

SOIL SURVEY OF MILLS COUNTY, IOWA.

By GROVE B. JONES, of the U. S. Department of Agriculture, In Charge, and
N. J. RUSSELL, of the Iowa Agricultural Experiment Station.¹

DESCRIPTION OF THE AREA.

Mills County is situated in the southwestern part of Iowa, in the second tier of counties north of the Missouri State line. It is separated from the State of Nebraska by the Missouri River. Pottawattamie County bounds it on the north, Montgomery County on the east, and Fremont County on the south.

The county contains 13 townships, two of which are irregular in shape, and has a land area of 430 square miles, or 275,200 acres.

Mills County comprises two general physiographic divisions, the river bottoms, which include the first bottoms or flood plains and the second bottoms or terraces along the rivers and creeks, and the uplands, which include the valley slopes and the divides.

All the larger streams and most of the smaller ones are bordered by first bottoms that are subject to overflow. Many of the lateral streams are short and some are shallow, inconspicuous draws, in which water flows only after heavy rains. By means of dredging most of the winding stream courses have been converted into deep and comparatively straight channels, and as a consequence overflows are less frequent than formerly.

Second bottoms or terraces occur along the West Nishnabotna River and Silver Creek and to a less extent along Keg and Wabonsie Creeks. There are none within the county along the Missouri River.

The county is drained toward the southwest through tributaries of the Missouri River. The eastern part is drained by the West Nishnabotna River. Its main tributaries are Indian Creek, which drains the greater part of the township of this name, and Silver Creek, which drains the north-central part of the county. Keg, Pony, and Wabonsie Creeks drain the western part.

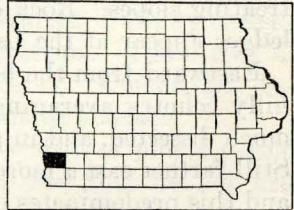


FIG. 4.—Sketch map showing location of the Mills County area, Iowa.

¹ Area inspected by Thomas D. Rice, of the Bureau of Soils, and P. E. Brown, of the Iowa Agricultural Experiment Station.

The Missouri River flows in a general southerly direction. The middle of the main channel is the boundary between Iowa and Nebraska as well as the western boundary of Mills County. The river frequently changes its course, and much valuable land is either washed away or made useless for agriculture. In recent years hundreds of acres of productive land between Folsom and Pacific City have been carried away or ruined. Further encroachment has been checked by works constructed by the Chicago, Burlington & Quincy Railroad. The valley of the Missouri in Mills County is approximately $3\frac{1}{2}$ miles wide at the northern and southern county lines. Its greatest development occurs about a mile south of Pacific Junction, where it is $6\frac{1}{2}$ miles wide.

The bluffs bordering this broad flood plain are peculiar in character and appearance. Beautifully rounded summits are interspersed with occasional sharply cut ridges or with smooth and abruptly retreating slopes. Rock outcrop is absent, except in rare cases where ledges appear at the base of the bluffs.

Eastward from the bluffs proper and parallel to them is a belt of hilly country averaging 3 miles wide. Parts of this belt are very much dissected, and in places the surface is too steep for cultivation. Still farther east a more smoothly rolling topography has developed, and this predominates over the greater part of the county.

The uplands, which constitute approximately 60 per cent of the county, are from 1,000 to 1,260 feet above sea level. In the Missouri bottoms the general elevation above sea level is from 960 to 980 feet.

Mills County was organized in 1857. Pioneer settlers came as early as 1836, but it was not until 10 years later that the first permanent settlement was made. During the period of emigration of the Mormons from Nauvoo, Ill., westward, a number located along Keg Creek. In the spring of 1847 this settlement was increased by the return of other Mormons from Nebraska. In February, 1848, a settlement was made on the present site of Glenwood, and later other settlements sprang up south and southeast of this place. The wooded areas were the first to be settled and farmed. There were few if any farms in the prairie in 1850. About 1853 the first land was entered, being that upon which Glenwood, formerly Coonsville, now stands. The town was plotted in June of the same year and made the county seat.

The population of Mills County, as returned in the 1920 census, is 15,422, about three-fourths of which is classed as rural. A large proportion is of Swedish, Norwegian, or German descent. Many of the settlers came originally from Illinois, Indiana, and Ohio.

Glenwood, the county seat and largest town, has a population of 3,862. The State institution for feeble-minded is located here. Mal-

vern, situated near the center of the county, is second in size, with a population of 1,195. Pacific Junction, a railroad town, has a population of 666. Emerson, with a population of 475; Silver City, with 430; Hastings, with 424; and Henderson, with 232, are incorporated towns. These and other smaller towns and railroad stations are commercial centers for their respective neighborhoods. Tabor, a college town on the southern county line, has a population of 1,186, of whom 120 reside in Mills County.

All parts of the county are well supplied with transportation facilities. The Chicago, Burlington & Quincy Railroad has three lines across the county. One main line passes through the central part of the county and its principal towns, and connects Chicago with Council Bluffs, Omaha, Lincoln, and points west. Another main line leads south from Council Bluffs through the Missouri lowlands to St. Joseph and Kansas City. A branch line crosses the eastern part of the county, extending along the West Nishnabotna River and passing through Hastings. The Wabash Railway crosses the county in a northwest and southeast direction. The Tabor & Northern Railway connects Malvern with Tabor. Omaha, St. Joseph, and Nebraska City are the principal outside markets.

The county is provided with an extensive system of public roads. Nearly all roads follow land lines and the few that do not are mainly in the rougher parts of the county or in the stream bottoms.

The main highways are graded and are usually well cared for, being dragged after heavy rains. The roads have not been hard surfaced, consequently during rainy weather they are slippery and travel is difficult, but crowned centers and side ditches permit them to dry out rapidly and travel can be resumed with safety within a few hours after a rain.

The county is crossed by the Bluegrass Trail, a main thoroughfare extending across the southern part of the State. There is no wagon bridge across the Missouri River, the only means of crossing being by ferry at Sharpsburg.

The system of consolidated schools has recently been introduced in some sections of the county. Modern commodious buildings advantageously situated have displaced the more numerous small schoolhouses. The pupils are taken to and from these schools in public conveyances. The system is said to be satisfactory and will doubtless be extended to other parts of the county. Graded schools and high schools are to be found in the larger towns. Practically all sections of the county are reached by rural delivery mail routes and the telephone is in general use.

CLIMATE.

The table below is compiled from the records of the Weather Bureau station at Thurman, in Fremont County. The station being so near, the data may be considered as fairly representative of climatic conditions in Mills County.

Normal monthly, seasonal, and annual temperature and precipitation at Thurman, Fremont County.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1905).	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December.....	25.7	65	-27	1.36	0.40	0.10	6.2
January.....	20.9	66	-30	.62	.91	.91	5.5
February.....	23.1	67	-37	1.26	.12	1.14	9.8
Winter.....	23.2	67	-37	3.24	1.43	2.15	21.5
March.....	35.7	90	-18	1.65	T.	1.39	5.8
April.....	51.2	95	13	3.13	.13	2.34	1.5
May.....	62.5	95	20	4.91	4.65	6.20	.1
Spring.....	49.8	95	-18	9.69	4.78	9.93	7.4
June.....	71.3	104	40	5.61	1.32	5.98	0.0
July.....	76.1	108	45	5.04	1.08	6.30	0.0
August.....	73.4	109	38	4.45	7.37	7.60	0.0
Summer.....	73.6	109	38	15.10	9.77	19.88	0.0
September.....	65.2	99	23	4.50	2.91	13.18	0.0
October.....	52.6	92	13	2.88	.92	2.94	.7
November.....	36.8	79	-11	1.61	.38	4.18	1.4
Fall.....	51.5	99	-11	8.99	4.21	20.30	2.1
Year.....	49.6	109	-37	37.02	20.19	52.26	31.0

It will be seen that the mean annual precipitation is 37.02 inches. Records kept at Glenwood from 1875 to 1906 show a mean annual precipitation of 28.72 inches. The greater proportion of this is normally distributed throughout the growing season, when it is most needed. At Thurman the rainfall is greatest during the three summer months—June, July, and August. The normal precipitation for this period is 15.1 inches, but the record shows a range of from 9.77 inches in 1910, the driest year, to 19.88 inches in 1905, the wettest year. The mean precipitation for the winter is 3.24 inches.

The average snowfall is 31 inches. Under normal conditions crops of winter wheat, clover, and alfalfa are well protected by a covering

of snow, but when the snowfall is light these crops are frequently damaged by thawing and freezing.

The mean annual temperature is 49.6° F. The lowest temperature recorded is -37° F., and the highest is 109° F. Such extremes are infrequent, however, and the winters as a rule are not excessively cold or the summers intolerably hot.

The variations in temperature in different parts of the county, though slight, may mean a difference of a week or more in the length of the growing season, especially for the more hardy plants. Wet bottom lands and depressed areas are more subject to frost than the ridges, and some hills and ridges, or even parts of the same ridge or hill, are more subjected to frost than others, depending largely upon protection from winds or thoroughness of drainage. During the summer months some sections appear to be visited more frequently by thundershowers than others. This is especially true along the Missouri River.

The prevailing winds in winter are from the west and northwest, and are rarely of that character known as a blizzard. The spring and summer winds are from a southerly direction, and the rains usually come in the form of thunderstorms. Tornadoes and hailstorms are of rare occurrence.

