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Soil Survey

Cass County Nebraska

By
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United States Department of Agriculture, in Charge
and
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Nebraska Soil Survey

UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Plant Industry
In cooperation with the University of Nebraska
State Soil Survey Department of the Conservation and
Survey Division

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UNIVERSITY OF NEBRASKA
STATE SOIL SURVEY DEPARTMENT OF THE
CONSERVATION AND SURVEY DIVISION

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Series 1936, No. 5 Issued March 1941

SOIL SURVEY OF CASS COUNTY, NEBRASKA

By T. E. BEESLEY, Division of Soil Survey,[1] Bureau of Plant Industry, United States Department of Agriculture, in Charge, and M. M. KUPER, W. S. GILLAM, and T. K. POPOV, Nebraska Soil Survey

Area inspected by T. D. Rice, Inspector, District 3

United States Department of Agriculture in cooperation with the University of Nebraska State Soil Survey Department of the Conservation and Survey Division

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COUNTY SURVEYED

Cass County is in the extreme eastern part of Nebraska immediately west of the Missouri River and south of the Platte (fig. 1). Its southwestern corner is about 14 miles from Lincoln, the State capital, and the northeastern corner is about 16 miles south of Omaha, the metropolis of the State. The county is roughly rectangular, with irregular northern and eastern boundaries. It is approximately 33 miles long from east to west, is about 19 miles wide from north to south, and comprises 555 square miles, or 355,200 acres.

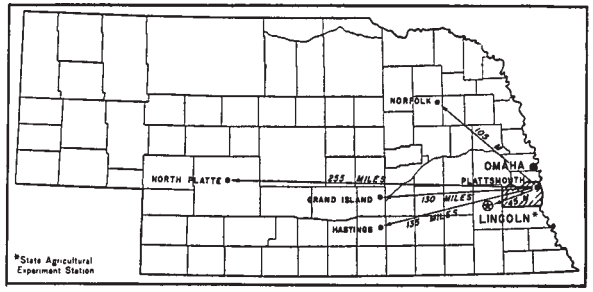

FIGURE 1.—Sketch map showing location of Cass County, Nebr.

This county lies in the Central Lowland province of the Interior Plains physiographic division. It is part of an eroded drift plain that

[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

is capped with loess of variable thickness and irregular distribution and is cut by numerous valleys partly filled with alluvium. In its local physiographic aspect that part of the plain within the county consists of a long, centrally located, east-west divide from which the terrain slopes gradually northward and southeastward to the bluff lands along the Platte and the Missouri Rivers, respectively. Here the rivers and their more deeply entrenched tributaries have cut steep-sided valleys extending through the loess and drift deposits into the underlying sandstone, shale, and limestone bedrocks. The flood plains along the rivers are from 150 to 300 feet below the general level of the upland.

The eroded drift plain was rolling to hilly before the loess was deposited, and, although the irregularities of its surface were reduced by the loess cover, they were not effaced, except where least pronounced. Thus the present relief corresponds, in a general way, to that of the old drift plain.

Recent erosion into the drift and loess has produced most of the rougher surface features, namely, the gullies, bluffs, and dissected slopes bordering the larger streams and their tributaries. The broadest and most continuous strips of rough land parallel the rivers around the eastern and northern sides of the county, where the width of the deeply dissected, harsh, and angular terrain exceeds 2 miles in places. Steeply sloping and gullied land, in strips ranging from 20 to 40 rods in width, extends upstream along the larger creeks and branches for a distance of several miles from their mouths.

Back from the dissected strips adjacent to the rivers and their tributaries the land surface, as a whole, is moderately to strongly rolling with the greater part of the slopes ranging between 5 and 40 rods in length and between 4 and 12 percent in gradient. Most of the longer and more gradual slopes are at some distance from the larger drainageways.

In the southern and southwestern parts of the county, chiefly south of Weeping Water Creek, part of the upland is moderately hilly, especially north, southeast, and southwest of Eagle and northwest and southeast of Elmwood. In these localities most of the hills and ridges, although well rounded and ranging only from 40 to 60 feet in height, have slopes between 9 and 15 percent.

The most nearly level upland areas are on or near the axis of the main divide, which extends east and west across the central part of the county. Here the surface of the old drift plain was comparatively smooth, and the loess cover effaced many of such irregularities as existed. The top of the divide, although less than a mile wide at most places, has an undulating to gently rolling relief modified in the vicinity of Murdock by about 2 square miles of nearly flat land. Smaller tracts having little relief are on some of the divides between the larger creeks, as south of Alvo, west of Mynard and Murray, northwest of Manley, and in a few other places.

Alluvial lands, including stream terraces and flood plains, occupy only a small part of this county. The widest areas of such land are along Salt Creek in the extreme northwestern part. The terraces occur at several levels. They were formed before the streams became so deeply entrenched, and they now lie from 10 to 30 feet above the present bottom lands. The highest and oldest benches are along Weeping Water Creek about 1 mile west of Union, along the Platte

River 5 miles northwest of South Bend and 4 miles northwest of Plattsmouth, and along Salt Creek. These benches were formed before the loess was deposited, were covered with the wind-laid loessial material at the same time as the uplands, and only their basal parts are water-laid. Much of the high terrace along Salt Creek is near the level of the Todd Valley terrace, described in the Soil Survey of Saunders County, Nebr. (*5*).[2] Most of the high benches are nearly level, although all have been eroded somewhat by drainageways issuing from the uplands. The bench west of Union is dissected to some extent.

The lower and younger benches are along Salt and Weeping Water Creeks and the Platte and Missouri Rivers. They are relatively inextensive. None of them has been subjected to abnormal erosion, and all are nearly level. The transition between the benches and the first bottoms is marked by a short steep slope in most places, whereas that between the higher terraces and the uplands generally is gradual.

The first bottoms occupy broken or continuous strips bordering all the larger and many of the smaller drainageways. Those along Salt and Weeping Water Creeks and the Missouri River are more than a mile wide in several places, but elsewhere they range in width from a few rods to about one-half mile. The bottom lands are generally flat but are modified by slight elevations, shallow depressions, and numerous overflow channels, some of which are barely perceptible.

Both the Platte and Missouri Rivers are rather sluggish and are building up their flood plains in places. The other streams of the county have steep gradients and are actively deepening their channels. They thoroughly ramify the uplands, except in a few nearly level areas on some of the divides where surface run-off is rather slow. The only poorly drained land is in local patches on the flood plains and in a few small and widely scattered depressions in the smoother parts of the uplands.

The average elevation of Cass County is about 1,200 feet above sea level, ranging from 1,360 feet at Eagle to 928 feet in the southeastern corner, giving a total range in elevation of 432 feet. The most pronounced relief is between the channel of the Missouri River and the top of King Hill, where the rise is about 300 feet within a horizontal distance of 25 rods. The elevation (*1*) at Greenwood is 1,125 feet; at Murdock, 1,272 feet; at South Bend, 1,036 feet; at Louisville, 1,041 feet; at Weeping Water, 1,079 feet; and at Plattsmouth, 968 feet.

This county is in the Prairie soil region of the United States. Before white men arrived all the uplands supported a luxuriant growth of prairie grasses. The greater part of the valley slopes along the lower course of Weeping Water Creek, and most of the bluff lands bordering the Platte and Missouri Rivers were forested. Except on the steeper and more stony slopes, nearly all of the virgin sod has been broken for cultivated crops or orchards. Most of the forested land has been cut over at least once. The grass vegetation on scattered virgin areas throughout the uplands consists mainly of little bluestem, needlegrass, side-oats grama, junegrass, and dropseed. On the bottom lands, big bluestem, tall panic grass, Indian grass, and wild-rye are abundant, with sloughgrass and sedges growing in the more poorly drained situations. Since early settlement, bluegrass has become established and now covers much of the pasture and hay land.

[2] Italic numbers in parentheses refer to Literature Cited, p. 54.

The present forest growth is confined mostly to nonarable areas, such as the bluff lands, recently deposited sediments along the rivers, and narrow strips on the valley sides and flood plains of many of the smaller drainageways. In the rougher areas the principal native trees are bur oak, red oak, black oak, ironwood, linden, and hickory, interspersed with honeylocust, black cherry, and an occasional red cedar tree. On the nonarable parts of the bottom lands and lower valley slopes, elm, ash, walnut, hackberry, boxelder, cottonwood, and willow are abundant, with sycamore and Kentucky coffeetrees occurring as scattered individuals. Northward-facing slopes generally support the most luxuriant growth and largest variety of trees and shrubs.

Good but medium-hard well water in sufficient quantities for family and livestock needs is readily obtained over most of the county. On the uplands the water is obtained mainly from lenses and buried channels of sand and gravel in the drift deposits, but partly from sandstone, limestone, and sandy shale bedrocks. The supply from the limestone and shale sources is small and rather uncertain. Throughout most of the uplands, water is reached at depths ranging from 50 to 80 feet. The depth in any particular locality depends partly on the character of the relief and the thickness of the loessial cap but mainly on the thickness and textural composition of the drift deposit and on the depth to suitable water channels in the bedrocks. In places in the rougher sections along Weeping Water Creek and the Platte and Missouri Rivers, the limestones and shales have only a limited and rather alkaline supply of water to depths of several hundred feet. In these localities considerable prospecting is necessary before satisfactory water can be obtained.

Throughout the alluvial lands well water is obtained from deposits of sandy stream-laid sediments, which, along the Missouri and Platte Rivers, contain an abundance of good water within a depth of 15 feet, but most of the wells along the smaller streams range from 70 to 80 feet in depth. Some of those in the valley of Salt Creek produce slightly alkaline water.

Little thought has been given to the location and care of the wells, and many farmers do not realize that surface water moving over and through polluted ground may affect the quality of the well water. It is not uncommon to see shallow wells immediately below feed yards and other sources of contamination. Many of the wells are poorly cased, and some of them are open and receive blow sediment and surface debris from surrounding land.

A few springs, most of which issue at or near the contact of the drift and bedrock formations, are in the valleys of the Platte and Missouri Rivers and along Weeping Water Creek. All the spring water is of good quality.

The first settlement in the territory now included in Cass County was made in 1853 just below the mouth of the Platte River. In March 1854 a treaty made by President Pierce with the Indians permitted white men to settle on the land bordering the west bank of the Missouri River. The county was established with its present boundaries by the Territorial Legislature in 1855 and was organized in the same year. It was named after Lewis Cass, who was Secretary of State during President Pierce's administration. By 1856, settlement had spread throughout the uplands. The early settlers were mainly from Iowa, Illinois, and Missouri. Most of them were American born, chiefly of German, Irish, and Swedish descent.

According to the Federal census, the population of the county increased until about 1890, when the inhabitants numbered 24,080. The number had decreased to 21,330 in 1900, to 19,786 in 1910, to 18,029 in 1920, and to 17,684 in 1930. During the latter year about 21 percent of the population was classed as urban and the remainder as rural. The rural population is densest in the vicinity of the towns and sparsest in the bluff lands bordering the Missouri and Platte Rivers. It averages 25.8 persons a square mile over the county as a whole.

Plattsmouth, the county seat and largest city, is in the extreme northeastern part of the county near the mouth of the Platte River. It had 3,793 inhabitants in 1930. Grain elevators, canning, brick, and cement-block factories, a flour mill, and a creamery are located here. Weeping Water, in the south-central part, with a population of 1,029, is the only other city. It has grain elevators and a flour mill. Louisville, an incorporated village with 969 inhabitants, is in the northern part near the Platte River. It has one of the largest cement plants in Nebraska and is noted for its limestone quarries and sand, gravel, and clay pits. Elmwood and Greenwood are incorporated villages with 515 and 404 inhabitants, respectively. The former is in the southwestern and the latter in the extreme northwestern part. A number of smaller villages and railroad points are scattered throughout the county. They are of local importance as distributing centers and shipping points for farm implements, supplies, and produce. Most of them have grain elevators.

Transportation facilities are good. No section is more than 8 miles from a shipping point. Railroads cross the county in several directions and furnish good connections with outside markets. The public-road system is well developed. Nearly all of the towns are on graveled or hard-surfaced highways, which cross the county from east to west and from north to south. Most of the earth roads follow land lines, except in the rougher sections, where many of them conform to the relief. The more important roads are kept well graded and are dragged as soon after each rain as possible. Nearly all roads have concrete culverts and bridges over the drainageways. Toll bridges cross the Platte and Missouri Rivers near Louisville and Plattsmouth, respectively.

Owing to good railroad and highway connections with Omaha and Lincoln, the market facilities are excellent, and the demand in Omaha and South Omaha for practically all of the general farm products and in Lincoln for dairy and poultry products is good.

Rural mail delivery reaches all parts of the county. Telephones are in common use, and the public-school system is highly developed.

The nonagricultural industries center chiefly in and near Louisville. They include the manufacture of cement, limestone, quarrying, and the production of sand and gravel, which, collectively, furnish employment for about 250 men. The portland-cement plant at Louisville has a capacity of about 3,000 barrels daily. It uses annually about one-half million tons of Pennsylvanian limestones and shales, which outcrop in the vicinity. The Pennsylvanian beds also supply limestone for buildings, bridges, culverts, and the construction of revetments used in controlling the channel of the Missouri River. Much of the stone is crushed for use in road surfacing. Gravel and sand from the flood plains of the Platte River near Louisville are shipped to all parts of southeastern Nebraska for building purposes and highway construction.

CLIMATE

The climate of Cass County is continental and temperate. Variations in temperature and precipitation between winter and summer are rather wide, as is typical of the Corn Belt, but the climate is well suited to the production of grain, vegetables, and hay crops and to the raising of livestock. The springs are cool, with considerable rainy weather, which favors the rapid growth of winter wheat and spring-planted small grains. The summers are long, with warm days and nights, which are especially favorable to the growth of corn. Low temperatures occur during the winter but usually are of short duration and are accompanied by snow, which protects the winter-grown crops from serious injury. The autumns are long and pleasant, with only occasional periods of rainy weather, giving the farmer ample time to prepare and seed the land for winter wheat and to harvest the corn crop. Differences in relief are not sufficient to cause appreciable differences in the local climate.

Table 1, compiled from the records of the United States Weather Bureau station at Weeping Water in the south-central part of the county, gives the normal monthly, seasonal, and annual temperature and precipitation at that place.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Weeping Water, Cass County, Nebr.*

[Elevation, 1,080 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1934)	Total amount for the wettest year (1883)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	26.1	77	−25	1.03	0.41	0.00	7.1
January	23.7	71	−31	.84	.39	.75	6.0
February	28.5	76	−29	1.17	.73	.75	7.7
Winter	26.1	77	−31	3.04	1.53	1.50	20.8
March	39.5	94	−17	1.29	1.07	.25	6.3
April	51.8	99	11	2.48	.10	.75	1.2
May	61.4	99	18	3.66	.92	6.75	.1
Spring	50.9	99	−17	7.43	2.09	7.75	7.6
June	73.9	107	37	4.59	2.18	14.62	.0
July	77.3	112	30	3.49	.49	1.88	.0
August	74.2	110	31	3.82	1.73	11.50	.0
Summer	75.1	112	30	11.90	4.40	28.00	.0
September	66 2	107	18	3.52	4.37	2.25	.0
October	54.0	95	−2	2.05	2.70	6.00	.4
November	39.4	81	−10	1.58	3.70	.50	1.8
Fall	53.2	107	−10	7.15	10.77	8.75	2.2
Year	51.3	112	−31	29.52	18.79	46.00	30.6

The average date of the last killing frost is May 4, and that of the first is October 7, which indicates an average frost-free season of 156 days, ample for the maturing and harvesting of all crops commonly grown. During the 20 years from 1895 to 1914 there were four times

in which the season without killing frost was 15 or more days shorter than the average (*7*). Killing frosts have occurred as early as September 13 and as late as May 26.

About 80 percent of the mean annual precipitation falls from April to October, inclusive, which comprises the growing season. In summer the rainfall usually occurs as heavy thundershowers, but torrential rains are rare. Droughts are almost unknown in May and June, but in the latter part of July and during August short dry periods sometimes occur. Crops seldom suffer from lack of moisture when properly tended, as nearly all of the soils are able to supply them with sufficient moisture through periods of dry weather. Hail may damage crops over small areas in some years, but injury from this source is local and does not reduce the total county yields to a great extent.

From about October 1 to April 1 the prevailing wind is from the northwest, and during the rest of the year it is from a southerly direction. Strong winds are common, but tornadoes are rare. According to the Weather Bureau records (*4*), the average annual wind velocity is between 8 and 10 miles an hour. The relative humidity is fairly regular, the average for the year being about 70 percent. During the period 1895 to 1914, inclusive, the number of clear days ranged between 120 and 160 annually (*3*).

AGRICULTURAL HISTORY AND STATISTICS

Cass County is essentially agricultural. Prior to the entry of white men, the land supported a luxuriant cover of grasses, together with a growth of trees along the larger streams. Most of the prairie sod has been broken for crop production.

The first settlers located near the Missouri and Platte Rivers, where fuel and water were obtained readily, and settlement extended onto the uplands after the desirable valley land had been homesteaded.

The first crops grown were chiefly corn, potatoes, and garden vegetables, which were required to supply the home needs. The climate was thought to be too dry for the production of corn on a large scale, and wheat early became the most important cash crop. The farmers soon recognized, however, that the land was well suited for the growing of corn, and prior to 1880 the acreage of this crop was increased until it held first place and that of wheat ranked next during most years. Oats, barley, and rye were grown to a small extent by the earliest settlers. Oats were needed to feed the work animals, and the area devoted to this crop was soon increased at the expense of that used for other small grains. Between 1889 and 1899 the acreage in oats exceeded that in wheat, but since the latter date it has been slightly lower, except during a few years.

Prior to 1889, barley occupied several thousand acres annually, but this crop has decreased greatly in importance and is now grown on less than 1,000 acres. Except possibly in a few seasons, the area devoted to rye has never exceeded 1,500 acres, and during the last two decades it has been less than 600 acres. Many of the earlier settlers planted buckwheat, flax, tobacco, and broomcorn, but these crops proved unprofitable and were soon discontinued.

The present-day agriculture is diversified. It consists mainly of the production of grain, forage, and tame hay and the raising and fattening of cattle and hogs.

The Federal census reports $5,190,132 as the value of all field and orchard crops, vegetables, and farm gardens in 1929. Dairy products, excluding those used for home consumption, were valued at $392,848, and poultry and eggs at $643,357. On April 1, 1930, the domestic animals and chickens had a value of $3,415,285. About 45.6 percent of this amount was the value of cattle, about 27.3 percent was that of horses, mules, and jacks, and about 21.4 percent represented the value of hogs. The remaining 5.7 percent was the value of the sheep, goats. and poultry.

