

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION; C. F.
CURTISS, DIRECTOR; W. H. STEVENSON, IN CHARGE OF SOIL SURVEY;
P. E. BROWN, ASSOCIATE IN CHARGE.

SOIL SURVEY OF MAHASKA COUNTY,
IOWA.

BY

E. C. HALL, OF THE U. S. DEPARTMENT OF AGRICULTURE, IN
CHARGE, AND J. AMBROSE ELWELL, OF THE IOWA
AGRICULTURAL EXPERIMENT STATION.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1919.]



WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., December 14, 1920.

SIR: I have the honor to transmit herewith the manuscript report and map covering the soil survey of Mahaska County, Iowa, and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1919, as authorized by law. This work was done in cooperation with the Iowa Agricultural Experiment Station, C. F. Curtiss, Director.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. E. T. MEREDITH,
Secretary of Agriculture.

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SOIL SURVEY OF MAHASKA COUNTY, IOWA.

By E. C. HALL, of the U. S. Department of Agriculture, In Charge, and J. AMBROSE ELWELL, of the Iowa Agricultural Experiment Station.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Mahaska County is situated near the center of the southeastern quarter of Iowa. It lies in the third tier of counties north of the Missouri State line and in the fourth tier west of the Mississippi River. The county is about 68 miles southeast of Des Moines. It is bounded on the north by Jasper and Poweshiek Counties, on the east by Keokuk County, on the south by Wapello and Monroe Counties, and on the west by Marion County. The county is rectangular in shape, and includes townships 74 to 77 north and ranges 14 to 17 west, containing 568 square miles, or 363,520 acres.

The surface of Mahaska County, as a whole, is that of a rolling plain sloping gradually from northeast to southwest, as shown by elevations. However, three main river valleys and three minor valleys cross this slope of the plain approximately at right angles, and, judging from these drainage lines on the map, the slope would appear to be from northwest to southeast instead of as stated above. This plain, which was originally almost level, has been dissected and eroded by these streams and materially changed in its topography. Lying across the county from northwest to southeast is a series of four water-shed ridges, the tops of which are remnants of the original upland prairie, but these divides have been changed from their original aspect by vigorous erosion. The topography varies noticeably in different parts of the county, being governed by the degree of erosion. This varies with the number and size of the streams, the areas near the large drainage ways being rough and hilly, while smoother belts lie along the upland divides. Although the county as a whole has been materially changed from its original plain, the northeastern and southwestern parts have been subjected to even greater degrees of dissection than other parts. The divides are high and narrow and generally parallel to the valleys. Jefferson, East Des Moines, West Des Moines, Richland, and parts



FIG. 1.—Location of the Mahaska County area, Iowa.

of White Oak, and Lincoln Townships include this kind of topography. The southeastern part of the county has been eroded less and has shallower stream valleys. The topography is smoother and more gently rolling, and the stream divides are broader. The slopes are long and gentle, but become steeper near the streams. This kind of topography is found in the greater part of Cedar Township, and in parts of Blackoak, Prairie, Madison, Lincoln, Pleasant Grove, and Union Townships.

Of the four ridges crossing the county, mentioned above, the first is in the northeastern part of the area. In this section is the North Skunk River Valley, and to the northeast of it is the plain or plateau which forms a watershed of the Iowa River and Des Moines River drainage system. Here the elevation is about 885 to 910 feet above sea level. The North Skunk River has cut 90 to 100 feet below the prevailing elevation. Most of the tributaries of this stream flow from the north, so that side has been dissected and eroded more than the area on the south side, where the bluffs are closer to the river and more distinct. Between the North and South Skunk Rivers, in about the north-central part of the county, lies the second plateau. This has been cut in the northwestern part of the county by Buckley Creek and its tributaries. Middle Creek has cut this plateau into two almost equal parts, leaving ridges of the original plain on each side, the north ridge having the greater elevation by 30 to 35 feet. Middle Creek channel lies about 90 feet below the highest upland level. South from Lacy, which is on the southern ridge of the creek, the slope is abrupt to the South Skunk River Valley. There is another plateau between the South Skunk and Des Moines Rivers. This is divided by the Muchakinock Creek Valley. From Oskaloosa in a southeasterly direction the plain becomes smoother and more prairielike in appearance. Cedar Creek cuts into it but has not roughened the topography.

The Des Moines River Valley, extending across the southwestern part of the county, is deep and wide. Southwest of it the topography as a whole is rough and broken. The topography of Mahaska County is common to southeastern Iowa. It is that of a drift plain which, changed by erosion, is now steep, broken, and hilly in places, and has low, gentle, well-rounded slopes in others.

The alluvial lands bordering the streams consist of terraces, which lie above ordinary overflow, and first-bottom lands or the present flood plains of the streams. The most extensive alluvial areas are developed along the Des Moines and the North and South Skunk Rivers. These lands are represented by high and low terraces, which form the greater proportion, and first-bottom lands. The alluvial area of the Des Moines River varies in width from three-fourths of a mile to 2 miles, the average width being about $1\frac{1}{4}$ miles. The

valley of the South Skunk River extends across the county from northwest to southeast, and its alluvial lands are the most extensive of any of the streams in the county. The alluvial area of the South Skunk River, including first-bottom and terrace land, varies in width from one-fourth mile to $1\frac{3}{4}$ miles, the average being about three-fourths to 1 mile. The North Skunk River has a comparatively wide valley, and its alluvial lands are only slightly narrower than those of the South Skunk River.

The surface deposits of Mahaska County are composed of unconsolidated material of Pleistocene age. Below this lie the indurated rocks of the Carboniferous. The Upper Carboniferous or Coal Measures lie just below the drift material.¹

The highest part of the county is at Barnes City, where the upland plain has an elevation of 915 feet above sea level. The elevations of other points that show the prevailing altitude of the county are: New Sharon, 876; Lacey, 841; Fremont, 888; Oskaloosa, 843; Rose Hill, 822; Stark, 856; Tioga, 834; Leighton, 769; Givin, 705; Evans, 743; Eddyville, 677; Beacon, 736; and Cedar, 872 feet.

With the exception of 2 square miles, Mahaska County lies wholly within the Des Moines River drainage system, and is drained by the North and South Skunk and the Des Moines Rivers and their tributaries. Those 2 square miles, sections 1 and 2, in the extreme northeastern corner, are drained by English River, which is a part of the Iowa River drainage system. The North Skunk River traverses the northeastern part of the county in a southeasterly direction, following a meandering course of about 23 miles, in which distance it has a fall of 60 feet. This stream is the smallest of the three rivers in the county. Its main tributaries are Buck, Moon, Pleasant, Cedar, and Middle Creeks. All of these tributaries have narrow alluvial flood plains and are bordered by wide belts of eroded upland. The South Skunk River, the second largest stream in the area, entering from the west at a point 3 miles south of the northern county line, flows southeasterly, crossing Richland, Blackoak, Madison, Spring Creek, and White Oak Townships. Its meandering course covers approximately 43 miles. The course of this river is now being straightened from the Marion County line to a point about one-fourth mile north of the Chicago, Rock Island & Pacific Railroad bridge between Oskaloosa and Rose Hill. The length of the straightened channel will be approximately 24 miles, compared with 30 or more miles as the length of the original channel between the same two points. The stream has a fall of 75 feet in this county. The new channel is being constructed to aid the river in carrying off flood waters at a more rapid rate, thus protecting the low lands as much as possible from inundation. The largest tributaries of the South

¹ Geology of Mahaska County, by H. F. Bain.

Skunk River are Buckley and Ballinger Creeks and Maddox Branch. This river and its tributaries drain the northwestern, central, and eastern parts of the area.

The Des Moines River is the largest stream in the county and with its tributaries drains the southern part. It flows across Scott and the northeast corner of Jefferson, and between West Des Moines and East Des Moines Townships. Its course covers approximately 19 miles in Mahaska County and has a fall of 54 feet. The largest tributary of the Des Moines is Muchakinock Creek; others are Cedar, St. Joseph, Bluff, and Coal Creeks. South of the Des Moines River the drainage runs in a northeasterly and easterly direction. The southeastern part of the county is drained by Cedar Creek, one of the three Cedar Creeks in Mahaska County.

The natural drainage system of Mahaska County is well developed; streams ramify over the whole area, and there is a drainage outlet for every section of land and for practically every farm. Only a few areas lack good surface drainage. All the streams, with the exception of Cedar Creek in the southeastern part of the area and a few of the smaller streams, have cut deep valleys and are still cutting. The Des Moines River channel is 100 to 175 feet lower than the upland plain. The North and South Skunk Rivers have cut their channels 90 to 150 feet lower than the upland prairie land. The drainage system, as a whole, is approaching maturity, but the streams have not yet reached base level. The Des Moines River has sufficient fall to furnish water power, but the stream is so wide that the expense of damming it would be great. The city of Oskaloosa is supplied with light generated from water power of the South Skunk River. Several water-power mills are located along the North and South Skunk Rivers. The chief source of water supply for Oskaloosa is the South Skunk River. In other parts of the county deep wells furnish the supply, but streams are numerous and furnish sufficient water for stock.

The history of Mahaska County began with the establishment of a small settlement near Eddyville. The county was purchased from the Sac and Fox Indians in 1842, by a treaty made at Agency, in Wapello County. By this treaty the Indians gave up all their territory in the State of Iowa. Before this time there were only a few white settlers, but as the Indians left immigration steadily proceeded. The county was organized in 1844. The early settlers came largely from Illinois, Ohio, Indiana, Kentucky, Missouri, Pennsylvania, and New York. At present the greater part of the population is American born, but there are also a large number of Hollanders in Mahaska County. In 1920 the rural population, which includes all towns of less than 2,500 inhabitants, exceeded the urban popula-

tion by 7,416, being 64.1 per cent of the total, and an average of 29.7 persons per square mile.

