Sand, Rock, and North Fork Rock Creeks, and Miller Branch. It occupies flat, rather benchlike areas along drainage ways, which are more or less modified by the cutting through of minor streams. The terraces are only 10 to 15 feet above the first bottoms toward the heads of these streams, but they rise higher above them with approach toward the mouth of the stream. The elevation of this phase corresponds to that of the main body in Todd Valley.

This type is the third most extensive soil in the survey, covering 162.4 square miles. It occurs in Todd Valley, as small remnant bodies on the south side of Wahoo Creek, and as distinct higher

benches along the Platte River and Salt Creek. The extensive area occupying Todd Valley is the main body.

The topography of the Waukesha silt loam has considerable variation. In Todd Valley proper it is rolling to undulating with numerous flat stretches, depressions, and knoblike elevations, which is also true of the area immediately west of Ashland. On the north side of Todd Valley the topography is more rolling. The benches of this type are usually narrow, flat strips which have only been dissected by upland streams seeking their way to major stream courses. Except along the edges, Todd Valley has been little affected by stream erosion, with the exception of Silver Creek, a probable occupant of the old channel of the Platte River, which rises within a few miles of the north line and traverses the county in a southeasterly direction. This type is well drained, except in local flat areas where the coarse basal material is near the surface and in depressional areas which serve as catch basins. Numerous drainage ditches have been dug on this type to remove the excess water, largely from the depressional areas, as in case of heavy rainfall they overflow and damage the crops on the surrounding land.

This type was originally prairie and has the same native grasses as the upland prairie.

Approximately 96 per cent of the Waukesha silt loam is under cultivation. It constitutes the most valuable agricultural land in Saunders County. Corn is the most important cash crop, though a large quantity of it is fed to stock. More than half of this soil is in corn, the ordinary yields being about 35 bushels per acre, though as high as 50 or 60 bushels are often obtained with proper cultivation. Corn is listed when it succeeds itself and usually checked when it is put in stubble or sod land, though stubble land is often listed. In dry years listing has given the best results when the soil was otherwise properly handled. Oats rank second in acreage to corn, and yield from 35 to 40 bushels per acre.

Wheat is strictly a cash crop, and within the last few years has given the highest returns per acre of any grain crop grown on this type. Ordinarily 25 bushels per acre are obtained. In 1913, from a thrasher's record of 19 fields on this type the average yield of oats was 52 bushels and of wheat 32 bushels per acre.

Except in very dry years, it is not difficult to get a stand of alfalfa on this type. From three to four cuttings per season, with yields of 3 to 5 tons per acre, are obtained.

Owing to the dry summers during the last few years, clover and timothy have been almost an entire failure. In wet seasons they do well and yields of 1½ to 2 tons per acre are obtained. 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, as on other soils of the county, not enough for home consumption. A little sorghum is grown for home use. Apple trees do not thrive on this type.

Most of the farmers follow no definite rotation, but the tendency has been to keep a field for two or three years in corn, one year in oats, one to two years in wheat, and once in every second or third rotation two to three years in clover. The last year the land is usually pastured, except on farms where there is a great deal of permanent pasture. Owing to the difficulty of getting a catch of clover, alfalfa is being substituted for it. When Kherson oats are sowed in the rotation they do better if the ground is plowed in spring and put in with a press drill. Unless the ground is properly tilled, this variety will not grow high enough to permit cutting with a binder. Growers of the Kherson oats claim a higher yield and a better quality of oats for feeding.

The 4-hitch team is used almost entirely in the preparation of the seed bed on this type. Gang plows are commonly used for turning the soil. Owing to the stone-free nature, slight relief, silty texture, and granular structure of this type, it is very easy to handle. Unless plowed too wet it does not bake or clod very much. Checks and cracks are rare, except very small ones. During periods of long drought this soil suffers considerably from lack of moisture, especially where the basal sands come within 3 to 5 feet of the surface. During the progress of the soil survey in 1913 it was noticed that the Marshall and Shelby silt loams withstood the long drought of that season longer than the Waukesha silt loam. Small quantities of barnyard manure are applied to this soil about every five or six years. A small quantity of commercial fertilizer has given increased yields on a few farms, but has had no apparent effect on others.

The price of farm lands on the Waukesha silt loam varies from $150 to $200 an acre, depending on improvements.

In the following table the average results of mechanical analyses of samples of the soil and subsoil of this type are given:

Mechanical analyses of Waukesha silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
371104, 371126.....	Soil.....	0.0	0.2	0.2	1.1	17.3	61.7	19.5
371105, 371127.....	Subsoil.....	.1	.1	.1	2.0	18.7	63.2	15.8

Sioux Series.

The Sioux series comprises dark-brown to black terrace soils occurring in the glaciated region of the Central and Northwestern States. These soils are characterized and distinguished from the Wabash soils by their occurrence on terraces above overflow and by the presence of a bed of gravel, usually within 3 feet of the surface. They differ from the Waukesha soils in having gravelly or sandy and somewhat droughty subsoils.

Sioux fine sandy loam.