The average date of the last killing frost in the spring is April 29, and of the first in the fall October 4, giving an average growing season of 158 days for the most tender vegetation. This year (1920) the first frost occurred September 30. The date of the latest recorded killing frost in the spring is May 16 and of the earliest in the fall September 13.

AGRICULTURE.

The early history of agriculture in Mills County dates back to 1847, when farming was first begun along Keg Creek. Instead of settling upon prairies or upon tracts only sparsely timbered, the pioneers chose sites along the heavily wooded borders of the streams. It was not until the early fifties that land in the more open upland country was farmed. From that time to the present the agriculture of the county has been marked by a steady and rapid growth without any great change in character. Corn, wheat, and oats constituted the first crops, and corn is still the principal crop of the county.

According to the census of 1880, there were 280,041 acres in farms, of which 86 per cent was improved land. The production of the leading crops in 1879 was: Corn, 4,192,319 bushels from 93,621 acres; wheat, 232,834 bushels from 21,742 acres; hay, 18,691 tons from 12,403 acres; oats, 230,171 bushels from 7,079 acres; potatoes, 71,401 bushels; and 32,156 bushels of barley from 1,853 acres. In addition, rye, buck-

wheat, broom corn, sorghum, and vegetables were produced, and orchard and forest products were of some importance.

In 1889 the acreage in corn was greater than in 1879 by 1,059 acres, but the yield was 236,634 bushels less. Oats had more than doubled, 555,403 bushels being produced from 16,790 acres. The wheat acreage was curtailed, the production being 63,193 bushels from 4,380 acres. The area in hay was doubled, and 36,994 tons were cut from 24,953 acres. The production of potatoes had increased to 134,883 bushels, and the value of market-garden products and small fruits sold was \$8,728.

According to the 1900 census, there was a noticeable increase in the acreage of corn and wheat during the preceding decade, while that of oats remained practically the same. The production of corn in 1899 was 4,462,570 bushels from 110,231 acres, or an average of slightly less than 40.5 bushels per acre. There were 17,432 acres in wheat, producing 211,070 bushels; 16,455 acres in oats, producing 512,140 bushels; 4,951 acres in clover, producing 8,793 tons of hay; 1,088 acres in alfalfa, producing 3,214 tons; 6,802 acres in wild grasses, producing 11,977 tons, and 12,986 acres of other tame grasses, producing 20,192 tons. There were many other crops grown, chief among which were rye, barley, broom corn, millet, sorghum, potatoes, beans, small fruits, and vegetables. In addition, 111,690 bushels of apples from 292,733 trees, and 161,400 pounds of grapes were reported.

In 1909 there was a noticeable decrease in the acreage of cereals, the wheat acreage falling below that of oats. There were 101,076 acres in corn, with a production of 3,768,935 bushels; 13,889 acres in oats, producing 343,755 bushels; and 11,355 acres in wheat, producing 158,480 bushels. The total hay and forage production was 45,900 tons from 26,792 acres. The production of timothy hay was 8,665 tons; clover alone, 3,208 tons from 2,260 acres; clover and timothy mixed, 17,865 tons from 12,389 acres; and alfalfa, 10,141 tons on 3,142 acres.

The acreage and production of the leading cereal crops for 1919 are as follows: Corn, 88,313 acres, 3,287,895 bushels; oats, 14,745 acres, 434,580 bushels; wheat, 29,229 acres, 456,895 bushels; barley, 956 acres, 23,725 bushels; rye, 815 acres, 10,860 bushels. These figures show a decided decrease in the acreage of corn and a marked increase in the acreage of wheat over 1909.

The total production of hay and forage in 1919 was 54,382 tons from 26,700 acres. About 70 per cent of the total consisted of tame hay, made up as follows: Alfalfa, 10,430 acres, 24,816 tons; timothy, 2,937 acres, 4,015 tons; clover, 1,726 acres, 2,198 tons; clover and timothy mixed, 3,475 acres, 4,846 tons; other tame grasses, 632 acres, 1,418 tons. Wild hay was cut from 3,353 acres, yielding 4,341 tons.

Small grains were cut for hay from 1,862 acres. Silage crops were grown on 833 acres, and corn for forage on 1,259 acres. Small quantities of annual legumes, kafir, and sorghum for forage were also grown.

The value of livestock and livestock products in Mills County for 1909 was \$2,113,420, which is only \$51,505 less than the value of all cereals produced, and is \$563,125 more than the value of livestock and livestock products for 1899. Animals sold or slaughtered on farms included 40,877 hogs, 983 calves, 15,792 other cattle, 6,341 sheep and goats, and 1,419 horses and mules, and the value of these was reported as \$1,786,319. The 1920 census does not report the value of animals sold or slaughtered. The value of dairy products in 1909, excluding those used in the home, is reported as \$114,415, and of poultry and eggs produced as \$209,725, and as \$255,720 and \$407,924, respectively, in 1919.

Agriculture is the principal industry in Mills County. The prevailing type consists of general farming, with no highly specialized crop or industry, the income being derived from various sources, such as dairy products, the sale of live stock, corn, oats, alfalfa, and the surplus of other crops.

Corn leads both in acreage and value. It is the most generally grown crop in the county and is not confined to any one type or series of soils. It does particularly well on the Marshall silt loam and the Waukesha silt loam, and during favorable seasons heavy yields are obtained on the bottom lands. Corn is the chief grain feed for work stock, cattle, and hogs. Under ordinary conditions at least 60 per cent of the corn crop is fed on the farms producing it, the surplus being shipped to Omaha, St. Louis, and Kansas City.

Much of the corn is planted on land previously in corn. About one-fourth is planted on sod land that has been plowed the previous fall or early in the spring. The greater part is put in with a check-row planter in hills 3 feet 6 inches or 3 feet 8 inches apart. If the season allows, corn planting is begun the 1st of May, but corn planted a month later frequently matures. The crop is given from three to five cultivations before being "laid by" about the middle of July.

Several varieties are grown, the most important being Reid Yellow Dent, Silvermine, and Boone County White. A few farmers grow Iowa Goldmine and Ninety Day corn. The selection of seed is a common practice.

Practically all the corn is husked from the standing stalk, and cattle and hogs are later turned into the fields to fatten. Owing to the high cost and scarcity of labor, many producers of hogs and beef cattle turn their stock into the corn. This practice not only enriches the soil but also saves the labor of husking. During the last few

years there has been an increase in the number of silos and in the acreage of corn cut for silage. Soy beans grown with corn make the silage a more balanced ration.

Oats occupied a larger acreage than wheat in 1909, but in 1919 the conditions were reversed. When oats follow corn, some farmers sow the oats and then double-disk the land, but this method often covers the seed too deeply for good results. Others disk the stubble land once, sow the oats broadcast, and then disk again, following this with the spike-tooth harrow. The best method seems to be to double-disk stubble land, then harrow, and drill in the seed, using about $2\frac{1}{2}$ bushels per acre. The Albion (Iowa 103) and Richland (Iowa 105) are the leading varieties of oats grown.

Wheat is not considered a cash crop in this county, although some is shipped to outside markets, principally to Omaha. Both spring and winter wheat are grown, by far the larger acreage being devoted to the latter. The average yields per acre are practically the same, being 13.93 and 13.33 bushels, respectively.² By many farmers spring wheat is not favored and its acreage is rapidly decreasing.

Timothy and clover are important hay crops. Practically all of the timothy hay grown is used in the county and in some years considerable is shipped into the county. Some timothy is grown for seed. Clover is generally sown with oats or wheat as a nurse crop or is sown with timothy. Clover is grown more extensively in the eastern part of the county than in the western part, where more attention is given to the production of alfalfa. A large proportion of the clover crop this year (1920) was harvested for seed. The acreage of clover and timothy mixed usually exceeds that of timothy or clover grown alone. All the hay is fed to stock on the farms, and the supply is often insufficient.

Alfalfa is an important crop in Mills County, occupying, according to the census, 10,340 acres in 1919. It is grown on the upland, terrace, and bottom land wherever drainage is good. The water table should be at least 3 feet below the surface. Alfalfa has given satisfactory results when sown either in the spring or fall. A number of farmers prefer August for sowing, stating that weeds are less troublesome than in the spring. However, judging from statistics gathered by the county agent, it is the general opinion among farmers that spring sowing is the more successful. Alfalfa may be sown alone or with a nurse crop, preferably oats. Approximately 60 per cent of the alfalfa growers do not use a nurse crop, according to information collected by the Mills County Farm Bureau.

For the successful production of alfalfa the soil should be well drained and reduced to the best physical condition. From 15 to 20

² Figures obtained from the county agent, based on 100 farms reporting.

pounds of alfalfa seed per acre is considered sufficient to insure a good stand. Inoculation is seldom necessary. Three or four cuttings, occasionally five, per season are obtained. The average yield for the county ranges from 2 to 3 tons or more per season. Frequently only three cuttings are made, and the land is pastured instead of making subsequent cuttings. Most of the farmers grow at least a few acres of alfalfa, and feed it to work stock, milk cows, and beef cattle. A few farmers grow it for the market.

Sudan grass, an annual which is very closely related to the cultivated sorghums, has been successfully grown in the county. It requires a well-drained soil and does best on the silt loams and heavier types. The only field observed during the survey was located on the Bremer silt loam near Malvern. The grass proved very promising there, and a large yield of hay was obtained.