Oskaloosa, the largest town and county seat, had a population of 9,427 in 1920. It is situated 2 miles south of the exact center of the county and is an important trading center. The second largest town is New Sharon, with a population of 1,084, about 10 miles due north of Oskaloosa. Its interests are largely agricultural. Fremont, in the southeastern part, is next in size, with a population of 544. Towns of less than 500 population include Barnes City, Leighton, Evans, Beacon, Givin, Cedar, Peoria, Taintor, Indianapolis, Rose Hill, and Union Mills.

The interests of Mahaska County are primarily agricultural, but there is some mining and manufacturing. Several important manufacturing industries are located at Oskaloosa.

The county is adequately provided with transportation facilities. Four railroads have lines in this area. The Minneapolis & St. Louis Railway traverses the county, passing through New Sharon, Oskaloosa, Beacon, Givin, and Eddyville. It brings the area in direct touch with Minneapolis and St. Paul to the north, St. Louis to the southeast, and Kansas City to the southwest. The Chicago, Rock Island & Pacific has several branch lines in the county. The Keokuk-Des Moines Branch passes through Leighton, Evans, Oskaloosa, Beacon, Givin, and Eddyville. The Knoxville Branch of the same road extends from Knoxville to Washington, passing through Olivet, Evans, Oskaloosa, and Rose Hill. Another branch of the Chicago, Rock Island & Pacific, from Montezuma to Muscatine, passes through Barnes City. The Chicago, Burlington & Quincy Railway has a branch line in the county, Fremont, Cedar, Oskaloosa, Beacon, and Fosterdale being located on this line. A branch of the Chicago & Northwestern Railway passes through Rex, Cricket, Lakonta, Arkel, Stark, Wright, and Tioga.

The wagon roads of the county are as a rule in good condition. Where the nature of the topography allows, the public roads are straight, following land lines. There are no roads of hard material, but the main dirt roads are kept in good condition by the use of drags. Tractors are used extensively for road work. Rural telephone service and mail routes reach every part of the county. Country schools and churches are numerous, and several consolidated schools are now in use.

Oskaloosa is the principal local market for farm products. Smaller trading points are Rose Hill, Fremont, New Sharon, Eddyville, and Barnes City. Outside the county the principal markets to which products are shipped are Chicago, Des Moines, St. Paul, Minneapolis, Omaha, Kansas City, and St. Louis.

CLIMATE.

The climate of Mahaska County is healthful and well suited to general farming and stock raising. Total crop failures are almost unknown, although the climate is characterized by hot summers and long, cold winters.

The mean annual precipitation, as recorded at Oskaloosa, is 29.07 inches. The heaviest rainfall occurs during the growing season, and when the precipitation is well distributed it is ample for all the common crops. May, June, and July are the months having the most rainfall. Heavy, destructive downpours are not frequent, and destructive hailstorms are uncommon. Extremely dry weather of several weeks' duration sometimes occurs and may cause serious damage to crops. In the driest year on record (1890) the total amount of rainfall was 16.54 inches, and in the wettest year (1902) 44.88 inches. The rainfall is lightest during the fall and early winter months.

The mean summer temperature is 72.4° F. Periods of excessive heat are common, and a maximum temperature of 109° F. has been recorded. The winters are generally cold, the mean winter temperature being 23.3° F., and a minimum of 31° below zero has been known to occur in February. Short periods of intense cold often occur, and are sometimes accompanied by cold winds, which are severe on live stock. Groves of evergreens and other trees have been planted on some farms to serve as shelter for stock. Forested areas along streams are also utilized for this purpose.

The earliest killing frost on record occurred September 13, and the latest in the spring, May 17. The average date of the first killing frost in the fall is October 5, and that of the last in the spring is April 22. There is thus an average growing season of 169 days. The average grazing season is about 200 days in length.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation, and the precipitation in the wettest and driest years on record, as compiled from the records of the Weather Bureau station at Oskaloosa:

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

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year. (1890).	Total amount for the wettest year. (1902).	Snow average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	26.1	62	-23	1.15	0.75	1.53	5.3
January.....	20.4	63	-31	.96	1.41	.28	6.0
February.....	23.4	66	-31	1.13	0.85	.88	6.3
Winter.....	23.3	66	-31	3.24	3.01	2.69	17.6
March.....	35.7	87	-14	1.80	.89	.97	3.8
April.....	50.6	89	12	2.76	.60	3.31	1.1
May.....	61.6	95	24	3.82	1.85	3.72	T.
Spring.....	52.6	95	-14	8.38	3.34	8.00	4.9
June.....	70.2	102	38	3.87	1.57	7.24
July.....	74.3	109	44	3.61	.37	8.79
August.....	72.8	104	37	3.19	2.78	7.57
Summer.....	72.4	109	37	10.67	4.72	23.60
September.....	64.7	99	23	3.05	2.61	5.12
October.....	52.5	88	12	2.18	1.59	3.60	T.
November.....	36.8	78	-10	1.55	1.27	1.87	1.3
Fall.....	51.3	99	-10	6.78	5.47	10.59	1.3
Year.....	49.9	109	-31	29.07	16.54	44.88	23.8

AGRICULTURE.

The agricultural development of Mahaska County began with the first white settlers. They were mostly traders and trappers, but they settled along the streams and grew some vegetables and corn on small cleared patches. Hunting and fishing were the principal means of support. Practically all of the earliest settlements were along wooded streams, where there was material for fuel and building and some natural protection from the cold. Gradually settlement extended to other parts of the county, and more attention was paid to the growing of corn, wheat, oats, and vegetables and the production of live stock, which are still the principal farm products. With the advent of the first railroad, and the consequent increase in immigration, more ground was cleared, and the settlement eventually extended to the prairie lands. Gradual changes in farming, due to better transportation and the introduction of farm machinery, have taken place.

Below is a table showing acreage and production of the staple crops as taken from the censuses of 1880 to 1920:

Acreage and production of cereal and forage crops, as reported by the censuses of 1880 to 1920.

Year.	Corn.		Oats.		Wheat.		Barley.		Rye.		Hay and forage.	
	<i>Acres.</i>	<i>Bush.</i>	<i>Acres.</i>	<i>Tons.</i>								
1879.....	90,457	3,846,572	22,501	874,214	31,028	393,938	107	2,302	1,712	28,996	35,803	56,208
1889.....	81,276	3,907,690	38,157	1,548,300	4,686	61,036	65	2,009	2,104	36,590	51,943	84,564
1899.....	116,424	4,719,370	42,027	1,509,440	2,933	43,100	2,536	74,300	1,182	18,130	31,684	43,049
1909.....	100,352	3,608,615	35,696	947,652	5,906	88,905	2,755	52,082	434	6,781	89,601	135,558
1919.....	98,195	4,444,569	40,429	1,272,237	19,253	361,293	424	9,886	657	9,221	40,689	87,431

The agriculture of Mahaska County at the present time consists of a general farming system; that is, the raising of live stock and the growing of hay and grain. Corn is the main crop, and the methods of farming are based upon its production. Other small grains and forage crops are produced that fit in with the production of corn. It is grown principally as a feed crop, but during the period of high prices brought on by the World War a large volume has been sold for cash. In 1879 corn was the most important crop. It was grown on 90,457 acres, as compared with 35,803 acres in hay and forage and 31,028 acres in wheat. Oats occupied about 22,501 acres and rye 1,712. Barley and buckwheat each occupied a little more than a hundred acres. The orchard products were valued at \$45,011 in 1879, and those of the forests at \$50,991.

In 1889 the acreage devoted to corn decreased to 81,276, but the production was slightly greater than 10 years previous. The reduced acreage was no doubt due to low prices during that time. The acreage of oats increased to 38,157, while that of wheat went down to 4,686, a decrease of about 26,000 acres. There was a marked increase in 1889 of hay and rye. Buckwheat was reported on 96 acres, potatoes on 2,483, broom corn on 27, and the value of market-garden products was \$22,085.

From 1889 to 1899 the increase in the area of corn was 35,148 acres. There was also a marked increase in the acreage devoted to oats, barley, and buckwheat, but that of wheat, rye, hay and forage, and potatoes showed a decided decline. The orchard products were valued at \$42,540 in 1899, grapes, at \$1,656, forest products at \$26,885, and small fruits at \$16,652. The animals sold and slaughtered in that year were valued at \$1,574,072, the dairy products at \$133,509, and the poultry at \$136,052.

From 1899 to 1909 there was a decided decrease in the number of acres in corn, oats, and rye, but a marked increase in the area occupied by wheat, barley, and hay and forage. There was also a great increase during those years in the value of animals sold and slaughtered, dairy products, and poultry and eggs.

Corn, oats, timothy, mixed timothy and clover, clover, and wheat are the main general farm crops. Corn is the most extensive crop produced, the 1920 census report showing corn grown on 98,195 acres, with an average yield of 45.3 bushels per acre. According to the same authority there were about two and one-half times as many acres in corn as in oats, and about the same proportion as compared with hay and forage. Of the 293,850 acres of improved land in Mahaska County about one-third is devoted to the production of corn.

A large number of cows, hogs, horses, mules, and bulls are kept on the farms for work stock and breeding purposes. Live stock is distributed over the entire county, and there are practically no farms that do not have some live stock on hand that can be readily turned into cash.