According to the Nebraska agricultural statistics, 246,746 acres, or about 70 percent of the land in the county, was under cultivation in 1929, and the remainder was included chiefly in pasture, wild-hay meadows, and woodland. During most years about 130,000 acres are used for growing corn, 31,000 for oats, 30,000 for wheat, 350 for rye, and 250 for barley. Of the tame-hay crops, alfalfa occupies between 8,000 and 10,000 acres, red clover between 2,000 and 5,000 acres, and sweetclover between 1,000 and 2,000 acres. Other cultivated crops, including spelt, sorgo, millet, Sudan grass, and potatoes, are of minor importance, each being grown on less than 1,000 acres during most years. With the exception of wheat, practically all of the grain and hay crops are used on the farms where produced, although some of the corn and alfalfa is sold to local cattle feeders. A few farms are devoted almost exclusively to the production of fruit, chiefly apples and peaches. The Federal census reports 10,227 apple trees and 6,094 peach trees in 1930.

Table 2, compiled from Federal census reports, shows the acreages devoted to the principal crops grown in this county in 1879, 1889, 1899, 1909, 1919, 1929, and 1934.

TABLE 2.—*Acreage of the principal crops in Cass County, Nebr., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	79,901	125,859	170,392	133,650	117,843	141,375	7,318
Oats	8,907	19,543	31,620	31,452	30,212	31,267	11,957
Wheat (all kinds)	39,443	14,537	21,123	36,292	59,138	36,009	25,922
Rye	1,216	620	522	35	622	152	313
Barley	7,810	6,064	279	6	247	571	124
Potatoes		1,887	1,429	1,305	864	626	235
All hay and forage	12,568	31,162	20,133	31,139	27,139	25,271	21,602
Wild hay			14,371	10,259	7,959	5,903	[1] 3,344
All tame and cultivated grasses			5,284	20,526	16,569	18,577	[2] 17,223
Alfalfa			212	1,829	9,147	9,993	10,783
Clover (all kinds)			1,589	1,561	1,436	6,341	1,128
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples		100,560	210,556	143,302	34,589	10,227	19,012
Peaches		1,984	40,863	42,853	1,926	6,094	8,506
Cherries			18,549	10,234	3,597	2,586	3,832
	Vines	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*
Grapes			79,934	38,686	9,427	27,339	32,671

[1] Includes tame grasses.

[2] Includes wild grasses.

Corn during the drought of 1934 was almost a complete failure, the total yield being 94.8 percent below that of 1929. The barley,

oats, and wheat yields were 78.3, 61.8, and 28.0 percent lower, respectively, in 1934 than in 1929. The total rye yield, however, was 51.4 percent greater in 1934 than in 1929, owing mainly to an increased acreage in this crop. All grains except rye were reduced in acreage during 1934, but this reduction accounts for only a part of the reduced yields caused by the great drought, which was far more devastating than any previously experienced since farming began in this county.

The yields of the different crops differ greatly from year to year and from place to place, in accordance with differences in the soils, the amount and distribution of precipitation, and the length of the growing season. For the county as a whole, however, the average yields of crops over long periods are fairly uniform.

Table 3, compiled from unpublished records of the Federal Bureau of Agricultural Economics and the Nebraska Department of Agriculture, shows the estimated average acre yields of the most important crops in the county and the estimated average percentage of the total land area occupied by each crop during the period 1923–32.

TABLE 3.—*Estimated average acre yields of the most important crops in Cass County, Nebr., and estimated average percentage of the total county area occupied by them during the period 1923–32*

Crop	Acre yields (1923–32)	Total land area occupied by crop	Crop	Acre yields (1923–32)	Total land area occupied by crop
	Bushels	*Percent*		*Bushels*	*Percent*
Corn	30.9	42.5	Potatoes	70.1	0.17
Wheat (all kinds)	17.5	10.1		*Tons*	
Oats	25.6	10.5	Alfalfa	2.0	2.54
Barley	23.4	.3	Wild hay	1.09	2.3
Rye	15.1	.07	Pasture and woodland		26.6

The returns derived from livestock and livestock products are the main sources of revenue. With the exception of wheat, which is grown to sell for cash, practically all the feeds produced in the county, in addition to considerable quantities from outside sources, are used in raising and fattening cattle and hogs and for feeding the work animals and other livestock.

Table 4, compiled from the Federal census reports, gives the number and value of domestic animals and poultry on farms in this county in 1910, 1920, 1930, and 1935.

TABLE 4.—*Number and value of livestock on farms in Cass County, Nebr., in stated years*

Livestock	1910		1920		1930		1935 [1]
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number* [2]
Cattle	28,373	$717,335	27,711	$1,453,045	27,467	$1,558,400	29,921
Swine	43,771	398,642	43,869	981,818	52,204	730,336	32,221
Horses	13,535	1,426,597	11,886	1,113,298	9,954	752,249	8,637
Mules	1,496	202,448	1,971	250,679	2,007	178,671	1,554
Sheep	1,543	6,207	3,471	36,942	4,692	30,077	3,111
Poultry	156,131	71,698	180,015	166,685	[3] 209,945	163,757	184,669

[1] Value not reported.
[2] Number of livestock greatly reduced in 1935 due to drought and shortage of feed crops.
[3] Chickens only.

The beef cattle are chiefly grade Herefords and Shorthorns. Most of them are shipped in for winter fattening, but many are raised locally. The cattle to be fattened for market are fed corn and alfalfa for a period ranging from 60 to 90 days and are then shipped to the Omaha markets. Many farmers fatten from one to five carloads of cattle each year. A few fatten calves for shipment as baby beef. The calves, when first weaned, are usually fed oats, but later the ration is changed to corn and alfalfa. They are shipped when between 14 and 18 months old.

Purebred dairy cattle, chiefly Holstein-Friesian, are kept on a few farms that are devoted exclusively to dairying. The greater part of the dairy products, however, is obtained from cows of mixed beef and dairy breeding. According to the Federal census, 4,963,327 gallons of whole milk and 176,213 pounds of butter were produced in 1934. Cream routes are established in nearly all sections, and most of the cream is collected by the purchaser. A cream station is maintained in each town, and two creameries are located in Plattsmouth. The greater part of the cream not used in these creameries is shipped to Lincoln or Omaha. The abundance of alfalfa to balance the corn ration, together with good marketing facilities, combine to favor the extension of dairying.

Most farmers raise from 20 to 60 hogs a year, and some have herds of several hundred. Many hogs are raised in connection with the feeding of beef cattle. All are of good breeding, and many herds consist of purebred animals. Duroc-Jersey, Poland China, and Hampshire are the leading breeds. Practically all of the hogs are fattened on the farms where raised, and most of them are sold in Omaha. Hog cholera has disastrously affected hog raising in the past, but this disease has been practically eliminated through vaccination and increased sanitation.

Ordinarily sheep raising does not receive much attention. A few farmers buy a carload or two of sheep in the fall, fatten the animals on corn and alfalfa, and sell them in Omaha when the price is most favorable.

The raising of horses and mules has been of minor importance during recent years and is confined mainly to the breeding of the work mares. Most farmers have a colt or two for sale each year.

Chickens are raised on every farm, and many farmers have large flocks. Most of the chickens are purebred Plymouth Rocks, White Leghorns, and Rhode Island Reds. A large number of the flocks are maintained through the purchase of baby chicks from hatcheries in Omaha, Plattsmouth, and Lincoln. The surplus poultry products are sold or exchanged for farm supplies in the local towns.

Most of the farm buildings are well painted and kept in good repair, and many of the houses are equipped with modern conveniences. According to the 1930 Nebraska agricultural statistics, 392 of the farmhouses had modern heating plants, 364 were equipped with electric-lighting systems, and 1,000 had radios. Most farms are enclosed with barbed wire, but many have woven-wire fencing, especially around the feed lots and alfalfa fields. The work animals include horses and mules of heavy draft types, although engine power is used to some extent in preparing the land for crops and during the harvest season. The farm machinery is of the most modern and labor-saving

types. In 1930, 580 tractors, 416 trucks, 1,726 automobiles, 192 grain threshers, 11 wheat combines, and 1,148 cream separators were reported on the farms in this county. Many farms are equipped with corn binders, corn shuckers, hay balers, incubators, and silos. The more expensive farm machinery is sheltered.

In general, farm laborers are plentiful, and the wages have been low during the last few years. Monthly wages range from $20 to $30 with board and lodging. Day labor usually is plentiful at $1.25. Many farmers hire help, especially during the corn and small-grain harvest seasons.

According to the Federal census, the 2,051 farms in the county in 1935 occupied 339,482 acres, or 98.6 percent of the land. The average size of farms is 165.5 acres. Many holdings are smaller, and a few livestock farms include more than 500 acres. The size of the farms has increased slightly since the county was settled. Some of the smaller farms have been combined into larger units by loan companies, and the more prosperous farmers have increased their holdings through purchase. The average size of farms in 1880 was 140 acres.

In 1935 owners operated 50.6 percent of the farms, tenants 48.6 percent, and managers 0.8 percent. The proportion of tenant farms has increased steadily since 1880, when only 28.7 percent of the farms were rented.

Both cash and share systems of land rental or a combination of the two are followed. In 1930, about 88 percent of the farmed acreage was rented for a share of the crops. Under this system the owner usually receives two-fifths of the grain delivered and from $1 to $2.50 an acre for the pasture land and building site. All seed, labor, and machinery are furnished by the tenant. When alfalfa land is rented on the sharecrop basis, the owner receives one-half of the hay stacked in the field. Under the cash system, it is customary for the tenant to pay from $3 to $5 an acre for the use of the land, including all pasture and hay areas. On most farms the larger pasture tracts are rented for a lump sum. Bottom-land pasture has the highest rental value. On a few farms the tenant is allowed the use of the pasture without charge. Only a small proportion of the land suited for the production of grain is rented for cash.

The 1935 Federal census reports the total value of land and buildings as $28,532,960, and the average acre value of the farms as $84.05. According to this census the average mortgage debt on farms operated by full owners was $52.59 an acre, and the taxes on these farms averaged $1.28 an acre in 1930. The selling price of individual farms ranges widely, depending on the general economic conditions, the character of the soil, surface features, drainage, improvements, and location with respect to markets. The location and improvements being comparable, the highest priced land is on the well-drained silty terraces along the Platte River, Salt Creek, and Weeping Water Creek, and the cheapest land is in the rougher and more eroded sections along the Platte and Missouri Rivers.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and of recording their characteristics, par-

ticularly in reference to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied at regular intervals. Each excavation exposes a series of layers, or horizons, and the entire section, from the surface down to the weathered but otherwise unmodified parent material, is known as the soil profile, or the solum. The classification is based on such internal characteristics of the soil profile as thickness, color, structure, texture, porosity, consistence, and content of organic matter and such external features as drainage, relief, and stoniness. The reaction of the soil [3] and its content of lime and salts are determined by simple tests.[4] The plant cover—either native vegetation or farm crops—is observed, and its relation to the soils is studied. In this way the natural productivity of the soil can be determined or estimated with a fair degree of accuracy. In classifying virgin lands, which may be brought under cultivation, the observation of like soils now being farmed is an important part of the work.

On the basis of their internal and external features the soils are grouped into mapping units. The three principal units are (1) series, (2) type, and (3) phase. In addition, areas of land, such as dune sand, riverwash, and stony mountainsides, which have no true soil, are called (4) miscellaneous land types.

The most important of these groups is the series, which includes soils that have developed from similar, although not necessarily identical, kinds of parent material, and that have the same genetic horizons, arranged alike in the soil profile. Thus, a series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture in that part of the soil commonly plowed may differ within a series. The series are given geographic names taken from localities near which they were first identified. Marshall, Cass, Knox, Waukesha, and Wabash are the names of soil series in Cass County.

Within a soil series are one or more soil types, defined according to the texture in the upper part of the soil, generally to about the depth of plowing. The name of the soil texture to this depth, such as silt loam, silty clay loam, fine sandy loam, and loamy sand, is added to the series name to give the complete name of the soil type. For example, Marshall silty clay loam and Cass fine sandy loam are types within the Marshall and Cass series, respectively. Except for differences in the texture of the surface layers, all soil types of the Marshall series have rather closely similar external and internal characteristics. The same holds true for all types of the Cass or any other series. The soil type is the principal unit of mapping, and because of its specific character is usually the unit to which agronomic data are definitely related.

A phase of a soil type is a soil which differs from the type in some minor feature, generally external, that may be of special practical

[3] The reaction of a soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values alkalinity, and lower values acidity.

[4] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

significance. A soil type may be very uniform throughout its distribution in all important profile features, but slight variations in its gravel content or in the relief may cause marked differences in the use capabilities of the soil in different localities. For example, within the range of relief of a soil type, there may be areas that are adapted to the use of machinery and the production of cultivated crops and other areas that are not. Even though there may be no important differences in the soil itself or in its ability to produce the native vegetation, there may be important differences in respect to the growth of cultivated crops owing to variations in the relief. In such an instance, the different kinds of relief, not normal for the soil, may be segregated on the map as either flat, sloping, or hilly phases, as the case may be. Similarly, soils having differences in stoniness may be mapped as phases even though these differences have no influence on the more important properties of the soil or on the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other cultural and natural features of the landscape.

SOILS AND CROPS

Cass County is in the corn- and wheat-growing belt of the United States. The climate and most of the soils are well suited for the growth of crops common to this belt and for the raising and fattening of livestock, which is the chief source of revenue. Nearly all of the soils are naturally fertile. Prior to their use for crops the more extensive soils supported a luxuriant growth of prairie grasses. Trees grew on the bottom lands and rougher valley slopes along the larger streams, but even in such localities the ground cover consisted mainly of grasses, except in places where the forest growth was unusually dense. The annual decay of grass roots produced an abundance of black well-decomposed organic matter, and all the soils except those on steep severely eroded slopes and on very recently deposited stream sediments have accumulated enough organic remains to make their surface soils dark, regardless of the color of the underlying parent material. The intensity of darkness and the depth to which the dark color has penetrated depend on relief, drainage, and the length of time the soils have lain in their present positions undisturbed by abnormal erosion.

In the more nearly level parts of the county, except those parts covered by recently deposited light-colored sediments, decomposed organic material is most abundant and has penetrated deeply into the soils, extending a little deeper, as a rule, in the well-drained than in the poorly drained soils. On the steeper slopes most of this material was removed before or shortly after it decomposed, and the soils are light-colored even at the surface. Between these extremes of drainage and relief the content and the depth of penetration of the organic matter varies mainly with the degree of slope. The areas where organic accumulations have been most restricted are in the bluff lands along the Missouri and Platte Rivers, on steep valley slopes along some of the creeks and their more deeply entrenched

tributaries, and in local areas of recently deposited sand, silt, or clay on the stream bottoms.

In addition to their prevailingly dark color, most of the soils are characterized by a granular or crumblike structure in their upper layers, this feature persisting to greater or less extent in all except the more sandy soils. It is best developed in the older and more nearly mature soils of the well-drained uplands and terraces, where a markedly granular structure commonly extends to a depth of 24 inches or more.

A third fairly uniform characteristic of the soils is the occurrence of lime (available calcium) in sufficient quantities for crop needs. This characteristic is less pronounced than the dark color and crumblike structure. None of the soils has an abundance of lime in the surface layer, and few contain noticeable amounts in the subsoil. Nevertheless, none of the soils shows evidence of a serious deficiency of lime, and only in scattered fields are increased yields obtained when lime is applied. Thick limestone layers, which outcrop at numerous places along the rivers and several of the creeks, afford an ample supply of easily obtained lime for use when the soils begin to respond more favorably to applications of this material.

With only a few exceptions, the soils of this county are friable and easily penetrated by air, roots, and water; nearly all of them have a high moisture-holding capacity; but few are porous enough to absorb more than a small part of the precipitation as rapidly as it falls. As a result, much of the rainfall is lost through run-off and evaporation without becoming available to plants. Over the county as a whole, the run-off alone probably removes more than 30 percent of the mean annual precipitation, and, since farming began, it has considerably thinned the surface soils in many cultivated fields. Little of the land has been rendered uncultivable by improper farming practices, and on the more nearly level areas practically no injury has occurred, but in some of the cultivated fields with a slope exceeding 5 or 6 percent, the soils have been noticeably damaged by gully erosion.

The three rather persistent characteristics—high organic-matter content of the surface soil, granular or crumblike structure of this layer, and lime sufficient for crop needs in the subsoil—are valuable soil assets in connection with crop production. Organic matter is a strong absorbent of both heat and moisture. It increases the rate of moisture absorption and the water-holding capacity of the soil and assists in maintaining a uniform soil temperature. It also promotes favorable tilth, retards water erosion, and is the chief source of nitrogen, an important plant nutrient. The granular or crumblike structure facilitates root penetration and the free movement of air and water, which change the raw vegetal and mineral constituents of the soil into nutrients for growing crops. Although lime, in the form of calcium carbonate, is almost entirely absent in most of the soils, none of them has a notably sour or acid condition, which would hasten the destruction of the organic matter and the crumblike structure.

A diversified farming system is almost universally practiced, partly because the soils and climate favor the production of feed for livestock and of wheat, and partly because the county is within short

hauling distance of Omaha, an important grain and livestock market. This system enables the farmer to grow considerable alfalfa in order to replace nitrogen removed from the soil by grain crops, and to rotate all crops in such a manner as to maintain the soils in a highly productive state without detracting from his net annual returns. It also enables him to apply manure to the land from his feed lots at no expense except for labor.

The crops most extensively grown are corn, wheat, oats, and legumes, chiefly alfalfa and red clover. These crops, with the exception of wheat, which is sold for cash, are used mainly as feed for livestock. Some wild hay is produced, mostly on small scattered areas on rather steep slopes throughout the uplands and on the more poorly drained parts of the bottom lands.

The grain and tame-hay crops common to the general region are grown to greater or less extent on all the soils suited to cultivation, but some of the soils are more productive of one crop than of another. Even on the same soil the crop adaptabilities and yields may vary with the degree of slope, which influences the rapidity of run-off and consequently the amount of moisture that penetrates the ground. Differences in the soil and moisture conditions have determined to a large extent the proportional acreages devoted to the different crops on the different soils and on different slope gradients of the same soil.

