

SOIL SURVEY OF SIOUX COUNTY, IOWA.

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DESCRIPTION OF THE AREA.

Sioux County borders the western boundary of the State of Iowa, and only one tier of counties separates it from the State of Minnesota on the north. The southern boundary is about 30 miles north of Sioux City, the second largest city in the State. The county is bounded on the north by Lyon County, on the east by O'Brien County, on the south by Plymouth County, and on the west by the State of South Dakota, from which it is separated by the Big Sioux River. The county has an area of 765 square miles, or 489,600 acres.

With the exception of the comparatively narrow strips of flat alluvial land along the larger streams, the topography of Sioux County varies from undulating to sharply rolling. The surface was originally that of a smooth, loess-covered plain, and the present relief is the result of erosion. The upland in the eastern three-fifths of the county ranges from almost flat to gently rolling.

The county is traversed by parallel streams which have a general southwestward flow. Near the streams the slopes are gently rolling, but with approach to the middle of the broad intervening divides the surface becomes undulating to almost flat. The upland in the western part of the county, which slopes toward the Big Sioux River, has a gently rolling to sharply rolling topography. Here the streams have cut deeply into the loess, and the surface has been completely dissected. The slopes become steeper as the valleys are approached, but the descent to the terraces is gradual, except in the northern part of the county along the Rock and Big Sioux Rivers, near the mouth of the former, where strips of rough and broken land are developed.

The alluvial lands along the streams may be divided into two natural divisions as regards topographic position, the ancient high

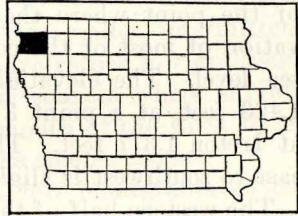


FIG. 52.—Sketch map showing location of the Sioux County area, Iowa.

terraces now standing above the level of possible overflow by the streams, and the first bottoms or present flood plains, practically all subject to frequent overflow.

High terraces occur along the larger streams in all parts of the county. They are most extensively developed along the Big Sioux and Rock Rivers. These benchlike areas are for the most part level to undulating and are broken only where cut by streams issuing from the uplands. They occur in discontinuous remnants, and the areas are very irregular in outline.

The lower or first bottoms, which occur along nearly all the streams of the county, are more uniform in development. They include the low-lying flood plains and the slightly higher terraces that are inundated only at rare intervals. Each of these terraces is in general level, but the surface is usually broken in places by tributary streams and by old stream channels.

In elevation above sea level Sioux County ranges from 1,164 feet in the extreme southwestern corner to 1,475 feet about a mile west of the point where the Floyd River enters the county. The elevation of most of the county is between 1,300 and 1,420 feet above sea level. The elevation at Orange City is 1,421 feet, at Boyden 1,423 feet, at a point 3 miles east of Rock Valley 1,323 feet, and at Ireton 1,377 feet. The general slope of the county from northeast to southwest is slight.

The western half of the county, including part of the northern tier of townships, is drained by the Big Sioux River, which flows into the Missouri River near Sioux City. The Big Sioux flows in a channel 100 to 200 feet in width, with an average fall of 3.2 feet per mile. The flow is utilized for the development of water power at Hawarden. The present flood plain along the Big Sioux lies 100 to 150 feet below the general level of the adjoining uplands 1 mile to 3 miles inland. The principal tributary of the Big Sioux is the Rock River. This is a swift-flowing stream which discharges into the Big Sioux 6 miles north of Hawarden. The alluvial land along the Big Sioux ranges in width from one-half mile at the north county line to 2 miles at the south line; it is of practically negligible width near Elm Springs, near the mouth of the Rock River, and a mile north of Chatsworth. The bottom land along the Rock River averages about a mile in width.

The Floyd River and its West Fork drain the eastern half of the county. The Floyd empties into the Missouri at Sioux City. The bottom land along the main stream is, on the average, between one-fourth and one-half mile in width, while that along the West Fork reaches a maximum width of three-fourths mile. The valley bottoms of each of these streams lie about 60 feet below the level of the adjacent uplands. The streams have a fall of about 5 feet per mile.

A small area in the northeastern part of the county is drained by Otter Creek, which flows into the Rock River in Lyon County.

From all indications, the larger streams of the county are of considerable age, as their valleys are out of proportion to the present size of the streams.

The surface of the county as a whole has been sufficiently diversified by stream erosion to have perfect drainage. Except along the Big Sioux River, there are no sharp ravines with steep sides; the slopes are gradual, leading from broad crests to wide valleys. The small streams flowing into the Big Sioux in the region of broken land, previously mentioned, are extremely short; they have almost precipitous slopes. The valleys of the other tributaries of the Big Sioux are distinctly V-shaped throughout their length, giving rise to rolling topography. The valleys of the Floyd River and its tributaries pass from V-shaped in their lower reaches to broadly U-shaped near their sources, giving a more gently rolling to undulating topography.

While every part of the county is reached by the intricate system of rivers, creeks, and branches, some of the smaller intermittent streams in the eastern third of the county have rather low gradients and there are a few small areas near their sources where surface water does not flow off readily. From the mouth of the Rock River south the drainage is excessive on some of the steeper slopes.

Sioux County was organized in 1860. A few immigrants settled in the Big Sioux Valley near the present site of Hawarden in the early fifties and a few near the present site of Rock Valley in the early sixties. The first permanent settlement of importance was made just north of what is now Orange City in 1870 by homesteaders from Pella, Iowa, of Dutch descent. Smaller settlements along the Floyd River were made the same year by immigrants of German descent from Jackson County, Iowa.

The population of Sioux County is reported in the 1915 State census as 25,346, an increase of only 98 over the enumeration of the 1910 Federal census. An increase in population has been reported at every five-year period since the county was organized, the largest gain being made in the period 1870-1875, within which the population increased from 576 to 3,220. The present population consists largely of descendants of the original settlers and of later immigrants from Holland and their descendants.

While the population of Dutch descent is scattered throughout the county, there are small settlements of Germans in the vicinity of Hospers and Granville and of Irish near Ireton and Lebanon. In the vicinity of Hawarden the population is more strictly of American descent, the early settlers here having come from the North Central and New England States.

Of the total population in 1910, 26.9 per cent consisted of persons of foreign birth. Sioux County has a higher proportion of foreign-born inhabitants than any other county in the State, the average for the State being 12.3 per cent.

The entire population of Sioux County is classed by the census as rural, there being no town in the county of 2,500 or more population. About 40 per cent of the inhabitants, however, live in towns. The population is fairly well distributed over the county, averaging 33.2 persons to the square mile. The least thickly settled part of the county is the rougher land adjacent to the Big Sioux River from the mouth of the Rock River north. The eastern half of the county is the more thickly populated.

Orange City, the county seat, in the southeastern part of the county, has a population of 1,414. Hawarden, with 2,045 inhabitants, is the largest and most important town in the county. Rock Valley and Hull, in the northern part of the county; Sioux Center, in the central part; and Alton and Ireton, in the southern part, are towns of local importance. There are several villages, important only as trading centers, distributed throughout the county. Sheldon, situated in O'Brien County, is an important trading center for many farmers in the northeastern townships. Each of the towns on the railroads has from two to five grain elevators. There are two flour mills at Hawarden, one at Rock Valley, and one at Sheldon.

Sioux County is well supplied with railroads, no point being more than 8 miles from a railroad station. The Chicago & North Western Railway crosses the southern part of the county from Hawarden east. It also has a line from Hawarden south to Sioux City. The main line of the Chicago, St. Paul, Minneapolis & Omaha Railway passes through the eastern part of the county, running from Omaha to Minneapolis. The Chicago, Milwaukee & St. Paul Railway crosses the northern part of the county, giving an outlet to the eastern part of the State and to Chicago. Another line of this system runs along the Big Sioux Valley, giving connection with Sioux Falls and Sioux City. This railroad has tracks for freight transportation from Rock Valley to Hudson, S. Dak., just across the Big Sioux River, 3 miles north of the mouth of the Rock River. The Great Northern Railway traverses the county north and south near the center, giving transportation facilities to Sioux City and Minneapolis. A branch line of the Illinois Central Railroad crosses the northeastern corner of the county, passing through Matlock and Sheldon, giving communication with Sioux Falls and eastern markets.

With but few exceptions, the wagon roads of the county conform closely to the section lines. The county has a good system of road maintenance and almost all the highways are kept in excellent con-

dition throughout the greater part of the year. The roads are commonly dragged after each rain. There are no rock-surfaced roads.

All parts of the county are reached by rural mail delivery service. Schools are maintained at intervals of 2 miles over most of the county and there are numerous churches. Telephones are in general use.

The principal markets for the agricultural products of Sioux County are Minneapolis, St. Paul, Sioux City, Omaha, Chicago, and Milwaukee. There is a ready market for grain and live stock at each of these cities. The population of the county consumes but a small part of the farm products.

CLIMATE.