Alfalfa, while in the experimental stage, may some time become an important hay crop. There are a few small areas of it grown at the present time, but there is little or no information available on its success or failure. The few acres devoted to this crop are located on the Grundy and Tama soils, but the Waukesha, Clinton, and Lindley soils should prove valuable for this crop. Bluegrass is a very important pasture grass, and its growth is depended upon in many of the rougher uplands to help control erosion. Sweet clover, while not a cultivated crop in Mahaska County, does well along the roadsides and ditches. It is considered a good feed crop and the seed is valuable. It is cultivated in many other counties of this State.

Fruit growing is not carried on extensively as a commercial industry in Mahaska County, but there is a considerable acreage devoted to the production of fruit for local use. The principal varieties of apples grown are the Baldwin, Jonathan, Willow Twig, Grimes, Ben Davis, Wealthy, and Greening (Northwestern). Cherries, strawberries, grapes, raspberries, and blackberries are crops of importance in local markets.

The Early Rose, Early Ohio, and Rural New Yorker are the main varieties of Irish potatoes grown. Watermelons, muskmelons, cantaloupes, pumpkins, and squash are grown for home consumption. Other crops of small importance are broom corn, peanuts, buckwheat, sweet potatoes, and other garden products.

Dairying, while not very important commercially over the county as a whole, is increasing. Most all farmers keep a few dairy cows. Jersey, Guernsey, Holstein, and Shorthorns are used, as well as other animals that are not purebred. Creameries are in operation at several places in the county, where the farmers market their surplus cream, which is usually separated on the farm.

Cattle feeding or the production of beef is an important industry, and is practiced to some extent on nearly all farms. The main breeds are the Angus, Hereford, and Shorthorn. There are also many

grades of these and other breeds. Cattle raising would be more profitable on the rougher uplands than the growing of cultivated crops, as good grazing can be had for the greater part of the year on slopes that would be damaged if cultivated. There are good blue-grass pastures and an adequate water supply. The transportation facilities are good. Feeders are usually shipped in from live-stock markets, kept on pasture until late fall, and then marketed, or sometimes wintered over on silage, hay, straw, and fodder.

Hogs are, as a rule, more profitable than cattle. They are put on the market usually when 6 to 10 months old. Nearly every farmer fattens 20 to 50, and on the larger farms several hundred are raised each year. Hogs are shipped to the packing plant at Ottumwa, to Chicago, Minneapolis, and Des Moines. All farmers butcher enough hogs to supply themselves with meat for the entire year. According to the 1920 census there were 106,516 hogs in the county January 1, 1920. The principal breeds of hogs are the Duroc-Jersey, Poland-China, Chester White, Hampshire, Berkshire, and Tamworth. The first two mentioned are the leading breeds.

Raising draft horses is important, the Percheron being the most popular breed. Mules are raised to a small extent.

Sheep raising is becoming more important from year to year. The Shropshire is the leading breed. A few herds of goats were seen during the progress of the survey. The census report for 1920 shows 23,819 sheep and goats in the county, and the total value of wool, mohair, and goat hair as \$77,296.

While the adaptation of crops to soils is not always considered carefully, the relative importance of general farming, raising of live stock, and hay production depends to a considerable extent upon the character of soil and topography. It is recognized that general farming is best adapted to the smoother, more level areas, occupied by the Grundy and Tama soils, and the terracè lands. Hay production and stock raising predominate in the rougher areas, where the Lindley and Clinton soils predominate. It is generally recognized that the Grundy, Wabash, Bremer, and Waukesha soils are best suited to the growing of corn. The Clinton soils are recognized as being best adapted to small fruits, tree fruits, and hay, though much of this series is used for corn, oats, and wheat. The Knox fine sand and some of the light bottom and terrace soils are recognized as being well adapted to the production of melons and truck crops.

Corn is grown on sod or oat stubble, and in preparing the seed bed the land is generally plowed in the late summer or fall and disked in the spring. The average depth of breaking the land varies according to the structure of the soil, but 5 to 8 inches is the average depth. Practically all the crop is check-rowed. It is cultivated three to five times, depending upon the season. Much of the corn crop is used for ensilage. Some is cut and shocked in the field to

be fed from the stalk or shredded. Much of the crop is husked by hand, the stalks being pastured during the late fall and early winter. Rape or cowpeas are sometimes sown between the rows at the last cultivation and then "hogged down" in the fall. This is a profitable and easy way to enrich the soil without additional labor or expense. More care and attention is being paid to the selection of seed corn, this being one sure method of increasing the yield and value of the crop. Reid's Yellow Dent, K. B. Yellow Dent, and Boone County White are the principal varieties. Other varieties grown are the Iowa Silver Mine, Johnson County White, and Silver King. There are a large number of silos in the county.

Oats rank second in acreage and almost invariably follow corn in the rotations. According to the census report in 1919 there were 40,429 acres in oats that produced an average of 31.5 bushels per acre. The land usually is prepared by disking and harrowing, but is sometimes plowed. The seed is broadcasted or drilled, and the crop is usually ready to harvest by July. The crop is cut with a binder and thrashed from the shock. The bulk of the crop is used for feed for horses and mules and the straw for roughage and bedding. The surplus is sold. The varieties grown are Albion (Iowa No. 103), Swedish Select, Early Champion (including Big Four), with a small acreage of Kherson. The Albion (Iowa No. 103) has proved to be an excellent variety for this county. The Early Champion is very susceptible to smut, which is a common disease and causes much loss annually. It can be controlled by seed treatment.

Wheat is not raised on a large scale in Mahaska County. The census reports a wheat acreage in 1919 of 19,253, with a production of 18.8 bushels per acre. Both winter and spring wheat are sown, but the acreage of winter wheat is much the larger. The crop follows oats or corn as a rule. The seed is drilled between the last of September and the middle of October. If sown too late the danger of winterkilling is increased. Some farmers sell the entire wheat crop, others grind it or feed it whole, mixed with other feed, to hogs. The leading and almost the only variety of winter wheat is Turkey, which comprises about 70 per cent of the total wheat acreage. The spring varieties in the order of their importance are Java (Early Java), Bluestem, and Marquis.

Hay and forage crops include timothy, clover, bluegrass, alfalfa, sweet clover, and prairie grasses. The chief hay crop is timothy and clover mixed. They do well, and as a rule there is little or no difficulty in securing a stand. They are sown in the spring with oats. Timothy is grown alone for seed, yielding 4 to 10 bushels per acre. Clover is grown alone in small areas for seed, yielding one-half to 5 bushels per acre. It is sown in the spring with a small grain crop as a nurse crop. Clover is sometimes used for pasture the first year; the second year the first crop is cut for hay and the second

for seed if the season is favorable. Clover is an important crop, not only for its value as hay but also for its effect upon the soil. As the productiveness of the soil decreases more attention is paid to the production of clover and other leguminous crops. Bluegrass does well and is used extensively for pasturage. Millet, rape, sorghum, cane, and rye are grown to a small extent and are used for winter roughage.

Definite crop rotations are followed by some of the farmers, though not by the larger number. The need of a systematic rotation is being recognized and its use is increasing. Corn is generally grown 2 to 4 years, followed by wheat or oats for 1 or 2 years, after which timothy and clover mixed or either one alone occupy the land for 2 years. Numerous forms of rotations are followed, but those that permit the greatest production of corn are favored.

The tillage operations over the county, as a whole, are thorough, principally because of the increased prices of the land. Most of the farmers farm intelligently, use care with their soils, and protect their fertility as much as is possible. Practically all of the barnyard and stable manure is utilized for maintaining fertility, being applied with a manure spreader, usually to sod land. The soils of the county are strong and fertile and, as yet, do not need any commercial fertilizers. According to the census figures the total expenditure in 1919 for fertilizers was only \$3,345. Green manures are used extensively for soil improvement.

Labor is scarce and commands a high price. Most of the farm laborers are native Americans. Some Hollanders have settled in Mahaska County. The usual wage now (1919) is \$40 to \$85 a month with board and washing, as compared with \$30 to \$40 per month in 1917. The wage paid to transient labor during harvest time ranges from \$3.50 to \$5 per day, with board. The greater part of the farm work is performed by the farmer and the members of his family. The total expense of farm labor in 1919 was \$624,202, or \$432.87 per farm.

Approximately 94 per cent of the area of Mahaska County is in farms. The average size according to the 1920 census report was 122.9 acres per farm, of which 105.5 acres was improved land. The farms range in size from a few acres to a section or more of land. The total number of farms was 2,784. In 1920 61.6 per cent of the farms were operated by owners, 37.1 per cent by tenants, and 1.3 per cent by managers. Only a few farms operated by tenants are rented for cash, the share system being the more popular. Cash rents range from \$3 per acre for the poorest land to \$25 per acre for the best. Under the share system several different plans are used. The most popular one is for the owner to furnish the land, all tools and power, and share the produce and stock raised half and half. Another method is for the owner to furnish land and part

of the seed, and receive one-half of the grain in the crib and cash for pasture land. Another system is for the owner to furnish the machinery, stock, seed, etc., and to give the tenant one-third of the produce and one-third of the increase of stock. The owners under all systems reserve the right to dictate to the tenant as to the method of farming to be used. Pasture land rents for \$5 to \$10 an acre for any number of steers, or for \$1 to \$2 per head.

Land values vary with the location of the farm with reference to markets and transportation facilities, and to some extent with the character of the soil and improvements. Land values during the past year have increased steadily, and are about two to four times as high as in 1917 for practically the same kind of land. In 1900 the average assessed value of all farms and improvements was \$41.41 an acre, in 1910 it had risen to \$94.61 an acre, and in 1920 to \$215.70. Of the total value of farm property 76.7 per cent is represented by the land, 11.2 per cent by the buildings, 3.4 per cent by the implements, and 8.7 per cent by the domestic animals. At present (1919) the price of farm land ranges from \$50 to \$500 an acre, depending on location, soil, improvements, and topography.