Corn, because of its ability to adapt itself to a wide range of soil and moisture conditions and because it is needed to feed livestock, is naturally the leading crop on all the cultivated land. The proportional acreage used for corn, however, is greater on the well-drained parts of the bottom lands (Wabash and Cass soils) than it is on soils of the uplands, because corn adapts itself better to bottom-land conditions than most of the other crops, particularly the small grains. Corn occupies a larger proportion of the rather steeply sloping land than it does of the smoother parts of the uplands, where small grains do best and are grown most extensively, because of the difficulty in using heavy machinery, such as binders and combines, on the slopes.

Oats and wheat are grown chiefly on those parts of the Marshall and Carrington soils where the slopes do not exceed 7 percent. Alfalfa is grown more extensively on the terraces (Waukesha soil) and on the better drained parts of the bottom lands, where an abundance of moisture is within reach of its roots. The greater part of the sweetclover and red clover is produced on rolling to strongly rolling upland areas of Carrington and Marshall soils, where they are used in crop rotations. In these localities they are especially valuable for retarding erosion and for building up the organic-matter and nitrogen contents of the soil, which, under grain cropping, become rapidly depleted on the sloping lands. Some of the light-colored silty soils of the Knox series are well suited to orcharding, especially on northward-facing slopes that are not too steep for cultivation. In well-drained areas the dark sandy soils of the bottom lands (Cass soils) are excellent for truck crops. They warm early in the spring and are used by many farmers for growing sweet corn, tomatoes, melons, and cucumbers, which are sold in the Omaha markets.

Although the soils differ more or less in their agricultural values, so far as their use for certain crops is concerned they may be placed in groups, each of which includes soils that are fairly uniform in their

producing powers and crop adaptations and that are used for some particular crop or crops more extensively than are soils belonging to another group. In this county five soil groups, based mainly on the drainage conditions, which are among the most important factors affecting local differences in the characteristics and agricultural possibilities of the soils, are recognized; namely, well-drained soils of the uplands and terraces, imperfectly drained soils of the uplands and terraces, excessively drained soils of the uplands, variably drained soils of the bottom lands, and miscellaneous soil materials.

This method of grouping is not meant to imply that the agricultural practices are strictly uniform on the soils of any particular group or that the soils of that group are equally productive. Even within a group some variation exists in the drainage conditions and in other characteristics that affect agriculture, such as the surface features of the soils, their moisture, lime, and organic-matter contents, texture, stoniness, and susceptibility to erosion. In addition, the farming systems and the crops grown may differ on the different soils of a group, or even on the same soil in different localities, with differences in the requirements of the individual farmer and in the amount and distribution of the local precipitation. Over long periods, however, the soils of each group here recognized give the largest returns from and are used chiefly for the crop or crops best suited to their moisture supply and to their texture, consistence, and other characteristics. In establishing the five groups, recognition is given to soil and crop adaptations and also to those soil characteristics that are responsible for these adaptations.

None of the soil groups is confined to any particular part of the county, and many of the soils belonging to one group are within larger areas of those belonging to another group.

In the following pages the individual soils of the different groups are described, and their cropping possibilities are discussed; the soil map accompanying this report shows the distribution of the soils in the county; and table 5 gives their acreage and proportionate extent.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Cass County, Nebr.*

Soil type	Acres	Per-cent	Soil type	Acres	Per-cent
Marshall silty clay loam	131,392	37.0	Lancaster sandy loam	128	(1)
Marshall silty clay loam, smooth phase	95,872	27.0	Sogn silt loam	3,456	1.0
Carrington silt loam	4,160	1.2	Wabash silt loam	33,664	9.5
Carrington silty clay loam	1,088	.3	Wabash silty clay	1,536	.4
Waukesha silty clay loam	10,624	3.0	Wabash fine sandy loam	832	.2
Judson silt loam	192	.1	Bremer silt loam	1,600	.4
Butler silty clay loam	2,560	.7	Lamoure silty clay	320	.1
Scott silty clay	320	.1	Cass fine sandy loam	2,688	.7
Pawnee silty clay loam	320	.1	Cass silty clay loam	1,024	.3
Marshall silty clay loam, slope phase	31,936	9.0	Cass loamy sand	320	.1
Carrington silt loam, slope phase	2,240	.6	Sarpy fine sandy loam	896	.2
Carrington loam	576	.2	Sarpy loamy fine sand	1,920	.5
Knox silt loam	17,984	5.1	Riverwash	2,880	.8
Knox silt loam, smooth phase	3,904	1.1	Made land	192	.1
Shelby loam	576	.2	Total	355,200	

[1] Less than 0.1 percent.

WELL-DRAINED SOILS OF THE UPLANDS AND TERRACES

The well-drained soils of the uplands and terraces occupy 68.6 percent of the total land area of the county. One or another of them occurs throughout the well-drained uplands and terraces wherever erosion is not severe. The relief ranges from nearly level on the terraces and tops of the broader upland divides to moderately sloping on the valley sides. Surface and internal drainage are everywhere good. The group includes all the Waukesha and Judson soils and the smoother areas of the Marshall and Carrington soils. The Waukesha soils are on stream terraces, the Judson soils on gentle colluvial slopes, and the rest are on the uplands.

The surface layers of all these soils are mellow, contain an abundance of well-decomposed organic matter, and are very dark grayish brown or almost black. They are thicker and darker, as a rule, than the corresponding layers in any other soils in the county, except part of those in the bottom lands. The texture is prevailingly fine, being a silt loam in most places. The subsoils are friable to the extent that they allow easy penetration of plant roots and free movement of air and moisture. They are thoroughly leached of lime carbonate, except in a few small and widely scattered patches, though soluble compounds of calcium and other bases are present in sufficient quantities to prevent a sour or acid condition, and none of the soils requires liming even when used for growing alfalfa and sweetclover.

The soils of this group have about equal moisture-infiltration rates and water-holding capacities, but the amount of moisture actually stored for plant use differs somewhat in the different soils and in different localities on the same soil. The greater part of the area occupied by these soils is under cultivation and is used for all the main crops commonly grown, with good results. Corn, small grains, and alfalfa are the principal crops. Slight differences in grain and tame-hay yields occur on the different soils, owing mainly to differences in relief, particularly the slope of the land and its elevation with respect to surrounding areas. On the uplands the soils are more sloping, as a rule, than on the terraces, and they suffer greater loss of moisture through run-off, hence are a little less productive. For the same reason the soils on the sloping parts of the uplands are a little less productive than those on the more nearly level parts. Within areas of a given soil type, those tracts in which the relief is sufficiently pronounced to affect the value of the land for cultivated crops are delimited as slope phases of the soil type to which they belong.

Marshall silty clay loam.—Marshall silty clay loam occupies 205.3 square miles in the county. It occurs in nearly all parts of the loessial uplands, mostly on slopes ranging between 4 and 7 percent,[5] although many of the areas shown on the map include patches in which the slope is a little less or greater than these percentages. The soil everywhere is well drained, and in places the run-off is sufficiently rapid to have caused noticeable erosion.

The surface soil, which contains an abundance of organic matter except locally, is mellow and finely granular and is very dark even

[5] A slope of 4 percent is one in which the land rises or falls 4 feet vertically in a horizontal distance of 100 feet. All other slope percentages are rated similarly.

when dry; when moist it is almost black. Normally it ranges from 11 to 15 inches in thickness, but in local patches it is 6 or 8 inches thinner than typical and in places a few gullies have developed. The subsoil is dark grayish brown at the top, is yellowish brown between depths of 18 and 30 inches, and becomes light yellowish brown at its base. It consists largely of silt loam and, except in the lower part, contains a little more clay and is slightly heavier than the surface soil, but it remains friable throughout. The material is coarsely granular in the upper half and cloddy below. The subsoil rests on Peorian loess, from which the soil has developed, in most places within a depth of 6 feet. The loess consists of very light grayish-brown or brownish-white floury massive silt containing scattered brown and dark-brown spots, splotches, and stains.

Except locally, the soil material within a depth of 10 feet does not contain sufficient lime to produce noticeable effervescence when dilute hydrochloric acid is applied, although the native vegetation does not indicate a deficiency of lime.

Marshall silty clay loam has all the essential plant nutrients and is admirably suited to any crop commonly grown in this section. Practically all of it is under cultivation. Corn is grown chiefly, followed by wheat, oats, alfalfa, and clover, ranking in acreage during most years in about the order named. The average yields on this soil, although a trifle lower than those on the smooth phase of Marshall silty clay loam, are among the highest obtained on the uplands, but yields of all crops differ in accordance with the amount and distribution of the moisture supply. In seasons of normal or above normal precipitation the better farmers obtain from 60 to 70 bushels of corn an acre, but the acre yields over a period of years average much lower. None of the crops, except alfalfa, produces as well as on Marshall silt loam of western Iowa, where the precipitation is higher. Alfalfa does better, as a rule, than on most upland soils in Iowa, where liming is necessary if the highest yields of this crop are obtained.

The soil is easily managed but requires a little more care in controlling erosion and conserving moisture, if optimum yields are to be maintained, than is required on the smoother soils of the terraces and bottom lands. Corn yields especially are increased under moisture-conservation practices.

The principal variation in this soil is in the southwestern part of the county, principally in Tipton and Stove Creek Precincts. Here the upper subsoil layer, although similar in color to that of the soil as a whole, is a trifle heavier than normal. The greater heaviness, however, is scarcely noticeable except through close comparison with subsoil material from the northern and eastern parts of the county, and it is not regarded as sufficiently important to warrant recognition on the soil map. It does not noticeably affect the agricultural value of the land.

Marshall silty clay loam, smooth phase.—The smooth phase of Marshall silty clay loam differs from the typical soil mainly in having more nearly even surface features. It occupies about 150 square miles in the county, occurring more or less extensively in nearly all parts of the loessial uplands wherever the ground does not slope more than 4 percent in any direction. The soil is well drained, but the run-off is not sufficiently rapid to have caused more than normal

erosion except in local patches. It absorbs moisture fairly rapidly and has a high water-holding capacity.

Owing to reduced run-off and consequently reduced erosion, the surface layer of this smooth soil averages about 3 inches thicker than the corresponding layer of typical Marshall silty clay loam. It is very dark, friable, and granular. The subsoil is identical in color, texture, and consistence with that of typical Marshall silty clay loam but averages slightly thicker. It rests on the parent Peorian loess at a depth of about 6 feet. Except in places where relatively impervious underlying beds have caused lime to remain in the subsoil, neither the soil material nor the upper part of the parent loess is noticeably limy.

Practically all of this soil is under cultivation. It is slightly superior to typical Marshall silty clay loam for corn and small-grain crops but seems to have no advantage over that soil for the production of alfalfa and clover. It is admirably suited for native pasture and hay land, but only a few small areas remain with their cover of native grasses.

This soil is easily managed and withstands severe cropping under rather poor management without serious reduction in yields. It is the most highly prized soil of the uplands for general farming.

In Tipton and Stove Creek Precincts the upper subsoil layer of this soil is slightly heavier than normal, but this condition does not seem to alter the agricultural value of the land and is not given separate recognition on the soil map.

Carrington silt loam.—Carrington silt loam occupies 6½ square miles. The greater part of it is in the south-central and southwestern townships, where it occurs in narrow strips and bodies of various, but mostly small, sizes on valley sides and low rolling divides, adjacent to deeply entrenched drainageways. Practically all of the areas have a slope ranging from 4 to 7 percent in one direction or another. Run-off is fairly rapid, owing chiefly to the rather low infiltration rate, but the slopes are not steep enough to have promoted severe erosion except in some cultivated fields that have been poorly managed.

All this soil is on glacial drift, which was exposed to weathering and soil development through the removal of the overlying loess by erosion. The surface soil averages about 12 inches in thickness. It contains an abundance of well-decomposed organic matter and is very dark grayish brown or almost black. The material has a highly developed fine-granular structure and is mellow and friable throughout. The silt loam texture predominates, although small patches, most of which are near the bases of slopes, have a silty clay loam texture. The upper subsoil layer consists of moderately heavy sandy clay loam or gritty silty clay loam. It is commonly of a uniform light-brown or yellowish-brown color but in some localities contains numerous rust-brown and gray mottlings caused by imperfect underdrainage. This layer extends to an average depth of 30 inches, where it gives way, through a thin transitional zone, to the weathered (leached and oxidized) but otherwise little altered parent drift. The drift is variable in texture but generally contains more or less coarse material including gravel and boulders of various sizes mixed with its more abundant silt and clay constituents.

All contacting horizons of the profile merge into one another in texture, color, structure, and consistence, or degree of compaction. Pebbles and gravel fragments as large as several inches in diameter, are scattered throughout the soil and over the surface of the ground but are nowhere sufficiently abundant to interfere seriously with cultivation. The soil does not contain enough lime to effervesce noticeably when hydrochloric acid is applied, but crops do not indicate a deficiency of lime.

Nearly all of this soil is under cultivation, and any crop common to the section can be grown on it with good results. As over most of the county, corn occupies by far the largest acreage, but wheat, oats, alfalfa, and clover also are produced. The rather slow absorption rate of this soil makes it a little more droughty and less productive, especially in dry seasons, than most loess-derived soils in areas of comparable relief, but in seasons of normal or above normal precipitation it is able to absorb enough moisture to insure nearly as high yields as are obtained on any of the Marshall soils.

Carrington silty clay loam.—Carrington silty clay loam has a more clayey and heavier surface soil than Carrington silt loam and occurs in areas having a slightly wider range of relief. It occupies small scattered patches and narrow strips, few of which exceed 100 acres in size, chiefly on valley sides in the southwestern part of the county. Most of this soil occurs on slopes ranging between 4 and 10 percent.

This soil absorbs moisture slowly, and much of the water falling on it runs off the land, but it occurs in a region of sufficient precipitation to be supplied with enough moisture for profitable crop production except in the drier years. Only a little of the land has been seriously eroded.

The surface soil is very dark grayish brown and ranges from 10 to 12 inches in thickness except in local patches of a few square rods each where it has been considerably thinned by erosion and become lighter colored. It consists of rather heavy silty clay loam with a pronounced fine-granular structure. The remainder of the soil material is similar to Carrington silt loam in most places, but locally it is more clayey and a trifle heavier. The soil contains enough sand to give all its layers a pronounced gritty feel. Gravel and pebbles are scattered throughout the soil mass and on the surface of the ground but are not numerous enough to alter notably the porosity or to interfere with cultivation. The parent drift is nearly everywhere within a depth of 4 feet. It is calcareous in places, but the overlying soil is lime free.

Carrington silty clay loam is adapted to all the commonly grown farm crops, and most of it is under cultivation. In dry seasons crop yields are considerably lower than are those obtained on the more silty soils of the uplands, chiefly because the silty clay loam surface layer of this soil absorbs less of the precipitation than is absorbed by the corresponding layer of more friable soils. In wet seasons all crops do about as well as on Carrington silt loam.

This soil cannot be worked under so wide a range of moisture conditions as the less clayey soils. If it is plowed when wet, hard lumps are formed, which require subsequent wetting and drying or freezing and thawing before granulation is restored. It is difficult

to plow the land when it is extremely dry, but under favorable moisture conditions the surface soil is easily kept in good tilth.

Waukesha silty clay loam.—Waukesha silty clay loam covers the stream terraces or benches and comprises a total area of about 16½ square miles. It has developed mainly from loess or loesslike material and occupies both low and high terraces, all of which are well above danger of overflow from the main streams.

The terraces have nearly flat or gently undulating surfaces except where crossed by drainageways issuing from the uplands. One of the oldest and highest is along Salt Creek in the extreme northwestern part of the county. This and a few of the other high benches were capped by loess, as were the uplands, and only their basal parts are water-laid. The lower terraces are mostly in the valleys of the Platte and Missouri Rivers near the mouths of large tributaries and along Weeping Water Creek. The material composing them is strictly alluvial, having been carried to its present positions by the streams and deposited upon their flood plains when they were flowing at higher levels. All areas of Waukesha silty clay loam have good surface and internal drainage, and practically none of the land is subject to damaging erosion. This soil does not differ materially in profile features from Marshall silty clay loam of the uplands.

The surface soil is very dark grayish brown when dry, almost black when wet, and consists of soft mellow silt loam with a high organic-matter content. It extends to an average depth of about 14 inches and is highly granular except in the 4- or 5-inch surface layer where tillage has destroyed the granulation. The upper subsoil layer is composed of brown or dark-brown granular silt loam or silty clay loam, slightly heavier than the surface soil but friable throughout. This gradually gives way, at a depth ranging from 20 to 30 inches, to light-brown or yellowish-brown mellow silt loam, which rests on floury light-gray parent silt a little below a depth of 4 feet. Neither the soil nor the upper part of the parent material is limy.

Included within areas classed as this soil are a few small patches of Waukesha fine sandy loam and Waukesha very fine sandy loam. These patches have about the same agricultural value as Waukesha silty clay loam. Owing to their small total extent, however, they are not shown separately on the soil map. Most of them are along the edges of the terraces nearest the flood plains where wind-blown sand from the stream beds has slightly coarsened the texture of the surface soil.

All this soil, except inaccessible strips and bodies in some of the narrower valleys where the terraces are severely dissected by stream meanders, is under cultivation. It is admirably suited for any of the crops commonly grown and is considered the best general farming soil of this general region. Corn is the principal crop, followed by wheat, oats, and alfalfa, ranking in acreage during most years in about the order named. Although most of the land is devoted to corn, a larger proportion of it than of any other soil in the county is used for growing wheat.

All crops yield higher on Waukesha silt loam than on the best soils of the uplands, chiefly because of the greater moisture supply on the terraces. Alfalfa can be grown more frequently than on the

upland soils without depleting the deep-seated moisture so essential for the continued production of alfalfa in Nebraska.

Judson silt loam.—Judson silt loam is limited to a few widely scattered patches and short strips. It is simply black surface soil material that has washed or rolled down from higher levels and accumulated at the bases of slopes leading to the uplands or from the bottoms to the terraces. A part of it occurs as fanlike deposits formed at the point where small drainageways enter the larger stream valleys.

The soil consists of a uniform mass of very dark grayish-brown or almost black friable silt loam to a depth of at least 36 inches. It has a high water-holding capacity and is naturally well supplied with organic matter. It is all under cultivation, and no soil in the county is more productive, but it is of little agricultural importance on account of its small extent.