The Sioux fine sandy loam consists of a brownish-gray to dark grayish brown fine sandy loam, with an average depth of 8 inches. It is underlain by a yellow fine sand, which, anywhere from 18 to 24 inches, merges into a loose, incoherent, yellowish-gray or light-gray fine sand, mottled with yellow. At 30 to 36 inches the subsoil is almost white in color. The depth of the soil varies considerably. On the tops of knoblike hills or on the top slopes at the edges of the Waukesha silt loam the soil is very shallow and often regular "sand blows" have been formed. Farther down the slope the soil usually becomes deeper and has a large admixture of silty material. Lower exposures of this type along the bluff line show quite a little coarse sand and fine gravel in the basal beds. This type is more or less interspersed with small patches of Waukesha silt loam and in general, through the process of erosion, there has been a mixing and slipping of the silty layers on the sand and vice versa on the lower slopes. In sec. 29, T. 16 N., R. 8 E., three small areas are included in this type where the sand has apparently been blown on the lower slopes of the upland adjoining Todd Valley. There is no difference in the soil except that it occupies a higher topographic position.

This type is of small extent. It occurs as numerous areas closely associated with the Waukesha silt loam.

The Sioux fine sandy loam covers knoblike elevations in Todd Valley and the slopes between the Waukesha silt loam and the bottomland soils. These slopes vary from a gentle to very steep gradient. The soil is thoroughly drained and on steep slopes is subject to both water and wind erosion.

This type is used for pasture and to some extent for corn, oats, and wheat. Owing to the closeness of the sand, the soil is very droughty and the pastures dry up as soon as the hot, dry weather comes on in July. Only small yields of oats, corn, and wheat are obtained, except on lower slopes, where seepage water often supplies the plants with the necessary moisture.

The results of mechanical analyses of samples of the soil and subsoil of the Sioux fine sandy loam follow:

Mechanical analyses of Sioux fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
371112	Soil	0.2	2.6	8.4	42.4	23.4	16.1	7.0
371113	Subsoil	.1	2.1	9.2	64.1	20.6	2.6	1.7

SCOTT SERIES.

The soils of the Scott series are dark brown to drab. The subsoils are lighter drab or brown. The members of this series consist of lake-laid material eroded from higher lying loessial soils and deposited by sheet surface waters or intermittent streams in the shallow waters of temporary lakes or ponds occupying local, undrained, sinklike depressions in upland plains. The soils are poorly drained, and in some places are subject to overflow.

SCOTT SILT LOAM.

The soil of the Scott silt loam is a dark-gray to grayish-black silt loam 12 to 15 inches deep underlain by a pulverulent, floury silt containing an appreciable amount of very fine sand and of a light-gray to ashen-gray color, mottled with rusty brown. At a depth of 24 to 30 inches, and sometimes deeper, the above stratum grades immediately through a brownish-gray silty clay into a dark-gray or slate-colored silty clay to clay, mottled slightly with brown. The lower subsoil is highly calcareous and contains some iron concretions. The upper layer of the subsoil is very loose, while the lower layer is very compact and impervious to water. Owing to its marshy condition a large quantity of organic matter has been incorporated with the surface soil.

This type occurs as numerous small isolated areas in the bodies of Waukesha silt loam in Todd Valley and west of Ashland. The areas range from 2 to about 100 acres in extent, the average size being about 5 acres. Numerous areas too small to map were encountered in the Todd Valley.

The Scott silt loam occupies depressed, swampy areas, which are very poorly drained. They have no natural outlet and serve as catch basins for the surrounding land. Owing to the fact that the lower subsoil is very impervious, water stands on this type for a number

of days after heavy rains. A few drainage ditches have been dug in Todd Valley, chiefly to supplement the natural drainage of the Waukesha silt loam, though they have also provided drainage for a number of Scott silt loam areas. When distant from the main ditches the drainage of these areas by lateral ditches or tiles is rather expensive. In view of this fact a number of farmers have provided drainage by digging wells to the basal sands. This scheme has been very satisfactory, but has not been extended very much on account of the dry seasons during the last few years.

The upper section of this soil is apparently derived from more recent silt washed from the surrounding higher land on the older soil, now occurring as the lower subsoil. The lower stratum, which is higher in organic matter, is apparently a very old soil formed by the deposition of clay and silts from standing water.

The native vegetation varies considerably from the center to the edge of areas of this type. It is not uncommon to find the middle of the area barren, surrounded by a zone of sedges which along the edges merge into a border of prairie grasses. Where the native sod has been disturbed by plowing white clover and sedges form the chief growth.

Only a very small percentage of this type has been reclaimed. The greatest problem in handling it is that of drainage. When the soil is properly drained wheat does well, but oats and corn do not yield profitable returns. In dry years crops do well where no artificial drainage has been provided, but even then heavy rains are apt to occur and drown out the plants. Most of this type is utilized for hay land and pasturage. From 1 ton to 1½ tons is the usual yield per acre. Land of this type is valued at about $40 an acre.

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

Mechanical analyses of Scott silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
371101	Soil	0.0	0.2	0.2	0.6	21.6	62.2	15.1
371102	Subsoil	.8	.9	.6	.6	10.4	76 7	9.9
371103	Lower subsoil	.6	1.4	.6	1.1	12.0	58.9	25.3

WABASH SERIES.

The Wabash soils are prevailingly black, ranging to dark-brown, and contain a high percentage of organic matter. The subsoils are gray or brownish gray. These soils are developed 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.

WABASH SILT LOAM.

The soil of the Wabash silt loam to an average depth of 18 inches is a dark grayish brown or dark-brown to black, rather heavy silt loam, with a high content of organic matter. When dry the soil takes on a dark-gray to grayish color, especially where the organic-matter content is below normal. The subsoil is a dark brownish gray or very dark gray, heavier and more compact silt loam. It is not uncommon to find no apparent difference in color or texture in the 3-foot section.