SOILS.

The greater part of Mahaska County is covered by two classes of transported materials, drift and loess, and from these deposits the principal upland soils have been derived. This region was overrun during Pleistocene time by a great sheet of ice known as the Kansan glaciation. Upon its recession there was left a mantle or covering of débris, which varied from a few feet to several hundred feet in thickness. This mass of material consisted principally of boulder clay and ground-up material of the underlying rocks and material which had been carried down from farther north. Later this drift material was, in turn, covered by a layer of silty material to a depth of 10 to 20 feet. The underlying rocks of the area belong to the Upper and Lower Carboniferous and consist of shales, limestone, and sandstone. These rocks are so rarely exposed that the residual soils from them are of little importance.

The superficial covering of loess is the parent material from which most of the upland soils have been derived. With the development of the present drainage system much of the loess mantle has been removed, and it now ranges in thickness from a few inches to about 12 feet, depending upon the degree of erosion to which it has been subjected. In its unchanged condition the loess material consists of about 75 per cent silt. The color ranges from pale yellow to brown. The material is slightly coherent, but breaks down into a loose, floury powder. It has a tendency to stand in vertical banks, and often has a columnar structure. Various changes have taken

place in this silty material or loess to bring it into its present condition, that of a productive soil. From it the Grundy, Tama, Clinton, and Putnam soils have been formed. The slow accumulation of organic matter through a long period has given a dark color to the surface soil, and weathering and leaching have removed the greater part of the lime and other soluble salts. There has also been some translocation of clay particles from the surface to the subsurface layers. The finer particles of soil or clay have been washed down, and their segregation in the subsoil, as in the Grundy and Putnam soils, has given a silty clay subsoil of a rather compact structure. However, except in the case of the small area of Putnam soil and possibly some Grundy areas, the upland soils have ideal conditions in the subsoil as to internal drainage and aeration. In the Clinton and Tama soils oxidation has been complete and uniform, as shown by their brown color and almost total absence of mottling.

Four series of soils have been derived from the loess material—the Grundy, Tama, Clinton, and Putnam soils—which occupy the higher uplands of the county and in all probability lie near the original prairie level. The dark color of the Grundy, Tama, and Putnam series is due to their organic-matter content, resulting from a heavy growth of grasses and other prairie plants. The lighter-colored Clinton soils developed under a forest of oak and hickory along stream borders, which prevented very much accumulation of organic matter such as caused the dark color of the prairie soils.

Immediately underlying the loess and resting upon the underlying consolidated rock is the heterogeneous mass of drift material deposited directly by the invasion of an ice sheet. This is known as the Kansan drift, and is composed of bluish gritty clay, sand, gravel, and boulders. Large boulders are rare, but smaller ones of different composition are common. The various agencies of weathering have changed the upper part of the Kansan drift layer, where it has been exposed, into soil. The original bluish-drab color has been changed by aeration and oxidation into shades of yellow and brown. The Lindley silt loam is the only soil type that has been derived from the glacial drift in Mahaska County. Its surface soil in many places is composed partly of loessial material. The type occurs only where the drift has been exposed along steep slopes and in deep valleys.

The older rock strata which appear at the surface are mainly limestones and shales of the lower Carboniferous. Exposures of these rocks occur along some of the streams, and small areas of soil have been derived from the weathering of these rocks. These areas are classed as Union silt loam.

The alluvial soils of Mahaska County consist of sediments washed from the uplands of glacial and loessial deposits of this and adjacent counties and deposited by streams on their flood plains at times of overflow. In the present flood plains or first bottoms the soils con-

sist of recent alluvium, transported from upstream and laid down by currents of varying velocities, which to a large extent accounts for the different textures of the bottom soil types. Upon the higher lying terraces or second bottoms, which are farther removed from the streams and which represent former flood plains now standing above overflow, the soils consist of older alluvium. Along many of the small streams much of the soil material is of colluvial origin, having been washed down from near-by slopes. It does not differ in characteristics to any marked degree from the true alluvium. The alluvial soils are dark in color. Usually the surface soil is a silt loam and the subsoils are of heavier material, but in some places the subsoils are lighter in structure than the surface. First-bottom soils are classed in the Wabash, Sarpy, and Genesee series, while the terrace soils are represented by the Bremer, Waukesha, Calhoun, Judson, Buckner, Jackson, and Plainfield series.

Soils are divided into groups according to the source of the material and the agencies by which they were deposited. They are then separated into series on the basis of origin and physical properties, as color, structure, content of organic matter, and other characteristics. The series is subdivided to get the soil unit, called the soil type, and the type separation is based upon texture.

The Grundy series includes dark-colored upland loessial soil types. The surface soils range in depth from about 6 to 15 inches, averaging about 10 inches in this county. The change from soil to subsoil is gradual. The subsoil is dark brown to drab with bluish-gray, drab, or yellowish-brown mottling. With increased depth the silty clay loam becomes a dense plastic clay. Drab and yellow colors predominate in the lower part of the soil section. These soils occupy level to undulating or slightly rolling areas and in many places need artificial draining. This series is extensively developed in this county.

The soils of the Tama series are dark brown to black, and the subsoils are yellow to yellowish brown. The structure is loose and friable. The topography is undulating to rolling. This series differs from the Grundy series in having a looser, more friable, and more thoroughly oxidized subsoil. It is better drained and occupies a more rolling topography. This series is widely distributed in this area.

The Putnam series includes types with soils that are brown to gray in color, overlying impervious, tough, dark-brown mottled with drab subsoils. It differs from the Grundy series in having an ashy, whitish silty subsurface layer between soil and subsoil. The Putnam soils occur on the level to flat upland areas and, owing to the impervious nature of the subsoil, require artificial drainage. This series is not extensively developed in Mahaska County.

The Clinton series is widely distributed over this area. It includes types with soils of a pale yellowish gray color and light-brown or yellowish-brown compact subsoils. The topography is rolling to broken, and the drainage well established. These soils are deficient in organic-matter content. The series differs from the Grundy and Tama series in the lighter color of its soils and its more rolling topography. It has a more compact subsoil than the Tama series and is or has been more heavily timbered.

The types in the Lindley series range in color from gray to brown and have yellowish-brown to reddish-brown subsoils that are heavy textured, gritty, and usually mottled with gray. The topography is usually rough, and the soil was originally covered with oak and hazel brush. The series is derived from weathering of the Kansan till, though the surface is often influenced by the admixture of loessial material. The soils of this series differ from the Clinton soils in their different origin and in having gritty clay subsoils. This series is not widely distributed over this area.

The Knox series includes types with light-colored soils derived by weathering from loess, from some other wind-blown material or from material of glacial origin. The subsoil, as developed in this area, is incoherent. The topography is undulating to dunelike.

The surface soils of the types classified in the Union series are generally brown. The subsoil is variable in color, being brown, gray, drab, and slightly red. The subsoils contain numerous fragments of limestone, shale, and chert. The Union soils are residual in origin and occupy steep slopes along streams and ravines.

The alluvial soils comprise first-bottom and second-bottom or terrace types. The first-bottom soils are classed in the Wabash, Sarpy, and Genesee series, while the terrace soils belong in the Waukesha, Bremer, Calhoun, Judson, Buckner, Jackson, and Plainfield series.

The Waukesha series comprises types with dark-brown to black surface soils, and lighter brown to yellowish-brown subsoils. The subsoils are heavier in texture than the soils, but are not very compact or impervious. In this area these soils were found to be non-calcareous. These soils occur on well-drained terraces which lie above overflow. The Waukesha series differs from the Bremer in having lighter and more friable subsoils and in occupying a higher, better drained position.

The soils of the Bremer series are black, and the subsoils are dark gray to black and mottled with drab and yellowish brown and iron stains. The subsoils are generally heavier than the soils and are tough and plastic. This series is, as a rule, confined to low terraces, but in Mahaska County it is found occupying some higher elevations. The drainage is in general not well developed. These soils differ from the Wabash soils in their higher position.

The members of the Calhoun series have gray or light-brown soils with light-gray or almost white upper subsoils and gray or drab heavy clay lower subsoils. The lower subsoils are characterized by a tenacious, waxy, impervious structure, and iron concretions are common. In places the substratum consists of sandy material. These soils occupy poorly drained, flat stream terraces. They are not subject to inundation, but water stands for long periods after rains. The material is alluvial in origin and has been derived principally from the silty soils of the prairie regions. Both soils and subsoils are deficient in lime.

The Judson series includes types with soils of a dark-brown color with subsoils of a slightly lighter color. There is not much change in color, texture, or structure in the entire soil section. These types are found on terraces above overflow. They differ from the Bremer, Waukesha and Jackson soils in having an almost uniform color and structure from surface to lower subsoil. The series is well drained, but is not extensive in Mahaska County.

The Buckner series consists of types with dark-brown soils and lighter colored friable subsoils, which may or may not be lighter in texture and structure than the surface soils. The series is composed of reworked loessial material, in places mixed with sediments from glacial and residual soils. The surface is level, drainage is good, and the soils occupy positions above overflow.

The soils of the Jackson series are brown to light brown in color, and are underlain by light-brown mottled subsoils. They are not subject to ordinary overflow. The series differs from the Waukesha and Judson in its lighter color.

The surface soils of the Plainfield series are light brown to brown, and the subsoils are lighter brown to yellowish, and are slightly lighter in texture than the surface soils. The types of this series occur on terraces above overflow.

The Wabash series includes types with soils of dark-brown to black color and high in organic-matter content, and with black subsoils which become slightly gray and drab in the lower part. The series is typically developed in the first bottoms of streams of this area, and is closely associated with the glacial and loessial soils of southern Iowa. It is subject to overflow. The natural drainage is poorly established in some places and well developed in others.