The ground for Sudan grass is plowed in the spring and prepared as for corn. Planting should be made the latter part of May, or as soon as the soil has become warm. The common grain drill is used for seeding, and the depth of seeding should be from 1 to 3 inches. If grown for seed production, better results are obtained by seeding in rows 36 to 42 inches apart, which will allow cultivation. A better quality of hay, however, is produced by broadcasting the seed, owing to the finer stems produced from such seedings. From 20 to 25 pounds of seed per acre is recommended for drilled or broadcast plantings. When grown for seed somewhat less seed should be used than for a hay crop.

Sudan grass for hay is cut with a mower, and is left in cocks until thoroughly cured, then removed to the barn or stacked. The grass cures readily under favorable weather conditions, and when properly handled it makes a bright, sweet hay that is relished by stock. The preferred stage for cutting is from the time it begins heading until it is fully headed. The average yield is about $2\frac{1}{2}$ to 3 tons of hay per acre. Sudan grass furnishes excellent summer pasturage for horses, mules, cattle, sheep, and hogs.

Melilotus, or sweet clover, millet, rye, rape, and barley are grown to a small extent.

Sorghum for sirup is grown mostly in the western part of the county. There are several mills in this section besides the one located at Glenwood. Sirup this year sold for \$1.50 a gallon, and the supply was not equal to the local demand. The canning factory ships a clarified sirup to outside markets.

Hog raising is the principal live-stock industry. On an average 75 to 150 hogs per farm are fattened each year. Hogs are marketed in all seasons. After supplying the home and local demands, the surplus is sold to buyers who ship to Omaha, St. Joseph, and Nebraska City. Approximately 55 per cent of the hogs raised are

of the Duroc-Jersey breed, 40 per cent Poland-China, and the remainder Chester White and Hampshire.

The fattening of beef cattle is carried on quite extensively, but the number of cattle fed each year depends upon local conditions and the price of feeds, as well as upon the markets. Feeders are bought in the Omaha market in the fall and usually returned to market in 60 to 120 days. Some are kept until the following fall. There are a number of breeding herds in the county, consisting of Shorthorn, Hereford, and Aberdeen-Angus. What is said to be the largest herd of Herefords in the State is located near Silver City. The average farmer keeps about 25 head of cattle. In addition, large numbers of western sheep are fed during the winter and early spring.

Conditions in the county are very favorable for dairying. From 7 to 10 milk cows are kept on the average farm. A few dairies located near the larger towns retail milk. Some farmers sell surplus milk in the towns, and many farmers sell surplus milk to the creameries located at Glenwood and Malvern. A large herd of Holsteins supplies the State institution for feeble-minded.

The Glenwood creamery makes approximately 60,000 pounds of butter a year, for which there is a local market. Buttermilk is sold to farmers for fattening hogs. This concern sold \$35,000 worth of eggs and live poultry the last year, all of which was shipped to a wholesale company at Creston, Iowa. The storage company at Malvern makes about 100,000 pounds of butter a year. Besides making butter and ice, this plant ships over 200,000 pounds of fancy dressed poultry to eastern markets. Many cases of eggs are also shipped.

Poultry raising is not a specialized industry. Small flocks provide food for family use and a small income from the sale of the surplus products.

Within the last few years the growing of tomatoes for canning has become an established industry in the vicinity of Glenwood, where there is a canning factory. Sweet corn and pumpkins for canning are grown in small quantities.

The trucking industry has not been extensively developed. A number of truck gardens near Glenwood and Malvern supply the local markets. Strawberries, tomatoes, potatoes, cabbage, carrots, muskmelons, watermelons, beans, peas, sweet corn, radishes, lettuce, onions, and cucumbers are grown successfully. This industry could be profitably extended. Potatoes are not grown on a commercial scale, but every farmer plants a few acres and sells the surplus.

Nearly every farm has a small orchard of apple trees and a few pear, plum, and cherry trees. There are a number of fair-sized apple orchards, but, as a rule, the trees have suffered from disease, insects, and lack of attention, and many have died. In places some

trees are said to have been winterkilled during the last few years. The principal varieties of apples grown are the Jonathan, Grimes, Winesap, Ben Davis, Gano, and Mammoth Blacktwig.

Grapes do well, especially on the Knox silt loam and the Marshall silt loam. Grapes occupy a considerable acreage, mainly in the western part of the county, but the individual vineyards are not large. The surplus is sold in the local markets.

On account of the general character of the farming and the tendency toward specializing in the dairy and livestock industries, no fixed rotation of crops has been adopted. However, a general plan, consisting of corn 4 years, followed by oats or winter wheat for 1 year and clover 2 years, is in common use. When alfalfa instead of clover follows the small grains the cycle is necessarily changed. The stand of alfalfa lasts from 6 to 10 years, but it is customary to return alfalfa ground to corn after 6 or 8 years. On the bottom lands the order of crops is less fixed. Land is frequently planted to corn for several successive seasons, followed by wheat, then seeded and allowed to remain in bluegrass or alfalfa for a period of years.

According to the census of 1920, there are 1,571 farms³ in the county, with an average size of 156.1 acres, of which 89.8 per cent is classed as improved land. The census of 1910 reported 1,730 farms, with an average size of 134.4 acres.

In 1920, 52 per cent of the farms were operated by owners, 46.4 per cent by tenants, and 1.6 per cent by managers. During the last 30 years the percentage of tenant farms has gradually increased.

Farm lands are usually rented under the share system. The rents vary. If the crop is corn, the owner receives half of the grain in the crib. In growing small grain the owner furnishes half the seed and receives half the crop. Some farms are rented partly on a share and partly on a cash basis, and about one-fourth of the rented farms are leased for cash, the rent ranging from \$10 to \$20 an acre. Many landowners lease their farms and live in the towns and villages. There are probably more rented farms in Ingraham Township than in any other part of the county. In character of buildings, neatness, and general appearance, there is marked contrast between farms operated by owners and those operated by tenants.

Throughout the county there are many beautiful and well-kept homesteads. Modern conveniences, such as water and electricity, are found in many of the farm houses.

The farm labor is efficient, but the supply is not at all times adequate. Most of the laborers come from Missouri and Tennessee. The monthly wage varies from \$50 to \$65, with board, for single men, and from \$65 to \$80, with the use of house, garden, and cow, for married men. Corn husking is paid for by the bushel. This year (1920) from 6 to 10 cents a bushel, with board, was paid.

³ In the census reports each tenancy is enumerated as a farm.

Modern farm machinery, including tractors, is in general use. The number of tractors is steadily increasing, and their value as a part of the farm equipment is generally recognized. Many of the farmers own automobiles, and these add greatly to the efficiency of operation.

Land values are relatively high. Farms located on the Marshall silt loam sell for \$150 to \$300 or more an acre, and the price of bottom land ranges from \$125 to \$400 or more an acre.

SOILS.⁴

Mills County lies in a region where the temperature and the moderately heavy rainfall have favored a heavy grass vegetation over the treeless and relatively smooth upland. Along the stream slopes and over eroded areas the better surface and subsoil drainage was more favorable to timber, so that at the time of the advent of the white man the forest had spread over the slopes and was gradually encroaching upon the upland. The native vegetation, therefore, under which the soils of this region were developed was grass on the relatively smooth upland and forest along the deeper stream valleys.

The soils may be differentiated on the basis of their most widely distributed and broadest characteristic into light-colored and dark-colored soils.

The area of the light-colored soils is nearly coextensive with the area covered by forest, or, to be more exact, it includes the soils developed under a native vegetation consisting of trees and the immature soils developed where erosion has prevented the accumulation of organic matter. The soil profile has a surface horizon, from 3 to 8 inches thick, of grayish-brown or brown color, and floury structure. This is underlain by a brown material, slightly more compact than the surface soil. At a depth of about 20 inches the loose silty parent material appears. This is rich in lime and other carbonates and in many places the material from the surface down is unleached. The soils of the Knox series belong to this group.

The area of dark-colored soils is coextensive with the prairie soils of the upland, and includes also areas of dark-colored alluvial soils. The dark-colored soils fall into subclasses or groups whose differentiation is based on drainage conditions of soil or subsoil or both during their development. The well-drained group, of which the Marshall series is representative, covers the whole of the upland and the better drained terraces. The typical profile has a surface

⁴ Pottawattamie County adjoins Mills County on the north. In places the soil names do not agree along the boundaries. This is due to changes in correlation resulting from a fuller knowledge of the soils of the State. The soil mapped as Hancock silt loam has been subdivided in this county and parts of it have been classed with the Lamoure and the Bremer soils. The Wabash soils have been subdivided, and a large part of their area is now mapped with the Lamoure soils.

soil 5 to 15 inches in thickness, of dark-brown to almost black color and a silty or fine granular structure. This is underlain by a brown upper subsoil, lighter in color than the surface soil and more compact and more coarsely granular in structure. This extends to a depth of 20 to 30 inches and is underlain by a slightly looser stratum differing only slightly from the fresh parent material. The extent to which leaching has taken place varies in the different types of this group. The Marshall soils have not been leached of all their carbonates, but in most places the amount is not sufficient to cause effervescence when treated with acid. The Waukesha series is a terrace soil, which is probably more thoroughly leached of its carbonates than the Marshall. The Hancock series which is developed from colluvial and terrace materials has a highly calcareous subsoil.

Another group of dark-colored soils has evolved under conditions of imperfect drainage. The surface soils are very dark brown to black, with a loose silty or granular structure. They are underlain by gray or mottled gray and yellow or brown subsoils, usually heavier in texture than the surface soil and more compact in structure. The profiles of such soils are variable, depending upon the depth to which good drainage and oxidation have extended. With this group are placed the greater number of the alluvial soils of the county, including the Bremer on the terraces and the Wabash and Lamoure on the first bottoms. The Lamoure series has a high content of lime and other carbonates, but the Bremer and Wabash have lost a large part of their carbonates through leaching.