There are a few minor variations in this type which are worthy of mention, although they do not differ sufficiently from the typical soil to warrant separating them on the soil map. Locally throughout the type there are areas with a typical soil underlain at 18 inches by a stiff, compact, black silty clay to clay. The largest area of this kind was recognized along Wahoo Creek at Weston. A heavier phase, called "gumbo" by farmers, was also encountered. A strip about one-fourth mile wide occurs along the third bottom in the northeast corner of section 8 and in sections 4 and 5, Ashland Precinct, besides numerous small areas which do not justify mentioning. This latter variation is an extremely heavy silt loam to silty clay loam to a depth of 20 or 24 inches, where a grayish heavy silt loam mottled with yellow and rusty brown is encountered. Along the major stream courses and their cut-offs a narrow strip of lighter textured material is encountered which usually consists of a dark-gray to grayish coarse silt loam to very fine sandy loam with an average depth of 10 to 15 inches, underlain by a light-brown stratum of the same texture. At 24 inches the lower stratum merges into a very coarse silt loam of a lighter brown or light-gray color mottled with brown. Along the border of the upland a narrow strip of colluvial material is usually encountered and this where wide enough is indicated on the soil map.

Another variation occurs 3 miles east of Ceresco. It consists of a black heavy silt loam 20 inches deep, resting on a dark gray silty clay loam containing black and yellow iron oxides. Along the bluff line there are many slight depressions, where the soil is a black silty clay loam to a depth of 3 feet. In general this phase contains a rather high percentage of sodium chloride, and in spots the salt content is so high that only a scanty growth of salt grasses occurs or the ground is bare. Owing to the marshy condition of the soil, a high percentage of organic matter has been incorporated with it.

This type is the most important bottom-land soil in the county, and with its colluvial phase covers 104.4 square miles. It occurs as first bottoms along the streams in the upland and to a very limited extent on a slightly higher bench along the Platte River.

The topography is flat and only slightly relieved in elevation by old cut-offs. Along Salt Creek and Wahoo Creek, below Wahoo, a natural levee has been aggraded by these streams along their courses, while toward the source of the latter stream, above Wahoo, and along the branches of both streams, a narrow first bottom has been formed, leaving the main body of the Wabash silt loam standing as a first terrace. Originally the drainage of this type was poor, but by cleaning and straightening the channels of the streams the natural drainage has been very much improved. The areas along Wahoo Creek below Wahoo and along Salt Creek are rather poorly drained and subject to frequent inundations, while the remainder of the type closer to the head of the streams is better drained and seldom subject to overflow, owing to the deep channels. Occasionally, however, these positions are inundated by a branch stream.

Originally most of this type was covered with a timber growth consisting of cottonwood, willow, elm, ash, black walnut, linden, hackberry, and bitter hickory. Approximately 45 per cent of this type is now devoted to the production of staple crops. On well-drained areas practically all of it is utilized in the production of corn, which returns higher yields on this land than on any other soil type in the county, except Muck. Yields of 45 to 55 bushels per acre are obtained, and with proper cultivation in favorable seaseasons as high as 90 bushels have been obtained. Reid's Yellow Dent gives the best results on the bottom land, whereas the white dent varieties seem to do better on the upland. Where this soil has been devoted to the production of corn for a number of years and is well drained wheat does well and produces ordinary yields of 27 bushels per acre. Not much wheat is grown. Kherson oats do fairly well, yielding from 30 to 40 bushels per acre. The long-strawed oats are apt to lodge. Oats are not grown very extensively. Where the Wabash silt loam lies high above the stream channel and its natural drainage is supplemented by a few ditches alfalfa does better than on the upland soils, yielding 3 to 5 tons per acre. Most of this soil is in hay land and pasture. Wild hay yields from 1 to 2 tons per acre, and in favorable years as high as 3 tons is sometimes harvested. Owing to the fact that this type affords good pasturage and a great deal of hay, the beef industry has been more extensively developed than on the upland.

A one-crop system prevails on this type, though occasionally corn is rotated with oats and wheat. It is not uncommon for a farmer to report that a certain field has been in corn for 15 years or more. The

flat topography, silty texture, and desirable structure make it a very easy soil to handle. It can be cultivated under a wide range of moisture conditions and seldom bakes or clods except upon "gumbo" spots, which are rather difficult to handle. Scarcely any barnyard manure and no commercial fertilizers are used.

The productiveness of the soil where it has been cultivated for a long time has fallen off, owing to the one-crop system. The greatest problem that confronts the farmer on this type is that of drainage.

The price of farms on this type ranges from $80 to $150 an acre, depending on drainage conditions and location.

Wabash silt loam, colluvial phase.—The soil of the Wabash silt loam, colluvial phase, to an average depth of 24 inches is a dark-brown to black, very friable and mellow, heavy silt loam, with a rather high content of organic matter. The subsoil is a more compact, dark grayish brown heavy silt loam. The gradation between the soil and subsoil is very imperceptible, and in many borings no apparent difference in texture or color was noticed in the 3-foot section.

This phase is of very small extent, covering 3.4 square miles. The largest area occurs immediately west of Morse Bluff and a number of small areas are scattered through the county.

The colluvial phase of the Wabash silt loam occupies a physiographic position between the upland and bottom-land soils. It has an appreciable slope and is well drained. In a few instances it occurs along intermittent streams where there has been a great deal of side-hill wash.

Practically all of this phase is devoted to the production of corn, though a few small areas of wheat and oats were seen during the progress of the soil survey. Corn does excellently and yields 45 to 60 bushels, while as high as 100 bushels an acre have been obtained.