The Sarpy series includes types with brown soils, underlain by subsoils of lighter texture, frequently passing within the 3-foot section into loose sand and gravel, thus differing from the Genesee series. This series occupies first bottoms and is subject to overflow.

The types of the Genesee series have brown surface soils and somewhat lighter colored subsoils. They are developed along streams draining the glacial and loessial regions of the United States. They differ from the Wabash soils in color, and in having lighter textured

subsoils. These types occupy first bottoms and are subject to annual overflow.

In the following pages of this report the various soils of Mahaska County are described in detail and their relation to agriculture discussed. The name and the actual and relative extent of each type are shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Clinton silt loam.....	121,472	33.4	Knox fine sand.....	1,216	0.3
Tama silt loam.....	81,344	22.4	Grundy silty clay loam.....	1,024	.3
Grundy silt loam.....	73,728	20.3	Calhoun silt loam.....	896	.2
Wabash silt loam.....	25,088	9.2	Bremer silty clay loam.....	640	.2
Colluvial phase.....	8,320		Buckner loam.....	640	.2
Lindley silt loam.....	14,848	4.0	Putnam silt loam.....	576	.2
Bremer silt loam.....	7,296	2.0	Sarpy loam.....	576	.2
Wabash silty clay loam.....	7,040	1.9	Sarpy fine sandy loam.....	320	.1
Waukesha silt loam.....	5,248	1.4	Riverwash.....	320	.1
Union silt loam.....	4,544	1.2	Judson silt loam.....	256	.1
Jackson silt loam.....	3,008	.8	Plainfield loamy fine sand.....	256	.1
Genesee silt loam.....	2,816	.8			
Sarpy silt loam.....	2,048	.6	Total.....	363,520

GRUNDY SILT LOAM.

The soil of the Grundy silt loam as it occurs in Mahaska County is a dark-brown to black mellow silt loam averaging 8 to 12 inches deep. It passes gradually into a moderately friable, light silty clay loam of a brown to dark-brown color. At about 18 inches this material grades into a heavier texture, becoming a dark-drab or yellowish-brown, heavy, tenacious silty clay or clay mottled dark drab and yellowish brown in color. With increased depth the yellow mottling becomes more pronounced. The deeper subsoil from about 30 to 36 inches is more friable than that part from 18 to 30 inches. Small iron concretions are encountered in places in the lower subsoil. In some few small areas the subsurface layer has a faint mottling of brown, and may be slightly gray in color where this type approaches the characteristics of the Putnam silt loam. In some places where the lower subsoil material is noticeably heavy and tenacious it is known locally as "hardpan," though it is not a true hardpan. The soil and subsoil of the type are acid, as shown by litmus tests in the field.

Originally the Grundy silt loam supported a rank growth of prairie grasses. This original condition, with the level topography of the type, favored the accumulation of a large amount of organic matter. The loessial material from which this soil originated ranges in depth from a few inches to 15 feet or more, being shallow near the breaks of the streams and deeper on the more level prairies. In those areas near drainage ways, where the loessial covering is

thinnest, it is very hard to determine accurate boundaries between the Grundy and Tama soils, and the boundaries shown are in many places arbitrarily placed. These two series are very closely associated as to surface characteristics, but topographic differences proved to be of great assistance in separating them. The Grundy silty clay loam occurs closely associated with this type, and small areas of the heavier member have been included with the silt loam.

The Grundy silt loam is extensively developed in this county. It is third in extent in the county, occupying about one-fifth of its total area. Topographically it occupies the broad, almost level divides and the gentle slopes. As the more rolling slopes are approached it gives way to the Tama and Clinton silt loams. The most extensive development of the type is in the southeastern, northern, and western parts of the county. Drainage is fairly well established, there being sufficient slope in most places to carry away the excess water. Only a few almost flat areas are without a sufficient drainage outlet and where the subsoil prevents ready downward percolation. Such places tend to remain wet longer than others and hinder the growth of crops. This condition can be remedied by sufficient tile drainage.

In every respect the Grundy silt loam is considered an excellent soil for general farming. It is easily tilled, fairly well drained, and contains a large amount of humus. Because of its smooth topography it contains a small percentage of waste land, and most of it is under cultivation or in pasture. It was never forested, but may at some time have supported a sparse growth of brush. Its native vegetation consisted of grasses.

This type is considered one of the best corn soils in the county, and corn is most extensively grown on it, followed in order of acreage by oats, hay, wheat, rye, buckwheat, and barley. All crops do well.

Wheat varies in importance, being grown some years on a large acreage and some years not extensively. Alfalfa, rape, sorghum, and millet are grown in a small way. The live-stock industry, consisting of raising hogs and feeding steers for market, is second to grain farming in importance. But this type is not as generally devoted to grazing as some of the rougher upland soils. A few cows are kept on most farms, and cream is sold in small quantities to local creameries. Some sheep are kept, and some farmers breed large numbers of horses and mules. Around Fremont is an important horse-breeding community.

Farmers report corn yields as ranging from 35 to 100 bushels per acre, the average being around 45 bushels. Oats yield 25 to 65 bushels per acre and wheat 12 to 40 bushels. The ordinary yield of timothy alone and of timothy and clover mixed ranges from 1 to 3 tons per acre. Alfalfa is in an experimental stage. This soil is

easily farmed; owing to the high percentage of organic matter present and the silty character of the soil cultivation is easy, and no difficulty is experienced in attaining an excellent tilth. It dries quickly and does not clod or bake if properly tilled. Practically no commercial fertilizer is used. Stable and barnyard manure is utilized on nearly every farm. It is usually applied with a manure spreader.

Farms composed wholly or largely of Grundy silt loam have a selling value of \$200 to \$500 an acre, the average being \$300 to \$400 an acre. The price varies according to the location and the improvements and the manner in which it has been farmed.

Under the best systems of farming liming would be very beneficial to the Grundy silt loam. Barnyard manure should be liberally applied, and crop rotations, including legumes, should be followed. Alfalfa is a crop that should be grown successfully on this soil if seeded properly. This type is not eroding badly in its present condition, but the time will come when this danger will become more pronounced and each rainfall will carry away large amounts of fertile material. Where practicable a cover crop should be grown during the fall, winter, and spring. All small ditches and washes should be stopped as soon as they appear. Tile drainage would prove beneficial in the more level and poorly drained localities. Plans should be made to maintain the productiveness of this soil on tenant farms.

GRUNDY SILTY CLAY LOAM.

The soil of the Grundy silty clay loam is a black, friable silty clay loam 6 to 10 inches deep. It grades into a heavy, compact, plastic, tenacious clay, which breaks down into small cubes when dry. At about 18 to 20 inches this passes into a bluish or yellowish-gray clay mottled with yellow and brown, the mottling becoming more pronounced with increased depth. Below 30 inches the subsoil, though still clay, generally becomes less compact than the overlying material. Tests with litmus paper show both soil and subsoil to be acid.

The Grundy silty clay loam is not extensively developed in Mahaska County. The largest area mapped occurs at and in the immediate vicinity of Wright. Smaller areas occur north, south, and west of Wright.

The surface of this type appears flat to depressed. Owing to this topography and to the compact subsoil both surface and internal drainage are inadequate. Artificial drainage is used.

This soil is all under cultivation. It was originally prairie land and, like the silt loam, is considered very productive. Corn is grown on the greater part of this soil and yields average about the same as on the silt loam, though where improved by tile drainage it gives

even better yields. Oats, wheat, grasses, and clover also do well and yield about the same as on the Grundy silt loam.

Owing to the heavy texture the silty clay loam type requires special care in handling and greater draft for all cultural purposes than the silt loam. The range of moisture conditions under which it must be worked is much narrower than that of the silt loam type. Liberal amounts of barnyard manure are applied, but no commercial fertilizer is used. Green manure crops plowed under give good results in loosening the dense structure.

The price of farm land of the Grundy silty clay loam is only slightly lower than that of the silt loam. The land was held during the summer of 1919 at \$300 to \$450 an acre. Artificial drainage and fall plowing should be used on this type.

TAMA SILT LOAM.

The surface soil of the Tama silt loam is a dark-brown when dry to black when wet, friable silt loam, with an average depth of about 10 to 12 inches. Below this the color gradually passes into a lighter brown and the texture becomes a silty clay loam, friable and crumbly when not too wet. This soil originated from the loessial material, from which the Grundy soils have come, but has been subjected to more erosion and more thorough oxidation. The depth to the underlying Kansan till varies from a few feet to about 15 feet. This type is free from stones and is an important agricultural soil in Mahaska County.

The Tama silt loam is one of the three predominating upland types in the county, ranking second in total area, and is found in almost every part of the county. It occurs typically at the outer border of the Grundy soils and characteristically occupies a topographic position between the Grundy and Clinton silt loams. The topography is undulating to rolling.

The moderate surface relief and friable structure insures excellent moisture conditions. The greater part of the Tama silt loam is under cultivation. The yield of corn probably averages about 50 bushels per acre during favorable seasons. The yield of oats is unusually high on this soil, often reaching 50 to 75 bushels per acre. This soil is well adapted to all staple crops. While returns vary, with the management and the season, a total crop failure is practically unknown. Good stands of clover and timothy are easily obtained, even though this soil is slightly acid.

The average value of this land with farm improvements is second only to that of the Grundy soils. The present selling prices range from \$150 to \$350 an acre.

Applications of barnyard manure and the growing of clover invariably insure additional crop yields on this soil. No commercial fertilizers are used.

KNOX FINE SAND.