The climate of Sioux County is essentially the same as that of Plymouth County on the south, and in the absence of official local records the precipitation data compiled from the records of the Weather Bureau station at Le Mars, in Plymouth County, are considered applicable. Data covering temperature and frost are compiled from the records of the station at Sioux City, about 30 miles south of Sioux County.

The mean annual precipitation recorded is 29.22 inches. The total rainfall for the driest year on record (1879) is reported as 16.49 inches, or slightly over half the normal, and for the wettest year (1884) 41.70 inches, slightly more than one-third above normal. Almost two-thirds of the annual rainfall occurs within the growing season, May to September, inclusive, and the precipitation usually is so well distributed that a drought of more than two or three weeks' duration is very rare. May and June are the wettest months of the year, and January and February the driest. The average annual snowfall, unmelted, is 28 inches.

Blizzards occur occasionally in the winter. On the other hand, there are occasionally periods of warm days in this season. Wheat sometimes winterkills on the uplands.

The mean annual temperature is recorded as 47.6° F. January and February are the coldest months, with mean temperatures a little below 20° F. July is the hottest month, with a mean of 73.8° F. The lowest temperature recorded at Sioux City is -31° F., and the highest 107° F.

The average date of the last killing frost in the spring is April 27, and that of the first in the fall, October 2. The average growing season is thus 157 days. The latest recorded killing frost in the spring occurred May 21, and the earliest in the fall, September 13.

The average number of clear days for the last 26 years covered by observations is 139 to the year; of partly cloudy days, 111; and of cloudy days, 115.

The prevailing direction of the wind is from the northwest. From the middle of May to the middle of September it is from the south or southeast, with occasional hot winds from the southwest in August. Tornadoes are very rare in Sioux County.

The following table, giving the normal monthly, seasonal, and annual temperature and precipitation, is compiled from records of the Weather Bureau stations at Sioux City and Le Mars:

Normal monthly, seasonal, and annual temperature and precipitation at Le Mars and Sioux City.

Month.	Temperature at Sioux City.			Precipitation.			
				At Le Mars.			At Sioux City.
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1879).	Total amount for the wettest year (1884).	Snow, average depth.
December.....	° F. 25.3	° F. 68	° F. -22	Inches. 1.00	Inches. 0.43	Inches. 2.60	Inches. 5.5
January.....	19.4	63	-28	0.58	0.30	0.10	5.6
February.....	19.3	75	-31	0.78	0.33	1.30	6.7
Winter.....	21.3	75	-31	2.36	1.06	4.00	17.8
March.....	32.8	83	-14	1.36	0.39	2.60	5.3
April.....	49.3	93	13	2.87	0.49	5.40	0.7
May.....	59.6	95	25	4.58	3.41	2.40	T.
Spring.....	47.2	95	-14	8.81	4.29	10.40	6.0
June.....	69.0	100	39	4.54	5.85	1.70	0
July.....	73.8	107	41	4.00	0.12	8.90	0
August.....	71.9	102	40	2.84	2.28	4.60	0
Summer.....	71.6	107	39	11.38	8.25	15.20	0
September.....	64.3	103	25	3.30	0.61	7.80	0
October.....	51.7	90	12	2.35	1.34	4.30	0.2
November.....	35.2	74	-9	1.02	0.94	0	4.0
Fall.....	50.4	103	-9	6.67	2.89	12.10	4.2
Year.....	47.6	107	-31	29.22	16.49	41.70	28.0

AGRICULTURE.

When Sioux County was first settled the soils supported an abundance of prairie and slough grasses. Considerable slough grass still remains along the creeks and intermittent drainage ways. There was no timber in the county, except along the courses of the Big Sioux and Rock Rivers.

The early settlers produced only such crops as were required to supply the home needs, such as wheat, corn, oats, barley, and rye.

Wheat became the first money crop. Yields of this grain at first were large, but, owing to the prevailing system of continuous cropping on the same land, they soon decreased. Wheat continued to decline in importance until about 1900, when it became more popular; for a few years the acreage in this cereal nearly equaled that devoted to corn. By 1910, however, wheat growing was again on the decline. In the early years spring wheat was grown almost exclusively, but more winter wheat was grown after the early eighties.

The first seed corn planted in Sioux County was brought from eastern Iowa in 1870. This corn, however, matured too late, but in response to the demand for a new cash crop to take the place of wheat new varieties better adapted to the climatic conditions were introduced, and with the building of the Chicago & North Western and the Chicago, Milwaukee & St. Paul Railways across the county in the late seventies and early eighties corn became the crop of first importance. As in the case of wheat, the yields of corn after several years of continuous cropping began to decrease, and it became apparent that some system of crop rotation was necessary to maintain the productivity of the soils. Farmers began to grow small grains, legumes, and corn in rotation, which, with the keeping of more live stock and the application of barnyard manure, has had the desired effect, the soils improving and the crop yields increasing.

A considerable acreage was devoted to flax between 1880 and 1885, but the yields of this crop soon decreased, and flax became relatively unimportant after 1890. Oats and barley have been grown from the beginning of agricultural development. These grains were used almost entirely for feeding stock on the farm, and it was not until 1895-1900 that even a small proportion of the crops was placed on the market. The acreage in barley has remained practically stationary since 1890, about 30,000 acres. The oat crop has always been important, and with the decline of wheat after 1900 it soon ranked second only to corn.

According to the census there were 23,554 acres in corn in 1879, producing 767,156 bushels, or about 33 bushels to the acre. The area in wheat was 37,580 acres and the production 86,790 bushels. Oats grown on 9,640 acres produced 133,273 bushels, and barley on 3,219 acres produced 25,416 bushels. The area cut for hay aggregated 12,143 acres, the crop amounting to 19,684 tons. There was a small acreage in rye, buckwheat, Canada peas, beans, and sorghum.

By 1889 the area devoted to corn had increased to 95,607 acres, with an average yield of about 38 bushels to the acre. The acreage in wheat, oats, and barley had increased to 62,273, 56,700, and 27,806 acres, respectively. Hay was cut on 45,243 acres, and there were 24,979 acres in flax.

By 1899 the area in corn had increased to 134,239 acres and the average yield to practically 40 bushels per acre. The wheat acreage was double that of 1889. The acreage devoted to oats and barley showed little change, but hay was cut on about 5,000 acres less and flax occupied only 796 acres. The value of dairy products sold in 1899 was \$143,938; of animals sold or slaughtered, \$1,322,866; and of poultry raised, \$64,099.

At the present time the agriculture of Sioux County consists of the production of the general farm crops, for sale and for farm use, of hog raising, beef-cattle production and feeding, and dairy farming. The principal crops are corn, oats, and hay. Barley and wheat are grown to some extent.

Corn occupies a larger acreage than any other crop in the county, and is the principal money crop. The census of 1910 reports 159,817 acres in corn, with a production of 6,786,387 bushels, an average of a little over 42 bushels to the acre. Most of the corn is from home-grown seed and is of mixed varieties. Of the pure strains grown, Reids Yellow Dent probably leads, followed by Iowa Silver Mine. The Silver King, recommended for this section of the State by the Iowa agricultural experiment substation at Orange City, is probably the earliest and most prolific variety, and this strain is planted more extensively every year. Field selection of seed is common and a germination test is often made. Between 50 and 60 per cent of the corn produced in the county is utilized for feeding work stock, fattening hogs and cattle, and feeding dairy stock. The remainder is sold to local elevators and shipped mainly to Chicago and Omaha.

Oats are grown on practically every farm, and constitute the crop of second importance. The census reports a total of 91,366 acres in oats in 1909, with a production of 2,746,351 bushels, about 30 bushels to the acre. Approximately one-half the production consists of early oats. Most of the crop is of mixed varieties. Of the pure strains grown, the Little Champion probably leads, with Kherson second. The latter variety is highly recommended for this county by the Iowa agricultural experiment substation at Orange City, and is increasing in popularity. Some side oats are grown. A little over one-half the production of oats is fed to work stock and to small pigs and calves. The remainder is sold to local elevators and shipped largely to Chicago.

The third crop in importance is hay. The land in hay in 1909 amounted to 56,877 acres, with a production of 98,495 tons. Of the total acreage, 36,741 acres were in tame or cultivated grasses, which yielded about $1\frac{3}{4}$ tons to the acre. Most of the wild or prairie hay is cut from the overflowed bottom lands, about the heads of drainage-way depressions, and along the slopes to the intermittent streams, where the land has been left in grass in order to prevent erosion.

All the hay produced is utilized on the farm for feeding work stock and beef and dairy cattle. Not enough hay is produced for farm consumption in parts of the county, and a considerable tonnage is annually shipped in.