IMPERFECTLY DRAINED SOILS OF THE UPLANDS AND TERRACES

The imperfectly drained soils of the uplands and terraces occupy a smaller total area than those of any other group in the county. They include the silty clay loam types of the Butler and Pawnee series and Scott silty clay. All have dark friable surface layers underlain by a heavy almost impermeable claypan. The Scott and Butler soils have developed on loessial deposits, whereas the Pawnee soil overlies glacial drift. The Scott soil occurs in basinlike depressions locally known as buffalo wallows or lagoons, the Butler soil occupies nearly level and gently sloping areas, and most of the Pawnee soil occupies slopes ranging from 3 to 7 percent in gradient. Scott silty clay is the only soil of the group that has been thoroughly leached of lime. The others have a pronounced zone of lime enrichment in the lower part of the subsoil. The claypan in all these soils is sufficiently dense to restrict greatly the movement of moisture and air, also penetration of roots. In the Scott and Butler soils the claypan apparently was formed mainly through the translocation of clay by downward percolating waters from the surface layer to the subsoil, but in the Pawnee soil it owes its development partly to clay from the surface soil and partly to an unusually fine textured layer in the parent drift.

None of the soils in this group is so well suited for farming as those of the group of well-drained soils of the uplands and terraces. The Scott soil has a very thin surface layer and is of practically no value for cultivation. It is covered with water, often for several weeks, after periods of heavy precipitation. The Butler and Pawnee soils have thick surface layers, are fairly productive, and most of the area occupied by them is farmed. During seasons of normal or above normal precipitation they return nearly as high yields of all crops commonly grown as are obtained on the best Marshall soils, but in dry years the layer above the claypan is unable to store enough moisture for high yields of grain and tame-hay crops. The claypan supplies little water, and any moisture that may be present in the material beneath it is not readily available to most crops.

Butler silty clay loam.—Butler silty clay loam covers a total area of 4 square miles. It occurs on the more nearly level and gently sloping parts of the loessial uplands, chiefly in the western part of the county.

Some of the largest areas, few of which exceed 300 acres in size, are in Tipton and Stove Creek Precincts.

This soil has accumulated an abundance of organic matter, but surface drainage is rather slow in most places, and much fine material has been carried downward by percolating waters, thereby producing a heavy claypan in the upper part of the subsoil. Internal drainage is practically negligible.

The surface soil is very dark grayish-brown or black finely granular silty clay loam, with an average thickness of about 14 inches. In most places the lower 3- or 4-inch layer of the surface soil, although very dark when moist, contains a rather heavy sprinkling of light-gray silt particles, from which the organic matter has been leached, and when dry it has a somewhat lighter shade than the overlying material. Beginning abruptly beneath the surface soil is a layer of very dark grayish-brown, in places almost black, heavy massive clay. This, the upper part of the subsoil, ranges from 10 to 15 inches in thickness and is a true claypan. It absorbs water very slowly and even during wet years allows little moisture to pass through. The lower part of the subsoil consists of grayish-brown friable or only moderately heavy silt loam or light silty clay loam. It is calcareous throughout, the lime occurring both as hard concretions and in finely divided form. The soil rests on light grayish-brown or yellowish-brown slightly oxidized and floury silt—the parent loess—at a depth of about 4 feet. The loess may or may not be limy.

Although most areas of this soil are nearly level, they have sufficient slope to carry off the surplus surface moisture, and none of the land is too poorly drained for farming. Practically all of the areas are under cultivation. The surface soil rests on less permeable material than that underlying the Marshall soils; and, generally, it cannot be cultivated so soon after rains as Marshall silty clay loam, owing to its wetter condition. This is well demonstrated in fields including both the Butler and the Marshall soils. If such fields are cultivated as soon after rains as moisture conditions in the Marshall soil become favorable, the associated Butler soil invariably puddles, bakes, becomes cloddy, and loses an excessive amount of moisture through evaporation. The dense claypan layer in the Butler subsoil holds little moisture that is available to plants, and when the moisture in the surface soil is depleted, crops generally suffer from drought; therefore, successful crop production on Butler silt loam depends largely on the moisture supplied by the surface soil.

All crops common to the general region are grown on this soil, but small grains, which mature early in the summer, largely on moisture stored near the surface of the ground, do better, as a rule, than corn, which requires moisture for a longer period. During seasons of normal or high precipitation all crops are as productive as on the more friable soils of the uplands, but in dry years corn, especially, suffers from drought.

Scott silty clay.—Scott silty clay occupies small shallow basins and depressions known as buffalo wallows or lagoons, scattered over the more nearly level loessial uplands and on the terraces, chiefly in the western part of the county. It is most typically developed in the vicinity of Greenwood. The greater part of the basins occupy less than 2 acres each and have a combined area of only

one-half square mile. Storm water accumulates in them all and in some remains on the surface of the ground for several weeks, disappearing slowly through seepage and evaporation. The soil is everywhere poorly drained.

The surface soil is somewhat granular silty clay ranging from less than 6 to about 10 inches in thickness. The upper one-half or two-thirds contains most of the organic matter and is almost black, and the remainder may or may not be dark but in most places is considerably leached and locally is light gray. The subsoil consists of gray, steel-gray, or light bluish-gray heavy massive clay containing numerous rust-brown spots and splotches caused by poor drainage. This layer, a true claypan, is practically impervious to water. Below a depth of 4 feet it gradually becomes more friable, and at a depth of about 6 feet it gives way to light grayish-brown or yellowish-brown floury silt of the parent Peorian loess. No part of the soil or of the underlying loess within a depth of 10 feet contains lime.

The soil does not react favorably to cultivation except under a limited range of moisture conditions. If plowed when wet, hard clods are formed that require wetting and drying or freezing and thawing before they can readily be reduced, and it is practically impossible to plow the land when it is extremely dry.

Scott silty clay is not well suited for cultivated crops. In wet seasons it is under water much of the time, and during prolonged droughts the clay subsoil shrinks and cracks, thereby breaking plant roots and exposing the soil to extreme desiccation. Nearly all of the areas, however, are within cultivated fields, and most of them are farmed with the rest of the land. In normal seasons the soil is fairly productive, but in wet or dry years cultivated crops generally fail. Some farmers leave the Scott soil areas in native grass, and a few have attempted to drain the land. All the areas are surrounded by higher land, in most places for a considerable distance on all sides, and drainage, as a rule, is not practicable. The soil occupies only a small part of the farms on which it occurs, and it is of negligible agricultural importance in this county.

Pawnee silty clay loam.—Pawnee silty clay loam occupies a small total area, chiefly in the southwestern part of the county. It has developed from glacial drift on slopes ranging in general between 2 and 6 percent. The greater part of this soil is closely associated with one or another of the Carrington soils. Few of the individual areas exceed 50 acres in size.

Surface drainage is everywhere good, and in a few places run-off is sufficiently rapid to have somewhat thinned the surface soil, but only a few small patches have been noticably damaged by erosion. Underdrainage is poor, owing to the claypan layer in the upper part of the subsoil.

Pawnee silty clay loam differs from Carrington silt loam in having a thinner surface soil, a much heavier upper subsoil layer, and lime in the lower part of the soil mass. The surface soil, which in most places is about 8 inches thick, has accumulated an abundance of organic matter and is very dark grayish brown or almost black. This layer may range from 4 to 10 inches in thickness and from loam to silty clay loam in texture. The dominant texture is silty clay loam.

The material is very friable under normal moisture conditions. Beneath the surface soil is brown or grayish-brown heavy massive clay containing sufficient sand to give it a noticeably gritty feel. This layer, which is a true claypan, ranges from 10 to 30 inches in thickness and is almost impervious to the penetration of moisture. It is lightest in color near its base, where it contains considerable lime in the form of soft segregations and scattered hard concretions. The material in this layer gives way, in most places within a depth of 4 feet, to glacial drift, similar to that beneath the Carrington soils, which may or may not be limy. The soil is almost free of gravel, although a few glacial pebbles may occur on the surface and in any part of the soil mass.

Because of its small extent, this soil is of little agricultural importance. The greater part of it is under cultivation, and a few areas, where the slopes exceed 8 percent, remain in pasture and woodland. All crops common to the general region can be grown successfully in the cultivated areas. Corn, wheat, oats, and alfalfa, ranking in acreage in about the order named, are the principal crops. Yields depend on the amount and distribution of the precipitation; in normal years they compare favorably with those obtained on Carrington silt loam, but in dry years all crops suffer severely from drought because the rather thin surface soil is unable to store enough moisture to sustain normal plant growth for more than a short period. This soil cannot be handled without injury under so wide a range of moisture conditions as can the more friable soils of the uplands. The surface layer has a pronounced tendency to form clods if plowed when wet, thus promoting rapid loss of moisture through evaporation; but under proper moisture conditions it is friable, mellow, and easily maintained in good tilth.

EXCESSIVELY DRAINED SOILS OF THE UPLANDS

The group of excessively drained soils of the uplands includes soils in which an unusually large proportion of the precipitation runs off the land without benefiting the vegetation. All the soils have suffered noticeable erosion, and some are severely eroded. The greater parts of them occur on slopes ranging from 7 to more than 15 percent, and much of the area occupied by them is extremely rough and broken.

Strongly sloping areas of Marshall, Carrington, Knox, Shelby, Lancaster, and Sogn soils belong to this group. Collectively these soils occupy 17.2 percent of the area of the county. One or another of them occurs in all parts, although the more steeply sloping areas of each are in or near the bluff lands along the Platte and Missouri Rivers.

The Marshall and Knox soils of the group have developed or are developing on loess; the Carrington and Shelby soils are on glacial drift; and the Lancaster and Sogn soils are on sandstone and limestone bedrocks, respectively. Although all these soils have become more or less eroded, either during or subsequent to their development, most of the Marshall and Carrington soils still retain an abundance of organic matter in their surface layers, which are very dark and more than 8 inches thick. The remaining soils of the group have thinner and, as a rule, lighter colored surface layers. Aside from the

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Sogn soils and some areas of Knox silt loam, none of these soils contains an abundance of lime, and some are nearly devoid of this material, but, as yet, no lime is required on any of them.

About two-thirds of the area occupied by the soils of this group is under cultivation and is used more or less extensively for growing all the crops common to this general region. The remainder, including part of the Knox soil and most of the Shelby, Sogn, and Lancaster soils, is too rough, broken, steeply sloping, or stony for farming and remains in native pasture or woodland or is included in orchards. All the cultivated land has enough of the essential plant nutrients to produce higher crop yields than the moisture supply allows. This land is naturally more difficult to farm than that of smoother areas, and it suffers greater erosion; but the most objectionable feature, so far as crop returns are concerned, is the excessive loss of moisture through run-off on the slopes. In seasons of high precipitation all crops yield nearly as well on these soils as on those of the smoother lying uplands, but in normal and dry years crop yields on the slopes decline much more than on the flats. All the cultivable soils of the group could be made more productive through farming practices designed to hold the precipitation longer on the land.

Marshall silty clay loam, slope phase.—The slope phase of Marshall silty clay loam differs from the typical soil previously described, mainly in its steeper relief. It occupies almost 50 square miles in Cass County and occurs chiefly on the valley sides of drainageways leading to the Platte and Missouri Rivers. Most of the areas are on slopes ranging between 7 and 15 percent, and a few are on steeper land.

Run-off everywhere is rapid, and all the soil has been subjected to rather severe erosion, but most of it still retains a 7- to 10-inch dark friable silt loam surface soil well supplied with organic matter. The remainder of the soil material is identical with that of typical Marshall silty clay loam in color, structure, and consistence, but it is slightly thinner and rests on the parent Peorian loess, in most places within a depth of 4 feet.

The greater part, probably over 90 percent, of the total area of the slope phase of Marshall silty clay loam does not contain enough lime to react visibly when hydrochloric acid is applied, and the remainder consists of widely scattered patches in which lime occurs in the lower part of the subsoil. These patches, few of which exceed one-half acre in size, are too small to be indicated legibly on the soil map.

Nearly all areas of this sloping soil are under cultivation and are used for growing the same crops as are produced on the less steeply sloping land. Corn occupies the largest acreage, and considerable alfalfa, red clover, and sweetclover are grown. The small-grain acreage is rather small, chiefly because of difficulty in using the larger and heavier types of farm machinery, such as drills, binders, and combines, on the slopes.

Under the customary farming practices this soil is less productive than the more level Marshall soils, because it loses a much larger proportion of the precipitation through run-off. It is more productive than any other soil in the excessively drained group, however, and under farming practices designed to retard erosion and to hold

moisture on the land it yields nearly as high as the more nearly level soils of the uplands.

Many of the steeper slopes are covered with native grasses and are included in grazing land, for which the soil is as well suited as any on the uplands.

Carrington silt loam, slope phase.—Carrington silt loam, slope phase, does not differ greatly in profile features from typical Carrington silt loam described with the group of well-drained soils. It has developed on the same kind of parent material as that underlying the typical soil, with which it is closely associated, but it occupies steeper slopes, ranging from 7 to 15 percent gradient, and has been subjected to much more rapid run-off and erosion. The greater part of it is on the lower slopes of deep drainageways in the southwestern part of the county, but it also occurs here and there in similar positions along Weeping Water Creek. Few of the bodies exceed 160 acres in size, and their combined area is small.

The surface soil, where well developed, is 8 or 10 inches thick and consists of very dark grayish-brown or almost black friable granular silt loam. In numerous patches, especially some of the cultivated fields, too small to indicate on the map, the surface soil has been nearly or entirely removed. The rest of the soil material is identical with that of typical Carrington silt loam, but the soil as a whole is thinner and rests on weathered Kansan drift, generally within a depth of 3 feet. In a few places the drift is exposed.

Owing to the steepness of the slopes on which it occurs, only about one-half of this soil is under cultivation. Corn, sweetclover, and red clover occupy most of the cultivated land. Yields of corn average considerably lower than those on the smoother soils of the uplands, although profitable yields are obtained in all except the driest years. Corn depletes the supply of nitrogen rather rapidly on the slopes, and the frequent growing of legumes is necessary if optimum yields of this crop are maintained. The producing capacity of the cultivated areas could be greatly increased by farming practices designed to retard erosion and to hold the precipitation on the ground until more of the water could be absorbed. All the arable areas are amply fertile to produce much higher yields if the moisture supply were increased. The steeper slopes of this soil are in pasture and woodland. The grass cover on them is nearly as luxuriant as that on the more nearly level soils of the uplands.

Carrington loam.—Carrington loam occupies less than 1 square mile, mainly in the southwestern part of the county. It occurs in widely scattered tracts and patches on valley sides and ridges where most of the slopes range between 7 and 15 percent. The soil has developed on glacial drift and differs from Carrington silt loam chiefly in the texture of its surface soil.

Surface run-off is rapid, and nearly all of the steeper slopes are severely eroded. Some of the tracts include gullies that cannot be crossed with the heavier types of farm machinery.

On the more gradual slopes the surface soil consists of very dark grayish-brown friable and highly granular loam 10 to 12 inches thick, and the subsoil is light-brown or yellowish-brown moderately heavy clay loam or sandy clay loam. The parent drift lies at a depth of about 4 feet. In these localities the soil can be distinguished from

Carrington silt loam only by the slightly coarser texture of its surface soil and the larger quantity of gravel on the surface of the ground. Elsewhere erosion has partly or entirely removed the surface layer or has considerably reduced its organic-matter content. In many of the tracts this layer is grayish brown or dark grayish brown and less than 8 inches thick. The subsoil in the eroded areas has been little modified by erosion and does not differ significantly from that of the other Carrington soils, but, as a rule, it contains a relatively high proportion of sand and gravel. The soil contains no lime, but the parent drift is calcareous in places.

Only small areas of Carrington loam are too steeply sloping for the use of farm machinery, and the greater part of the soil is under cultivation. On comparable slopes it has about the same agricultural value as Carrington silt loam and is used for growing all crops common to the general region. Owing to its small extent, however, it is of little agricultural importance in this county.

The more steeply sloping areas remain in pasture and woodland. They support a luxuriant growth of prairie grasses and are equal to most of the other soils on the uplands for grazing purposes.

Knox silt loam.—Knox silt loam is the most severely eroded and the lightest colored soil of the loessial uplands. Most of it is on slopes ranging from 8 to 20 percent, but it also occupies numerous areas in which the land is extremely rough and broken. The relief, as a whole, is very hilly, and run-off is rapid. The greater part of the soil is in the bluff lands along the Missouri and Platte Rivers around the eastern and northern sides of the county.

This soil has been subjected to such severe erosion, either during or subsequent to its development, that the unweathered or only partly weathered loess is kept at or near the surface of the ground. The surface soil, even where least eroded, has accumulated only a little organic matter and in few places is darker than light brown. It consists of loose floury silt loam, except in a few small patches where it is somewhat sandy. This layer, in most places, does not exceed 6 inches in thickness. It grades downward through a thin transitional layer into raw yellowish-white or brownish-white silt of the parent Peorian loess, in most places within a depth of 2 feet. Even in areas where the surface soil is thickest, the substratum is exposed in numerous places, and much of the soil mapped as Knox silt loam is essentially raw loess.

The soil varies considerably in its content of lime. In the bluff lands along the rivers, where it is developing mainly on the deeper loess strata, it is generally very calcareous from the surface downward, but in many of the smaller areas along the valley sides of creeks and branches throughout the rest of the county it is low in lime or is lime free. It is probable that the upper strata in the loess, of which the soil so largely consists, have been leached of most of their lime.

Much of this soil in the bluff lands formerly was forested, and a part, including that nearest the rivers, still supports trees, but most of it developed under prairie grasses. About 55 percent of the land, including nearly all of the areas that are not too steeply sloping for the use of farm machinery, is under cultivation. Corn and oats are grown chiefly, although a considerable proportion of the land is used

for the production of alfalfa, sweetclover, and red clover. The crops seem to grow largely, and in some areas probably entirely, on nutrients supplied by the loess alone. Average yields of grain are lower than on soils of the less steeply sloping terrain, but alfalfa and the clovers do nearly as well as on any of the smoother soils of the uplands. Under careful management, including the frequent growing of leguminous crops in rotations, both grain and tame-hay yields are high, except in the drier seasons, when all soils of the uplands produce rather low yields.

Areas of this soil that are too steeply sloping for farming remain with their native cover of grasses or trees and are included in pasture or woodland. The cultivated areas have suffered more severe erosion than if they had remained in their virgin state, but their producing power has not greatly diminished, and they all give larger returns than could be obtained from native pasture or woodland. They had little or no soil when the land was first broken, and under current farming practices probably will not decrease appreciably in productivity as long as the loess, of which they consist for the most part, remains intact. Some reduction in yields may result from gullies, but this form of erosion does not become serious if the land is managed with reasonable care. The producing capacity of all the cultivated areas, however, could be greatly increased by retaining the precipitation longer on the slopes, by applications of barnyard manure, and by growing leguminous crops more frequently.