As developed in Mahaska County the Knox fine sand is a loose, incoherent, fine to medium sand, of a gray, grayish-brown, or brown color, extending to a depth of 3 feet without much change in color or texture, though the subsoil in places ranges from very light brown to orange or yellow. This sand has a depth in this county of 40 to 60 feet, and is of doubtful origin, but is supposed to be a glacial or eolian deposit.

The type is not extensively developed in the county, but it is prominent and very noticeable in those places where it does occur. The largest area is situated $1\frac{1}{2}$ miles northwest of Eddyville on the east side of the Des Moines River. This body covers about 1 square mile. The next largest area lies just northeast of Eddyville and is a continuation of the type as mapped in Wapello County. Other smaller areas occur 2 miles south of Peoria and $4\frac{1}{2}$ miles north of Oskaloosa. A few small areas are found along the east bank of the North Skunk River near Indianapolis. The surface varies from undulating to dunelike, and drainage is well established. The type is not an important one, only about three-fourths of it being under cultivation, the other one-fourth supporting a sparse growth of wild plum, shrubs, scrub oak, grass, and sand bur. The most important crops are melons, small fruits, and truck crops, though some corn and hay are grown.

Stable manure and some commercial fertilizers are used on this soil. The soil is loose and easily plowed and cultivated. Farmers allow crab grass to grow unhindered in the late summer, or else put in a winter cover crop to protect the surface from the severe winter winds, as the soil drifts badly if left unprotected. Land of this type sells for \$35 to \$150 an acre. The soil needs organic matter, which can be applied in the form of barnyard manure and by plowing under green manures, the legumes preferred.

UNION SILT LOAM.

The Union silt loam consists of a brown silt loam, 6 to 8 inches deep, underlain by a silty clay loam to clay subsoil, which varies in color from brown to gray or drab, in places splotched with yellow, brown and various shades of red. It contains numerous fragments of limestone, chert, shale, and some sandstone. In many places bed-rock is reached within the 3-foot section.

The type is quite variable. In some places the surface soil is a silty clay loam and in others it is quite sandy. The type is closely associated with the Clinton and Lindley silt loams, and a definite, accurate boundary between it and these types can not be drawn.

The type occurs as narrow bands along deep drainage ways, ravines, and steep slopes, the areas being most numerous in the southwestern part of the county. It is not important agriculturally,

because of its small extent and rough, eroded condition. Practically none of it is under cultivation. It is largely forested with various kinds of oak, hickory, hazel, and other trees and shrubs. Several coal mines are located on or in the vicinity of this type.

PUTNAM SILT LOAM.

The surface soil of the Putnam silt loam consists of 8 to 10 inches of dark-gray smooth silt loam, which appears almost black when wet. The upper subsoil is a distinct layer of ashy-gray to white silt, about 6 to 8 inches thick, which passes abruptly into a heavy silty clay loam to clay of a mottled gray, brown, and yellow color. In flat, poorly drained places the soil has a light-gray color, while it is dark brown to black where deep and better drained. This type gives a decided acid reaction with litmus paper.

The Putnam silt loam is not an extensive nor an important soil in Mahaska County. Its total acreage is small, and it is not typically developed. The largest area of the type occurs $1\frac{1}{2}$ miles south of Lakonta. One of the two other areas is in secs. 33 and 34, T. 74 N., R. 16 W., and the other is on the Mahaska-Monroe County line in sec. 36, T. 74 N., R. 17 W.

This soil is used principally for the production of the same crops as grown on the Clinton, Grundy, and Tama soils. Crops give about the same yields as on the Clinton soils, but do not yield as well as on the Grundy and Tama silt loams. The type is handled in the same manner as the Clinton silt loam, with which it is closely associated. The selling price ranges from \$50 to \$200 an acre.

In poorly drained areas, where the acidity is very pronounced, the type would be benefited by liming. It can generally be improved also by growing legumes and by applications of stable manure.

LINDLEY SILT LOAM.

The Lindley silt loam consists of a light yellowish brown or brown silt loam, passing at about 8 to 10 inches into a yellowish-brown gritty silty clay loam, which grades at about 18 to 20 inches into a brown stiff clay somewhat mottled with drab. This soil was derived from weathered Kansan drift material and a superficial layer of loess. The subsoil contains a large percentage of sand, gravel, and small stones. The type in some places is coarse and in some places is a loam, especially where it occupies the steep hillsides and broken slopes. In these places the soil is darker in color than typical.

This soil occurs in close association with the Clinton silt loam and the Union silt loam. It occupies slopes approaching stream courses and areas lying between the Clinton silt loam and the stream bottoms. The larger areas occur along the breaks of the Blackoak, Muchakinock, and St. Joseph Creeks, and the tributaries of the North and South Skunk Rivers. The drainage is good.

The Lindley silt loam is not important agriculturally. Only a few areas have been cleared and put under cultivation. The native forest growth consists principally of white oak, hickory, ash, hazel, and elm. Corn and oats are grown on a small acreage. Cattle are grazed upon the native grasses, and some hogs feed upon the mast. Sheep and goats are used to kill small brush and sprouts. The soil, if it could be separated and sold alone, would bring a low figure, but as it is sold in conjunction with other soils it brings from \$25 to \$150 an acre, depending much upon the topography, nearness to water, and improvements.

This type is deficient in organic matter. When cultivated it should be given liberal applications of barnyard manure, and green manures should be used. Owing to its broken topography and tendency to erode, it should be kept in bluegrass and used as pasture land.

CLINTON SILT LOAM.

The Clinton silt loam to an average depth of 8 to 12 inches is a light-brown to buff-colored, smooth, uniform silt loam, though the immediate surface when dry may be light gray, and in places resembles the Marion silt loam. In wooded areas the immediate surface material consists largely of organic matter and is dark colored in the upper few inches. The soil gives way gradually to a more compact, brown silt loam to light silty clay loam. With increased depth the subsoil increases in clay content and becomes a distinct silty clay loam, and, in rare instances, a true clay in the lower part. The color consists of various shades of yellow and brown and may be slightly mottled with gray. The Clinton silt loam is characteristically free from grit, a constituent of those soils coming from the Kansan drift. In some places the soil may be slightly calcareous in the lower subsoil, but as a rule litmus paper tests show it to be acid. The type is closely associated with the Grundy, Tama, and Putnam silt loams, and in places it is impossible to draw exact boundaries between the several soils.

Small areas of the Marion silt loam are found in this county, but their total acreage is not large enough to warrant a separate type, so such areas have been included with the Clinton silt loam. The Marion has a distinctly light ashy gray soil with a heavy, compact, practically impervious subsoil. The areas of this type that have been included are situated 2 miles northeast of Bellefontaine; in sec. 36, T. 75 N., R. 14 W.; and 1 mile southwest of Givin.

There is a considerable area of the Clinton silt loam that is quite rough and broken. This condition usually exists near streams, on the steep slopes, in the ravines, and on high narrow ridges. In Wapello County a small area of such land was mapped as a broken phase of the type, but in this county it was not separated.

The Clinton silt loam is the most extensive soil in the county. It is widely distributed in irregular belts along both sides of the North and South Skunk Rivers and the Des Moines River. The largest area lies in the southwestern part of the county, where it is interspersed with areas of the Tama silt loam. The type occupies the tops of ridges and the higher and more rolling land along the stream valleys. It was originally covered with oak, hickory, hazel, wild cherry, and other trees and shrubs common to this region.

Good drainage prevails over practically all this type and is even excessive in some places. In some of the almost flat level areas the run-off is not sufficient and the compact subsoil prevents the downward percolation of water. This often develops characteristics causing, locally, the name "hardpan soil."

The Clinton silt loam is a very important upland type, although large areas of it are in pasture and forest and there is often much of it that can not be cultivated. Probably about 65 per cent of the type is in cultivation, and it is fairly productive under favorable conditions. Much of the type is being cleared, and each year a larger acreage is put into cultivation.

All the common crops are grown on this soil, the more important being corn, oats, wheat, clover, and timothy. The type is well adapted to the growing of apples, pears, cherries, and small fruits and berries. This soil is easily cultivated, except in the rough rolling areas. It is easily reduced to a fine state of tilth.

Corn yields 20 to 75 bushels, oats 20 to 60 bushels, wheat 10 to 35 bushels, and clover and timothy about 1 to 1½ tons of hay per acre.

The type is as a rule well farmed. Stable manure is used extensively and commercial fertilizer in small amounts. The soil responds readily to fertilization. The prevailing system of farming consists of live-stock raising and diversified cropping.

This type has such a varied topography that the land prices show a wide range. Where closely associated with the Grundy and Tama soils the type is as a rule more valuable, and where it occupies the rough broken topography along streams it is less valuable. The range in price is from \$50 to \$275 an acre.

This soil washes badly and will be seriously damaged through erosion unless it is carefully watched. Gullies should be filled as soon as they begin to form. The steeper slopes should be kept in grass as much of the time as possible, and the cultivated fields in a cover crop during the winter months. Plowing should be deep and the addition of organic matter a part of the routine, not only to aid in the control of erosion but to enrich the soil with a constituent in which it is deficient. This may be done by applying barnyard manure, by plowing under green manure crops, or both. Where the rougher areas are cultivated, washing may be prevented to some ex-

tent by plowing and planting intertilled crops with the contours of the land.

BUCKNER LOAM.

The soil of the Buckner loam consists of 10 to 15 inches of brown loose-structured loam. The subsoil is a dark-brown loam, which becomes heavier in texture with increased depth, until in the lower part of the 3-foot section it may be a silt loam or clay loam. However, in some places the material continues from the surface to a depth of 3 feet with little change in color or texture.