Of the 36,741 acres devoted to tame or cultivated grasses in 1909, mixed timothy and clover led, with an area of 21,707 acres, yielding about 1.8 tons to the acre. Timothy alone ranked next, occupying 12,691 acres, with an average yield of 1.7 tons to the acre. The area devoted to clover was 563 acres, the yield being about 2 tons to the acre. Nearly all the clover grown is red clover, though there are small patches of sweet clover, grown mainly to inoculate the soil for alfalfa. Some white clover is sown with bluegrass and timothy in seeding pastures. The 1910 census reports 474 acres in millet and 875 acres in other tame or cultivated grasses.

Although alfalfa was first grown in the county about 15 years ago, it has not received much attention until within the last 5 or 6 years. The 1910 census reports only 431 acres, with an average yield of about 3 tons to the acre, but the acreage has increased considerably since that time. Alfalfa is fast gaining popularity and all indications point to the general production of this legume throughout the county to the extent of supplanting clover or mixed timothy and clover in some measure. Sufficient alfalfa seed was shipped into Hawarden alone in 1915 to sow more than 1,000 acres. Alfalfa gives a larger number of cuttings a year and usually makes a greater yield than either clover or clover and timothy mixed.

The acreage of barley has varied but little in the last 25 years, the 1910 census reporting 30,385 acres in this grain, with an average yield of about 17 bushels to the acre. Barley is grown both as a money crop and as a substitute for oats in the rotation. The barley grown is all of the six-rowed varieties. Some of the crop is fed at home to growing pigs, although the bulk of it is shipped to Milwaukee.

According to the census, the area devoted to wheat in Sioux County decreased from 126,838 acres in 1899 to 13,546 acres in 1909. In the latter year the average yield was about 13 bushels per acre. Very little winter wheat is grown, as it too frequently winterkills. The leading variety of winter wheat is Turkey Red. Of the spring wheats, Bluestem, Velvet Chaff, and Marquis are the leading varieties. Practically all the wheat produced is sold to the local mills, though some is sent to the larger markets, mainly Minneapolis.

The minor crops of Sioux County include potatoes, buckwheat, flax, and sorghum. The area in potatoes in 1909 was 2,165 acres and the production 204,206 bushels. Potatoes are grown to some extent on every farm, and this crop does well throughout the county, but the

distance to large markets and the rather late maturity of the crop prevents the production of potatoes on a commercial scale.

Many of the farms have a few apple trees, and apples are the only fruit of importance in the county, although there is a small production of cherries, plums, peaches, and grapes. The apples grown are practically all of summer and fall varieties, the Wealthy and Duchess leading. More winter apples have been planted recently, with the Northern Greening as the chief variety. In general, no care is taken of the fruit trees and many of the orchards are gradually dying. There is not enough fruit produced in Sioux County for home use.

Dairying in conjunction with general farming is gradually being extended. There were 19,148 dairy cows reported in the county in 1909, and the number has been steadily increasing since. The total revenue derived from dairy products in 1909 was \$514,168. Dairying is carried on the year round. In the growing season the cattle are kept on pasture, but given supplementary feed. There are but few silos in the county, although the number is increasing. All the farmers having silos report good results from the investment. The average number of milch cows to the farm is about 8. A few farms have as many as 20 or more. Very little attention is paid to the selection of dairy stock, and most of the animals are grade Shorthorn. There are a few purebred Holstein herds in the northern part of the county and a few purebred Shorthorn herds in the south-central part. Practically all the farmers sell cream to local creameries. The milk is separated on the farm and the cream either delivered by the farmer or collected by the buying station. The cream is made into butter, most of which is shipped to New York.

One of the most important live-stock interests in Sioux County is the raising of hogs. Nearly every farm has 40 to 60 or more hogs and about a dozen brood sows. On some farms all the corn produced is fed to hogs. The leading breeds are Poland China and Duroc Jersey, with some Chester White animals. There is not a very pronounced tendency to keep the strains pure. The census reports nearly 80,000 hogs sold or slaughtered in Sioux County in 1909. Most of the animals disposed of are sold to local buyers. The stock not needed for local supplies is sold in the Chicago, Omaha or Sioux City market.

Most of the beef cattle fed are raised in the county, though in the western part several carloads of western cattle are annually shipped in and fattened during the fall and winter months. Very little effort is made to keep the strains of cattle pure, and most of the stock is grade Shorthorn. Of the purebred animals, most are of Shorthorn, Hereford or Polled Angus blood, with the Hereford gaining in popularity. Beef cattle are finished on roughage and

for four or five years. Over 95 per cent of the corn is planted or checkrowed, the remainder being drilled for use as ensilage or fodder. Corn is cultivated three, four or five times. In the spring following a crop of corn the ground is double-disked and seeded to a small grain, with which grass, mainly clover and timothy mixed, is sowed. Following the harvesting of the small grain the clover and timothy produces one cutting of hay. The second growth of hay is usually allowed to go to seed, so as to make pasturage the following year; there may be some pasturage the first year if the season is favorable. The pasture land is plowed in the late fall and put into corn. In the majority of cases corn yields average 5 to 10 bushels higher the first year following clover than the second year.

Wheat is seldom grown two years in succession, as the yield the second year is not large enough to be profitable. Winter wheat is sometimes drilled in corn in the fall without plowing. In this case clover and timothy are either sown with the wheat or are added the following spring. Oats are usually sown broadcast, though part of the crop is drilled.

Alfalfa usually occupies a field about five years. This crop may be sowed in the fall or in corn in the early summer; both methods have been used successfully. Farmers have tried to raise alfalfa with a nurse crop, but small grains, especially oats, take too much moisture from the alfalfa to be useful as nurse crops.

The implements used in plowing, tillage, and harvesting include the latest labor-saving devices. The farm machinery is usually well protected from the weather when not in use. Plowing is generally done with 5-horse teams. The depth of breaking is usually about 5 inches.

The commercial fertilizer used in 1909 in Sioux County amounted in value to only \$717, and practically no commercial preparations are used at the present time. For several years a small application of ground limestone was commonly made in preparing the soil for alfalfa, but it has been found that liming is not necessary and the practice has been discontinued. Occasionally the last crop of red clover is plowed under as a green manure, and as a rule the feed-lot and stable manure is carefully saved. Manure spreaders are in general use throughout the county, and it is a common practice to haul the manure to the field as soon after it is made as is possible. Manure is usually applied to clover land that goes into corn the following spring. Top dressing of pastures, however, is quite common.

Owing to the fact that a large number of Hollanders come to the county each year and work on the farms until they learn the cultural methods, the supply of labor is usually sufficient, except in the southwestern part of the county. Labor is usually hired either for nine months or the year round, the hands receiving \$30 to \$35 a month

with board and washing and the maintenance of one horse. Harvest help is seldom hired; the pay is \$2 to \$2.50 a day. In 1910, 1,710 farms, 63 per cent of the total number in the county, reported an average labor expense in 1909 of \$272.73 each.

The 1910 census reports a total of 2,715 farms in Sioux County. The farms range in size from a few acres, near the towns, to over 1,000 acres. Most of them comprise between 100 and 240 acres. The 1910 census reports the average size of farms as 175.1 acres, an increase of 26 acres over the average size in 1880. The percentage of farms operated by owners has steadily decreased from 77 per cent in 1880 to 46.7 per cent in 1910. This decrease is due largely to the fact that many farm owners have moved to town and rented their land. Most of the tenanted farms are rented for one year, usually on a cash basis, for \$6 to \$7 an acre. When land is rented on the share basis the owner receives two-fifths to one-half the grain produced and cash rent for all the pasture and hay land, the grain to be delivered at the market.

According to the 1910 census approximately 98 per cent of the area of the county is in farms, and 92.4 per cent of the land in farms is improved. Land values vary according to the soil, topography, improvements, the location, and the distance from market. Throughout the eastern two-thirds of the county unimproved land is held at \$125 to \$175 an acre, while improved land sells at \$150 to \$225 or more an acre. In the extreme western part of the county the selling price of land averages about \$150 an acre.

The farm buildings, including the dwellings, are in general large and substantial. The barns have considerable storage room for grain and hay for the work stock, as well as ample room to shelter the draft and dairy animals. In addition, most of the farms have several other buildings to shelter stock and for storage purposes. The fences are good, usually of barbed or woven wire, and are well kept.

SOILS.

The soils of Sioux County may be divided into four general divisions, viz, loessial soils, glacial soils, terrace, or second-bottom, soils, and first-bottom, or recent-alluvial, soils. The soils of these broad divisions are further grouped into series on a basis of similarity in color, origin, topography, and structural characteristics. The series are divided into types on the basis of texture. The soils of the upland are predominantly silty, while those of the bottom lands are silty along the smaller streams and lighter textured along the larger streams.

A thick superficial layer of loess once covered the entire upland of Sioux County, but through a long period of time it has been thinned

by erosion to a greater or less extent over a considerable part of the area. The loess now ranges in thickness from a few inches to about 20 feet; its average depth is about 6 feet. The unweathered loess consists of a light-brown or buff-colored silty material, loosely cemented with lime. Near the surface it is usually leached, but in general at a depth of less than 3 feet there is an abundance of lime, which in many places has accumulated to form small lime concretions.