No crop rotation is practiced on this soil and scarcely any barnyard manure is applied. It is easily cultivated and can be worked under a rather wide range of moisture conditions. There are no farms in the county composed entirely of this phase. Land of the colluvial phase of the Wabash silt loam is valued at $125 to $160 an acre.

WABASH LOAM, COLLUVIAL PHASE.

The soil of the Wabash loam, colluvial phase, consists of a dark grayish brown loam containing a rather high percentage of very fine and fine sand. There is no apparent difference in color and texture in the 3-foot section, except that the third foot is a shade lighter in color and more compact in structure. The soil is rather high in organic matter.

This phase covers 1.1 square miles. Three areas occur along the bluff line near Morse Bluff, one 3 miles southeast of Ithaca, and

another, which approaches a sandy loam, about 1 mile south of Ashland.

The phase occupies a physiographic position between the third and first bottom lands of the county. It has an appreciable slope and is well drained.

Most of this soil is devoted to corn, producing yields of 40 to 60 bushels per acre. Only a few small areas of oats and wheat were encountered during the survey. Wheat yields 25 to 30 bushels per acre and oats 35 to 45 bushels.

Very little attention is given to crop rotation, though occasionally corn is followed by one year of oats and one year of wheat. Very little barnyard manure and no commercial fertilizers are used. The rather high sand content of the soil gives it a mellow and loamy structure. It can be cultivated under a wide range of moisture conditions without baking or clodding in the least. There are no farms in the county composed entirely of this phase.

The Wabash loam, colluvial phase, ranges in value from $125 to $175 an acre, depending on its location.

WABASH CLAY.

The soil of the Wabash clay consists of a black clay underlain at an average depth of 12 to 15 inches by a stiff, waxy clay of the same color as the soil. At 30 inches the color of the subsoil merges into dark gray, though often the black color persists to a depth of 30 inches. The lower portion of the subsoil is highly calcareous, the lime existing in the form of organic shells and concretions. Black iron oxides in the form of small concretions are very abundant, and where the lower subsoil is slightly oxidized the black oxide has partly changed to a rusty brown or yellowish color. As the color indicates, the soil is high in organic matter, and it is not uncommon to find remains of plants throughout the soil section.

As mapped the Wabash clay includes a lighter phase, consisting of a black silty clay loam to an average depth of 20 inches, underlain by a silty clay loam or even a heavy silt loam. As a rule the subsoil changes to a drabbish or light-gray color mottled with rusty brown or yellowish iron blotches at 24 to 30 inches. The high percentage of black iron oxides in the lower portion of the subsoil gives it a very gritty feel. Areas in sections 11, 12, 13, 14, 16, 17, 20, 22, 23, the western part of 26, and in sections 27 and 28, T. 13 N., R. 9 E., and the area in sections 19 and 20, T. 17 N., R. 5 E., conform to the above description. A few small spots throughout the type have a grayish incrustation of salts.

The Wabash clay is not very extensively developed and occurs almost entirely in the southeastern part of the county. There is

one area in the northwestern part. The type is confined to the lower end of the Wahoo Creek first bottoms and the Platte River first bottoms.

The topography is flat and the soil is poorly drained, owing to its low position and the impervious subsoil. Only a small percentage of this type has been reclaimed for cultivation, though enough drainage has been provided by ditching to make it good pasturage and hay land. A deep ditch with a few laterals traverses the main body of this type west of Wann. With the levee along the Platte River to keep out the overflow waters and the large drainage ditches already installed it should not be very expensive to further reclaim this land.

This type undoubtedly marks an abandoned channel of the Platte River, which has been silted in by slowly moving waters and back waters during overflows.

The greater part of the Wabash clay is utilized for hay land, though a small portion is devoted to pasturage and the production of corn. The main body of this type is owned in small lots by farmers living on the Waukesha silt loam and is used for hay lands. Most of the hay is stacked in the fields and hauled as it is needed or in winter when work is not very pressing. Some is pressed into bales and sold. Owing to the coarse quality of the hay it only brings about $6 to $9 per ton. Where properly reclaimed this is an excellent corn soil. It is one of the best corn soils of Douglas County.

Farm land of this type ranges in value from $80 to $125 an acre, depending on the drainage conditions.

Cass Series.

The surface soils of the Cass series are dark brown to black. The subsoils are lighter in color and in texture. These soils are alluvial, and most extensively developed in the bottoms along the Mississippi and Missouri Rivers and their tributaries. They occur in association with the Sarpy soils, differing from them in having a darker color. The drainage is good, though they are subject to overflow.

CASS VERY FINE SANDY LOAM.

The Cass very fine sandy loam consists of a gray to dark-gray very fine sandy loam with an average depth of 15 inches. The color of the soil varies from light gray or brownish gray to dark gray, depending on the length of deposition, drainage condition, and period of cultivation. The surface soil is very fine in texture, approaching a silt loam in many places, and is exceedingly mellow and friable. It is underlain by a light-gray very fine sandy loam, mottled slightly

with yellow. Sometimes the yellow mottling is entirely absent and again it is very prominent. A layer of black silt loam is occasionally encountered in the lower subsoil. Seams of coarser material, though not common, occur in the lower subsoil. The soil is rather low in organic matter. Along streams and sloughs a narrow strip of coarser material is encountered within this type.

The Cass very fine sandy loam is different from the Cass silt loam in that it is lighter in texture and better drained. However, in a great many instances it grades imperceptibly into the latter type, and as a result only a very arbitrary boundary line can be drawn. As would be expected the marginal areas of the Cass very fine sandy loam contain a high percentage of silt.