The Cass series includes dark-colored soils, formerly or at present poorly drained, which have loose sandy or gravelly subsoils. The Sarpy soils have similar drainage conditions, but the surface soils are light colored. The subsoil consists mainly of sand and gravel and has a porous structure similar to the subsoil of the Cass series.

On the basis of the origin of the parent material the soils in Mills County may be arranged in two general groups, one comprising all of the upland soils and the other the alluvial soils, including both recent-alluvial and terrace soils. The soils of the uplands are by far the most extensive.

The upland soils have been formed by the weathering of the loess deposit which covers the county to a depth of 5 to 100 feet. This loess mantle is composed mainly of silt, a fine-grained material, ranging in color from yellowish gray to pale yellow. Its origin is somewhat uncertain, but the deposit is generally believed to be the result of wind action.

The glacial-drift material which underlies the loess is exposed only in a few places, usually at the base of steep slopes or in the valleys of those streams which have deeply eroded channels. Where exposed the

bluffs along the Missouri River lowlands and has a steep and rough topography.

The Waukesha series includes types with dark-brown to black surface soils and a brown to yellow subsoil. Neither soil nor subsoil is calcareous. The types occupy level to gently undulating terraces above normal overflow. The drainage is good. The material consists of alluvial sediment washed down from upland loessial soils and deposited at a time when the streams were flowing at higher levels. Only the silt loam of the Waukesha series is mapped.

The types of the Bremer series have dark-brown to black surface soils, a dark-brown upper subsoil, and a mottled gray and rusty-brown lower subsoil. Generally the subsoil is rather heavy. Both soil and subsoil are noncalcareous. The topography is level to gently sloping, and the drainage is fair to poor. This series differs from the Wabash series in occupying positions above normal overflow, and from the Hancock series in being too low in lime to effervesce with acid. The Bremer silt loam is mapped in this county.

The Hancock series, which is developed over a very small area in this county, includes types with dark-colored surface soils. In color the subsoil may be mottled yellowish brown and gray, or mottled gray and brown, or drab. Both the soil and the subsoil are distinctly calcareous. The series occupies terraces and slopes above overflow. The Hancock silt loam is mapped in Mills County.

The types of the Wabash series are characterized by dark-brown to black surface soils and a dark-brown, drab, or black heavy subsoil. Both surface soils and subsoil were found to be noncalcareous where tested. The surface is prevailingly level, and the drainage is fair to poor. All types of this series are subject to overflow. The soil and subsoil are rich in organic matter. The series is represented in this county by the silt loam with a colluvial phase, the silty clay loam, and the silty clay.

The Lamoure series consists of types with dark-colored surface soils, a yellowish-brown to black upper subsoil, and a brown to black or mottled brown and gray lower subsoil. The types occupy nearly flat and depressed areas with poor drainage. The soils of this series are highly calcareous and differ from the Wabash series in this respect. Two types, the silty clay loam and the clay, were mapped.

The Cass series includes types which have dark-brown to black surface soils and a lighter textured subsoil. Below depths of 30 to 36 inches, the substratum is loose and friable, consisting usually of sand and gravel. Both soil and subsoil are calcareous. The topography is typically level, and the drainage ranges from good to poor. The content of organic matter is moderately high. These soils are subject to overflow, which are not frequent, except on the Cass clay. The types of this series mapped in Mills County are the fine sandy loam, silt loam, silty clay loam, and clay.

glacial drift contains well-worn pieces of gneiss and hornblende, and small fragments of sandstone, limestone, and slate. Limestone appears at the base of bluffs bordering the Missouri River in places in the southwestern part of the county. In the northeast corner of the county, chiefly along Farm Creek, a coarse-grained, friable, ferruginous sandstone is exposed, but this rock has had little if any influence in soil formation.

The soils of the alluvial group are separated into two classes, second-bottom or terrace soils and first-bottom soils. They are extensively developed along the Missouri and West Nishnabotna Rivers and the larger creeks. Where there is no appreciable difference in elevation, as is frequently the case between the Bremer silt loam and the Wabash silt loam, it is difficult to draw the boundary line between first and second bottoms.

The soils of this group are prevailingly heavy, except over a part of the flood plain along the Missouri River. These soils are composed of reworked materials deposited by overflows. In the case of the smaller streams these sediments have been transported from loessial upland soils, principally the Marshall soils. The character of some soils of the Missouri River bottoms would indicate that at least a considerable part of the sediment brought down represents formations other than the loess. The terrace or second-bottom soils represent reworked loessial material deposited when the streams flowed at a higher level than at present.

Both upland soils and alluvial soils are grouped into soil series on the basis of similarity in origin, color, structure, topography, and drainage conditions. Each series is divided into soil types on the basis of texture; that is, the relative content of the different grades of sand, silt, and clay. Gradations and other minor differences, where not of sufficient extent and agricultural importance to warrant the recognition of a distinct type, are mapped as phases.

The soils of Mills County are grouped in 9 series, represented by 15 types and 1 phase, not including Riverwash and Meadow, which consist of miscellaneous materials. The upland soils belong in the Marshall and Knox series. The Waukesha, Bremer, and Hancock series occur on the terraces or second bottoms, and the Wabash, Lamoure, Cass, and Sarpy series on the first bottoms.

The Marshall series includes types having brown to black surface soils and a light-brown to yellowish-brown subsoil. The subsoil is slightly calcareous only in the western part of the area. The topography ranges from gently rolling to hilly. The drainage is good. The Marshall silt loam, which is formed by the weathering of the Missouri loess, is mapped in this county.

The Knox series includes types with light-brown surface soils and a yellowish-brown to yellow subsoil. Both soil and subsoil are calcareous. The series is represented by the silt loam. It occupies the

bluffs along the Missouri River lowlands and has a steep and rough topography.

The Waukesha series includes types with dark-brown to black surface soils and a brown to yellow subsoil. Neither soil nor subsoil is calcareous. The types occupy level to gently undulating terraces above normal overflow. The drainage is good. The material consists of alluvial sediment washed down from upland loessial soils and deposited at a time when the streams were flowing at higher levels. Only the silt loam of the Waukesha series is mapped.

The types of the Bremer series have dark-brown to black surface soils, a dark-brown upper subsoil, and a mottled gray and rusty-brown lower subsoil. Generally the subsoil is rather heavy. Both soil and subsoil are noncalcareous. The topography is level to gently sloping, and the drainage is fair to poor. This series differs from the Wabash series in occupying positions above normal overflow, and from the Hancock series in being too low in lime to effervesce with acid. The Bremer silt loam is mapped in this county.

The Hancock series, which is developed over a very small area in this county, includes types with dark-colored surface soils. In color the subsoil may be mottled yellowish brown and gray, or mottled gray and brown, or drab. Both the soil and the subsoil are distinctly calcareous. The series occupies terraces and slopes above overflow. The Hancock silt loam is mapped in Mills County.

The types of the Wabash series are characterized by dark-brown to black surface soils and a dark-brown, drab, or black heavy subsoil. Both surface soils and subsoil were found to be noncalcareous where tested. The surface is prevailingly level, and the drainage is fair to poor. All types of this series are subject to overflow. The soil and subsoil are rich in organic matter. The series is represented in this county by the silt loam with a colluvial phase, the silty clay loam, and the silty clay.

The Lamoure series consists of types with dark-colored surface soils, a yellowish-brown to black upper subsoil, and a brown to black or mottled brown and gray lower subsoil. The types occupy nearly flat and depressed areas with poor drainage. The soils of this series are highly calcareous and differ from the Wabash series in this respect. Two types, the silty clay loam and the clay, were mapped.

The Cass series includes types which have dark-brown to black surface soils and a lighter textured subsoil. Below depths of 30 to 36 inches, the substratum is loose and friable, consisting usually of sand and gravel. Both soil and subsoil are calcareous. The topography is typically level, and the drainage ranges from good to poor. The content of organic matter is moderately high. These soils are subject to overflow, which are not frequent, except on the Cass clay. The types of this series mapped in Mills County are the fine sandy loam, silt loam, silty clay loam, and clay.

The Sarpy series includes types with brown surface soils underlain by a subsoil of lighter texture, in places loose sand. Both soil and subsoil are decidedly calcareous. These soils occupy first bottoms and are subject to frequent overflow. This series differs from the Cass in the light color of its surface soils. The fine sandy loam is mapped.

Riverwash and Meadow represent the most recent alluvial deposits along the Missouri and West Nishnabotna Rivers. The Riverwash sediments consist principally of sand, but flats of silt and clay occur at intervals. Meadow includes narrow strips of material ranging in texture from sand to heavy silty clay loam.

The following table gives the names and the actual and relative extent of the soils mapped in Mills County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall silt loam.....	160,832	58.4	Lamoure clay.....	3,200	1.2
Wabash silt loam.....	25,344	21.8	Riverwash.....	3,072	1.1
Colluvial phase.....	34,560		Wabash silty clay loam.....	2,560	.9
Lamoure silty clay loam.....	7,104	2.6	Cass clay.....	1,856	.7
Bremer silt loam.....	6,528	2.4	Meadow.....	1,728	.6
Cass silt loam.....	6,016	2.2	Sarpy fine sandy loam.....	1,728	.6
Waukesha silt loam.....	5,184	1.9	Hancock silt loam.....	1,088	.4
Knox silt loam.....	5,184	1.9	Cass fine sandy loam.....	448	.1
Wabash silty clay.....	4,864	1.8			
Cass silty clay loam.....	3,904	1.4	Total.....	275,200

MARSHALL SILT LOAM.