Although the loess material is sufficiently coherent to stand up in vertical faces under erosion and to assume a columnar structure in many places, it crumbles readily into a loose, floury powder. The origin of the loess is still a subject of disagreement among geologists, the most generally accepted explanation being that it represents fine material from glacial drift reworked and redeposited over vast areas either by wind or water or possibly both.

The soil derived from loess is classed in the Marshall series. Where it has weathered in an undisturbed situation the loess has accumulated organic matter, indicated by the dark color of the surface soil, and has undergone a gradual leaching of lime from the surface soil and a concentration of clay in the subsoil. These processes have reached a more advanced stage in the level or gently rolling areas, and in the eastern part of the county there have been developed deep-black surface soils with subsoils containing a slight accumulation of clay. In the more rolling country to the west the color of the surface soil is not so deep a black, the surface soil is shallower, and the subsoil is loose and friable. The soil conforming to the latter description is recognized as the typical Marshall silt loam, while the well-weathered material is classed as the Marshall silt loam, smooth phase.

The surface soils of the Marshall series are dark brown to black in color, underlain by yellowish-brown subsoils. These soils are highly calcareous, the lower subsoil effervescing with acid. The lower subsoil is light and friable, approaching the characteristics of unweathered loess. The surface soil is usually high in organic matter. The topography of the typical Marshall soils is rolling, but the Marshall silt loam, smooth phase, has a nearly level surface.

Directly underlying the loess lies glacial drift, in all probability of the Kansan sheet.¹ This drift is about 200 feet in thickness and is composed of a uniform mass of clay and silt, with some sand, gravel, and bowlders. Often a layer of sand, gravel or bowlders is encountered between the loess and the drift; in all cases the line of separation between the two is distinct. The drift where it has been oxidized has a yellowish-brown, brown or reddish-brown color, but below the oxidized zone to the depth of about 90 feet it is yellow or

¹ See Annual Report of the Iowa Geological Survey, Vol. X, 1899.

grayish yellow. This drift is in turn succeeded by a blue clay, which continues until the underlying shale is reached. The drift is nearly everywhere unleached and lime concretions, similar to those in the loess, are common. The drift, where it has been exposed by the removal of the overlying layer of loess, weathers into soils quite distinct from those derived from loess. The soil material, however, has been more or less influenced by the overlying loessial layer. The dark surface soil contains glacial gravel and boulders and is underlain by a yellow or light-brown subsoil, usually containing similar coarse material. Those types derived from glacial till are classed in the Carrington series. They have dark-brown to black surface soils, with yellowish to yellowish-brown subsoils. This series is developed in the Central and Western Prairie States and consists mainly of prairie soils. Only one type is developed in Sioux County, the Carrington loam.

The terrace or second-bottom soils occur along the rivers and larger creeks in benchlike situations, practically free from stream inundations. Those terrace soils along the Big Sioux and Rock Rivers were formed by the deposition of a loessial layer over the Wisconsin gravel train. The terrace soils elsewhere are of similar origin, except that the outwash of gravel is probably from older glacial material. The overlying loessial layer varies in thickness from less than 3 feet, in which case the resulting soil is classed in the Sioux series, to 3 feet or over, where the Waukesha soils are developed. In the eastern part of the county the loessial material varies in general from 5 to 15 feet in thickness.

The Waukesha series is characterized by dark-brown to black surface soils and yellowish subsoils. The material is derived from water-assorted glacial débris, deposited in broad filled-in valleys or as outwash plains and terraces. The topography is nearly flat to gently undulating. The Waukesha silt loam is the only member of this series recognized in Sioux County.

The Sioux series includes types with dark-brown to black surface soils and light-brown upper subsoils. The soils are distinguished from those of the Waukesha series by having usually a bed of gravel, in the nature of a lower subsoil or substratum, developed near enough to the surface to have a marked effect on the drainage, causing the soils to be somewhat droughty. The Sioux soils differ from the Wabash soils in their occurrence on terraces above overflow as well as in the presence of the bed of gravel in the subsoil. The series is represented in Sioux County by the Sioux loam.

First-bottom, or recent-alluvial, soils occur in strips along all the larger streams of the county and many of the smaller ones. These soils are constantly receiving additional deposits from the overflow waters of the streams. The alluvium along most of the smaller

streams is composed of silty material washed from the loessial uplands of the region, while that along the larger streams and some of the smaller ones has in addition considerable wash from the drift underlying the loess or from the sand and gravel underlying the terraces. Along the Big Sioux and Rock Rivers part of the recent-alluvial deposit is from glaciated areas to the north of Sioux County. Practically all the first-bottom alluvium is high in organic matter. With the exception of a small development of Riverwash, the soils derived from recent alluvium in this county are correlated with the Lamoure and Wabash series.

The types included in the Lamoure series have dark-brown to black surface soils and brownish or drab subsoils. These types differ from those of the Wabash series only in their high lime content. Only one Lamoure soil is mapped in Sioux County, a colluvial phase of the silt loam.

The Wabash series includes types with dark-brown to black surface soils containing much organic matter and gray or brownish-gray subsoils. These soils are developed typically in the first bottoms of streams of the Central Prairie States. The drainage is rather poorly established. Four types of this series are mapped in Sioux County—the Wabash fine sandy loam, loam, silt loam, and silty clay loam.

In addition to the nine soils grouped in the six series already described, two miscellaneous classifications are made. Riverwash includes small areas of nonagricultural, coarse-textured soil along the channel of the Big Sioux and Rock Rivers, where the material is altered at each rise of the stream. Rough broken land is the term used to designate the areas of steep and broken slopes leading from the uplands to the lowlands along the Big Sioux and Rock Rivers.

The various soils encountered in Sioux County are described in detail in the following pages of this report and their relation to agriculture discussed. Their distribution is shown on the accompanying map and their actual and relative extent in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam.....	151,232	80.8	Rough broken land.....	2,368	0.5
Smooth phase.....	244,288		Riverwash.....	1,152	.2
Wabash silt loam.....	32,000	6.5	Wabash fine sandy loam.....	832	.2
Carrington loam.....	15,488	3.2	Wabash silty clay loam.....	704	.1
Waukesha silt loam.....	14,720	3.0			
Wabash loam.....	12,800	2.6	Total.....	489,600
Sioux loam.....	10,752	2.2			
Lamoure silt loam, colluvial phase.....	3,264	.7			

MARSHALL SILT LOAM.

The surface soil of the typical Marshall silt loam is a dark grayish brown to dark-brown, moderately heavy silt loam, 8 to 12 inches deep. This is underlain by a yellowish-brown to brownish-yellow, rather compact, friable, heavy silt loam to light silty clay loam. In the areas of deeper soil the subsoil often takes on a grayish cast and becomes loose and friable. There are numerous lime concretions and some faint reddish brown iron stains in the subsoil. The loess throughout the areas of this type varies considerably in thickness and in many places is very thin.

The surface soil of the typical Marshall silt loam is not so high in organic matter nor so uniform in color as is that of its smooth phase. When dry the material assumes a rather grayish brown color. Often on the more eroded slopes, especially in the region south of Hawarden, several areas too small to map occur where the surface soil has been eroded almost entirely away, exposing a brown to yellowish-brown heavy silt loam carrying many lime concretions on the surface. On the rather flat divides the surface soil in many places is somewhat heavier than typical, more closely resembling that of the smooth phase, but it is rarely over 12 inches deep. The subsoil is not so compact, as a rule, as that of the smooth phase and the surface is more rolling, with more sharply defined drainage-way depressions.

The typical Marshall silt loam is developed in the western part of the county, in the drainage basins of the Big Sioux and Rock Rivers. Over most of the type the surface is rolling, becoming more steeply rolling in the areas adjacent to the larger streams and, on the other hand, milder in relief as the divide between the Big Sioux and Floyd basins is approached. Smooth, distinctly V-shaped valleys are characteristic of the areas of the Marshall silt loam. Most of the type lies between 1,300 and 1,400 feet above sea level. Drainage is good and in some places, if the soil is not handled carefully, erosion takes place.

The typical silt loam is the second most extensive soil in the county and an important agricultural soil. It is exceeded in area only by its smooth phase, the typical soil and its phase together occupying over four-fifths the area of the county. Probably 85 per cent of the typical soil is under cultivation. Some small areas in the more steeply rolling sections of the county remain in native prairie grass.

Corn, oats, hay, barley, and wheat are the principal crops. The acreage devoted to oats and wheat is a little larger, and more alfalfa is grown in proportion to clover than on the smooth phase of the type. The raising of hogs, the fattening of beef cattle, and dairying are the most important live-stock industries on farms on this soil.

More beef cattle are fattened than in districts in which the smooth phase predominates.

Corn yields on the Marshall silt loam are ordinarily between 32 and 42 bushels to the acre.¹ Other crops yield about the same as on the smooth phase, with the exception of alfalfa, which apparently does better, owing to the more open nature of the subsoil in the case of the typical soil. The soil is handled and manured in practically the same way as is that of the smooth phase.