Knox silt loam, smooth phase.—The smooth phase of Knox silt loam is similar to the typical soil in profile features, but it has a more nearly even relief. It occupies elongated and generally narrow areas on the more rounded hilltops where the slope ordinarily does not exceed 7 percent and where farm machinery can be used with little difficulty. These areas are severely eroded, and in many places the unaltered or only slightly altered loess is exposed. The more gradual slopes favor slower run-off than occurs on typical Knox silt loam and allow more of the precipitation to penetrate the ground. All crops common to the section are grown on this smooth soil, with slightly higher yields than are obtained on the areas of the more steeply sloping Knox soil. The soil, however, is deficient in organic matter and, consequently, nitrogen, and it is less productive than the darker colored soils of the loessial uplands. Its productivity can be considerably increased through farming practices designed to retard erosion, to hold the water longer on the slopes, and to increase the naturally low supply of nitrogen. The frequent growing of alfalfa and sweetclover in rotation, the plowing under of green cover crops, the application of barnyard manure, and contour farming, all tend to increase the producing capacity of this soil.

Shelby loam.—Shelby loam is developing on glacial drift under conditions of severe erosion. It occupies only a small total acreage, chiefly in the southwestern part of the county, where it occurs in several small bodies on narrow ridges and on the lower parts of valley sides adjacent to the more deeply entrenched drainageways. The greater part of the land slopes from 8 to 20 percent in one direction or another. None of this soil contains as much organic matter as the more level soils of the uplands.

The surface layer, where best developed, exceeds a thickness of 6 inches in very few places. It consists of dark-brown friable loam containing numerous stones and a small quantity of decomposed grass remains. The rest of the soil material consists of raw Kansan drift, which is limy in most places. It ranges in color from gray to light brown and varies considerably in texture but in most places has considerable coarse sand and gravel mixed with its more abundant silt and clay constituents.

This soil is of little agricultural importance, owing to its small extent, unfavorable relief, and generally stony character. Some of it is used for growing corn and clover, but yields are low except in seasons of high precipitation, as the soil absorbs water slowly and suffers excessive loss of moisture through run-off. Most of the areas remain with their cover of native grass or trees and are used for pasture or woodland. None of them occupies more than a small part of the farm on which they occur.

Lancaster sandy loam.—Lancaster sandy loam occupies a very small acreage. It is developing from the soft reddish-brown Dakota sandstone, which underlies the Kansan drift and is exposed on the lower slopes of a few deeply entrenched valleys. The largest bodies, none of which exceeds 50 acres in size, are along small streams south and southwest of Louisville.

The relief ranges from steeply sloping to rough and broken. Erosion is severe nearly everywhere, and practically all areas of the soil include numerous outcrops of the parent sandstone. The surface soil, where best developed, has accumulated considerable organic matter and is dark grayish-brown or dark rust-brown mellow sandy loam about 7 inches thick. The remainder of the soil material is reddish-brown or pale reddish-brown sand or rotten sandstone, which rests on the unweathered or only slightly weathered Dakota formation within a depth of 2 feet in most places. Neither the soil material nor the parent sandstone contains sufficient lime to react noticeably when hydrochloric acid is applied, although the native vegetation does not indicate a deficiency of lime.

Most areas of this soil are topographically unsuited for cultivation. Some corn and truck crops are grown on the more gentle slopes where the bedrock lies deepest, but the greater part of the land remains with its virgin cover of grass and trees and is included in pastures or wood lots. The Dakota sandstone is used locally for construction purposes.

Owing to its high sand content, the soil absorbs water rapidly and warms early in the spring. In counties where it is more extensive and more deeply developed, the smoother areas are used largely for growing truck crops.

Sogn silt loam.—Sogn silt loam is an immature shallow and stony soil developing on limestones and light-colored limy shales under conditions of severe erosion. It occupies 3,456 acres in this county, chiefly on steep slopes and narrow ridges along Weeping Water Creek and in the bluff lands bordering the Platte and Missouri Rivers.

The surface soil, which exceeds 6 inches in thickness in few places, ranges from almost black to nearly white, the color depending on the quantity of organic matter present, but in most places is dark grayish brown. The silt loam texture predominates, although lime-

stone fragments are numerous throughout, and in many places the texture is stony silt loam. Except in coves and pockets where dark colluvium has accumulated, the rest of the soil mass consists largely of light-colored shales, clays, and limestone fragments, the latter in various stages of decomposition. Hard, unweathered limestone is present within a depth of 2 feet in most places, and it outcrops on all the steeper slopes.

The greater part of this soil is topographically unsuited for cultivation or is too stony for the use of farm machinery. Some corn and alfalfa are grown on the more gradual slopes where the soil material is relatively deep and is not too stony for farming, but yields are low except in the most favorable seasons. Most of the nonarable land supports bur oak trees and a rather sparse undercover of grasses and does not have a high value even for grazing. The trees are not of merchantable size but are of value for fuel and fence posts.

Some of the largest rock quarries in Nebraska are located on limestone beds within areas of this soil, and a large cement mill at Louisville operates on limestones and clays obtained within these areas. The limestone of this region, although rather soft, is suitable for use in small buildings, bridges, and culverts, and for road surfacing. Much of it is used in revetments to control the channel of the Missouri River for navigation.

VARIABLY DRAINED SOILS OF THE BOTTOM LANDS

The variably drained soils of the bottom lands occupy 12.4 percent of the total area of the county. They occur in bodies and strips of various sizes on the bottom land or flood plains along all the larger and many of the smaller streams. The largest bodies, some of which attain more than a mile in width, are along the Platte and Missouri Rivers and Salt and Weeping Water Creeks.

The surface of the bottom land is remarkably smooth except where traversed by old and active stream channels or where modified by slight elevations and shallow depressions. Surface drainage, although rather slow, is well established in most places. Much of the land lies less than 6 feet above the present stream channels and is subject to occasional overflow, but most of the water drains off within a few hours after the streams subside. Practically all of the formerly poorly drained areas, in which the soils are suitable for farming, have been ditched or tiled. Along the rivers the water table lies from 4 to 15 feet beneath the surface of the ground and the subsoils are kept well supplied with moisture even in the drier years.

This group includes the Wabash, Bremer, Lamoure, Cass, and Sarpy soils. None of these soils is old enough to have become greatly modified by soil-developing processes, and subsoil horizons such as occur in most soils of the uplands have not yet formed. The composition of the sediments on which the soils of this group are developing is the dominant factor in determining the character of the soils. The sediments deposited by the local streams flowing through loessial uplands are naturally uniform and silty in texture; and those laid down by the more deeply entrenched streams, which have cut through the loess into the underlying drift and bedrock formations, are coarser and more variable in texture. The mixing and reassorting of the fine

and coarse particles have produced a varied assortment of sediments, especially along the Platte and Missouri Rivers, where materials originated not only from the local loessial uplands but also from areas outside the county, mainly to the north and west. The Wabash, Bremer, and Lamoure soils are developing on the finer textured sediments, chiefly silts and clays, whereas the Cass and Sarpy soils are developing on the sands and gravels.

All the soils of this group are naturally better supplied with moisture than soils of the uplands and terraces, because they receive not only the precipitation but also considerable moisture through run-off from higher levels and through capillarity from the underlying water table. The moist condition prevailing in the bottom lands has favored a luxuriant growth of plants, chiefly grasses, and rapid decay of vegetation. All except the Sarpy soils, which are on the most recently deposited sands, have accumulated an abundance of organic matter and have very dark surface layers.

About 60 percent of the area occupied by the soils of this group is used for the production of grain and tame hay. These soils are best suited for growing corn and alfalfa, and, except in occasional years when serious damage results from floods, they produce higher yields of these crops than can be obtained on any soil of the uplands or terraces. Small grains grow well on the bottom lands, but, owing to the abundant supply of organic matter and moisture, they generally make a rank vegetal growth, at the expense of the grain, and mature rather late.

The uncultivated soils of the group are mostly in woodland or occupy narrow strips so severely dissected by stream meanders that they can be used only for pasture land. The greater parts of them produce a luxuriant growth of grass, together with some trees.

Wabash silt loam.—Wabash silt loam is the most extensive soil on the bottom lands. It occupies broken or continuous strips along all the larger and most of the smaller drainageways. The broadest and most typical areas are along Weeping Water Creek. The total area of the soil in this county is 52.6 square miles, or 9.5 percent of the county.

The relief in areas of this soil is practically negligible, although most areas have sufficient slope down the valleys to afford ample surface drainage. The soil lies only a few feet above the stream channels and is subject to occasional overflow, but most of the water drains off within a few hours after the streams subside. Many of the areas that are naturally poorly drained have been ditched or tiled.

Wabash silt loam probably has as much organic matter as any soil in the county, regardless of location. It consists largely of dark-colored alluvium that has been washed from the surface layers of soils on valley sides farther upstream and carried to its present position as sediment during periods of high water. The 15- to 18-inch surface soil is almost black silt loam, even when dry, and is mellow and friable throughout. The rest of the soil material consists of moderately heavy silt loam or silty clay loam, which extends downward for several feet with little change except for an occasional thin layer of lighter colored or coarser textured material, the result of slight variations in the velocity of the water or in the source of the sediment at the time of deposition. The subsoil, as a whole, is as well supplied

with organic matter and is almost as dark as the surface soil. No part of the soil material contains a noticeable quantity of lime, but the vegetation does not indicate a deficiency of lime.

This soil produces higher yields of corn and alfalfa than any other soil in Nebraska, except during occasional years when yields on the bottom lands are reduced by floods. Although moderately heavy in the subsoil, it has no claypan or gumbolike characteristics and is readily penetrated by moisture, air, and plant roots. The soil is easily worked and is not subject to injurious erosion. It can be plowed under a fairly wide range of moisture conditions, considering its silty texture, but, if stirred when wet, hard lumps are formed, which require subsequent wetting and drying before favorable tilth is restored.

All the small-grain crops common to this section can be grown on this soil, but the unusually high organic and moisture contents of the soil have a tendency to produce a rank vegetal growth at the expense of the grain, and crops mature rather late.

About 80 percent of the soil, including all the readily accessible and better drained areas, is under cultivation. The only areas remaining in pasture and hay land are along some of the smaller drainageways, where the flood plains are severely dissected by stream meanders, and in undrained sags and swales on the broader bottoms. Most of these areas support a scattered growth of trees, which furnish fuel and posts, and in addition they produce hay and pasturage.

Wabash silty clay.—Wabash silty clay differs from Wabash silt loam mainly in having a more clayey and heavier texture throughout the soil mass. It occupies only a small acreage in this county, most of which is on the broad flood plains of Weeping Water Creek in the southeastern part and along Salt Creek in the northwestern part.

The relief is slight. The soil lies a little below the general level of the surrounding bottom land and is not quite so well drained as is Wabash silt loam. It is all subject to overflow during periods of high water, but the greater part has sufficient drainage for cultivation except in seasons of unusually high precipitation. Some areas have been ditched or tiled, in order to provide better drainage.

In common with all the Wabash soils, this soil has an abundance of organic matter and is very dark to a depth of several feet. The surface soil consists of almost black silty clay ranging from 10 to 16 inches in thickness. It rests on heavier material consisting largely of clay, which is almost as dark as the overlying layer but includes a few rust-brown spots, splotches, and streaks caused by imperfect drainage. This layer extends to a depth of 3 or more feet, generally with little change. In places it contains one or more thin layers of sandy, silty, or lighter colored material—the result of slight changes in the position or rapidity of the stream or in the source of the sediments at the time the layers were deposited. None of the soil material shows a noticeable content of lime, but crops do not suffer from a deficiency of lime.

Included within areas of this soil are a few poorly drained patches of Wabash clay and Wabash clay loam. These occur chiefly in unusually low depressions and in narrow strips along overflow channels where almost pure clay has been deposited. In places these deposits, which support a rank growth of vegetation, have accumulated so much

organic matter that they resemble muck. They are not sufficiently extensive to warrant separation on the soil map.

Wabash silty clay, where adequately drained, is as productive as Wabash silt loam, but it is more difficult to manage. It cannot be farmed under so wide a range of moisture conditions as can Wabash silt loam, and it remains wet and intractable later in the spring and longer after rainy periods. If plowed when wet it puddles and bakes, and it is extremely difficult to till when dry. During periods of drought it shrinks and cracks considerably, breaking some of the plant roots and promoting further desiccation. It is inherently as productive as Wabash silt loam and under favorable moisture conditions can be kept in good tilth. About 60 percent of it, including nearly all areas having good natural drainage and those that have been ditched or tiled, is under cultivation. Corn and alfalfa are grown chiefly, in the proportion of about 15 acres of corn to 1 acre of alfalfa. Practically no small grain is grown. The uncultivated areas and nearly all of the included areas of Wabash clay and Wabash clay loam are used for pasture and woodland.

Wabash fine sandy loam.—Wabash fine sandy loam differs from Wabash silt loam only in having more sand in its surface layer, which averages fine sandy loam in texture to a depth ranging from 8 to 15 inches. The soil is well supplied with organic matter, is almost black to a depth exceeding 3 feet, has a moderately heavy silty clay loam subsoil, and is very low but not deficient in lime. It is nearly flat, with its surface only a few feet above the normal level of the streams, and is subject to occasional overflow, but the water drains off rapidly, and practically none of the land is too poorly drained for cultivation.

The sand content of the surface layer slightly increases the moisture-absorbing rate but is not sufficient to impair noticeably the stability of the surface soil or to promote drifting during periods of dry windy weather. It does not reduce crop yields, and the soil has about the same producing capacity as has Wabash silt loam. It can be cultivated sooner after heavy rains without injuring its tilth and with less power. Practically all of the land is used for growing corn and alfalfa.

Although very productive, Wabash fine sandy loam is inextensive in Cass County and is of only local agricultural importance. Most of it occurs in close association with Wabash silt loam.

Bremer silt loam.—Bremer silt loam differs from Wabash silt loam only in topographic position. It occupies very low terraces or second bottoms, which form continuous or broken strips of various widths, chiefly in the valleys of Callahan and Greenwood Creeks in the northwestern part of the county and Weeping Water Creek in the southeastern part. One of the largest bodies is along the latter stream near Union. The total area is small.

This soil is developing on fine-textured sediments, chiefly silts and clays, that were washed from dark-colored soils of the uplands and deposited on the flood plains when the streams were flowing at slightly higher levels. The deposits now lie from 4 to 6 feet above the present bottom land, and although subject to overflow during unusually high stages of the streams, they are not so frequently inundated as the bottom land proper. They are not enough older than the bottom

lands on which Wabash silt loam is developing for the two soils to be notably different in character, and were it not for the slightly higher position of the Bremer soil it would all be included with Wabash silt loam on the soil map.

The 10-to-15-inch surface layer of Bremer silt loam is very dark grayish-brown or almost black friable silt loam. The rest of the soil material, to a depth of about 3 feet, differs little from the surface layer except that it is slightly lighter in color and a trifle heavier. Below a depth of 3 feet, thin alternating layers of sand, silt, and clay occur in places, and here and there the lower part of the subsoil contains scattered rust-brown and gray splotches and spots caused by imperfect underdrainage. No lime reaction can be obtained within a depth of 6 feet, although the vegetation does not indicate a deficiency of lime.

Practically all of this soil is under cultivation. Corn and alfalfa are grown chiefly, although a considerable acreage is devoted to the production of wheat and oats. Crop yields are about the same as on Wabash silt loam during most years. In wet seasons yields on the Bremer soil may be slightly higher than those on the Wabash soil, especially if crops on the bottom land proper are damaged by floods.

Lamoure silty clay.—Lamoure silty clay differs from Wabash silty clay mainly in having a wider color range in its subsoil and a much higher lime content. It occupies a very small acreage. One of the largest and most typical areas is along Salt Creek in the extreme northwestern part, and an area is on the flood plains of Weeping Water Creek east of Union. Nearly all of the soil lies a little below the more silty and sandy soils of the bottom lands and is not quite so well drained. It is subject to overflow during periods of high water, but the drainage is sufficient for cultivation in most places, except during unusually wet years.

The 10- to 16-inch surface layer of this soil is almost black silty clay containing an abundance of organic matter. The rest of the soil material consists of clay or heavy silty clay ranging from gray to nearly black but in most places is variegated gray and dark brown, with numerous rust-brown specks, splotches, and spots. It is very limy below an average depth of 20 inches.

Where adequately drained, Lamoure silty clay is as productive of corn and alfalfa as is Wabash silt loam, and it is used mainly for growing these crops. It cannot, however, be cultivated satisfactorily under a very wide range of moisture conditions and is not so easily managed as the less clayey soils of the bottom land. When plowed while wet it has a tendency to form clods that do not break down readily. The more poorly drained areas of this soil are included in woodland, hay land, and farm pastures for the milk cows and work animals.

Cass fine sandy loam.—Cass fine sandy loam is the most extensive sandy soil of the bottom land. It occurs in numerous strips and irregular-shaped areas on the broader flood plains, chiefly those along the Platte and Missouri Rivers. The areas are nearly flat except near stream channels and in local patches where the wind has produced slight undulations. All the land is subject to overflow during periods of high water, but it does not remain inundated after the

streams subside, and, except in a few places, the soil has ample drainage for cultivation.

The 10- to 14-inch surface soil, which has accumulated an abundance of organic matter, is very dark grayish-brown friable and mellow fine sandy loam or very fine sandy loam, the former texture predominating. Beneath the surface soil the material becomes lighter in color, looser, and more sandy. It grades downward into gray incoherent almost pure sand within a depth of 2 feet. The sand commonly is mixed with more or less fine gravel below a depth of 3 feet, and the lower part of the soil material ordinarily contains rust-brown spots and splotches, caused by imperfect drainage. No part of the soil material contains sufficient lime to react noticeably when acid is applied, but the vegetation does not indicate a deficiency of lime.

This soil is not quite so productive as is Wabash silt loam, owing probably to the higher sand and lower organic-matter content of its subsoil. It can be cultivated under almost any moisture conditions without injury and warms earlier in the spring than any of the finer textured soils. About 90 percent of it is used for growing corn and alfalfa, both of which yield well even during seasons of prolonged drought. This soil responds favorably to applications of manure and is one of the best soils in Nebraska for the production of truck crops. Small grains grow well, but, as on all soils of the bottom lands in this section, the abundant moisture and organic-matter supplies cause these crops to produce a rank vegetal growth at the expense of the grain.