The surface soil of the Marshall silt loam, as mapped in Mills County, consists of dark-brown silt loam 10 to 14 inches deep. The subsoil is a light-brown silt loam to a depth of 18 to 20 inches, underlain by a yellowish-brown heavy silt loam or silty clay loam. Faint mottlings of gray, yellow, or drab are noticeable in the lower subsoil throughout the greater part of the type.

Over extensive areas of gently rolling to rolling land the type is remarkably uniform. In undulating areas the surface soil is usually slightly deeper and uniformly darker in color. This condition is noticeable south of Henderson and north of Tabor. The strongly rolling to hilly topography of the type in the western part of the county has not permitted the accumulation of weathered material as deep as over the less rolling areas, and the surface soil has a light-brown color. The soil in forest areas also has a lighter color than in cultivated fields.

Narrow bands of glacial till containing varying quantities of small glacial gravel occur in a few small areas at the base of steep slopes. If this material were more extensive, it would be mapped as Shelby silt loam. Other variations of limited extent and minor

importance consist of "gall spots" along the steeper slopes where the surface soil has been washed away, and stony areas on the crests of some hills.

Over the greater part of the county the soil and subsoil of the Marshall silt loam are not highly calcareous. In the western part of the area, however, tests with acid give slight effervescence in places. The material at a depth of 6 to 8 feet is apparently well supplied with lime, judging from tests with acid.

The Marshall silt loam is the most extensive and important soil in the county. It occupies all the upland country with the exception of about 7 square miles of Knox silt loam bordering the Missouri River lowlands.

The topography varies from undulating to rolling or hilly. The western one-third of the type is sharply rolling to hilly, and along some of the stream slopes and the slopes toward the Missouri River bottoms the land is so steep and eroded that its value for farming is considerably reduced. Elevations above sea level range from 1,000 to 1,260 feet. According to the topography, the natural drainage is good to excessive.

The original forest, which was, in places, encroaching upon the upland as a scattering growth, included hickory, black walnut, bur oak, red oak, ash, elm, and some basswood. Some of these wooded areas remain uncleared.

The Marshall silt loam is well supplied with organic matter, easy to till, and retentive of moisture, and its structure gives good aeration. The type is devoted to general farming. Corn occupies the largest acreage, followed by wheat, oats, and hay. Corn yields 35 to 50 bushels per acre; wheat, 13 to 20 bushels; and oats, 40 to 60 bushels.

About 60 per cent of the corn grown is fed on the farm. Wheat is not considered one of the main cash crops, although some is shipped to Omaha. Flouring mills are located at Henderson and Malvern. The acreage in spring wheat is not large. In 1918 the average yield for winter wheat, according to reports received from over 100 farmers, was slightly higher than for spring wheat. Approximately all of the oats is fed to the work stock and milk cows. Rye is grown to a limited extent for pasture. Barley is grown only as a nurse crop. It has a high feeding value, and its acreage should be increased. Oats and wheat are not grown on the Marshall silt loam in the extreme western part of the county. In this hilly section corn and alfalfa are the main crops, supplemented by sorghum and navy beans.

Alfalfa makes up a large part of the hay crop, and its acreage is increasing. Considerable alfalfa hay grown on the Missouri River bottoms is fed in the eastern part of the county. Alfalfa does well on all the Marshall silt loam area. It ordinarily gives a total yield

of 2 to 4 tons per acre per season. Three or four cuttings usually are made. Clover alone yields $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre, and clover mixed with timothy yields $1\frac{1}{2}$ to 2 tons. Clover is more extensively grown in the eastern part of the county, and in some seasons a considerable part of the crop is threshed for seed. Timothy also is sometimes grown for seed. Practically all clover and timothy hay is fed on the farm, and as a rule there is not enough to supply farm needs. Melilotus, or sweet clover, does exceptionally well on this type. The acreage is not large, but is increasing. The yellow-flowered species (*M. officinalis*) is preferred to the white-flowered species (*M. alba*); it is more readily eaten by stock. Some melilotus is grown for seed. Soy beans are grown to a limited extent for fattening hogs, and the acreage is increasing gradually. Some rape is sown with oats for sheep pasturage.

On this type the greatest development of the various branches of the live-stock industry has taken place, including the raising and fattening of hogs, the feeding of beef cattle and sheep, the raising of purebred stock for sale, and dairying. Many farmers make a specialty of one or more of these branches. Hog raising, however, is the most important. The average farmer raises from 75 to 150 hogs each year. Dairying is profitable and is on the increase. Milk is sold to creameries located at Glenwood and Malvern. From 6 to 10 milk cows are kept on the average farm.

The Marshall silt loam is the most efficiently farmed type in the county. The grade of work stock is good, and modern farm machinery is in general use.

Crops are generally rotated. The most common rotation consists of plowing sod land for corn, which is grown three or four years, followed by oats or winter wheat, and this by clover, which usually stands for two years. Alfalfa, which usually follows a small grain crop, remains for a number of years. Sod land is generally plowed in the fall to a depth of 6 to 8 inches, and the seed bed is usually well prepared. By feeding the greater part of the crops at home, much plant food is returned to the soil in the form of manure. The more extensive growing of leguminous crops for soil improvement would aid greatly in maintaining the productiveness.

The Marshall silt loam is well suited to truck crops and fruit, which are grown in all parts of the county for home consumption and local markets. Tomatoes, cabbage, potatoes, carrots, beans, sweet corn, onions, watermelons, and muskmelons do well. In the vicinity of Glenwood, tomatoes, sweet corn, and pumpkins are grown for canning. Apples, plums, cherries, pears and grapes are successfully grown, chiefly for home use, although some reach the local markets. The apple orchards commonly are neglected, but wherever the trees are pruned and sprayed good results are obtained, and it is believed

that with proper care the growing of apples on a commercial scale would be profitable. The Iowa Agricultural Experiment Station orchard in Pottawattamie County is located on the Marshall silt loam.

Farms on this type range in price from \$150 to \$300 or more an acre, depending upon location and improvements.

KNOX SILT LOAM.

The Knox silt loam consists of a light-brown to grayish-brown silt loam, with an average depth of about 8 inches, passing gradually into a yellowish-brown to buff-colored silt loam. Both soil and subsoil are calcareous. Except in places where organic matter has accumulated, rendering the surface soil somewhat darker, the type is remarkably uniform in both color and texture. There is absence of coarse material throughout the deep loess or silt mantle from which this soil is derived. The type differs from the Marshall silt loam in the lighter color of the soil, loose structure of the subsoil, and the rougher topography.

The Knox silt loam occurs only in the hilly section of the western part of the county. It occupies what are known as the "bluffs," which skirt the Missouri River lowlands, although its development is not continuous and rarely exceeds a mile in width. A few small areas detached from the bluffs proper occur east and southeast of Folsom on hills and ridges. The type occupies the highest as well as the roughest part of the county. The loessial material offers slight resistance to erosion, and much of the rainfall is lost through run-off, consequently the greater part of the type is gullied by numerous drainage ways and is unsuited for grain production. Internal drainage is also thorough.

The Knox silt loam is well supplied with lime and produces good yields of alfalfa. Where the character of the surface is favorable, corn, wheat, oats, and various vegetables do well. Grapes are successfully grown, but there are no extensive vineyards, such as are situated on this type in the vicinity of Council Bluffs in Pottawattamie County. Most of the type is devoted to pasture.

The Knox silt loam commands about the same price as the hilly land of the Marshall silt loam, \$100 an acre.

WAUKESHA SILT LOAM.

The surface soil of the Waukesha silt loam consists of a brown to dark-brown silt loam 8 to 14 inches deep. The subsoil is a brown silt loam or silty clay loam to a depth of 20 to 24 inches, below which the material is a light-brown, heavy silt loam or silty clay loam. Neither soil nor subsoil contains sufficient lime to effervesce with acid. Several small areas south and southwest of Henderson have a subsoil only slightly heavier in texture than the soil. Such areas have been formed of colluvial material washed down from the surrounding areas of Marshall silt loam.

The Waukesha silt loam is a second-bottom or terrace soil situated well above the present limit of overflow. Except for small areas along Wabonsie and Keg Creeks, the type is confined to the second bottoms of the West Nishnabotna River and Silver Creek. The largest areas occur along the West Nishnabotna River in the vicinity of Etta, Hastings, White Cloud, and Clark. The type has a level to gently undulating topography. The drainage is thorough, which is the distinguishing feature between this type and the Bremer silt loam.

The Waukesha silt loam is not difficult to till. The surface soil has a moderately high content of organic matter, and the type is productive. Practically all of it is in cultivation to corn, grain, and grass. Part of it is used for pasture. Corn does well and is grown on a large acreage each year, yielding from 35 to 75 bushels per acre. Oats yield 25 to 40 bushels; and wheat, 18 to 30 bushels per acre. Alfalfa, clover, and timothy and clover grown together, constitute the hay crop.

The application of manure and lime has proved decidedly beneficial, although not essential, in securing a good stand of clover or alfalfa. A nurse crop of either oats or barley is generally sown with alfalfa. Clover should be included more often in the rotation in order to keep up the natural fertility of the soil.