The ordinary selling price of land of the typical Marshall silt loam ranges from \$125 to \$200 an acre, although in the vicinity of the towns and nearer the watershed between the Big Sioux and Floyd basins many farms have recently sold for higher prices.

Rotation of crops and the application of barnyard manure are used to maintain the productiveness of the farms on this type of soil. There is need of keeping the land in cover crops as much of the time as possible in order to prevent erosion. Many farmers keep the draws and drainage ways in grass for this purpose. Where the former surface soil has been eroded away or the layer has become very thin, as on many of the steeper slopes, the surface material is greatly in need of organic matter, and the best farmers make it a practice to apply large quantities of barnyard manure in these places annually. Green manuring would be of considerable benefit.

Marshall silt loam, smooth phase.—The surface soil of the Marshall silt loam, smooth phase, is a dark-brown, rather heavy silt loam extending to a depth of 12 to 15 inches. This is underlain by a layer of brownish-yellow to dark yellowish brown, very heavy, compact silt loam. At about 22 inches the subsoil grades into a yellow to brownish-yellow, rather compact, heavy silt loam or light silty clay loam, which becomes quite friable in the lower part of the 3-foot section. The substratum, of the same material as the lower subsoil, continues quite uniform to the underlying drift. Reddish-brown or rusty-brown iron stains frequently occur below 30 inches. Small lime concretions, although in many places encountered throughout the entire 3-foot section, are more abundant in the lower part.

On the flatter areas of the phase and adjacent to areas of the colluvial phase of the Lamoure silt loam the subsoil is in places quite crumbly, and it often assumes a grayish cast in the lower part, the surface soil here becoming a very heavy silt loam. In the eastern and northern parts of the county, along intermittent streams, there occur many narrow strips of the Lamoure soil, too inextensive to be mapped separately.

Over most of the phase there is a slight concentration of clay between the depths of 15 and 22 inches, resulting from the washing

¹ Statements in this report as to crop yields are based on information obtained from farmers.

down of clay particles from the surface soil. This intermediate layer of rather compact material is often absent on the steeper slopes. The surface soil is quite uniform in depth over the entire area of the phase, although on the breaks to the steeper slopes it is in places shallower than typical. It is rarely less than 6 or 8 inches deep. As the typical Marshall silt loam is approached the surface soil usually becomes smoother to the feel than typical and more dark grayish brown in color; the rather compact intermediate layer gradually disappears.

Originally the phase supported a growth of slough and prairie grass. There was practically no native timber.

The Marshall silt loam, smooth phase, is the most extensive soil in Sioux County, covering two-thirds of the upland area. It occurs as a large continuous area covering nearly all the upland in the eastern half of the county. In general, the topography is undulating to very gently rolling, with enough relief to insure good drainage without inducing erosion. Near Granville and in the vicinity of Hull and Boyden the topography is undulating to nearly flat. In these sections the smaller creeks and intermittent streams have very low gradients and the slopes are very gradual, the valleys representing a wide U in cross section. Here drainage, though rather slow, is adequate. Where drainage is so poor as to affect the character of the soil, the areas are mapped as the Lamoure silt loam, colluvial phase. Over the remainder of the phase the topography is more undulating, even becoming gently rolling along the larger streams and as the south county line is approached, and the stream gradients are higher.

Over the whole of the phase the subsoil is retentive of moisture, and crops rarely, if ever, suffer from drought. The greater part of the phase lies between 1,400 and 1,475 feet above sea level.

Practically all the Marshall silt loam is in tilled crops or in cultivated grasses. The most important crops produced on this soil are corn, oats, hay, barley, and wheat. Corn is the principal money crop. Oats rank next to corn in acreage and in importance as a source of income. About one-half the production of corn and one-third that of oats are sold. The acreage devoted to cultivated grasses has steadily increased in the last few years. The main live-stock industries are the raising of hogs, the raising and fattening of beef cattle, and dairying. Hog raising is the most important interest. Dairying is relatively well developed. Dairying is carried on the year round. Fruit growing has been neglected on this soil. Many farmers are now setting out orchards of winter apples.

On the Marshall silt loam, smooth phase, corn ordinarily yields 35 to 45 bushels per acre, and as much as 75 bushels an acre has been obtained. Oats commonly yield 30 to 40 bushels, barley 15 to 20

bushels, and spring wheat 14 to 18 bushels per acre. Little winter wheat is grown, owing to its tendency to winterkill. Clover and timothy mixed yield ordinarily $1\frac{1}{2}$ to $2\frac{1}{2}$ tons of hay per acre, red clover alone about 2 tons, timothy alone 1 to $1\frac{3}{4}$ tons, and alfalfa $2\frac{1}{2}$ to $3\frac{1}{2}$ tons. Potatoes yield on an average about 100 bushels per acre.

This soil is quite friable and silty and it can be cultivated under a comparatively wide range of moisture conditions. If plowed when too wet, however, it forms clods that are slow to weather to a friable condition. By employing the proper methods of handling, such as are followed by the more progressive farmers, the productiveness of this soil can be easily maintained. The farmers recognize the value of crop rotations, and a definite system is in general followed. Corn is usually grown for two years, and a small grain for one year, followed by red clover or red clover and timothy for two years, after which the land is returned to corn. When clover is grown primarily for soil improvement it is seeded alone. Many of the better farmers say that the first crop of corn following clover yields 5 to 10 bushels more to the acre than the second crop. If alfalfa is introduced into the rotation, it is allowed to remain for several years before the land is returned to corn. It is usual to apply the barnyard manure to the soil as soon as possible after it is made, usually on clover sod that is to be plowed up for corn the following spring. Pastures are also top-dressed with manure.

Farms on the Marshall silt loam, smooth phase, are, as a rule, well improved and well cared for. Each farm has one or more wells. Water is obtained at depths of 25 to 50 feet in dug wells, and of 100 to 350 feet in drilled wells. In general, farms on this soil range in price from \$150 to \$225 an acre, though many have been sold recently for as much as \$250 an acre. The price varies according to the improvements, location, and condition of the land.

The widespread success with alfalfa indicates that the Marshall silt loam, smooth phase, is well suited to this legume. Alfalfa produces one or two cuttings a year more than red clover and gives a heavier yield. It also stands longer without reseeding. There is a lack of sufficient live stock on some farms to produce enough manure to keep the soil in the best condition and the occasional turning under of a green manuring crop, such as red clover, would be of great benefit to the soil where this condition exists.

CARRINGTON LOAM.

The surface soil of the Carrington loam, to a depth of 8 or 10 inches, is a dark grayish brown to dark-brown loam to silty loam. This is underlain by a light-brown to yellowish-brown, heavy loam to light silty clay loam extending to a depth of 24 inches and grading

below into a yellowish-brown sandy loam or clayey sand. There is a rather high percentage of fine sand in the material throughout the soil section. Often a layer of yellowish-brown sand, practically free from clay, occurs below 27 inches. This material is exposed in places on the steeper slopes in areas too small to map separately. On some of the more gradual slopes and near the areas of other upland soils the subsoil occasionally contains very little sand, in which case it greatly resembles that of the typical Marshall silt loam. A subsoil of this character is developed most prominently in the vicinity of Hawarden and south to the county line.

The surface soil of this type has a fairly high content of organic matter. The subsoil is highly calcareous, the lime occurring mainly in the form of concretions, but to some extent in small bowlders of limestone. The subsoil also contains numerous reddish-brown iron stains. On some of the more abrupt slopes pebbles, cobblestones, and bowlders are abundant on the surface and throughout the soil section, in places being so abundant as to interfere with cultivation. The bowlders are chiefly of quartzite and granite.

The Carrington loam reaches its greatest development in the western part of the county, largely along the south and east slopes leading to the bottoms along Big Sioux and Rock Rivers. Small areas are scattered over other parts of the county. Most of the type occupies gradual slopes. Surface drainage is thorough, and on some of the more abrupt slopes it is excessive. Internal drainage also is in general inclined to be rapid, owing to the open structure of the soil. In the areas of heavier soil and subsoil the type maintains a good supply of moisture, but in exceptionally dry years a small proportion of the area is inclined to be rather droughty.

About 60 per cent of the Carrington loam is under cultivation, the rougher areas being utilized for pasture. Fairly good yields of all the common crops are obtained. On the areas of heavier subsoil the yields are about the same as on the typical Marshall silt loam. On areas where the substratum of sand is prominently developed and this coarse material is exposed at the surface in spots corn yields 20 to 40 bushels, wheat 8 to 15 bushels, oats 15 to 35 bushels, and barley 15 to 25 bushels per acre in normal years. Some trouble is experienced in starting clover and alfalfa, but when once established these legumes give good yields. Sorghum does well, but is grown to only a small extent. The live-stock industries on this type are practically the same as those on the surrounding upland soils. More of the type is pastured than of the Marshall soils.