The uncultivated areas are in pastures, wild-hay meadows, or woodland. They include tracts that are either so poorly drained or are so inaccessible, owing to stream meanders and overflow channels, that it is not practicable to farm them.

Cass silty clay loam.—Cass silty clay loam is an inextensive soil. It occurs chiefly on the Platte and Missouri River flood plains, for the most part in shallow depressions and old partly filled stream channels and meanders where the water table is near the surface and the ground is continually wet or moist except during the drier part of the summer.

The last sedimentary deposits in areas of this soil were composed largely of clay, and the upper part of the soil material is very heavy. The 8- or 10-inch surface soil consists of very dark gray or almost black heavy silty clay loam, which is sticky and plastic when wet and hard and brittle when dry. It is almost identical with the corresponding layer of Wabash silty clay loam. It is underlain by material of similar texture and consistence, but it contains less organic matter, has a slightly lighter color, and contains numerous rust-brown and brown mottlings. Beneath this layer is dark-brown fine sandy loam, which becomes gradually coarser with depth, and below a depth of 30 inches is light-gray incoherent sand. The entire soil mass is lime free.

Very little of this soil is under cultivation. Most of it supports a luxuriant growth of grass and a few willows, and it is used for native pasture or hay land. The few cultivated areas are difficult to manage, owing to the heavy intractable character of the soil and to the excessive moisture conditions. In dry years high yields of

corn are obtained, provided the weeds are controlled and favorable tilth is maintained. In wet seasons all cultivated crops are severely injured by floods.

Cass loamy sand.—Cass loamy sand occupies a few small bodies and narrow strips, most of which border active or overflow channels in the bottom lands along the Platte and Missouri Rivers. It differs from the other Cass soils of this county mainly in having a coarser textured and less coherent surface layer. It is all developing on extremely sandy alluvium deposited on the flood plains during high stages of the streams, and sufficient time has not elapsed for the deposits to have been greatly altered by soil-forming processes. The sand, however, has accumulated an abundance of organic matter in its surface layer, which is very dark grayish brown and ranges from 8 to 10 inches in thickness. The rest of the soil material is incoherent gray sand stained with rust-brown spots and splotches below a depth of 2 feet and mixed with considerable gravel below a depth of 3 feet.

Although the surface layer is very dark, it does not contain enough organic matter or other binding material to prevent soil blowing when the cover of native grass is destroyed. Only a small proportion of the soil is used for growing cultivated crops, chiefly corn. Yields are nearly as high as on the more silty soils of the bottom lands, except in years when the spring season is unusually dry and windy. In such years much of the seed fails to germinate on account of the lack of moisture, and many of the young corn plants are seriously injured by shifting sand before their roots are firmly established. Some alfalfa and sweetclover are grown on the cultivated areas, and these crops do well, provided good stands are obtained, but the difficulty experienced in obtaining satisfactory stands in the loose sand has prevented most farmers from growing legumes.

The greater part of this soil remains with its native cover of grasses and trees and is used for pasture, hay, meadows, or woodland.

Sarpy fine sandy loam.—Sarpy fine sandy loam occurs in close association with Sarpy loamy fine sand, from which it differs only in having a slightly finer textured and more stable surface soil. It occupies scattered bodies and narrow strips on the bottom lands along the Platte and Missouri Rivers. Few of the areas exceed 100 acres in size, and their combined area is very small.

This soil has accumulated but little organic matter. Its 6- to 8-inch surface soil consists of light-brown or grayish-brown mellow fine sandy loam or sandy loam. The material contains enough silt to bind the sand grains together loosely and to afford considerable stability, even under cultivation. The rest of the soil material consists mainly of incoherent gray sand similar to that in the subsoil of Sarpy loamy fine sand. It contains rust-brown spots and splotches below a depth of 2 feet and here and there considerable gravel below a depth of 3 feet. No part of the soil material is noticeably limy.

All this soil lies only a few feet above the normal level of the streams. It is subject to occasional overflow, but about one-half of it is sufficiently drained for cultivation during most years. It is used mainly for growing corn and alfalfa. Alfalfa yields almost as well as on the darker soils of the bottom lands, provided a good stand is obtained, but corn yields differ widely, according to differences in

the drainage conditions. In normal seasons good yields are obtained, but in wet years much of the corn on this soil is ruined by excessive moisture or by floods.

Sarpy loamy fine sand.—Sarpy loamy fine sand occupies numerous small bodies and narrow broken strips on the bottom lands along or near the banks of the Missouri and Platte Rivers. Its total area in the county is small.

Areas of this soil are nearly flat, although the surface is modified, in places, by active and overflow channels and by slight elevations and depressions formed by the wind. These areas are subject to flooding but lie slightly higher than the areas of riverwash and are not affected by slight fluctuations in the level of the streams. The soil, as a whole, is well drained, although the water table is everywhere within a depth of 12 feet and the subsoil is almost continually moist. In wet years marshy conditions prevail in many of the depressions.

This soil consists of slightly weathered sandy alluvium that has been so recently deposited that it has not accumulated much organic matter. It consists almost entirely of gray sand. The surface layer, which averages less than 6 inches in thickness, has been only slightly darkened by decayed plant remains. It is darkest in the depressed situations and is very light colored on low knobs and ridges where the wind has nearly or entirely prevented accumulations of organic matter.

Beneath the surface soil the gray sand extends downward for several feet with little change, except rust-brown stains below a depth of 30 inches and thin layers in which the material becomes coarser or finer in texture. In places considerable gravel occurs below a depth of 2 feet.

Owing to its low organic-matter content and sandy unstable character, practically all of Sarpy loamy fine sand is used for grazing, hay, or wood land. It supports a fairly dense growth of tall nutritious pasture grasses wherever trees do not shade the ground completely. The forest growth consists mainly of cottonwood and willow trees, although elm and ash are numerous. The trees are of value mainly for fence posts and fuel.

MISCELLANEOUS SOIL MATERIALS

Riverwash.—Riverwash consists of sand bars, islands, and flats adjacent to and within the channels of the Platte and Missouri Rivers. It represents the first stages of formation of an alluvial soil, and with the general accumulation of organic matter it will develop ultimately into soil. Areas of this material are very unstable, as they lie only a few inches above the normal level of the water, and their boundaries change with each rise and fall of the streams. Even during normal flow, the material is shifted about, added to, or carried away by the varying current. In places it has a thin surface layer of organic matter, and the texture ranges from clay to coarse gravel. Only the larger areas are shown on the soil map. Most of the riverwash supports a fairly dense growth of small willows but practically no grass. The greater part of it is included in pastures, but it is regarded by most farmers as wasteland.

Made land.—Made land, as mapped in this county, includes any earthy material that has been placed in its present position by man. It consists chiefly of refuse from quarries, and most of it is in the vicinities of the larger rock quarries and the cement plant at Louisville. Only the larger areas are indicated on the soil map, and even some of these are considerably enlarged, in order to be clearly legible. Most of the areas northeast of Louisville are mapped to include not only the refuse from quarries but also a large part of the quarry itself.

LAND USES AND AGRICULTURAL METHODS

The cropping and land-management practices in Cass County are similar to those in other southeastern Nebraska counties. They have been reasonably profitable during most years, and the greater numbers of the farmers have followed them with little change since this section was settled; but the more progressive farmers have adjusted their crops and cultural practices rather closely to the requirements of the soils, relief, and drainage conditions, with the result that their returns over long periods have considerably exceeded those obtained on similar land less carefully managed. They use most of their acreage to grow feed for livestock, which is their chief source of income. So long as they produce an adequate supply of feed they can grow soil-building and soil-conserving crops as extensively as desired without detracting from their net annual returns, and they can return to the land, through animal manures, much of the fertility removed by the feed crops.

On the better managed farms the well-drained soils of the bottom lands are used almost exclusively for the production of corn and alfalfa in the proportion of about 12 acres of corn to 1 of alfalfa. Sweetclover or red clover is sometimes substituted for alfalfa, although the clovers are grown most extensively on the thin light-colored Knox soils of the uplands, where they serve to retard erosion and to replenish the nitrogen supply, which so rapidly decreases on the slopes under grain-farming practices.

All the corn grown is of the dent varieties. Reid Yellow dent, Iowa Silvermine, and hybrids of these are grown chiefly. The greater part of the seed is produced locally because it usually yields better than imported seed. The present tendency is to select the smoother and heavier dimple-dented ears for seed instead of the rougher deep-kerneled seed ears so popular in the past. Tests have shown that the former type of seed tends to produce less leafy and somewhat earlier maturing plants, which require less moisture for development and yield higher than plants produced by the deep-kerneled seed.

Although the available moisture supply is the leading factor in determining the yield and profit from corn on all the arable soils of the county, organic matter and nitrogen rank next in importance. In seasons of abundant precipitation the corn yield is invariably greater when this crop follows a legume in the rotation, but in dry seasons the large nitrogen supply left in the soil by a preceding crop of alfalfa or clover may cause the corn to produce an unusually luxuriant early vegetal growth, which the moisture supply of middle and late summer cannot support. For this reason, it is generally

advisable to follow alfalfa or clover with a small-grain crop before using the land for growing corn.

Red clover, sweetclover, and alfalfa are used to maintain fertility. The use of sweetclover as a soil builder is increasing, and it is sometimes seeded with small grain, particularly oats or barley, to be plowed under as a green-manure crop early the following spring, and corn is then grown on the land.

The corn is planted between the first and middle of May, either in checkrows with a planter or in furrows with a lister. The former method requires more thorough preparation of the seedbed but allows cultivation of the crop in two directions, thus facilitating control of the weeds. Listed corn is considered by most farmers to be more drought-resistant than that planted in checkrows. Moreover, it can be planted on the contour so that the lister ridges and furrows can retard erosion and reduce the amount of moisture lost through run-off. The corn crop usually is cultivated three times. The main value of cultivation, according to tests, is to eradicate weeds, and any stirring of the ground in excess of this requirement is not likely to prove profitable, nor do the farmers of this county generally practice it. Corn on the Wabash, Lamoure, and Cass soils in many seasons requires four cultivations on account of the rapid growth of weeds on the bottom lands.

The corn crop matures in September or early in October, depending on the season. The greater part of the grain is husked from the standing stalks, after which cattle and hogs are pastured in the fields during the winter. On many farms a part of the corn is cut for winter roughage, and some farmers annually fence off a few acres of unhusked corn to fatten hogs and cattle, thereby saving part of the expense of husking. On a few farms some of the crop is cut for silage.

Many farmers have grown corn successively on the same ground for several years with but slightly lowered yields. This practice is not recommended for any of the land, although it probably does little damage on the alluvial soils, which annually receive more or less organic matter and other plant nutrients through surface wash from higher land.

Treatment of seed corn has not proved beneficial and is not generally practiced. Corn smut is carried over from year to year in the fields, which makes treatment of seed ineffective as a control measure for this disease.

Practically all of the wheat is of the winter varieties, chiefly Cheyenne and Turkey Red. This crop usually follows oats, although occasionally it is seeded between the rows of standing corn or on cornland from which the corn has been removed for silage or fodder. Early preparation of the seedbed is of prime importance in the production of good yields of wheat. Experiments show that the yield of winter wheat on early prepared land is approximately double that produced on fields plowed late. Small-grain stubble land plowed or listed in July and kept free from weeds until seeding time has produced 29 bushels of wheat an acre on Carrington clay loam at the Nebraska Agricultural Experiment Station at Lincoln, compared with 14 bushels on similar land plowed in September. Apparently the increased yield on land prepared early is because of the accumu-

lation of soil moisture and nitrates through the prevention of a growth of weeds prior to planting the seed.

Wheat is planted with a press drill, makes good growth before killing frosts occur, remains practically dormant during the winter, resumes growth in the spring, and usually matures early in July. The crop is cut with either a binder or a combine. When cut with a binder it is shocked or stacked for threshing. A combine cuts and threshes the crop in one operation. Nearly all of the grain is hauled to market directly from the threshing machine. Most of the wheat is produced on tenant farms, and in some fields it is grown several years in succession. Generally it is grown on the deep mellow well-drained smoother lying soils of the uplands and terraces, which are most productive of wheat and best suited for the use of large machinery.

The yields of wheat sometimes are reduced by bunt or stinking smut, which distorts the kernels, stunts their normal growth, and gives the grain an offensive odor. This form of smut can be controlled by mixing the seed before planting with copper carbonate powder at the rate of 2 ounces of the powder to a bushel of grain (*6*).

Although the hessian fly ordinarily is not a serious pest in this county, it may cause some injury to very early seeded fields of wheat. When this fly is prevalent, it is recommended that sowing be delayed until the fly-free date is announced by the State entomologist.

Sweetclover or red clover is sometimes sown with winter wheat in late winter or early spring and is harrowed or rolled in. Winter wheat is a poor nurse crop, and the likelihood of obtaining a satisfactory stand of clover is less than when the clover is seeded with a spring-sown grain.

Oats are not very profitable. They are grown mainly because they are needed to feed the work animals and young livestock, also because they fit well in rotations between corn and alfalfa or corn and sweetclover and are a good nurse crop for either clover or grass. Some farmers are reducing their acreage of oats in favor of barley, which is equally as good as a nurse crop and produces about one-third more feed to the acre.

Early-maturing varieties of oats are grown, chiefly Kherson or strains of this variety, and some Burt. Oats ordinarily follow corn in the rotation but are grown on all the arable soils whenever needed as a nurse crop for legumes or for use in rotation systems. They do best on Waukesha silty clay loam on the terraces, and on the more nearly level parts of Marshall silty clay loam on the uplands.

The land to be used for oats usually is disked, and the seed is broadcast or drilled in during late March or early April. Early seeding is recommended, as it generally results in higher yields than are obtained from late-seeded grain. The crop is harvested in the same manner as wheat. Practically all of it is consumed on the farms where produced.

Smut sometimes lowers the yields of oats during prolonged periods of rainy or cloudy weather. The injury from this source can be controlled by killing the smut spores on the seed, after the grain has been fanned, with a solution containing 1 pint of commercial formaldehyde to 35 gallons of water (*6*).

Rye is not an important crop. Winter rye, chiefly of the Rosen variety, is grown to some extent for the grain but mostly for temporary fall and spring pasture for the brood sows and young pigs. The seed is planted with a press drill early in the fall. When grown for grain the crop usually is cut with a binder in July and shocked or stacked for threshing. Rye does well on all the well-drained soils of the uplands and terraces, but it produces the highest yields on the Waukesha and Marshall soils.

Cass County does not have a large acreage in barley, but the production of this crop is increasing. Barley ranks next to corn, measured in terms of feed produced to the acre. The chief varieties grown are Spartan and Oderbrucker. Early seeding of barley during late March or early April at the rate of 2 bushels an acre has given the best average results. Nearly all of the barley grown is fed on the farms. A reasonable acreage in this crop will insure feed for livestock if unfavorable weather should materially reduce the yield of corn. Barley is equal to oats as a nurse crop for alfalfa or clover.

Alfalfa is the leading hay crop. The varieties grown are among the most hardy obtainable, including Common, Grimm, and Cossack, all of which are resistant to winter-killing. Usually the seed is planted with a press drill, not deeper than 1 inch, in a thoroughly prepared seedbed during April or early May or during August or early September. If seeded in the fall, it should be sown as soon after a heavy rain as possible. That sown at the earlier date usually gives the best results. The standard seeding rate is 15 pounds an acre. Only pure certified seed should be used.

A stand of alfalfa is allowed to remain as long as it yields profitably, generally 4 to 5 years on the upland and 5 to 6 years on the bottom land. The crop is rarely frozen out. Ordinarily it is cut three times during the summer, and occasionally a fourth cutting is obtained.

Tests fail to show the need of, or beneficial results from, liming or inoculation for the production of alfalfa or clover. It is not good practice to leave alfalfa on upland fields too long, as the subsoil moisture is likely to be exhausted after four or five seasons, with resulting low yields of hay. The alfalfa plant seems unable to make optimum growth in Nebraska on the precipitation alone. Difficulty may be experienced in obtaining satisfactory yields of this crop when it is seeded a second time on upland fields that previously had been in alfalfa for a number of years. This, according to investigations at the Nebraska Agricultural Experiment Station, is due to the exhaustion of the deep-seated moisture supply (*2*). The deep moisture, probably stored during some higher precipitation cycle of the past, is restored very slowly after the alfalfa sod is broken, because most of the seasonal rainfall is used by the annual crop grown on the land. Yields from a second planting of alfalfa are likely to be lower than those obtained from the first, even though several years may have elapsed between the plantings. Such results do not take place on the soils of the bottom land where the alfalfa roots are able to obtain a continual supply of moisture from the water table.

Sweetclover, although still of minor importance, is being grown more extensively each year, especially throughout the uplands. This

plant is a biennial and dies at the end of the second season, after producing seed. It is used chiefly for pasture and to some extent for hay and seed. When hay is desired the crop is cut during the first year, before the growth becomes coarse and woody. In the second year the crop may be allowed to reseed itself, or it may be cut with a binder and threshed for seed. The permanence of a stand of sweetclover depends entirely on its ability to reseed, and most farmers take care during the second year not to allow it to be grazed so closely as to prevent the maturity of enough of the crop to reseed the land (*8*). The most common time of seeding is in March or early April. The seedbed is prepared in the same manner as for alfalfa.

Sweetclover has an unusually wide adaptation. It thrives on both comparatively wet and dry soils and on soils of either light or heavy texture. It is very valuable for soil improvement, and most farmers consider it more satisfactory for this purpose than alfalfa, especially on the upland, and it is adapted to shorter rotations than alfalfa. The roots are large and vigorous, and they decay rapidly at the end of the second year of growth. The crop not only adds organic matter to the soil but, in common with other legumes, it has the power of fixing atmospheric nitrogen in the nodules on its roots. It is a good soil binder and is especially valuable on the Knox soils where erosion is severe.

Wild hay, in which bluestem and grama grasses predominate, is cut from the more poorly drained parts of the bottom lands and from steep slopes throughout the uplands where soil washing is severe unless the land is kept covered with sod. Most of the hay is fed to horses within the county.

The permanent pastures are composed largely of bluegrass and white clover or the native bluestem, grama, and dropseed grasses. Bluegrass has become established naturally over much of the uncultivated land since the section was settled and is now one of the leading pasture grasses in all parts. Most of the pasture land is in the rougher or more poorly drained situations. Many pastures are grazed too early in the spring and overgrazed during the summer season, thereby allowing weeds to become established.