This type occurs as a terrace soil principally along the Des Moines River. It is not extensively developed in this county. Some of the larger areas are situated in secs. 34 and 36, T. 75 N., R. 17 W., and secs. 5, 15, 22, 26, and 35, T. 74 N., R. 16 W.

The topography of this soil is level to gently sloping, modified in detail by slight elevations and depressions. The soil in the elevations is inclined to be more sandy than in the depressions. Drainage is fair to good, owing to the open nature of the soil and subsoil.

The type is largely under cultivation, and corn, oats, hay, and melons are the principal crops. Some vegetables and small fruits are produced for local use. Corn yields 30 to 50 bushels and oats 20 to 35 bushels per acre. The type is valued at about \$75 to \$250 an acre, depending upon location and improvements.

This soil lacks organic matter, and would be materially improved by heavy applications of barnyard manure or the turning under of leguminous crops.

JUDSON SILT LOAM.

The Judson silt loam is a dark-brown silt loam to an average depth of 10 to 12 inches, resting on a subsoil differing little from the soil except in its somewhat lighter color. Typically this type is supposed to be of colluvial origin, but as found in this area it is distinctly alluvial. It is a terrace soil and lies above overflow. It is of small extent, occurring as small patches along the Des Moines River. One of its larger areas lies one-half mile northeast of Eveland Bridge. Drainage is fairly well established. Agriculturally the Judson silt loam is not important because of its small total acreage, though it is an excellent soil and produces good yields of all crops common to the area. It is practically all under cultivation. Corn, oats, timothy, and clover are the principal crops. Of these corn is the most important, and yields from 30 to 75 bushels per acre. Oats yield 20 to 35 bushels, and hay 1 to 1½ tons per acre.

The soil is naturally productive. It breaks easily, and because of its uniform structure is easy to cultivate.

The type as sold in conjunction with other terrace soils is held at \$100 to \$250 an acre.

WAUKESHA SILT LOAM.

The Waukesha slit loam is a dark-brown to black friable silt loam, the color, owing to a high content of organic matter, extending to a depth of 10 to 12 inches, where it changes to light brown, which continues to the 3-foot depth. The upper subsoil consists largely of silt, but gradually becomes heavier until in the lower part it is a heavy silty clay loam.

Several areas of other types have been included with the Waukesha silt loam, because of their small acreage and similarity to this type. Among these are patches of Waukesha loam, a dark-brown to black loam, containing more or less coarse material. A few small areas of loam and silt loam that have a lighter textured subsoil also have been included with this type. Areas of the loam are situated 2 miles southeast of Eveland Bridge (Des Moines River) and one-half mile south of Fosterdale, and one of the larger areas of silt loam texture 2 miles east of Eveland Bridge. These soils are dark brown to black in color and underlain by friable subsoils that become more incoherent with increasing depth.

The Waukesha silt loam is one of the most extensively developed terrace soils in the county. It occupies high terraces of the Des Moines and North and South Skunk Rivers. It has a level to slightly undulating topography and drainage is fairly well established. This type represents old alluvial deposits and is not now subject to overflow. Some of the larger areas are in sections 8, 16, 17, and 21 of T. 74 N., R. 16 W., and in sections 29, 30, 31, 32, and 33 of T. 77 N., R. 14 W. Smaller areas occur along the smaller streams.

The Waukesha silt loam is an important agricultural soil. It is practically all in cultivation and is a very productive and desirable farming soil. All the general farm crops are grown. Owing to the high organic content and good physical structure this type endures seasonal extremes well and gives good crops nearly every year. The average yield of corn is about 45 to 50 bushels per acre. As a rule the most modern methods are used on farms on this type.

The land is now (1919) being held at \$100 to \$300 an acre.

Care should be taken in farming this soil to maintain its natural fertility. Systematic crop rotations should be used. Stable manure should be applied heavily to all the less productive patches, and all washes stopped as soon as they appear.

CALHOUN SILT LOAM.

The Calhoun silt loam is a smooth, velvety, gray to grayish-brown silt loam, 7 to 10 inches deep. It grades into a light silty layer which is white or ashy gray, mottled in places with brown iron stains. This layer varies in thickness, but ordinarily continues to about 18 inches, where it rests upon a tough, hard, impervious clay subsoil. In color

the subsoil is grayish brown to brown, but it may be mottled with yellow and drab in the lower part.

The Calhoun silt loam is not extensively developed in this county. It occurs in small areas on terraces lying above ordinary overflow, along the larger streams, and represents old alluvial deposits. A few small areas of lighter color are located along the North Skunk, South Skunk, and Des Moines River valleys, and along Muchakinock Creek. The topography of the type is level, and the surface drainage may be good or poor. The underdrainage is retarded by the heavy, impervious subsoil.

The soil, which is productive, is practically all under cultivation to the common farm crops, corn, oats, wheat, and hay. Crops give about the same yields as the upland type, Clinton silt loam. It has a deep loose surface soil and is easily plowed and cultivated.

The type would be benefited by improvement of surface and internal drainage. It is also low in organic matter, the supply of which should be increased by green manures. Land of this type occurs in such small bodies that it is usually sold in conjunction with other types. It is held at about \$75 to \$175 an acre.

BREMER SILT LOAM.

The Bremer silt loam, to a depth of 10 to 12 inches, is a smooth, uniform, very dark brown silt loam, black when wet. This top layer merges gradually into the subsoil, which is a heavy silty clay loam, black in color in the upper part, and passes into a heavy tenacious clay of dark-brown to black color and mottled with drab and yellow in the lower part. The type as a whole does not contain any gritty material. A few variations of the type have been included. In section 32, T. 75 N., R. 16 W., and section 36, T. 75 N., R. 17 W., small areas of Bremer have not been separated.

The Bremer silt loam is rather extensively developed, having a larger total acreage than any other terrace soil in the county. Typically it occupies low terraces, but in the southwestern part of the county on the south side of the Des Moines River it is extensively developed on terraces that lie at least 100 feet above the river. In its lower situations it is sometimes subjected to overflow. Along the small streams it merges into the upland and first-bottom soils so gradually that the lines of separation are very indistinct and difficult to determine. The larger areas lie 1 mile west of Eveland Bridge (Des Moines River), three-fourths mile northeast of Eveland Bridge, 1 mile east of Centennial School, in sections 20 and 21, T. 76 N., R. 16 W., 2 miles northeast of Rose Hill, and 1 mile south of Bellefontaine. Many smaller bodies lie along the North Skunk, South Skunk, and Des Moines Rivers, and along Middle, Muchakinock and other smaller creeks.

The topography is level to slightly undulating, and, owing to the low-lying position of typical areas and to the dense subsoil, the drainage is poor to only fair.

This soil is strong and productive and is very desirable and important agriculturally. Nearly all of it is under cultivation, corn, oats, and hay being the principal crops. This type closely resembles the Wabash silt loam, with which it is closely associated, the greatest difference being the slightly higher elevation of the Bremer. It gives about the same yields as the Wabash silt loam. The soil is deep, fertile, and easily handled under proper moisture conditions. Land of this type sells for \$100 to \$350 an acre.

The Bremer silt loam would be benefited by artificial drainage and applications of lime. Its present sufficient supply of humus should be maintained.

BREMER SILTY CLAY LOAM.

The Bremer silty clay loam to an average depth of 6 to 8 inches is a black silty clay loam. Below this the material grades into a dark-brown to black, heavy, compact, dense clay extending to the lower subsoil. Here the color becomes lighter and mottled with dark drab and yellow.

This type is not extensively developed and does not occur in any very large single areas. It is found in scattered patches along the main stream valleys as low terraces. Only about 50 per cent of the type is under cultivation. The topography is level, and the surface and internal drainage is poor to only fair.

Corn is the principal crop and gives excellent yields. Oats, wheat, and timothy also do well. The selling value of this land is lower than that stated for the Bremer silt loam. Suggestions made for the improvement of the silt loam apply equally well to this type.

PLAINFIELD LOAMY FINE SAND.

The Plainfield loamy fine sand consists of a dark-brown loamy fine sand underlain at 12 to 15 inches by a light-brown sand, which gradually becomes lighter in color and coarser in texture with increased depth. In some places adjacent to the uplands the type includes small areas of soil of slightly heavier texture.

The type occupies a high terrace lying just below the upland bluff. The area mapped in this county is located in the northern part of Eddyville and extends north from that town, and is a continuation of an area mapped in Wapello County. It lies adjacent to the upland, which is here occupied by the Knox fine sand, and it seems probable that much of the material is colluvial wash from the upland.

The Plainfield loamy fine sand is inextensive and of little agricultural importance. That part of it not occupied by the town of Eddyville is cultivated. Watermelons, cantaloupes, truck crops, and ber-

ries are the most important crops. They are produced largely for home use and for sale on local markets.

JACKSON SILT LOAM.

The surface soil of the Jackson silt loam ranges from a light-brown to dark-brown, uniform, smooth silt loam, 10 to 12 inches deep. This grades into an upper subsoil layer of light-brown heavy silt loam, streaked with gray. The subsoil becomes heavier with depth, and in places is in the lower part a brown heavy silty clay loam, mottled with yellow and gray. The type includes a few small patches of soil varying in color, texture, and structure. In some places near the foot of the upland bluff sandy materials have been washed down over this type, forming small strips of soil rather dark in color for the Jackson silt loam and approaching in this character the Waukesha silt loam.

The Jackson silt loam occurs as a second-bottom or terrace soil, is well drained, and lies above overflow. The surface ranges from level to slightly undulating.

Soil of this type is fairly extensive. The larger areas occur on the terraces of the Des Moines, North Skunk, and South Skunk Rivers, and Muchakinock and Middle Creeks. There are other small developments along many of the smaller streams.