The Carrington loam is farmed in much the same way as are the other upland soils of the county, though it can be worked under a wider range of moisture conditions. Much of the type is included in farms with other upland soils. It warms up earlier in the spring

than the associated types, and the planting and maturing of crops are usually slightly earlier.

Except in the vicinity of Rock Valley and Hawarden, the farms on the Carrington loam are, as a rule, not highly improved. Farms that are well improved are valued at \$125 to \$175 an acre, the price depending upon the distance from market and the condition of the soil.

The productiveness of the Carrington loam depends to a considerable extent upon the care used in handling the soil and the methods of improvement employed. It has been found by the more progressive farmers that a good supply of organic matter aids materially in holding moisture and increasing yields. Liberal applications of barnyard manure and the occasional plowing under of a green manuring crop would benefit the soil. The land should be kept in cover crops as much as possible, to prevent washing and leaching.

WAUKESHA SILT LOAM.

The surface soil of the Waukesha silt loam consists of a dark grayish brown to dark-brown, moderately heavy silt loam, with a depth of 12 to 15 inches. The upper subsoil is a brown, rather compact, heavy silt loam to light silty clay loam. It is underlain at a depth of about 22 inches by a yellowish-brown to brownish-yellow, friable, very heavy silt loam to light silty clay loam, ordinarily extending to a depth of 5 to 20 feet, where the basal material, consisting of light-gray or yellowish-gray stratified sand and gravel, is encountered. In many places where this type grades into the lower lying Wabash soils the gravelly beds are exposed, giving rise to a loamy soil. Such areas are narrow, rarely over 75 feet wide. The lower subsoil is often faintly marked with brownish iron stains. The surface soil proper is usually leached, but occasional lime concretions are found near the 3-foot depth. In the more undulating areas the intermediate brownish layer is lacking and the subsoil becomes a brownish-yellow, friable, heavy silt loam. From all indications the soil in the smaller areas of this type that occur along the minor streams varies from the typical in being underlain by the same basal material as are the upland soils, instead of by the stratified sand and gravel.

The Waukesha silt loam occupies distinct benchlike areas, standing 10 to 15 feet above the first bottoms, along both large and small streams. It lies almost entirely above overflow. Along the rivers the type occurs in rather narrow strips, while along the creeks it is developed in small, detached areas. The surface is nearly flat, but may be slightly dissected by small draws or streams issuing from the upland. The type has good drainage, but withstands drought

over long periods. On the broader terraces a few small depressions occur, in which water occasionally stands a short time in wet seasons, though rarely long enough to affect growing crops.

The terraces along the Big Sioux River above the mouth of the Rock River are as a rule higher than those elsewhere in the county, lying 20 to 50 feet above the present flood plain. The Waukesha silt loam along the line of the Chicago, Milwaukee & St. Paul Railway in the northwestern corner of the county differs from the typical soil in that the surface slopes gradually from the base of the upland to the first bottoms, with a drop of about 40 feet. From indications in deep cuts the basal material of the high terrace contains a large number of waterworn boulders.

Approximately 85 per cent of the Waukesha silt loam is under cultivation. A considerable proportion of the lower lying areas of this soil along the creeks is used for pasturage. This soil originally supported a growth of the common prairie grasses.

The same crops, ranking in the same order of importance, are grown on the Waukesha silt loam as on the Marshall silt loam, smooth phase, namely, corn, oats, and hay, with considerable barley and some wheat. Probably a little larger proportion of this soil is devoted to corn. Crop yields do not differ noticeably from those obtained on the smooth phase of the Marshall silt loam.

As a rule the soil of the Waukesha silt loam is more silty and mellow than the Marshall soil, and it can be cultivated under a wider range of moisture conditions. Ordinarily it is farmed in much the same way.

Land of the Waukesha silt loam can be bought for \$150 to \$225 an acre, the price varying with the improvements and location.

Soil of this type can be improved by the same farm practices as are beneficial in the case of the Marshall silt loam, smooth phase.

SIOUX LOAM.

The Sioux loam differs from the Waukesha silt loam in having a somewhat lighter color and a lower content of organic matter. The surface soil, extending to a depth of 8 to 12 inches, is a dark grayish brown to dark-brown loam. This is underlain by a yellowish-brown to brown silty clay loam. Considerable fine and medium sand is present throughout the soil section and there are occasional gravel particles. The underlying silty clay loam layer gradually becomes more sandy until a bed of stratified gravel and sand is encountered, usually at a depth of about 30 inches, although it may not occur within the 3-foot contour. Exposures in gravel and sand pits show this bed to be over 40 feet thick in places. Immediately underlying the true soil the material may be a brownish mixture of medium and coarse sand nearly free from gravel, or it may be mostly gravel,

and occasionally in the higher lying terraces it carries large water-worn boulders.

Over part of the type, especially back from the streams or adjacent to the Waukesha silt loam where the bed of coarse material may be below the 3-foot level, the surface soil usually is quite silty. Again, near the streams or where surface drainage has been active enough to remove part of the soil, the coarse-textured stratum in places comes close to the surface and the soil is lighter textured.

A sandy variation of the Sioux loam occurs in small areas along the Big Sioux River. It occupies narrow, rather flat ridges lying 10 to 15 feet above the typical Sioux loam. The soil to a depth of 10 or 12 inches is a grayish-brown to dark grayish brown sandy loam, underlain by a light-brown or yellowish-brown mixture of fine, medium, and coarse sand, with some gravel and a small percentage of clay. The loose, porous nature of the subsoil induces excessive drainage and crops on this soil are the first to suffer in dry seasons. The greater part of this land is cultivated, being included in fields with the typical Sioux loam. Crop yields are low. This soil, if of sufficient area, would be mapped as Sioux sandy loam.

The Sioux loam reaches its greatest development along the Big Sioux and Rock Rivers, but a few small, isolated areas occur along the other larger streams. The type usually occupies rather flat, distinctly benchlike areas which stand 10 to 20 feet above the stream bed; a large area, however, north of the mouth of the Rock River lies on an older terrace 20 to 50 feet above the first bottoms. This area also is distinctly benchlike, but the surface is more ridgy or undulating near the stream than is typical. Some of the areas of the Sioux loam are somewhat eroded by streams issuing from the upland.

Where the bed of coarse material lies near the surface drainage is likely to be excessive, owing to the rapid percolation of water through the surface soil and this open material, but over much of the type this stratum is at a more favorable depth or is more retentive, and the soil holds moisture fairly well, though not so well as the other important soils of the county, and in very dry years crops are likely to suffer. Practically all the type lies above overflow.

The Sioux loam is one of the most extensive alluvial soils in the western part of the county and is important in the agriculture of that section. Probably 90 per cent of the type is cultivated, the remainder being in native prairie grasses or utilized for town sites and farmsteads. Corn is the principal crop, followed by oats. The acreage devoted to winter wheat is relatively greater than on any other type in the county. Spring wheat, barley, clover, timothy, and alfalfa are other important crops. The raising of hogs and the fattening of beef cattle are the most important live-stock indus-

tries on farms on this soil. Dairying is developed to a considerable extent.

In a normal year corn yields 35 to 45 bushels per acre, oats 35 to 40 bushels, winter wheat 25 to 30 bushels, and spring wheat 14 to 18 bushels. In especially favorable years the yields are much higher. Where the soil layer is fairly deep, clover and timothy give as good yields as on the Marshall silt loam, smooth phase, and alfalfa also does fairly well. Potatoes yield from 80 to 100 bushels an acre.

Owing to the level surface of this type and to the wide range of moisture conditions under which most of it can be handled, it is possible to obtain the maximum efficiency from farm machinery. Several tractors are in use. About the same crop rotations are practiced on the Sioux loam as on the Marshall silt loam, smooth phase, except that there is a tendency to grow corn for only one year and to use winter wheat as the chief small grain. Cultivation methods on the two soils are the same. Land of the Sioux loam is valued for agricultural purposes at \$140 to \$175 an acre.

As a rule the Sioux loam has a slightly lower content of organic matter than the other important soils of the county, and there is need for the application of this material in the form of animal or green manures in order to increase the capacity of the soil to retain moisture.

LAMOURE SILT LOAM, COLLUVIAL PHASE.

The soil of the Lamoure silt loam, colluvial phase, consists of 12 inches of dark-brown to nearly black, heavy silt loam to light silty clay loam, containing relatively large quantities of organic matter. The subsoil is a dark yellowish brown, heavy silt loam or light silty clay loam that shows some grayish-yellow spots, grading at a depth of 20 to 24 inches into a grayish-yellow silty clay loam. The subsoil is highly calcareous and contains lime concretions. It is marked in many places with dark-brown or rusty-brown iron stains. In the smaller areas and along the margins of the larger areas the lime content and iron stains decrease with increase in depth, and at 30 inches the subsoil is a brownish-yellow, rather friable, heavy silt loam.