The rotation most commonly used on this type consists of two or three years corn, two years wheat, or one year wheat, and one year oats, and one or two years clover, followed by one year pasture, before the ground is returned to corn. Where alfalfa is grown no definite plan of rotation is followed.

The selling price of the Waukesha silt loam ranges from \$175 to \$300 an acre.

BREMER SILT LOAM.

The surface soil of the Bremer silt loam consists of a dark-brown or black silt loam 8 to 12 inches deep. The subsoil is a dark-brown heavy silt loam or silty clay loam, which at an average depth of 20 to 24 inches changes into a mottled gray and rusty-brown clay. In depressions and swales the subsoil is relatively impervious to water and the mottlings and iron-stain discolorations are more pronounced. A high content of organic matter gives this soil its characteristic dark color. According to tests the Bremer silt loam contains very little lime.

The Bremer silt loam is the most extensive of the terrace soils. It occurs in a number of areas along the outer edge of the West Nishnabotna River bottoms, and in smaller areas along Silver Creek. It borders the uplands in all places. In many places it is separated from the first-bottom soils by narrow areas of the higher lying and better drained Waukesha silt loam.

The Bremer silt loam has a level to gently sloping topography and is rather poorly drained. It differs from the Wabash silt loam in occupying positions above overflow.

This type is considered a valuable soil for general farming. Most of it is under cultivation, and the poorly drained areas are used for pasture. Corn leads in acreage, followed by wheat, oats, and grass. Corn yields from 35 to 80 bushels per acre; wheat, 15 to 35 bushels; and oats, 30 to 50 bushels. Alfalfa can be grown where the soil is well drained. It yields one-half ton to 1 ton of hay per cutting, with three or occasionally four cuttings a year. Sudan grass thrives on the better drained land. An excellent yield of hay was produced on an area northwest of Malvern. This grass is valuable for summer pasture. The live-stock industries are of minor importance, although some income is derived from the sale of cattle and hogs. Dairying is not developed. The farming methods are practically the same as on the Waukesha silt loam. Land values on this type vary from \$175 to \$300 or more an acre.

The first need of this soil is the improvement of drainage. This can be accomplished by tiling or by means of open ditches. Although tile drains are more expensive than open ditches, they are more efficient, and it is believed that they would prove a profitable investment. The liberal use of lime is beneficial in increasing yields.

HANCOCK SILT LOAM.

The surface soil of the Hancock silt loam consists of a brown to dark-brown silt loam with an average depth of 12 inches. It is composed of wash material from the steep slopes of the adjacent Knox silt loam and is decidedly calcareous. The subsoil is a lighter brown silt loam to silty clay loam, and usually contains sufficient lime to cause effervescence with acid.

Small fragments of decomposed limestone are visible in the soil in places. These are derived from the limestone rock which underlies the Knox silt loam and frequently outcrops. In the vicinity of Burr Oak School the limestone has evidently exerted some influence upon the soil, and the Hancock silt loam in this locality resembles the Dodgeville silt loam, which is of limestone derivation.

The Hancock silt loam is not extensive. It occurs in the western part of the county in narrow bands on the more gentle slopes at the base of the bluffs, between the Knox silt loam and the soils of the Missouri River bottoms. The topography is gently sloping and surface drainage is good.

Practically all the type is cultivated in conjunction with the bottom soils, and is used for the same crops. It is recognized as a strong soil for the production of alfalfa, of which good yields are obtained. Corn is the principal crop. All kinds of garden truck do well.

Land of this type is usually included in farms with the bottom soils and is not sold separately.

WABASH SILT LOAM.

The surface soil of the Wabash silt loam is a brown silt loam 10 to 18 inches deep. The subsoil is a dark-brown to black silty clay loam. In depressions and swales the surface soil is darker, frequently black, and the subsoil heavier than on slightly higher areas, and these areas would be mapped as Wabash silty clay loam if of sufficient size. Both soil and subsoil have a low lime content.

Where the Wabash silt loam merges into the colluvial phase and the Waukeshia silt loam, the boundary drawn is frequently an arbitrary one owing to the similarity of these soils in color and origin.

The Wabash silt loam is the most extensive first-bottom soil in Mills County. Its greatest development is along the West Nishnabotna River and its principal tributaries, Silver, Indian, and Farm Creeks. It also occurs in considerable areas along Keg Creek, following it to the point where it enters the flood plain of the Missouri River. Here the area leaves the dredged channel of the creek and extends in a more southerly direction. Other less extensive areas lie along the smaller streams and in the Missouri River bottom.

The surface of the Wabash silt loam is fairly level, and although subject to inundation, considerable of the type is fairly well drained between overflows. Since the straightening and deepening of the channels of West Nishnabotna River and Keg Creek and the greater part of Silver Creek, extensive areas of this type have been made less subject to inundation and to severe erosion.

The Wabash silt loam has a large content of organic matter and is a strong, productive type. About 80 per cent is either under cultivation or in pasture. The original forest on uncleared areas consists of willow, cottonwood, boxelder, ash, and walnut.

Corn is most extensively grown and yields from 40 to 75 bushels per acre. It may be grown for a number of years in succession, without noticeably decreasing the productiveness of the soil. Higher lying and better drained land is often planted to wheat and oats, but frequently the crop can not all be harvested because of lodging. The type is one of the best grass soils in the county, and a large acreage is either cut for hay or pastured. Large herds of cattle, sheep, and hogs are common, especially on the areas along the West Nishnabotna River and Silver Creek.

The soil of the Wabash silt loam is rather sticky when wet, and if plowed when too wet or too dry it forms clods that are difficult to pulverize. When the moisture conditions are favorable, however, a good tilth can be maintained. Little or none of the type is plowed in the fall on account of possible overflows which remove the surface soil from freshly broken areas.

Land of the Wabash silt loam sells for \$200 to \$300 or more an acre, according to location and conditions of drainage.

Wabash silt loam, colluvial phase.—The surface soil of the Wabash silt loam, colluvial phase, is prevailingly a brown to dark-brown silt loam to a depth of 15 to 20 inches. It is underlain by a darker brown silt loam or silty clay loam to a depth of 3 feet or more. In places along the upper reaches of the smaller streams, where silt material from the upland has been spread through colluvial action, there is no appreciable difference in color or texture between soil and subsoil. This material is similar to the Judson silt loam and would have been mapped as such if the separation had been possible on a map of the scale used. These colluvial deposits are inundated for short periods during heavy rainfall. Along the larger streams some areas of Wabash silt loam and silty clay loam which were too small to separate are included with this phase.

Two fair-sized areas in the Missouri River bottom vary somewhat from the above description. The area north and northeast of Pacific Junction has a surface soil consisting of a brown mellow silt loam, extending to an average depth of 12 inches. This material is decidedly calcareous and rests upon Wabash clay or silty clay, which shows no effervescence with acid. This surface soil, locally known as "wash," represents material from the upland country which was deposited only a few years ago by overflow waters from Pony Creek. Previously to the deposition this area had an extremely low agricultural value, but at present it is considered one of the best corn soils in the county and is valued at \$400 an acre. The area southeast of Williams School is similar, except that the deposit has greater depth, being in places more than 3 feet deep.

The topography of the Wabash silt loam, colluvial phase, is level to gently sloping. Approximately 80 per cent of it is fairly well drained, except in seasons of abnormal rainfall. The rest is usually too wet for cultivation, but supports a good growth of native grasses and is kept in pasture.

Practically all the crops commonly grown in the county are produced on the better drained areas of this phase. Corn yields 35 to 75 bushels; wheat, 15 to 20 bushels; oats, 25 to 40 bushels; and hay, 1½ to 2½ tons per acre. Alfalfa and clover are profitable crops. The phase is farmed in conjunction with larger adjoining areas of typical soil.

WABASH SILTY CLAY LOAM.

The surface soil of the Wabash silty clay loam is a dark-brown to black silty clay loam, 8 to 12 inches deep. The subsoil to an average depth of about 20 inches is a black to very dark gray heavy silty clay loam, which grades into a heavy, tenacious silty clay or clay of similar or gray color. In some places, especially where drainage is restricted, the surface soil rests directly upon the heavy clay.

The type as mapped in this county represents a transition between the Wabash silty clay and the Wabash silt loam, and includes occa-

sional small areas of each. According to tests made with acid the Wabash silty clay loam is not highly calcareous.

The type occurs only in the first bottoms of the West Nishnabotna River in White Cloud Township. The surface is level or slightly depressed, and the natural drainage is poor. Since the river channel along which practically all the type occurs has been straightened and deepened, overflows are less frequent.

Approximately 95 per cent of this soil is devoted to pasture, the remainder being planted to corn. The yield of corn is from 35 to 80 bushels, the average being about 50 bushels per acre. Bluegrass, bluestem, and slough grass afford an abundance of grazing. The fattening of beef cattle and hog raising are the principal industries on the type. In its present condition the Wabash silty clay loam is better suited to pasture than to cultivated crops, and there is apparently a tendency to keep most of it in grass.

The price of the Wabash silty clay loam ranges from \$200 to \$300 an acre, depending mainly upon the improvements in drainage.

WABASH SILTY CLAY.

The Wabash silty clay is a dark-brown or black silty clay, about 10 inches deep, underlain by a very dark gray heavy silty clay or clay which extends to a depth of 3 feet or more. The material is dense and impervious. It is sticky and hard to till when moist, and is locally referred to as "gumbo." During very dry weather cracks, 2 to 4 inches wide, frequently extend several feet below the surface.