This type is one of the most extensive soils on the Platte River first bottoms and is best developed in the southeastern part of the county. It occupies a position about 3 to 4 feet higher than that of the Cass fine sandy loam.

The Cass very fine sandy loam has a flat topography, the surface being varied only by a number of meandering depressions. Owing to its light texture and fairly high position in the flood plain it is well drained, while the closeness to the surface of the water table makes the moisture conditions comparatively good even during droughts.

The native vegetation of this type was largely marsh grasses and a few sedges and rushes, though along the creeks a growth of willows and cottonwood, with a scattering of ash, elm, box elder, black walnut, and hackberry, was found.

About 96 per cent of the Cass very fine sandy loam is under cultivation and the remainder is largely in farm lots and roads. Grain farming, involving the keeping of a few dairy cows and other live stock, especially hogs, is the chief type of agriculture followed on this type. Over one-half of the type is devoted to the production of corn, producing yields of 35 to 45 bushels per acre. Oats is second to corn in acreage and yields ordinarily about 35 bushels per acre, though as high as 65 bushels have been obtained. The farmers are beginning to grow more wheat, because in dry years it is a more certain crop than corn and also permits a better rotation of crops. Ordinary wheat yields are about 22 bushels per acre, though as high as 40 bushels have been obtained. A few patches of alfalfa were noticed on this type during the progress of the soil survey. Thus far it has done well, and there seems no reason why it can not be grown successfully. Very little of this soil is devoted to the production of hay, as most of the hay is secured from the Wabash clay and Cass fine sandy loam. The tendency of the farmers on this type is to grow less corn and more wheat, oats, alfalfa, clover, and timothy. A very

small portion of this type is utilized for growing seed crops, principally pumpkins and sweet corn.

A few farmers follow a rotation which consists of 2 to 4 years of corn, 1 year oats, 2 to 3 years of wheat, and 2 to 3 years of clover and timothy, returning to corn. Sometimes the clover and timothy are omitted. Most of the farmers do not follow any definite rotation, and it is not uncommon for a farmer to report that he has had a certain field in corn for 20 years. This system has materially reduced the productiveness of the soil.

The Cass very fine sandy loam, owing to its rather light texture, does not require heavy farm equipments. It works up into a fine, mellow seed bed. Only a small quantity of barnyard manure is applied to this soil, as not very much live stock is raised on the type as a whole. Commercial fertilizers have not been used.

The Cass very fine sandy loam ranges in price from $100 to $135 an acre, depending on the improvements and the location with reference to towns.

CASS SILT LOAM.

The soil of the Cass silt loam consists of a dark-gray to black heavy silt loam containing a rather high percentage of very fine sand. It has an average depth of 15 to 18 inches and grades through a thin layer of light-gray silt loam into a light yellowish gray very fine sandy loam mottled with brown. Seams of silt and old soil are not uncommon in the subsoil. Owing to its original marshy condition, a large amount of organic matter has been incorporated with the soil.

In sections 26 and 35, T. 13 N., R. 9 E., north of Wahoo Creek and along streams and sloughs in this type, the Cass silt loam is a dark grayish brown coarse silt loam, approaching a very fine sandy loam. Another variation worthy of mention is found in the extreme northeastern corner of the county. This phase consists of a heavy black silt loam to silty loam, 15 to 18 inches deep, underlain by a light-brown, light-textured silt loam, which at about 20 or 24 inches passes into a pale-yellow very fine sandy loam. This stratum, in turn, is underlain at 30 inches or deeper by a medium almost white sand with yellow and brownish iron stains. A slight admixture of gravel with the lower portion of the subsoil is not uncommon. Local spots of the latter phase are common throughout the type.

This type is different from the Wabash silt loam in that it has a light-textured subsoil, whereas the subsoil of the Wabash silt loam either has practically the same texture as the surface soil or heavier. They are similar in the texture and color of their surface soils.

In the aggregate this type covers 9.8 square miles. It occurs as rather small areas, and is almost entirely confined to the Platte River first bottoms.

The topography is flat and only slightly modified by a few meandering sloughs. Originally the soil was poorly drained, but with the clearing out of the stream channels and the digging of drainage ditches it has been given fairly good drainage. Northwest of Cedar Bluffs it is poorly drained, owing to the seepage from the basal material of Todd Valley. Where the soil is still rather wet a standard system of tiling should be installed. When properly managed this is one of the most drought-resistant soils in the county and an excellent general farming soil.

The native vegetation consisted of marsh grasses, sedges, and rushes. Approximately 15 per cent of the type is still in native grasses.

Corn is the predominant crop and oats and wheat rank next. Corn does excellently, yielding from 40 to 50 bushels per acre. Oats grow too rank to be a very profitable crop, though the short-strawed varieties give good results. Winter wheat does better than oats, and from 20 to 30 bushels per acre are obtained. A small portion of this type is cut for wild hay and some is used for pasturage.

No system of rotation is practiced, although the crops are occasionally changed. When the soil is first reclaimed the land is usually left in corn until an appreciable reduction in yield is experienced.

When properly drained it is comparatively easy to obtain a good mellow seed bed on this type, though not nearly so easy as on the Cass very fine sandy loam. Only a small quantity of barnyard manure is applied and no commercial fertilizer is used. Where a coarse subsoil comes close to the surface the crops usually suffer during long droughts.

From $125 to $150 an acre is the price asked for farms on this soil type.