Some farms include fields that have been used almost continuously for grain crops and have received little or no fertilizer of any kind since the virgin soil was broken. No commercial fertilizer is used. A large quantity of barnyard manure is produced, but little care is taken to preserve it. On most farms manure is piled outdoors, where much of its value is lost through leaching. The manure is hauled in the fall or spring and generally is spread on the more sandy Cass and Sarpy soils of the bottom lands and on the eroded Knox and Carrington soils of the uplands. On tenant farms little care is taken to apply the manure where it is most needed, and the greater part is spread on the land nearest the barnyard.

Definite systems of crop rotation are not followed generally, although the more progressive farmers have rather indefinite systems, subject to numerous substitutions, which they use on their land. A rotation recommended for the Marshall soils is corn 2 years, oats 1 year, and wheat, rye, or barley 1 or 2 years. Sweetclover or red clover should then be grown 2 years, or sweetclover should be used

with oats or barley for pasture and later plowed under for green manure. Alfalfa may be substituted for the clovers but does not lend itself well to short rotations. It is seldom grown unless it can be left on the ground 3 or 4 years.

On the Knox soils, the corn and small-grain acreage should be reduced in favor of the acreage devoted to legumes, in order to curtail erosion as much as possible. A rotation consisting of corn 1 year, and oats, barley, or rye 2 years, followed by at least 2 years of clover or alfalfa, is recommended on these soils. On the steeper cultivated slopes, where farming is extremely difficult and where grain yields are low on account of excessive loss of moisture through run-off, the Knox soil could be planted to bluegrass and used advantageously for pasture land.

Although alfalfa and the clovers do best on the better drained Wabash, Lamoure, and Cass soils of the bottom land, they are not needed in rotations here as frequently as on the uplands. On most of the alluvial soils corn can be grown 3 or 4 years in succession without a serious decrease in yields. The land can then be used 1 or 2 years for growing small grains and 3 or more years for growing alfalfa before returning it to corn.

PRODUCTIVITY RATINGS

In table 6 the soils of Cass County are rated according to their capacity to produce the more important crops of the general region, and are listed in the approximate order of their general productivity under current farming practices.

The rating compares the productivity of each soil for each crop to a standard, namely, 100. This standard index represents the approximate average acre yield obtained without amendments on the more extensive and better soil types of the regions in which the crop is most widely grown. An index of 50 indicates that the soil is about one-half as productive for the specified crop as are soils having the standard index. Soils given amendments, such as lime, commercial fertilizers, and irrigation, and unusually productive soils of comparatively small extent may have productivity indexes of more than 100 percent for some crops.

The soils are listed in the order of their general productivity, which is determined chiefly by their ability to produce the more important staple crops. No attempt is made to group the soils best suited for specified crops or to account for differences in the quality of the crops.

As the soils in this county do not receive significant quantities of amendments, such as lime, phosphate fertilizer, or complete fertilizer, no rating is given to indicate their response to fertilization. The use of manure produced from crops grown on the land is not considered an amendment.

The factors influencing the productivity of land are mainly climate, soil characteristics, and surface configuration. As long-time yields [6]

[6] Data on long-time yields for specific soils were collected by the field personnel during and subsequent to the survey. Also, free use was made of unpublished estimates on average annual crop yields for the period 1923–32 supplied by the Bureau of Agricultural Economics, U. S. Department of Agriculture, cooperating with the Nebraska Department of Agriculture.

TABLE 6.—*Productivity ratings of soils in Cass County, Nebr.*[1]

Soil type[2]	Crop productivity index[3] for—									Principal crops or type of farming
	Corn	Oats	Wheat	Rye	Barley	Alfalfa	Sweetclover	Wild hay	Pasture[4]	
Bremer silt loam	85	60	60	60	60	85	85	80	105	Corn and alfalfa.
Wabash silt loam, well drained	85	60	60	60	60	85	85	80	110	Do.
Wabash silty clay, well drained	80	60	60	60	60	85	85	80	110	Do.
Lamoure silty clay, well drained	80	60	60	60	60	85	85	80	110	Do.
Cass silty clay loam, well drained	80	60	60	60	60	75	75	80	110	Do.
Wabash fine sandy loam, well drained	80	50	50	55	50	80	85	75	100	Do.
Waukesha silty clay loam	75	75	75	75	75	80	80	75	100	Corn, small grains, and alfalfa; general farming.
Judson silt loam	75	75	75	75	75	80	80	75	100	Do.
Cass fine sandy loam, well drained	75	45	45	50	45	70	75	70	95	Corn and alfalfa.
Marshall silty clay loam, smooth phase	70	70	70	70	70	55	75	75	90	Corn and small grains; general farming.
Marshall silty clay loam	65	65	65	65	65	55	75	75	85	Do.
Sarpy fine sandy loam, well drained	65	40	40	45	40	60	70	65	85	Corn and alfalfa.
Cass loamy sand, well drained	60	30	30	35	30	50	65	60	80	Do.
Butler silty clay loam	50	55	55	55	55	55	75	75	90	Corn, small grains, and sweetclover.
Carrington silt loam	50	45	45	50	45	50	70	70	80	Corn, small grains, and pasture.
Carrington silty clay loam	45	40	40	45	40	45	65	65	75	Do.
Marshall silty clay loam, slope phase	45	40	40	45	40	45	65	65	80	Corn, small grains, and sweetclover.
Carrington loam[5]	40	35	35	40	35	45	65	65	75	Do.
Knox silt loam, smooth phase	35	35	35	35	35	45	65	55	75	Do.
Pawnee silty clay loam	35	35	35	35	35	40	60	60	70	Do.
Carrington silt loam, slope phase[5]	30	30	30	30	30	35	55	55	70	Do.
Knox silt loam[5]	30	25	25	30	25	35	55	55	75	Corn, alfalfa, clover, and pasture.
Lancaster sandy loam[5]	25	20	20	25	20	30	50	50	35	Corn, clover, pasture, and woodland.
Wabash silt loam, poorly drained[6]	------	------	------	------	------	------	------	85	120	Native pasture and hay.
Wabash silty clay, poorly drained[6]	------	------	------	------	------	------	------	85	120	Do
Lamoure silty clay, poorly drained[6]	------	------	------	------	------	------	------	85	120	Do.
Cass silty clay loam, poorly drained[6]	------	------	------	------	------	------	------	85	120	Do.
Wabash fine sandy loam, poorly drained[6]	------	------	------	------	------	------	------	80	115	Do.
Cass fine sandy loam, poorly drained[6]	------	------	------	------	------	------	------	75	105	Do.
Sarpy fine sandy loam, poorly drained[6]	------	------	------	------	------	------	------	70	100	Do.
Cass loamy sand, poorly drained[6]	------	------	------	------	------	------	------	70	90	Do.
Sarpy loamy fine sand, poorly drained[6]	------	------	------	------	------	------	------	50	35	Do.
Sarpy loamy fine sand, well drained[6]	------	------	------	------	------	------	------	40	30	Do.
Shelby loam	------	------	------	------	------	------	------	35	35	Native pasture and woodland.
Sogn silt loam	------	------	------	------	------	------	------	35	30	Do.
Scott silty clay	------	------	------	------	------	------	------	30	30	Native pasture and hay.
Riverwash	------	------	------	------	------	------	------	------	18	Native pasture and woodland.

[1] This table has been prepared jointly by officials of the following organizations: Division of Soil Survey, Bureau of Plant Industry, and Division of Land Economics, Bureau of Agricultural Economics, U. S. Department of Agriculture; and the Conservation and Survey Division, University of Nebraska.

[2] Soils are listed in approximate order of their productivity in the county, the most productive first.

[3] The soils of Cass County are given indexes that indicate the approximate average production in percent of the standard of reference. The standard represents the approximate average yield obtained without fertilizers or amendments on the more extensive and better soil types of the regions in which the crop is most extensively grown.

[4] This column shows the approximate number of days that 1 acre will support 1 animal unit during the grazing season without injury to the range. The grazing season in Cass County is 6 months.

[5] Considerable areas of these soils are too steep, rough, or stony to be cultivated. The ratings apply only to the smoother and less stony areas.

[6] No ratings on grain and tame-hay crops are given to soils that are generally unsuited to cultivation or are farmed only in small patches.

furnish the best available summation of the factors contributing to soil productivity, these were among the data used in determining the inherent productivity indexes given in table 6.

The rather low indexes given to most of the soils do not necessarily indicate that these soils are poorly suited for the crops grown on them. Many of the soils are among the strongest and most productive in the general region. Few of them give as high yields of a particular crop as are obtained on what is regarded as the standard soil for that crop, but this, in most instances, is due mainly to less favorable moisture conditions or surface features, or both, than occur in areas of the standard soil. Nearly all of the soils in this county contain enough plant nutrients to insure higher yields were moisture more abundant.

In rating the soils on the bottom lands or flood plains, two index ratings are given, one applying to the better drained areas and the other to poorly drained areas. The soil map, however, does not distinguish between these areas except in localities where drainage is so poor that a marshy condition prevails a part of each year. In such places the conventional marsh symbol is used. Elsewhere on the bottom lands the poorly drained tracts, although numerous, occupy such small patches and narrow strips that they cannot be legibly indicated on the published map.

Streams occasionally inundate the flood plains, but no special consideration is given to overflow, because it is of little importance in the agriculture of the county.

Table 6 is not based on enough of the factors that influence land use to warrant interpreting the ratings directly into specific land values. It is based on essentially permanent factors relating to the inherent productivity of the soils, and no consideration has been given transitory economic factors. In some instances the information on which the ratings are based is not so complete as desired, and further study may suggest changes.

The following tabulation lists the more important crops of the county and the acre yield that has been set up as a standard of 100 for each crop. These standard yields represent long-time production averages of the more productive soils of significant acreage in regions where the crop is most extensively grown. They are for products of satisfactory quality, obtained without the use of fertilizers or amendments other than those produced directly or indirectly by the soil.

Crop:		
Corn (grain)	bushels	50
Oats	do	50
Wheat (all kinds)	do	25
Rye	do	25
Barley	do	40
Alfalfa	tons	4
Sweetclover	do	2
Wild hay	do	1
Pasture	cow-acre-days [1] per year	100

[1] Cow-acre-days is a term used to express the carrying capacity of pasture land. As used here, it is the product of the number of animal units carried per acre multiplied by the number of days the animals are grazed without injury to the pasture. For example, the soil type able to support 1 animal unit per acre for the entire year rates 360, whereas another soil able to support 1 animal unit on 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days the rating is 25.

MORPHOLOGY AND GENESIS OF SOILS

All except the most immature soils of Cass County owe their characteristics partly or entirely to the prairie type of soil formation. The mean annual precipitation, about 30 inches, over 80 percent of which falls from April to October, inclusive, has supported a luxuriant growth of typical prairie grasses. Forest occurs in narrow strips along most of the streams and covers much of the rough land along the Missouri and Platte Rivers around the eastern and northern sides of the county, but the tree cover is not sufficiently dense to have prevented the growth of grass or to have influenced noticeably the character of the soils. Organic matter, derived principally from decayed grass roots, has produced very dark, in places almost black, surface layers, except in the soils developing on the most recently exposed or deposited geologic materials.

All the soils, aside from those that have developed a claypan or that occur in areas where run-off is rapid, have received enough moisture to leach the readily soluble salts from the solum and, in most places, from the upper part of the underlying formations. Only a few of them, however, have become noticeably acid, even in their surface layers. Except in a few places, the surface soils are neutral, and the rest of the solum is at least slightly alkaline. In steeply sloping and severely eroded areas, where the parent materials are at or near the surface, some of the soils are moderately limy in the lower part of the solum. A few of the soils, including those in which downward leaching has been practically prevented by an almost impervious claypan, have developed a zone of lime enrichment just below the impervious layer. The parent material beneath the limy zone in these soils is not noticeably calcareous.

All the better developed soils of the county are markedly granular in their surface and upper subsoil layers. This characteristic, so common in Prairie soils, is more pronounced in the general region of which Cass County is a part than in any other section of Nebraska. The granules, which range between one-sixteenth and one-eighth of an inch in diameter, are subspherical and moderately firm. They have been destroyed to a depth of about 6 inches in cultivated fields. Most of the immature soils also are more or less granular in their upper layers, provided they have accumulated sufficient organic matter to darken the surface soils noticeably. Some of them, developing from clay and silty clay sediments on the bottom lands, are rather heavy, but the only claypan soils of the county occupy local areas on the uplands.

All the soils have good surface and internal drainage, except in some places on the flood plains and in a few places where claypans have developed. Throughout most of the uplands the slope in one direction or another is considerable, and on many of the valley sides run-off is rapid and erosion is severe. The steepest slopes are in the bluff lands along the rivers, where the soils are immature, thin, and light-colored.

As in most counties of southeastern Nebraska, the more extensive soils have developed, or are developing, on Peorian loess, a yellowish-gray or light yellowish-brown massive and floury wind-laid silt. This material caps all the uplands and higher terraces, except in small areas where it has been removed by erosion. At the time of

its deposition the loess was limy, presumably throughout, but in this locality its upper layers have been almost entirely leached of their carbonates wherever the terrain is sufficiently smooth to prevent excessive loss of moisture through run-off. The loess still contains some lime in areas where it has been kept at or near the surface by erosion and where it thinly caps less pervious beds.

The most extensive and among the most nearly mature soils of the county are the Marshall soils, all of which have developed from Peorian loess on the smoother parts of the uplands. In some cultivated fields these soils have been considerably eroded, but in the pasture areas they still retain most of the products of soil development. They are regarded as normal soils for the Prairie soil region.

Following is a description of a virgin profile of Marshall silty clay loam, observed 105 feet east of the northwestern corner of sec. 21, T. 11 N., R. 10 E. This area is on about a 3-percent slope on a high gently undulating divide southwest of Murdock.

1. 0 to 5 inches, very dark grayish-brown or almost black granular and friable silt loam. The granules are soft, small, and poorly developed in the upper part of the layer and are well-formed subspherical aggregates averaging a little more than one-sixteenth of an inch in diameter in the lower part. No color change occurs when the material is crushed.
2. 5 to 14 inches, very dark grayish-brown markedly granular and heavy but friable silt loam. The granules are firm but crush easily between the fingers and thumb. The material becomes slightly lighter in color when crushed.
3. 14 to 30 inches, granular and friable silty clay loam, dark grayish brown grading into brown. The granules, which average about one-eighth of an inch in diameter, are largest and least regular in size and shape near the base of the layer. They crush, with only moderate difficulty, to a light-brown or yellowish-brown powder. This, the upper part of the subsoil, is the heaviest layer in the profile, but its increased heaviness is scarcely noticeable except through close comparison with other layers.
4. 30 to 48 inches, light-brown or light grayish-brown friable and cloddy silt or silty clay, stained and splotched with rust brown and brown.
5. 48 to 96 inches, yellowish-brown or grayish-yellow massive silt of the parent Peorian loess.

No part of the soil material to the depth examined gives a noticeable lime reaction when hydrochloric acid is applied, and road cuts in the vicinity show no lime above a depth of 10 feet. All contacting horizons of the profile merge in color, texture, and consistence. To a depth of about 12 inches, the organic matter is intimately mixed with the mineral soil constituents, but below this depth it occurs mainly as a film or coating on the surfaces of the granules, the film becoming thinner downward and practically disappearing at a depth of about 3 feet. The second and third layers contain numerous insect casts. A few crooked rodlike soil forms, about one-fourth inch in diameter, of various lengths, and slightly darker or lighter than the surrounding matrix, are in most layers of the solum. They probably represent fillings in old root, worm, and insect holes.

The profile described is similar in its principal characteristics to that of all the well-drained soils of the county which have attained normal or near normal development. It is almost identical with the profile of Waukesha silty clay loam on the well-drained terraces or benches.

Within areas of Marshall silty clay loam are small and widely scattered patches, few of which occupy more than an acre, in which geo-

logic lime still remains in the lower part of the solum. Most of these patches are near the base of the Peorian loess where it overlies comparatively impervious beds and where downward percolating waters probably have released a part of their lime on reaching the less pervious strata. Owing to their small total extent, irregular distribution, and slight agricultural significance, these patches are not shown separately on the accompanying map.

Throughout much of the bluff-land strip along the rivers and on the steeper slopes along many of the creeks and branches throughout the county, the Peorian loess has been so severely eroded that little or no soil has developed. In these localities Knox silt loam is mapped. Here, the surface layer, in most places, has accumulated enough organic matter to make it slightly darker than the rest of the soil material, but the darkened part ordinarily does not exceed 6 inches in thickness. The soil is essentially loess, the topmost few inches of which are only slightly modified by weathering and organic accumulations. Throughout the bluff lands most of the soil mapped as Knox ranges from moderately to highly calcareous from the surface downward, owing largely to rapid run-off, which has prevented the precipitation from acting effectively as a leaching agent, but partly because of severe erosion, which has kept the loess near the surface. Throughout the interior of the county where the land, as a whole, is less steeply sloping, more of the precipitation is absorbed, and the Knox soil is rather low in lime in places.

In some areas along Weeping Water Creek and in the bluff lands along the rivers, erosion has removed the light-colored Peorian loess and also an underlying pale-red silt or sandy clay, known as the Loveland formation, on which no soils have developed in this county. In these areas either the Kansan drift, Dakota sandstone, or Pennsylvanian limestones and shales, named from top to bottom in the order of their occurrence, have been exposed to weathering and soil development.

The Carrington, Pawnee, and Shelby soils are on the Kansan drift. The first-named, where best developed, have genetic horizons similar to those in the Marshall soils but have somewhat thinner profiles and contain more sand and gravel than the Marshall soils. Nearly all of the Carrington soils in this county are heavier, especially in the subsoils, than is typical for these soils.

The Pawnee soils are developed on unusually fine-textured strata of the Kansan drift. They have dark and moderately thick surface layers, which rest directly on a dense almost impervious claypan. The development of the heavy layer is not clearly understood. In the smoother areas it is usually densest near the top and seems to have been formed, in part at least, by the downward translocation of fine material from the surface soil through the agency of percolating waters. In some of the rolling areas it is uniformly dense from top to bottom and resembles gumbotil. Beneath it, beginning at a depth ranging from 2 to 4 feet, is a fairly well developed zone of lime enrichment, in which the carbonates have been protected from leaching by the impervious layer above. The parent drift is not calcareous, as a rule, at least within a depth of 8 feet.

In this county the Shelby soil is simply severely eroded Carrington soil. It has accumulated little organic matter and in most places

consists mainly of unweathered or only slightly weathered Kansan drift. The material is commonly limy within a depth of 2 feet.