The Wabash silty clay is the heaviest of the river-bottom types having a low lime content. It occurs in three areas in the northern part of the West Nishnabotna River bottom, and in one area in the southern part of the Missouri River lowlands, well back from the river channel. The type is closely associated with the Wabash silt loam.

The topography is flat, except where broken by depressions and sloughs. The type has poor natural drainage owing to its flat surface and heavy texture, and is subject to overflow during high water. Artificial drainage is necessary before the land can be cultivated. Considerable of the type has been reclaimed by means of large open ditches.

Corn is grown almost exclusively. The yields in favorable seasons range from 40 to 70 bushels per acre. A little wheat is grown on the higher and better drained areas, with fairly good yields. In exceptionally wet seasons corn may be drowned out, and in such cases millet is sown. A large proportion of the Wabash silty clay is used for pasture. Native grasses furnish excellent grazing for cattle and hogs, and large yields of wild hay are obtained.

The type is difficult to cultivate, and heavy equipment is required. Tractors are in general use. If plowed when too wet or

too dry it breaks up into large irregular clods which can be pulverized only with difficulty. Its unyielding character makes it a much less desirable soil than the Wabash silt loam and silty clay loam. Land of this type is held at prices ranging from \$200 to \$300 or more an acre.

LAMOURE SILTY CLAY LOAM.

The Lamoure silty clay loam consists of a dark grayish brown silty clay loam, 8 to 12 inches deep, underlain by a yellowish-brown mottled with gray silty clay loam or clay. The mottled subsoil in some places is impervious to water, but the type as a whole is moderately well drained. A high content of organic matter gives the soil its characteristic dark color. According to tests made with acid the surface soil nearly always shows some effervescence, and in the subsoil the lime content is high. The area mapped immediately south of Pacific Junction is rather light in color and texture in the surface soil, and would have been mapped as Lamoure silt loam if it had been of sufficient importance to be separated. This type differs from the Wabash soils, which it closely resembles in appearance, mainly in being calcareous.

The Lamoure silty clay loam is one of the most important soils of the Missouri River bottoms. The largest areas are south of Pacific Junction and northwest and southwest of Pacific City. A good-sized area lies along the Pottawattamie County line, and several smaller areas lie in the northern part and two in the southern part of the lowlands.

The Lamoure silty clay loam has a level to gently undulating topography and is subject to overflow during high water. Some of the lower lying areas have been drained by open ditches, and other areas in similar positions could be greatly improved in the same way. Such areas include occasional spots of Lamoure clay.

The Lamoure silty clay loam is practically all under cultivation or in grass for hay and pasture. It is a durable soil producing large yields in favorable seasons. Corn is the main crop. It can be grown several successive years upon the same field without any noticeable decline in yield. Wheat, oats, and tame grasses are grown successfully. The acreage of alfalfa is slightly greater than that of clover and timothy mixed. Corn yields from 40 to 75 bushels per acre; wheat, 18 bushels; oats, 25 to 40 bushels; and alfalfa, one-half to 1 ton per acre at each cutting, three to five cuttings being obtained in a season. A large acreage in bluegrass and other native grasses is devoted to pasture. The raising of hogs and the fattening of beef cattle are the chief live-stock industries.

This soil must be handled under proper moisture conditions to get a good tilth. The surface soil bakes when dry, and when wet it is sticky and clods if plowed in this condition.

The price of land on this type ranges from \$125 to \$300 an acre, depending upon location and improvements.

LAMOURE CLAY.

The surface soil of the Lamoure clay is a dark grayish brown to black clay or silty clay, 6 to 8 inches deep. The upper subsoil consists of similar material, but somewhat darker in color, and passes into a dark-gray or drab clay at an average depth of 18 to 24 inches. The soil and subsoil have a high content of lime.

This type occurs in the bottoms of the Missouri River, in one large and a few small scattered areas in close association with the Lamoure silty clay loam. The large area lies northwest of Folsom. It is between 4 and 5 miles long, from one-fourth to 1 mile wide, and includes small knolls and narrow, low-lying ridges of Riverwash. With the exception of four small areas, the type is confined to St. Mary Township.

The Lamoure clay occupies low, flat, and poorly drained areas. All are subject to deep overflow, except those northwest and northeast of Pacific Junction, and the type is in a saturated or semiswampy condition, except in seasons of unusually light rainfall. Checks and cracks an inch or more in width are commonly found wherever the surface dries out.

This type is not cultivated. The largest area supports a dense but small growth of willow and cottonwood and a scant growth of grass. The other areas are covered with a rank growth of sedges and rushes and are used for pasture. Wild grasses are cut for hay on the best-drained areas near Pacific Junction. This is a strong soil, but in its present condition very little of it can be cultivated.

CASS FINE SANDY LOAM.

The Cass fine sandy loam consists of a dark-brown fine sandy loam, 8 to 10 inches deep, underlain by a subsoil of brown medium to fine sand. Small areas of loamy fine sand, not of sufficient importance to be separated, are included in the type as mapped.

This type is very easy to cultivate and can be worked under a wide range of moisture conditions. The soil is well supplied with organic matter, and for this reason has a higher agricultural value than the Sarpy fine sandy loam. Both soil and subsoil are calcareous.

The Cass fine sandy loam occupies less than 1 square mile. The largest area lies $2\frac{1}{2}$ miles south of Pacific Junction, and three of the five other areas are in St. Mary Township. The type is associated with the Cass silt loam and Sarpy fine sandy loam in the Missouri River bottoms. Although occupying first-bottom positions, the type is well above ordinary overflow. The largest area has a billowy surface, and the smaller areas occur as low knolls and ridges.

Its topography and its loose structure give it good natural drainage. Crops seldom suffer from drought. Most of the type is under cultivation, corn being the principal crop.

The Cass fine sandy loam is better adapted to early truck and pasture grasses than to general farming. Early truck crops, watermelons, and muskmelons can be profitably produced.

CASS SILT LOAM.

The surface soil of the Cass silt loam consists of a dark-brown silt loam, having an extremely smooth and velvety feel and extending to a depth of 10 to 16 inches. The subsoil is a light-brown very fine sandy loam which becomes sandier with depth, and in places grades, at depths ranging from 28 to 36 inches, into a fine sand. Abundant lime is present in both soil and subsoil, as indicated by tests made with acid. The soil is easy to cultivate and can be worked under a wider range of moisture conditions than the silty clay loam.

The Cass silt loam occurs throughout the Missouri River bottoms in areas of varying size. It occupies a higher position than the soils surrounding it, which position and the loose character of the subsoil insure good drainage. The surface is level to gently undulating. Some parts of the type are more subject to overflow than others, but the greater part lies well above normal overflow.

The Cass silt loam is considered one of the most desirable bottom soils for general farming. Corn, oats, wheat, alfalfa, and clover are the principal crops. Considerable quantities of surplus corn and alfalfa are sold.

Alfalfa is grown on a comparatively large acreage. It produces from $1\frac{1}{2}$ to 3 tons per acre. Three or four cuttings are made, the first usually from the 1st to the 10th of June. Instead of making a fourth cutting, a number of farmers pasture the land with hogs.

Corn on this soil yields from 40 to 80 bushels or more per acre, and on a number of farms an average of 65 bushels is maintained. Oats yield 35 to 60 bushels; wheat, 15 to 25 bushels; and wild hay, $1\frac{1}{2}$ to 3 tons per acre.

The type is well adapted to truck crops. Heavy yields of potatoes of good quality are produced. Gardens and small orchards are maintained on most every farm.

Land of the Cass silt loam sells for \$200 to \$300 or more an acre.

CASS SILTY CLAY LOAM.

The surface soil of the Cass silty clay loam, to a depth ranging from 8 to 12 inches and averaging about 10 inches, is a dark-brown silty clay loam. The subsoil is a grayish silty clay loam to a depth of 20 inches, where it passes into a yellowish-brown fine sandy loam. The lowest part of the 3-foot section is a loose fine sand in places. Both soil and subsoil are highly calcareous.

The type is developed in the Missouri River bottoms, but is subject to overflow only in times of very high water. The most extensive areas are found west and northwest of Pacific Junction.

The Cass silty clay loam has a level to gently undulating topography and fairly good surface and internal drainage. It lies from 2 to 6 feet below the Cass silt loam. Usually it lies slightly higher than the Lamoure silty clay loam, with which it is closely associated and from which it differs mainly in the friable and sandy character of the lower subsoil.

Practically all the type is cleared and farmed. It is used largely for growing corn, oats, wheat, alfalfa, and clover. The yields are about the same as those on the silt loam, except in extremely wet seasons. Planting, however, is frequently delayed, as the soil does not warm up early, and crops mature later as a rule.

The yields of corn upon the type vary from 40 to 80 bushels or more per acre, with an average of about 65 bushels. Reid Yellow Dent is the leading variety, but Silvermine, Boone County White, and Iowa Goldmine are grown. The wheat yield seldom exceeds 25 bushels per acre, and the crop is more subject to damage from heaving than upon the silt loam of this series. Oats yield from 35 to 55 bushels per acre. Albion (Iowa 103) and Richland (Iowa 105) are the varieties that do best. Alfalfa occupies a considerable acreage. It yields from 2 to 4 tons per acre per season. Inoculation is not necessary.

Although the Cass silty clay loam is used almost entirely for general farming, the largest apple orchard in the county, containing over 100 acres, is located upon this type west of Pacific Junction. The Jonathan and Grimes are the chief varieties grown. The type is also well suited to the growing of tomatoes, cabbage, potatoes, onions, and strawberries. Dairying succeeds upon this soil, but is not extensively developed.