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

Mechanical analyses of Cass silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
371134	Soil	0.0	0.1	0.3	1.6	11.8	63.4	22.4
371135	Subsoil	.0	.0	.0	.3	31.2	63.5	4.9

CASS LOAM.

The soil of the Cass loam consists of a heavy black loam containing a rather high percentage of very fine sand. It has an average depth

of 15 to 18 inches and, as the color indicates, is high in organic matter. The texture of the soil is variable and ranges from a very fine sandy loam through a loam and silty loam into a heavy silty clay loam or clay loam, though the average is a fairly good loam. These variations in the soil were too small and patchy to justify mapping. As a rule the surface soil is underlain by a gray loam which immediately passes into a light-gray very fine sandy loam. The subsoil is highly calcareous and not uncommonly contains yellowish and brownish iron stains which give it a mottled appearance.

The area about a mile northeast of Wann is a black loam, about 18 to 24 inches deep, underlain by a light-gray, loose, incoherent fine sand which becomes much coarser with depth. The area about 5 miles east of Morse Bluff is characterized by a very high content of very fine sand and is a border type between the Cass silt loam and the Cass very fine sandy loam.

This type is of very small extent, covering 2.3 square miles in the Platte River first bottoms.

The Cass loam occupies a flat topography and is not very much dissected by old channels. The main body of this type west of Wann occupies a very slightly lower topographic position than the Cass very fine sandy loam, but it has fairly good drainage. This tract is in many spots quite highly impregnated with soluble salts. It is protected by a levee, as is also the area northeast of Wann, while that east of Morse Bluff is subject to occasional inundation. These latter two bodies, lying in the lower situations along the Platte River, are poorly drained.

The native vegetation on this type is wild marsh grass and salt-tolerant plants where the soil has a high salt content. A few spots are barren owing to the excessive salt content.

Approximately 30 per cent of the type is under cultivation and the remainder is largely in hay lots, with a small portion in pasture. The area east of Morse Bluff is largely in hay land, the one northeast of Wann in pasturage, and the main body west of Wann largely in hay land, but partly in corn and pasturage. Where the soil is well drained and not saline corn does well, giving ordinary yields of 40 bushels to the acre. Only a few small fields of oats and wheat were noticed on this type during the progress of the soil survey. Very little barnyard manure and no commercial fertilizers are used on the reclaimed land of this type.

In general, drainage is the greatest problem that confronts farmers on this type. A standard system of drainage, including ditches and tiles, should be installed.

The price of farms on this type ranges from $70 to $100 an acre, depending on drainage improvements.

The results of mechanical analyses of samples of the soil and subsoil of the Cass loam are given in the following table:

Mechanical analyses of Cass loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
371142	Soil	0.0	0.4	0.8	7.7	33.0	44.4	13.9
371143	Subsoil	.0	.2	.4	5.6	54.8	31.9	7.1

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$) : No. 371142, 7.45 per cent; No. 371143, 4.13 per cent.

CASS FINE SANDY LOAM.

The soil of the Cass fine sandy loam consists of a gray to dark-gray fine sandy loam, 10 to 15 inches deep, which grades through a stratum of yellowish-gray fine sandy loam about 3 inches thick into a loose, incoherent, almost white fine sand, becoming coarser with depth. Occasionally fine gravel is encountered in the third foot, but usually it occurs at a lower depth. Seams of black silt loam may be encountered in any part of the 3-foot section. Where the soil has been under cultivation for a long time the organic matter has been consumed, and the surface soil assumes a light-gray color. Ordinarily the organic-matter content of this soil is fairly high.

In the depressions and sloughs the soil is a black, light-textured loam or silty loam ranging from 4 to 18 inches in depth. It is underlain by a 4-inch layer of almost white very fine sand which rests on a stratum of fine sand of the same color. At the average depth of 20 inches or less a medium or coarse sand with a slight admixture of fine gravel in the lower portion of the subsoil is encountered. As a rule, however, the very fine sand stratum is absent and the soil lies directly on the fine sand.

Another phase of this soil is encountered in the northwestern part of the county in sections 16, 17, and 18, T. 17 N., R. 5 E. This is a black, light-textured loam, with an average depth of 8 to 10 inches. The soil is high in organic matter and is underlain by light yellowish gray to almost white fine sand, stained by yellowish and brownish iron oxides. The sand becomes coarser with depth and it is not uncommon to strike a medium or coarse sand anywhere from 24 to 36 inches. Where cultivated the soil has a lighter textural appearance, owing to the fact that the underlying sand has been more or less mixed with the surface soil. In addition this type includes numerous areas of Sarpy fine sand which were too small to indicate on the map.

The Cass fine sandy loam is the most extensive Platte River first-bottom soil and occurs as a narrow, discontinuous strip along the stream course varying from a few rods to 1½ miles in width and as islands in the stream channel. A few areas are found outside this zone away from the stream. This type covers 21.9 square miles.

The topography in general is level, though extremely ridgy on a detailed scale. There are numerous sloughs on this type, and, like the low ridges, they run in the same direction as the Platte River. The surface soil is well drained, but, on account of the high level of the water table, the subsoil is poorly drained, except on high elevations. The water table is between 4 and 5 feet from the surface. This type lies about 3 to 4 feet lower than the Cass very fine sandy loam and Cass silt loam areas of the bottom land, and, with the exception of the higher outlying areas and the portion in the southeastern corner of the county, where it is protected by a levee, is occasionally overflowed.