After thorough drainage has been established the soil of this phase in many areas closely resembles the Marshall silt loam, smooth phase, which surrounds it, except that the surface soil is somewhat darker and heavier and the subsoil has a more grayish cast.

The Lamoure silt loam, colluvial phase, occurs in small patches within developments of the Marshall silt loam, smooth phase. It is encountered near the heads of drainage ways and in narrow strips along streams having a low gradient. Many narrow areas of this type occurring along intermittent streams, particularly north of

the line of the Chicago & North Western Railway, are included with the Marshall soil, on account of their small extent. The phase occurs mainly in the vicinity of Hull, Boyden, and Granville, and north of Orange City. The surface is nearly flat, and drainage is rather poor. In some of the larger areas which are still undrained water stands on the surface for some time after each heavy rain.

Although inextensive, this phase is a rather important agricultural soil. Where the land is not drained and devoted to grain or cultivated grasses, it supports slough grass, which furnishes good hay and pasturage. Most of the land, however, is tile drained and generally, after remaining for a few years in either native or tame grasses, it is seeded to grain crops with the adjoining types of soil. Many of the areas of this soil, locally called "sloughs," are kept in grass even after being drained and form the only pasture land on many of the farms.

Probably 75 per cent of the Lamoure silt loam, colluvial phase, is utilized as hay or pasture land. Bluegrass, supplemented to some extent with white clover and timothy, is used for pasturage, and red clover and timothy, either mixed or seeded separately, are used for the production of hay. Corn is the principal grain crop.

Slough grass yields from 1 to 2 tons of hay per acre. With good drainage and in normal years other crops yield about the same as on the Marshall silt loam, smooth phase.

The Lamoure silt loam, colluvial phase, is invariably included in farms with the surrounding soil. As most of the phase is drained, and as it is a valuable soil for producing hay and pasture grasses, the farms in which it is included bring about the same prices as farms composed wholly of the Marshall soils.

In the improvement of this type the first requisite is thorough drainage. Many experienced farmers report that a good tile-drainage system pays the cost of installation in a short time. The top-dressing of old pastures on this phase has proved quite beneficial.

WABASH FINE SANDY LOAM.

The soil of the Wabash fine sandy loam consists of about 20 inches of dark grayish brown to dark-brown fine sandy loam. The subsoil is a brownish-gray, heavy fine sandy loam to light loam, extending to 3 feet or more. Both surface soil and subsoil are variable in texture. In places in the lower lying areas the content of coarse sand is relatively high and the texture approaches a sandy loam. Here the surface soil inclines toward dark gray in color. A few areas in old bends of the streams have a subsoil of grayish-yellow fine sand. The virgin surface soil usually contains considerable organic matter, though not so much as the other Wabash soils.

The Wabash fine sandy loam occupies first-bottom land along the Big Sioux and Rock Rivers, where soil material has been deposited by the more recent overflows. The type usually occurs in bends or old loops of the streams. The surface is level to gently undulating or ridgy, and the areas are interrupted by many old channels of the streams. Drainage over the type is adequate and in many places where the surface soil and subsoil are loose and open it is excessive. Although the Wabash fine sandy loam is one of the first soils to be overflowed with any material rise of the streams, it lies high enough above the normal level of the water to drain rapidly as soon as the floods subside.

The Wabash fine sandy loam is not an important agricultural type on account of its small extent and its liability to frequent overflow. Probably three-fourths of it has never been cultivated and supports a growth of native grasses used for pasturage. A few willow, box elder, cottonwood, and ash trees are found on these areas. When cultivated the type is usually farmed in conjunction with the Wabash loam. Corn is grown most extensively, as the soil in most cases is too light textured for profitable small-grain production. Yields are not so good as on the associated types.

Land of the Wabash fine sandy loam is usually sold in farms including also the Wabash loam. It has a lower value than the loam.

Farm practices and methods of soil treatment that tend to increase the productiveness of the Wabash loam are equally beneficial to soil of this type.

WABASH LOAM.

The Wabash loam consists of 15 to 18 inches of dark grayish brown to nearly black, friable loam, high in organic matter, underlain to a depth of 40 inches by a brownish-gray, heavy loam, which becomes slightly heavier in the lower part. In the more poorly drained areas the subsoil is in places a light silty clay loam. The surface soil varies considerably in texture. Near the stream channel, where the soil has been more often reworked, it is in places more sandy and open than typical, occasionally even approaching a sandy loam in texture. Farther from the stream course the silt content is higher and the soil here is in many places a heavy loam or sandy silt loam. Invariably the percentage of fine sand is relatively large. Occasionally there is a small quantity of gravel throughout the soil section.

In places the Wabash loam as mapped includes scattered areas of Sioux loam too small to separate. In an area covering about 100 acres in a lower lying development of this type adjacent to Horse Shoe Lake, south of Hawarden, the soil differs from the typical in being underlain at a depth of about 27 inches by a layer of yellowish-gray fine sand.

The Wabash loam occurs chiefly along the Rock, Big Sioux, and Floyd Rivers. One area south of Maurice is encountered on the West Fork of the Floyd River. The type usually occurs in long, narrow strips, though along the Rock and Big Sioux Rivers the areas are often rather wide. The Wabash loam occupies the lowest part of the bottoms, lying only 2 to 10 feet above the level of the streams, and, like the closely associated Wabash silt loam, it is more or less subject to overflow with any general rise in the streams. The type is subject to a thorough inundation once in every four or five years. There are, however, higher lying areas along the Rock and Big Sioux Rivers which have not been overflowed in the last 15 years. The surface of the type varies from nearly flat to slightly undulating. The areas are often dissected considerably by old sloughs and channels, especially along the Rock River. Drainage, as a rule, is fairly good, owing to the rather loose and open structure of the surface soil and subsoil. In wet seasons, however, water often stands on the surface over considerable periods in the lower lying areas, especially along the Floyd River.

The Wabash loam is a rather important soil. In the eastern part of the county most of the type is devoted to hay and pasture grasses, owing to its liability to frequent overflows. In the western part probably 70 per cent of the type is under cultivation, the remainder supporting either a growth of grass or a stand of timber, chiefly willow, box elder, ash, and cottonwood.

All the crops common to the region are grown on this soil. Corn is the most important crop, followed by oats, wheat, clover and timothy, and alfalfa, in the order named. More winter wheat is grown in proportion to corn than on the upland soils. The most important live-stock industries on the type are beef-cattle feeding, hog raising, and dairying. Several large pastures are maintained adjacent to the streams.

When crops are not damaged by floods corn on the Wabash loam ordinarily yields 45 to 60 bushels per acre, winter wheat 25 to 35 bushels, spring wheat about 15 bushels, oats 35 to 45 bushels, and barley 20 to 35 bushels. Higher yields than these have been obtained in extremely favorable years. Oats are seldom grown on this soil in the eastern part of the county because of a tendency to grow too rank and lodge. Clover and timothy mixed yield about 2 or 2½ tons of hay to the acre, red clover alone about 2 tons, timothy from 1 to 1½ tons, and alfalfa 3 to 4 tons. Potatoes give an average yield of about 90 bushels to the acre.

The Wabash loam can be worked under a wide range of moisture conditions, and the soil does not clod or bake badly on drying. The type is handled in much the same manner as the Marshall silt loam, smooth phase.

Farms of this type sell for \$100 to \$200 an acre, the price depending upon the location and improvements.

As in the case of the Wabash silt loam, this type would be greatly benefited by diking the streams. There is a tendency over part of the type to neglect the maintenance of the productiveness of the soil, no effort being made to keep up the organic content. Owing to the open nature of the soil, the addition of barnyard manure and the plowing under of green manuring crops are of great benefit.

WABASH SILT LOAM.

The surface soil of the Wabash silt loam consists of a very dark brown to nearly black heavy silt loam, extending to an average depth of 18 or 20 inches. It is underlain by a brownish-gray heavy silt loam to light silty clay loam. The change in color and texture between the surface soil and subsoil is very gradual or often imperceptible, and in places there is no change within the 3-foot section, although in general the clay content increases with depth. The surface soil contains a relatively large quantity of organic matter. In well-drained areas faint-brown to rusty-brown iron stains are encountered in many places in the lower subsoil.

Along some of the larger streams and adjacent to areas of Wabash loam the surface soil often contains considerable very fine sand and becomes a very mellow silt loam. Numerous areas of Wabash loam, too small to map, are included with this type along the rivers or next to exposures of very sandy drift material along the streams in the upland. Another variation from the typical soil is met with south of Hawarden and near Chatsworth, where the subsoil is a very stiff compact silty clay loam.

The Wabash silt loam is widely distributed throughout the county. It occupies nearly all the bottom land of most of the smaller streams, occurring in strips ranging in width from a few hundred feet to one-half mile. Along the Big Sioux, Rock, and Floyd Rivers it occurs usually in relatively small, detached areas. The surface of the type is nearly flat, and it is only occasionally dissected by old stream channels and sloughs. The type lies only 2 to 10 feet above the normal water level of the streams and is practically all subject to occasional overflow. Drainage over the type, as a whole, is poor. Along most of the smaller streams water stands on the soil for quite a period after each inundation or heavy rain. The higher lying areas along the rivers are seldom overflowed and have better drainage.