The price of land of this type depends upon the character of improvements, drainage, and nearness to markets, and ranges from \$200 to \$300 or more an acre.

CASS CLAY.

The surface soil of the Cass clay consists of a dark grayish brown clay, from 8 to 16 inches deep, with an average depth of 10 inches. The subsoil consists of a lighter grayish brown clay extending to a depth of 20 to 24 inches, where it is underlain by a light grayish brown fine sand or sticky fine sandy loam. Both soil and subsoil are highly calcareous. The light-textured layer in the subsoil distinguishes this type from the Lamoure clay. Owing to recent overflow, the immediate surface layer in a few places consists of a brown silt loam, beneath which the typical soil is encountered.

The Cass clay occurs in the first bottoms of the Missouri River and is subject to frequent overflow. It is not extensive. The largest area borders the river channel west of Burr Oak School. Several smaller areas occupy low positions, such as depressions, swales, and overflow channels, west of Pacific Junction and Pacific City, and one small area is in St. Mary Township. The surface is low and flat, and the natural drainage of the type is deficient.

The chief crops grown upon this type are corn and wheat. During favorable seasons good yields are produced, but crops are frequently ruined by floods.

Care must be exercised in cultivating this soil. If plowed when too wet or too dry it clods badly, and is almost impossible to put in proper condition for planting. Heavy equipment is required, tractors being used to advantage. On uncultivated areas the native growth consists of grasses, cocklebur, willow, and cottonwood. The price of land of the Cass clay ranges from \$100 to \$150 an acre.

SARPY FINE SANDY LOAM.

The surface soil of the Sarpy fine sandy loam consists of a grayish-brown or brownish-gray fine sandy loam, 8 to 10 inches deep. The subsoil is a gray fine to very fine sand. The surface material approximates a fine sand in a few spots too small to be indicated on the map.

Because of its loose, open structure the type is very easy to cultivate. The surface soil is low in organic matter and crops suffer from lack of moisture during dry seasons. Both soil and subsoil have a moderately high lime content.

The Sarpy fine sandy loam is not extensive. It occurs in the Missouri River flood plain, the largest areas being in the northwest corner of the county, west of Lincoln School, and at Sharpsburg. These areas either border the river channel or areas of Riverwash, and in places the type includes Riverwash material. It is subject to frequent overflow. A thin veneer of silty clay covers the surface in some of the slightly depressed areas and narrow swales, and thin layers of clayey material occur throughout the 3-foot section in places, particularly in those areas nearest the river. The topography is slightly undulating, with occasional low ridges, and drainage for the most part is good.

Corn is the principal crop grown, and in favorable years fair yields are obtained. A little wheat is grown. On account of the danger of loss of crops from overflow, much of the type is devoted to pasture. Upon areas less subject to inundation both grain and early truck crops are successfully produced. Watermelons and muskmelons do especially well. Stable manure should be applied liberally to increase the content of organic matter, and rotations for this

type should be planned so as to return as much vegetable matter as possible to the soil.

MEADOW.

Meadow includes low-lying narrow strips of poorly drained land along the former channels of the Nishnabotna River and Silver Creek. These areas are cut up by many low ridges and depressions marking the old courses of the streams. The material ranges from loose sand to heavy clay loam. Practically none of the land mapped as Meadow is cultivated, but it usually affords some pasturage.

RIVERWASH.

Riverwash includes recent alluvial deposits along the Missouri River over and through which the stream flows. It occurs in detached strips, mainly in the northwestern part of the county, where the course of the river has changed considerably in recent years. In places this bed of recent sediments becomes part of the stream channel in times of high water.

The greater part of these deposits consists of fine sand, but beds of silt and clay occur at intervals. On account of the frequent changes in the course of the river, the extent and position of the Riverwash areas varies from year to year.

A dense growth of either small willow or cottonwood covers the areas outside the present stream bed; the growth is seldom mixed. Riverwash has no agricultural value.

SUMMARY.

Mills County lies in the southwestern part of Iowa, adjoining the Missouri River. It comprises a land area of 430 square miles, or 275,200 acres.

The topography of the upland varies from undulating to rolling and hilly, the roughest areas bordering the Missouri River bottoms. The extensive first bottoms and terraces along the Missouri and West Nishnabotna Rivers are prevailingly level.

The elevation of the uplands ranges from 1,000 to 1,260 feet above sea level. The Missouri River bottom is 960 to 980 feet above sea level. The general dip of the county, averaging about 2 feet to the mile, is a little west of south.

The county is well drained in a southwesterly direction into the Missouri River through the West Nishnabotna River, Keg and Wabonsie Creeks, and their numerous tributaries.

Pioneer settlers arrived in 1836, but farming was not begun until 1847. Mills County was organized in 1857. The population for 1920 is 15,422, of which about 75 per cent is rural. The principal towns are Glenwood, the county seat, Malvern, Pacific Junction, Emerson, Silver City, Hastings, and Henderson.

Transportation facilities are good. The main line of the Burlington system crosses the central part of the county east and west. Other lines of this same road, extending north and south, serve the eastern and western parts. The Wabash Railway crosses the county diagonally in a northwest-southeast direction. The Tabor & Northern Railway connects Malvern and Tabor.

The public roads, although not hard surfaced, are well graded and cared for. The county is crossed by the Bluegrass Trail highway.

The mean winter temperature of Mills County is 23.2° F.; the summer mean, 73.6° F.; and the annual mean, 49.6° F. The mean annual precipitation is 37.02 inches. The distribution of the rainfall is favorable to crop growth.

Agriculture has been the chief industry since 1850. A system of general farming, combined with the feeding of beef cattle and the raising of hogs, predominates. Corn, oats, wheat, clover, and alfalfa are the principal crops. Apples and grapes are produced commercially in the western part of the area. Practically every farm has an apple orchard, and other small fruits and truck crops are produced for home consumption.

Commercial fertilizers are seldom used. Liming has proved profitable.

The farms are usually well improved and present a prosperous appearance. The grade of work stock is good. Modern machinery of all kinds is in general use.

According to the 1920 census there are 1,571 farms in the county, with an average size of 156.1 acres, of which 89.8 per cent is improved land. Of all farms, 52 per cent are operated by owners and 46.4 per cent by tenants.

Selling prices of land range from \$100 to \$400 an acre.

The soils of the county are divided into two groups—the upland types, and the alluvial types of the stream terraces and bottoms. The upland soils consist of weathered loessial material and are classed in the Marshall and Knox series. The alluvial soils consist chiefly of loessial material and are classified in the Waukesha, Bremer, and Hancock series on the terraces, and in the Wabash, Lamoure, Cass, and Sarpy series on the first bottoms.

The Marshall silt loam, the most extensive type in the county, is derived from the Missouri loess. The soil is brown to black in color and friable. The surface is undulating or gently rolling to hilly, and drainage is good. Many of the best farms of the county are situated on this soil. Corn, wheat, hay, clover, alfalfa, and pasture grasses are the chief crops.

The Knox silt loam is developed in the bluff region in the western part of the county bordering the Missouri River bottom. The soil is light brown and the subsoil is yellowish brown. The topography

is hilly to rough. Corn, wheat, alfalfa, and orchard crops are successfully grown where the surface is not too uneven.

The Waukesha silt loam occupies second bottoms or terraces above overflow. It has a dark-brown to black surface soil and a yellowish-brown subsoil. The soil and subsoil are noncalcareous. The surface is level to gently sloping and the drainage is good. All of the type is cultivated to corn, small grain, and grasses.

The Bremer silt loam, the largest terrace type, is characterized by a dark-brown to black surface soil and a subsoil of black or drab color, mottled with yellowish-brown and black iron stains. Both soil and subsoil are noncalcareous. The type is the most poorly drained of the terrace soils. Corn, grain, alfalfa, and pasture grasses are the chief crops.

The Hancock silt loam occupies areas between the hills bordering the Missouri River bottoms and the alluvial soils. The soil material consists of wash from the adjacent hill slopes. Both soil and subsoil are highly calcareous.

The Wabash silt loam, with a colluvial phase, the silty clay loam, and silty clay, constitute the principal first-bottom types. They are characterized by noncalcareous dark-brown to black surface soils and a drab or gray subsoil, also noncalcareous. The surface is generally level and the natural drainage of the heavier types is poor. Corn, oats, wheat, hay, and pasture grasses are the chief crops.

The Lamoure soils differ from the Wabash soils, having a calcareous soil and subsoil. The silty clay loam and clay of the Lamoure series are mapped. These soils occur in the Missouri River bottom and are subject to overflow. The clay is the more poorly drained. Corn, wheat, and hay are the chief crops.

The Cass series includes dark-brown to black soils, with a lighter textured subsoil, which may pass into loose sand within the 3-foot section. Both soil and subsoil are calcareous. The series is represented in the present survey by four types. The silt loam and silty clay loam are good general farming soils. The fine sandy loam and clay are not extensive. The Cass soils are developed in the first bottom of the Missouri River and are subject to overflow.

The Sarpy fine sandy loam is a light-brown soil developed in the first bottom of the Missouri River. Both soil and subsoil are calcareous. The type is subject to overflow and is generally considered too light and uncertain for farm crops.

Riverwash areas have no agricultural value.

Meadow consists of low-lying strips of land adjacent to the old channels of West Nishnabotna River and Silver Creek. These areas, which are not cultivated, are composed of materials too varied in character to be classed in any soil series.

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