The islands and a narrow strip along the river are or were originally covered with a growth of timber consisting mostly of cottonwood, cedar, and a few walnut trees, hackberry, coffee bean, wild mulberry, and honey locust. A small percentage of the timbered areas have been cleared. Farther from the stream most of this type was originally in native marsh grasses, quite a portion of which has never been broken up. About 75 per cent of it is used for pasturage and hay land and the remainder, which is higher lying, for general farm crops. Owing to the high water table, this soil, though very sandy, is admirably adapted to pasturage and hay land. Wild hay yields from 1 to 2 tons per acre, depending on the rainfall. Where the land is higher lying it is extremely droughty unless it has a heavy subsoil. Corn does not do very well, especially on the lower lying areas, and only yields from 10 to 30 bushels per acre. Some wheat and oats are grown with fair success. The raising and feeding of beef cattle is the most important industry.

Where the soil is high enough to permit cultivation it has decreased considerably in productiveness.

The price of farm lands on the Cass fine sandy loam ranges from $50 to $75 an acre.

Sarpy Series.

The soils of the Sarpy series range from light gray to brown in color. They differ from the Wabash and Yazoo soils in having loose silty or fine sandy subsoils, distinctly lighter in texture than the surface soils. This series is developed in the bottoms of the Mississippi and Missouri Rivers and their larger tributaries. The material is alluvial in origin. Owing to their low position these soils are

subject to overflow, although between the flood stages of the streams the nature of the soil and subsoil is such that drainage is thorough to excessive. In general the topography is flat.

SARPY FINE SAND.

The soil of the Sarpy fine sand consists of a gray fine sand, with an average depth of 15 inches, underlain by a light-gray, loose, incoherent fine sand, which immediately passes into an almost white fine sand of the same structure. The subsoil becomes coarser with depth and it is not uncommon to encounter some medium sand and small gravel stones in the lower subsoil. In the subsoil there are always more or less iron stains, varying in color from rusty brown or brown to reddish yellow. A portion of this type is of such recent formation as to be devoid of the dark surface soil, and in other places the surface soil has been removed by wind action, the loose, almost white fine sand subsoil being exposed. In secs. 2, 3, 10, and 11, T. 15 N., R. 9 E., this type includes a phase consisting of a veneering of light-gray to almost white fine sand with an admixture of fine gravel varying from a few inches to 4 feet in depth. This material was deposited during a recent ice gorge on a typical area of Cass fine sandy loam. A number of small areas of this character occur in the survey.

This type is of very small extent and is found entirely on the Platte River first bottoms. It occurs as a low, natural levee along the Platte River, as elongated islands in the channel, and as a single ridge or a series of ridges which sometimes coalesce and form an extremely complicated topography.

Scarcely any of the Sarpy fine sand is used for agriculture. Most of it is in native grass and sand bars, and a portion is entirely devoid of vegetation. It forms fairly good pasturage in the early spring, but as soon as hot weather ensues the grasses turn brown and lie dormant until the following spring. The areas adjoining the river and the islands in the channel are timbered with cottonwood, willows, elm, and cedar.

As the Sarpy fine sand is subject to wind erosion, it should be left in its native growth of either grass or timber. This type ranges in value from $15 to $30 an acre.

MISCELLANEOUS MATERIAL.

MUCK.

The material included in the Muck type consists of well-decomposed organic matter varying in depth from 3 feet along the edge to 10 feet or more in the middle of the area. The Muck is underlain by a grayish clay. A shallow phase of this type is found on the Platte

River first-bottom lands in the northwestern part of the county. It is a black loamy muck, varying from 12 to 24 inches in depth, and is underlain by a yellowish-gray to almost white fine sand.

There are only three areas of this type in the county, covering 0.8 of a square mile. The largest body is about 2 miles west of Wann, and the other two areas are west of Morse Bluff.

The areas of Muck are all flat and the natural drainage is poor. Most of the body west of Wann has been reclaimed by a system of ditching and tiling. During periods of long drought the outlets of the tile are plugged and the tract is subirrigated. Owing to the fact that the springs issuing from the basal material of Todd Valley are very constant, the supply of water is unlimited.

The native growth on the Muck consists of wild grasses and sedges.

The areas in the northwestern part of the survey are used for pastures and hay land. On the typical area west of Wann most of this type is devoted to the production of corn, and only a small portion is left in pasturage. Corn yields on the average about 50 bushels per acre, though much higher yields have been obtained. Some potatoes have been grown, with yields of from 200 to 250 bushels per acre. Certain areas of this type seem well adapted to the production of truck and special crops.

As yet Muck has not shown any decrease in its efficiency. It is high in nitrogen, though its rather low content of phosphorus and potash will undoubtedly demand some mineral fertilizer in a few years to keep up its productivity. As a general rule the Muck soils are very productive at first, though they deteriorate very fast unless some mineral or manurial fertilizer is applied.

Land values on this type range from $60 to $200 an acre, depending on drainage conditions. When reclaimed the land rents for $10 an acre.

RIVERWASH.

There are 5.6 square miles of Riverwash in the Platte River channel of Saunders County. It occurs as sandbars and flats and consists of an almost white, fine, medium, and coarse sand with an admixture of fine gravel. This type lies only a few feet above the normal flow of the river and is inundated with a corresponding rise of the stream. The Riverwash is not very permanent and changes with every overflow of the stream, and even during the normal flow small areas are shifted about, destroyed or added to with the varying current. This type is considerably modified also by drifting. It has no agricultural value and is practically devoid of vegetation.

Saline Soils.