The Wabash silt loam is the most extensive bottom-land soil in the county. Probably 30 per cent of its total area is under cultivation, the remainder being in native grasses. On the higher lying and better drained areas corn is the principal crop. Small grains are not

grown very extensively, owing to their tendency in wet years to grow too rank and lodge. Alfalfa is seldom grown except where the soil is exceptionally well drained. Wild grasses produce from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons of hay per acre and clover and timothy mixed about $2\frac{1}{2}$ tons. Where the soil is protected from overflows and is well drained corn ordinarily yields 50 to 55 bushels per acre, wheat 15 to 18 bushels, oats 30 to 35 bushels, and alfalfa 3 to 4 tons. The chief use of the soil is as pastures for beef and dairy cattle. As a rule the pasturage is excellent. More of this type is used for grazing beef cattle than of any other in the county.

Corn is probably grown longer in succession than on any other soil, the crop being alternated only occasionally with a small grain or legume. The type where well drained can be handled as easily and under as wide a range of moisture conditions as the Marshall silt loam, smooth phase, and the soil is less inclined to clod. Very little manure is applied to this soil.

As the type is well adapted to grass and is for the most part subject to occasional inundation, it is considered to be more valuable as grassland than for cultivated crops. It is naturally one of the most productive soils in the county, and where it is diked to prevent inundation, as at Chatsworth, it is valued highly for all the common crops, yields averaging as high as on the upland soils, if not higher.

Land of the Wabash silt loam sells for \$175 to \$225 an acre, even where utilized only for pasturage and hay production.

The straightening and deepening, or otherwise the diking, of the streams would benefit all areas of this soil.

WABASH SILTY CLAY LOAM.

The surface soil of the Wabash silty clay loam is a very dark brown to nearly black, heavy silty clay loam, high in organic matter. The subsoil, beginning at a depth of about 15 inches and continuing to 36 inches, is a brownish-gray, stiff, waxy, silty clay to clay. Usually there are numerous brown or reddish-brown iron stains throughout the subsoil. In places near the adjacent sandy soils there is a considerable admixture of fine sand and coarse sand in the material throughout the soil section.

The Wabash silty clay loam is developed only in the immediate vicinity of Hawarden. The material was deposited by quiet waters, probably at late stages of stream overflows. The topography is nearly flat, drainage is rather poor, and the run-off after heavy rains rather slow. The type lies about 20 feet above the river channel and has not been overflowed since the railroads were built and Dry Creek was diked.

All the Wabash silty clay loam is under cultivation excepting the small part occupied by farmsteads and the town of Hawarden. The

same crops, occupying practically the same places of relative importance, are produced on this soil as on the Wabash loam. The yields of all crops are good.

Owing to the more unfavorable texture and structure of this soil in its natural condition, it is more difficult to work than the associated bottom-land soils along the Big Sioux River. It is sticky when wet and cracks upon drying. Cultivation must be carried on when it is in a fairly moist condition, and it is necessary to break the clods immediately after they are turned up.

It is advisable, in farming this soil, to maintain a loose mulch throughout the dry season, in order to prevent the rapid loss of moisture and to counteract in some measure the tendency to crack and bake. The physical condition of the soil may be improved greatly by the liberal application of barnyard manure and by occasionally turning under a green manuring crop. Deeper ditching would hasten the removal of surface water.

RIVERWASH.

Small areas of coarse-textured soil occurring along the Rock and Big Sioux Rivers, where the material consists of a mixture of yellowish-gray, fine, medium, and coarse sand, with some small gravel particles, are mapped as Riverwash.

This type lies but a few feet above the normal level of the rivers. It is overflowed with any general rise of the streams and the surface-soil material is shifted about or added to at each inundation.

Riverwash is practically valueless for agriculture at present. Where not barren the land supports a growth of willow.

ROUGH BROKEN LAND.

Rough broken land includes areas along the Rock and Big Sioux Rivers where the slopes to the lowlands are too steep and broken for cultivation. The areas include a variety of soil materials, ranging from coarse sand to stony or gravelly clay and containing some glacial boulders and cobblestones. The soil represents an exposure of glacial drift, with some admixture of overlying loessial material.

Rough broken land occurs in three small, irregular strips, varying from one-eighth to one-half mile in width. The largest strip lies in the northwestern corner of the county, extending back into the upland a mile or more along the small tributary streams. One of the other two strips lies just above and one just below the mouth of the Rock River. From the lower lying border to the higher margin of the strips of this type there is a range in elevation of 75 to 150 feet.

Rough broken land supports a good growth of native grass on the more moderate slopes and the type is utilized almost entirely as pasture land.

SUMMARY.

Sioux County is situated on the western boundary of Iowa, one county separating it from the State of Minnesota. The Big Sioux River lies between it and the State of South Dakota. The county contains 765 square miles, or 489,600 acres.

The surface is that of a broad loessial plain. It varies from undulating in the eastern part of the county to rolling in the western part. Drainage, effected by the Big Sioux, Rock, and Floyd Rivers, is well established. Elevations range from 1,164 to 1,475 feet above sea level.

The first large settlement was made by Hollanders, near the present site of Orange City, in 1870. Early development was rapid and the population has steadily increased. Sioux County has the highest percentage of foreign-born inhabitants in the State.

The county has a large number of towns, of which the most important are Hawarden, Orange City, Rock Valley, Sioux Center, and Alton. It is well supplied with railroads, which give good communication with large markets. The wagon roads are well kept. The rural school facilities are ample.

The mean annual rainfall is 29.22 inches; the precipitation is distributed favorably for the growth of crops. The mean annual temperature is 47.6° F. There is an average growing season of 157 days.

The agriculture of Sioux County is well developed. It consists of grain farming, stock raising, and dairy farming. The principal farm crops are corn, oats, clover, timothy, alfalfa, barley, and wheat.

Hog raising is the most important live-stock interest. In the western part of the county a number of cattle and sheep are shipped in annually for fattening.

A definite system of crop rotation is followed over most of the county. Barnyard manure is saved and applied to the land, usually to clover sod before breaking for the corn crop.

The average size of farms in Sioux County is 175 acres. There is a total of 2,715 farms, with 47 per cent operated by owners and the remainder mainly by tenants.

Farm land rents by the year for \$6 to \$7 an acre. In share renting two-fifths to one-half the production is given the owner, and cash rent is paid for all hay and pasture land.

Sufficient labor is available over most of the county. Farm laborers receive \$30 to \$35 a month, with board, washing, and the keep of one horse.

Land values in Sioux County range from \$100 to \$250 an acre.

The farms are equipped with modern labor-saving machinery, and most of the farms have large, substantial buildings.

Excluding Riverwash and Rough broken land, nine different soils, classed in six series, are recognized in Sioux County. They may be divided into four groups, loessial soils, glacial soils, terrace soils, and first-bottom soils.

The loessial division comprises the Marshall silt loam and its smooth phase. These are the predominating soils of the county. The smooth phase is the most extensive soil mapped, and is considered the best upland soil for grain farming. Corn, oats, clover, and timothy are the chief crops grown. The typical Marshall silt loam is nearly as important as the smooth phase, and is devoted to the same agricultural uses.

The Carrington loam is the only glacial soil encountered. This type is developed mainly on slopes, and as a whole is not so well suited to grain farming as are the Marshall soils, owing to its sandy nature and rather excessive drainage.

The terrace, or second-bottom, soils include the Waukesha and Sioux series. The Waukesha silt loam is the most extensive of the two terrace soils. It is similar to the Marshall silt loam in all respects except origin and topography. The Sioux loam is an important terrace soil in the western part of the county. It is more inclined to be droughty than are the other important soils, but it gives good yields in normal years.

The first-bottom soils include those of the Lamoure and Wabash series. The Lamoure silt loam, colluvial phase, is inextensive. This soil is devoted mainly to the growing of hay and pasture grasses. The Wabash fine sandy loam is rather inextensive and is an unimportant type agriculturally. The Wabash loam is developed along the rivers of the county. It is one of the best first-bottom soils for the production of grain crops. The Wabash silt loam is the predominant first-bottom soil. It is poorly drained and is mainly utilized for pasture and hay grasses. Where drained and protected from overflows the type is well adapted to corn. Oats and wheat succeed, but are not as good crops for this soil as corn. The Wabash silty clay loam occurs in only one area. It produces yields similar to those on the Wabash loam, but is the most difficult soil in the county to farm.

Riverwash includes low-lying, recent deposits of coarse material along the Big Sioux and Rock Rivers. It is practically devoid of vegetation.

Rough broken land includes slopes along the Big Sioux and Rock Rivers where the surface is too broken for cultivation. The land is utilized for grazing.

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