The soil developing on Dakota sandstone is classed as Lancaster sandy loam and that on the Pennsylvanian beds as Sogn silt loam. Both the Lancaster and Sogn soils are immature and shallow. Areas in which they occur include numerous outcrops of bedrock.

None of the soils on the bottom lands is old enough to have made much progress in development. The moist conditions prevailing on the flood plains have favored a rapid growth and decay of vegetation, and all the soils, except those on very recently deposited light-colored sediments, have dark surface soils. The sediments are water-stratified in numerous places, but none of them has developed zones or layers of true soil character. Oxidation and aeration are inhibited by excessive moisture, and the surface soils rest on the unweathered or only slightly weathered alluvial deposits.

The more sandy soils of the bottom lands are mapped with the Cass and Sarpy series and the more silty soils with the Wabash and Lamoure series. All except the Sarpy soils, which are light colored throughout, have accumulated an abundance of organic matter and have almost black surface layers. None of these soils except the Lamoure contains much lime.

For further information on the chemical composition of the soils of this general region the reader is referred to the following publications of the United States Department of Agriculture: Technical Bulletins 316, 430, 461, and 484, and Department Bulletin 1311.

Table 7 gives the results of mechanical analyses of samples from three soil profiles.

TABLE 7.—*Mechanical analyses of three soils from Cass County, Nebr.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Marshall silty clay loam, smooth phase:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
379546	0- 8	0.0	0.4	0.2	0.6	1.0	69.3	28.5
379547	8- 20	.0	.1	.1	.4	2.7	65.3	31.4
379548	20- 34	.0	.0	.1	.2	2.4	61.5	35.8
379549	34- 48	.0	.0	.1	.2	3.2	63.1	33.4
379550	48-130	.0	.0	.1	.2	3.4	69.6	26.7
Carrington silt loam:								
379527	0- 4	.7	3.4	4.0	4.9	3.9	56.9	26.2
379528	4- 12	.4	2.1	2.6	3.4	3.4	53.6	34.5
379529	12- 20	.5	1.8	2.1	3.0	3.0	49.4	40.2
379530	20- 30	.5	2.7	3.1	3.6	3.1	55.3	31.7
379531	30- 60	6.6	11.8	14.3	18.0	5.5	23.8	20.0
Knox silt loam:								
379539	0- 5	.1	.1	.1	.5	3.2	73.6	22.4
379540	5- 15	.0	.1	.1	.2	2.3	69 3	28.0
379541	15- 50	.0	.1	.1	.3	4.7	71.7	23.1
379542	50-130	.1	.2	.1	.6	6.3	79.7	13.0
379543	130+	.0	.1	.0	.2	2.0	72.2	25.5

SUMMARY

Cass County is in eastern Nebraska immediately west of the Missouri River and south of the Platte. It is roughly rectangular, with irregular northern and eastern boundaries, and comprises 555 square miles.

The county lies in the Central Lowland province of the Interior Plains physiographic division. It is part of an eroded drift plain capped with loess of variable thickness and cut by numerous valleys partly filled with alluvium. The relief ranges from nearly level on the tops of a few of the broader divides and on the alluvial lands to extremely rough and dissected in a bluff-land strip along the Platte and Missouri Rivers around the northern and eastern sides of the county. The most nearly level upland areas are near the axis of a main divide extending east and west across the central part.

All the drainage is effected northward and eastward to the Platte and Missouri Rivers. The only poorly drained land is in local patches on the flood plains along the streams and in a few small widely scattered depressions in the smoother parts of the uplands.

The average elevation of the county is about 1,200 feet above sea level, and the range in elevation is about 432 feet. The most pronounced relief is between the channel of the Missouri River and the top of King Hill, where the rise is about 300 feet within a horizontal distance of 25 rods.

The dominant native vegetation consists of prairie grasses. The forest growth occurs in narrow strips on the flood plains and occupies much of the bluff lands along the rivers. The trees are of value chiefly for shade, posts, and fuel.

In most places throughout the uplands good well water is obtained in quantities sufficient for family and livestock needs, at depths ranging from 50 to 80 feet. On the river flood plains the well water is commonly obtained within a depth of 15 feet, but along the smaller streams most of the wells range from 70 to 80 feet in depth.

The first settlement in the territory now included in this county was made in 1853 near the mouth of the Platte River. The county was established and organized in 1855. It was named after Lewis Cass, who was Secretary of State during President Pierce's administration. The early settlers were mainly from Iowa, Illinois, and Missouri and were chiefly of German, Irish, and Swedish descent.

The population increased steadily until about 1890, when the county had 24,080 inhabitants. Since then it has decreased, the Federal census reporting 17,684 inhabitants in 1930. During the latter year about 21 percent of the population was classed as urban and the remainder as rural. Plattsmouth, the county seat and largest city, had 3,793 inhabitants in 1930.

Transportation facilities are good; rural mail delivery routes reach all sections; telephones are in common use; and the public-school system is highly developed.

The climate is continental and temperate. It is well suited for the production of grain, vegetable, and hay crops and to the raising of livestock. The mean annual precipitation at Weeping Water is 29.52 inches, about 80 percent of which falls from April to October, inclusive. The mean annual temperature is 51.3° F., and the average frost-free season is 156 days, which is ample for the maturing and harvesting of all crops commonly grown.

The agriculture consists mainly of the production of grain, forage, and tame hay and the raising and fattening of cattle and hogs. About 70 percent of the land was under cultivation in 1929, and the remainder was included chiefly in pasture, wild-hay meadows, and

woodland. During most years about 130,000 acres are used for growing corn, 31,000 for oats, 30,000 for wheat, 350 for rye, and 250 for barley. Of the tame-hay crops, alfalfa occupies between 8,000 and 10,000 acres, red clover between 2,000 and 5,000 acres, and sweetclover between 1,000 and 2,000 acres. A few farms are devoted almost exclusively to orcharding. Most of the grain and tame-hay crops are fed to cattle and hogs, which are the chief sources of revenue.

The farm buildings, in general, are kept painted and in good repair. Modern labor-saving machinery and household equipment are in general use.

The average size of the farms has increased slightly since the county was settled. It was 165.5 acres in 1935.

During 1935, owners operated 50.6 percent of the farms, managers 0.8 percent, and tenants 48.6 percent. About 88 percent of the farmed acreage was rented for a share of the crops in 1930.

The 1935 Federal census reports the average acre value of the farms as $84.05 in that year. The average mortgage debt on farms operated by full owners was $52.59 an acre, and the taxes on these farms was $1.28 an acre in 1930.

On most farms systematic crop rotation is not practiced, but the more progressive farmers rotate their crops with reasonable regularity, grow considerable alfalfa and sweetclover, and occasionally plow under green legumes to increase the nitrogen supply. Barnyard manure, when available, is applied to the land. Practically no commercial fertilizers are used.

Most of the soils throughout the uplands and on the terraces have developed from loess, a light-gray floury silt deposited by the wind. A few have developed on underlying formations, including glacial drift, Dakota sandstone, and Pennsylvania limestones and shales, but such soils occupy small areas. The soils on the bottom lands are on a variety of stream sediments that came mainly from areas outside the county, though partly from the local uplands. Nearly all of the soils, except in severely eroded localities throughout the uplands and on the most recently deposited alluvial sediments, have accumulated an abundance of organic matter derived through the decay of prairie-grass roots, and they have very dark, in places almost black, surface soils. Most of them are highly granular, especially in their upper layers, are friable throughout, and are easily penetrated by air, moisture, and crop roots. Only a few contain noticeable quantities of lime, but none seems to be seriously deficient in this material so far as crop needs are concerned.

On the basis of drainage conditions and the available moisture supply, which are the most important factors in determining productivity in Nebraska, the various soils of the county are grouped as follows: (1) Well-drained soils of the uplands and terraces, (2) imperfectly drained soils of the uplands and terraces, (3) excessively drained soils of the uplands, (4) variably drained soils of the bottom lands, and (5) miscellaneous soil materials. In establishing these groups recognition is given to the relief, or lay of the land, to soil and crop adaptations, and to those soil characteristics that are responsible for these adaptations.

The well-drained soils of the uplands and terraces occupy 68.6 percent of the total land area of the county. These soils have good

surface and internal drainage; deep, mellow, and dark surface soils containing an abundance of organic matter; and friable lighter colored subsoils, which allow easy penetration of roots and free movement of air and water. They include all the Waukesha and Judson soils and the smoother areas of the Marshall and Carrington soils. The Waukesha soils are on stream terraces, the Judson soils on gentle colluvial slopes, and the rest are on the uplands. The soils of this group are among the best soils for general farming in Nebraska. None of the soils is so productive of corn and alfalfa as the best soils on the bottom lands, but all are adapted to a wider variety of crops. They differ somewhat among themselves in their crop-producing powers, but this is due more to differences in the surface features, particularly the lay of the land with respect to higher and lower levels, than to differences in the soils themselves. The Waukesha soil receives some moisture through run-off from the uplands and is naturally a little more fertile than the higher lying soils.

Marshall silty clay loam and its smooth phase, both of which belong to this group, occupy more than one-half of the total land area of the county. They are the most productive soils of the uplands and hold first place in the general agriculture of the region.

The imperfectly drained soils of the uplands and terraces occupy less than 1 percent of the county. They include Scott silty clay, Butler silty clay loam, and Pawnee silty clay loam, all of which have dark friable surface layers and heavy claypan subsoils, which practically prevent internal drainage. The Scott and Butler soils have developed on loess, the Scott soil in shallow undrained depressions throughout the uplands, and the Butler soil mainly on upland flats. The Pawnee soil is developed on undulating to rolling areas of glacial drift.

Most of these soils, except Scott silty clay, which is too shallow and poorly drained for farming, is under cultivation. Butler silty clay loam and Pawnee silty clay loam are highly productive during seasons of normal or above-normal precipitation, but in dry years their surface soils do not hold enough moisture to sustain crops through prolonged droughts, and the dense claypan does not allow plant roots to obtain much moisture from the subsoil. Small grains do better, as a rule, than corn on the Butler and Pawnee soils, because they mature earlier, generally before the moisture stored above the claypan during the winter and spring is exhausted.

The excessively drained soils of the uplands occupy 17.2 percent of the county. They occur in areas where an unusually large percentage of the precipitation runs off the land without benefiting the vegetation. All the soils of this group have suffered some erosion, and several of them are severely eroded. They include slope phases of the Marshall and Carrington soils and all the Knox, Shelby, Lancaster, and Sogn soils. One or another of these soils occurs in all parts of the county but most extensively in or near the bluff lands along the Missouri and Platte Rivers.

The Marshall and Knox soils have developed or are developing on loess, the Carrington and Shelby soils are on glacial drift, and the Lancaster and Sogn soils are on sandstone and limestone bedrocks, respectively. The more extensive soils of this group have dark sur-

face layers well supplied with organic matter. Except during the driest years, they return profitable yields of all the crops commonly grown. The Knox soils have the thinnest and lightest colored surface soils in the county. In many places they consist essentially of raw loess, the topmost few inches of which have been only slightly darkened by organic matter. A large part of the area occupied by them remains in pasture and woodland. The areas of Sogn and Lancaster soils include numerous outcrops of the parent bedrocks. They are farmed only in places where the slopes are not too steep or the soils too shallow for cultivation.

The group that includes the variably drained soils of the bottom lands comprises the Wabash, Bremer, Lamoure, Cass, and Sarpy soils, which, collectively, occupy 12.4 percent of the county. All these soils are nearly flat and lie at an elevation of only a few feet above the normal level of the streams. They are developing on alluvial sediments deposited during periods of high water and are subject to occasional inundation. Most of the water drains off within a few hours after the streams subside, and the greater part of the land is sufficiently well drained for cultivation.

The Wabash, Bremer, and Lamoure soils are developed on the finer textured sediments, chiefly silts and clays, whereas the Cass and Sarpy soils are developed on sands and gravel. Aside from the Sarpy soils, which have accumulated only a little organic matter and are light-colored throughout, the soils of this group have almost black surface layers. The Lamoure soils are the only soils in the group that contain an appreciable quantity of lime.

Where well drained, the dark soils of the bottom lands give higher acre yields of corn and alfalfa than are obtained on any of the soils of the uplands or terraces. They are not quite so well suited for small grains as are the higher lying soils, chiefly because the abundant supply of moisture in the bottom lands causes these crops to produce a rank vegetal growth at the expense of the grain and to mature rather late. In dry seasons, however, no soil on the uplands or terraces returns higher yields of any crop than can be obtained on the better drained parts of the bottom lands.

The group classed as miscellaneous soil materials includes riverwash and made land, which together occupy 3,072 acres. Riverwash is alluvium recently deposited by the Platte and Missouri Rivers. It has not yet developed into a soil, but it supports willows and brush and is of some value for pasture land. Made land consists chiefly of stone refuse that has accumulated as a result of rock quarrying. It has no agricultural value.

Although most of the soils in this county are highly productive, they differ considerably in their producing capacities and use suitabilities, according to differences in soil characteristics, surface features, and drainage conditions.

LITERATURE CITED

(1) GANNETT, HENRY.
1906. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U. S. Geol. Survey Bul. 274, ed. 4, 1072 pp.

(2) KIESSELBACH, T. A., RUSSEL, J. C., and ANDERSON, A.
1929. THE SIGNIFICANCE OF SUBSOIL MOISTURE IN ALFALFA PRODUCTION. Amer. Soc. Agron. Jour. 21: 241–268, illus.

(3) KINCER, JOSEPH B.
1922. PRECIPITATION AND HUMIDITY. U. S. Dept. Agr., Atlas of American Agriculture, pt. 2, Climate, sect. A (Advance Sheets No. 5), 48 pp., illus.
(4) ———
1928. TEMPERATURE, SUNSHINE, AND WIND. U. S. Dept. Agr., Atlas of American Agriculture, pt. 2, Climate, sect. B (Advance Sheets No. 7), 34 pp., illus.
(5) MEYER, A. H., SMIES, E. H., BUSHNELL, T. M., SPAFFORD, R. R., BURN, R. R., and SCARBOROUGH, R. J.
1916. SOIL SURVEY OF SAUNDERS COUNTY, NEBRASKA. U. S. Dept. Agr., Bur. Soils Field Oper. 1913, Rept. 15: 2011–2058, illus.
(6) NEBRASKA UNIVERSITY AGRICULTURAL COLLEGE EXTENSION SERVICE, DEPARTMENTS OF AGRONOMY AND PLANT PATHOLOGY.
1925. CEREAL SMUTS AND THEIR CONTROL. Nebr. Agr. Col. Ext. Cir. 126, 8 pp., illus.
(7) REED, WILLIAM GARDNER.
1918. FROST AND THE GROWING SEASON. U. S. Dept. Agr., Atlas of American Agriculture, pt. 2, Climate, sect. 1 (Advance Sheets No. 2), pp. 29–40, illus.
(8) STEWART, P. H., and GROSS, D. L.
1923. SWEETCLOVER IN NEBRASKA. Nebr. Agr. Col. Ext. Cir. 122, 15 pp., illus.

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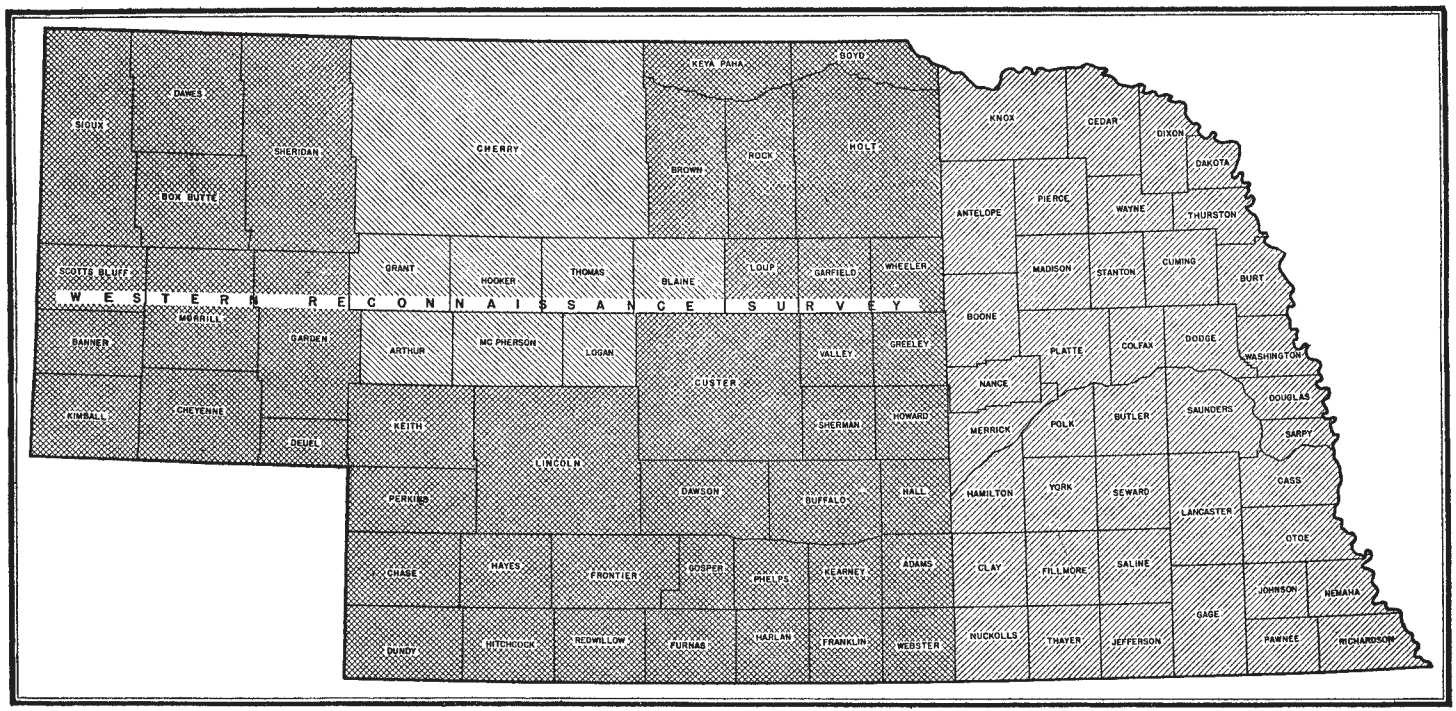

Areas surveyed in Nebraska shown by shading. Detailed surveys shown by northeast-southwest hatching; reconnaissance surveys shown by northwest-southeast hatching; crosshatching indicates areas covered in both ways.

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