There are in Saunders County numerous saline spots too small to be indicated on the soil map. They are characterized by a grayish surface layer of loose gray soil, resting on an indurated layer whose compactness is due to the high content of soluble salts. Where the soil is most highly impregnated there is a white incrustation over the surface which has a distinctly salty taste. Salt-resistant plants form the principal growth, and in places the content of salts is so high that no plants can live.

These saline spots occur mostly in the southern and southeastern part of the survey. The best-developed areas are found as patches in the vicinity of Wann on the Cass loam, Cass very fine sandy loam, and Wabash clay, and southeast of Memphis on the Wabash clay and Wabash silt loam. Smaller, scattered areas are found throughout the county, but mostly on the Waukesha and the Marshall silt loam areas southwest of Wahoo Creek. The largest area lies a few miles east of Ceresco.

Dakota sandstone, the bedrock of the county, which is locally highly impregnated with sodium chloride, is undoubtedly the main source of the salt found in spots in the upland region. On bottom lands bordered by higher lying Dakota sandstone the salt is largely derived from the saline springs. Where the sandstone is rather remote from the first, second, or third bottoms it is probably due to a local concentration of salts through evaporation. According to an analysis made of a saline area in Cass County similar to those in Saunders County, the sample contained 0.25 per cent water-soluble salts, 0.06 per cent being bicarbonate, while the remainder was mostly sodium chloride. According to Hilgard, greasewood, a saline-tolerant plant, refuses to grow on soils containing more than 3,680 pounds per acre-foot. As the sodium-chloride content of the saline salts of the county are even higher, the barren surface or stunted growth of prairie grasses or farm crops on such spots is assuredly caused by an excess of sodium chloride.

SUMMARY.

Saunders County is located in eastern Nebraska. It comprises an area of 761 square miles, or 487,040 acres.

The surface ranges from flat in the stream bottoms and terraces to extremely dissected in parts of the upland.

Saunders County is drained by Platte River and Wahoo and Salt Creeks.

The first permanent settlement was made in 1856 in the vicinity of Ashland, and the county was organized in 1867. Wahoo is the county seat.

A number of railroads connect the county with large markets. Practically all parts of it are provided with telephone service and rural free delivery of mail.

The mean annual precipitation of the county is 30.21 inches, and the mean annual temperature is 50.9°. The average growing season is about 161 days.

The type of agriculture followed at present consists of grain farming, with the raising of beef cattle and hogs and dairying as adjuncts. Dairying is gradually becoming more important. Corn, oats, wheat, wild hay, and alfalfa are the leading crops. Drainage is one of the most important problems on the heavier soil types of the bottom land.

Fifteen soil types, 2 miscellaneous types, and 4 phases, representing 10 series, were recognized in the survey. The soils in the uplands are derived mainly from loess and glacial drift. On the terraces and in the stream bottoms the soils are formed of the alluvial deposits washed from the uplands.

The Marshall silt loam is a very extensive upland soil in the northern and eastern parts of the county. Corn, oats, and wheat are the chief crops grown on this type. The flat phase of this type is more desirable for farming than the typical soil.

The Knox silt loam is a light-colored loess soil and, as the color indicates, is low in organic matter. Owing to the dissected topography, only a small portion of it is utilized for grain farming, most of it being in pasture.

The Shelby silt loam is the most extensive soil type in the county, occurring in the southwestern and western parts. It is devoted largely to the production of corn, oats, and wheat.

The Shelby loam, owing to its higher content of clay, gravel, pebbles, and bowlders, is not as well suited to grain farming as the Shelby silt loam. A light-colored phase occurs in small scattered areas. It is stony and almost entirely utilized for pasturage.

The Lancaster fine sandy loam, owing to its hilly topography and light texture, is not a good farming soil.

The Waukesha silt loam is the third most extensive soil type in the county. It is a terrace soil and considered the best agricultural soil in the county. Corn, oats, and wheat are the chief crops.

The Sioux fine sandy loam is of small extent and, owing to its porous structure, not well adapted to general farm crops.

The Scott silt loam occurs as depressions in the Waukesha silt loam. It is utilized largely for pasture and hay land.

The Wabash silt loam is the most important first-bottom soil in the county. It is considered the best corn soil in the county, but is not so well adapted to wheat and oats. The colluvial phase of this

type is of very small extent and is largely utilized for the production of corn.

The Wabash loam, colluvial phase, is of small extent. It is almost entirely devoted to the production of corn, of which it gives large yields.

The Wabash clay is confined entirely to the Platte River and Wahoo Creek first bottoms. It is heavy and difficult to handle. Only a small part of it is reclaimed. The remaining area is used for the production of wild hay or for pasturage.

The Cass very fine sandy loam is one of the most extensive soil types on the Platte River first bottoms. It is largely used in the production of corn, oats, and wheat.

The Cass silt loam is another of the Platte River first-bottom soils. It is nearly as easily handled as the very fine sandy loam.

The Cass loam has a small extent. It is not as well drained as other members of the Cass series in the county. About 30 per cent of it is under cultivation. The remainder is largely wild hay and pasture land.

The Cass fine sandy loam occupies islands and a narrow discontinuous strip along the Platte River. Owing to its low position it is utilized largely for pasturage.

The Sarpy fine sand occurs, as a rule, as small, elongated areas on the Platte River bottoms. It is very droughty, supporting a scant growth of grass which furnishes fair pasturage in the spring.

Muck covers four-fifths square mile in the Platte River bottoms. It is used to some extent for the production of corn and potatoes.

Riverwash includes the sand bars and flats of the Platte River. It is nonagricultural land.

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[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved, March 14, 1904.

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

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