This is a valuable farming soil, and the greater part of it is under cultivation. It is used principally for hay and grain production in connection with the raising of live stock.

Corn yields an average of 40 to 45 bushels per acre. Oats, wheat, timothy, and clover do well. Fruit, small fruits, and garden crops are produced for local consumption. Stable manure is used extensively. The range in selling price is from \$75 to \$275 an acre.

This soil would be improved to a marked degree by the addition of organic matter. Where the surface is flat to slightly depressed small ditches should be provided to carry off the excess rain water.

WABASH SILT LOAM.

The surface soil of the Wabash silt loam is prevailingly a dark-brown or black silt loam of smooth uniform texture. It is rarely less than 10 to 14 inches deep, but may be deeper on the loamy or silty areas. The upper subsoil is dark drab to black, the lighter color being associated with the heavier textures. The lower subsoil is generally a drab or yellowish-gray clay loam mottled with brown. Typically this type is free from grit, but near stream beds, pockets or layers of sand are encountered in the lower subsoil.

In many places, especially near streams, the type as mapped includes some small areas of light-brown silt loam and some areas of a brown sandy and fine sandy loam. In some places along the Des Moines and North and South Skunk Rivers, where the Wabash silt loam is closely associated with the Wabash silty clay loam, the line

between the two has been arbitrarily drawn because of the difficulty of distinguishing them accurately where they merge.

The Wabash silt loam is the most extensive first-bottom soil in the county. It is important agriculturally and occurs most extensively along the North and South Skunk Rivers. Smaller areas lie along the Des Moines River, Buckley, Middle, Cedar, Muchakinock, and St. Joseph Creeks, and many of the smaller streams. The type has a level topography, and drainage is poorly to fairly well developed. Owing to the uncertainty of overflow the type is not cultivated as extensively as it might be. The tree growth is sparse except near stream channels, where there is considerable oak, maple, elm, hickory, ash, and other species. Corn, wheat, oats, and hay are the staple crops. Bluegrass grows well, and a large part of the type is devoted to this grass and used as pasture for cattle, sheep, and horses. Hogs are grazed on this pasture and on nuts and acorns in the forested areas. Corn is the dominant crop and yields ordinarily 25 to 85 bushels. Oats do well, yielding 20 to 40 bushels. The soil is so fertile and strong that no attempt is made to maintain or increase production by rotations.

In managing this soil the chief problem the farmers have is one of establishing good drainage. The soil is loose, friable, and easily plowed and cultivated. For corn it is sometimes plowed in the fall and allowed to remain rough until spring. Many farmers have tilled this soil in order to allow plowing and seeding earlier in the spring, others have dug shallow ditches through the fields, which hasten the run-off of surface water.

This land has a wide range in selling price. The value depends largely upon the liability to overflow, the improvements, such as clearing and drainage, and the location with reference to markets and lines of transportation. The land is held at \$50 to \$275 an acre.

A considerable proportion of the Wabash silt loam could be improved by drainage. The ditch now being constructed along the South Skunk River and the one proposed for the North Skunk River, when completed, will make the farming of this soil less uncertain, but they will hardly prevent all inundations. Flooding of some areas could be prevented by diking and building small open ditches.

Wabash silt loam, colluvial phase.—The Wabash silt loam, colluvial phase, is a dark-brown to black silt loam 10 to 12 inches deep. The subsoil to about 20 to 24 inches is a black heavy silt loam to light silty clay loam, below which there lies a coal-black silty clay loam to clay. The subsurface in places may be streaked with brown and gray. The phase is variable in texture, having been formed by the downward movement of soil particles from the adjoining slopes by rain water or gravity, aided by cultivation and to a slight extent by wind action. It occurs in the narrow V-shaped valleys of a very large number of the smaller streams of the county, and along

some of the outer margins of the wider valleys of the larger streams. It has been deposited in narrow strips by sheet wash from the uplands, or in some places as alluvial fans or small outwash plains. Drainage is poorly to fairly well developed.

The phase is not important agriculturally, owing to its small acreage and its occurrence in narrow valleys. Only a small percentage of it is in cultivation, though it is very productive, corn and hay giving excellent yields. It is used largely for pasture. Land of this type is always sold with other soils. In many places the areas need drainage and steps to prevent erosion.

WABASH SILTY CLAY LOAM.

The surface soil of the Wabash silty clay loam is a dark-brown to black friable silty clay loam 6 to 10 inches deep. This grades into the subsoil without much change in texture, structure, or color, until at a depth of about 18 to 20 inches the material becomes slightly mottled with drab and rusty brown, and at greater depth a dark-drab, plastic clay mottled with brown and gray. The type is generally free from grit and sand. As mapped the Wabash silty clay loam includes some small areas of Wabash clay, which consists of a crumbly to granular black silty clay loam to clay, overlying a subsoil of heavy, dark-drab, sticky, waxy clay.

The Wabash silty clay loam occurs in first-bottom land along the larger streams of the county. Some of the larger bodies lie in section 18, T. 77 N., R. 17 W., and on the north side of the South Skunk River, in sections 22 and 23, T. 76 N., R. 16 W., and in sections 7 and 18, T. 75 N., R. 14 W. Smaller bodies are developed along the North Skunk and Des Moines Rivers, and along Middle and Muchakinock Creeks and other minor streams. The type has a level to flat topography, is low lying, and subject to overflow. The surface drainage is poor, and the subsoil, though not impervious, is so heavy the rapid downward percolation of water is impossible. As a result the land is often wet for long periods after heavy rainfall.

Only a small proportion of the type is under cultivation. It supports a heavy growth of coarse grass. Corn, oats, wheat, hay, and bluegrass occupy the cultivated areas. Cattle and hog raising is important. The type is naturally strong and productive, and under good moisture conditions gives good yields. It plows easily when not too wet or too dry, the clods break down readily owing to the granular structure of the soil. This type is sold in conjunction with the Wabash silt loam and has about the same selling value.

The type would be benefited by the methods of treatment suggested for the Wabash silt loam.

GENESEE SILT LOAM.

The soil of the Genesee silt loam is in color grayish brown to light brown when dry and brown when wet. In texture it is a true silt

loam, but it gradually becomes heavier with increase in depth. The subsoil, beginning at 6 to 12 inches, is usually a little lighter colored than the surface, and as a rule is a light silty clay loam, though material of silt loam texture may extend to the lower subsoil. Both soil and subsoil have a loose friable structure. The content of organic matter is lower than in the Wabash silt loam.

Several areas of Genesee silty clay loam have been included with this type because of their small extent. These are located on the west side of Muchakinock Creek, where it empties into the Des Moines River, 1 mile north of Bellefontaine, and in sections 27, 28, and 29, T. 75 N., R. 17 W.

The Genesee silt loam occurs mainly along the Des Moines River. Some of the larger areas are located $1\frac{1}{2}$ miles southeast of Bellefontaine, $2\frac{1}{2}$ miles south of Givin, and along Bluff Creek from Lakonta to the Des Moines River. Smaller areas are located along the North and South Skunk Rivers and their tributaries. The type has a flat topography, but owing to its rather loose and friable subsoil it is well drained between wet periods. The areas lie in the first bottoms and are subject to frequent overflow.

The type, while of small extent, is productive and locally important. The greater part of it is under cultivation and is devoted mainly to corn, oats, and hay. Corn yields 25 to 75 bushels, oats 20 to 40 bushels, and hay 1 to 2 tons per acre. The selling price ranges from \$50 to \$150 an acre.

The Genesee silt loam needs the incorporation of organic matter, and liberal applications of manure should be made.

SARPY FINE SANDY LOAM.

The surface soil of the Sarpy fine sandy loam consists of 8 to 15 inches of material ranging in texture from fine sand to silt loam, the areas of different textures being so small that differentiation on the map was not deemed important. Prevaillingly the soil is a fine sandy loam of light brown to brown color. The subsoil is characteristic of the series, being a brown loamy fine sand to fine sandy loam. There is no sharp line between soil and subsoil. A few areas where small sand "blows" occur have been included with this type. They consist of fine sand with which there is not sufficient finer material to bind the soil particles together.

The Sarpy fine sandy loam occurs in small areas and its total acreage is small. Some of the larger areas lie just east of the Marion County line where the Des Moines River crosses it, and small areas are scattered along the Des Moines and the North and South Skunk Rivers. The type is a first-bottom soil and owes its origin to recent depositions of sandy sediments during periods of overflow. The light soil and the sandy substratum insure good drainage between overflows.

This is not an important type because of its small acreage. Possibly 50 per cent of it is under cultivation. Practically all the crops common to this region are grown successfully. Melons and other truck crops could well be produced on this type. Few soils in the area are adapted to as great a diversity of crops as the types in the Sarpy series.

Land values are variable, depending upon location, improvements, and drainage. It is generally sold with alluvial land of other types. Prices range from \$30 to \$175 an acre.

The Sarpy fine sandy loam should respond readily to green manuring, as it needs organic matter.

SARPY LOAM.

The surface soil of the Sarpy loam consists of a brown loam, with a depth of 8 to 12 inches, grading gradually into the characteristic Sarpy subsoil—a brown loamy fine sand. The type is, however, quite variable and as mapped includes as wide a range in texture as the Sarpy fine sandy loam. Thus, there are patches of loamy fine sand, fine sand, and silt loam, though the prevailing texture is a loam.

The Sarpy loam is a first-bottom soil, resulting from the deposition of sandy material by overflow waters, usually on the immediate banks of the stream. It occurs principally in small areas along the Des Moines River. One of the larger bodies is situated just east of Eveland Bridge. The type is level to slightly undulating, but includes some ridges of small extent. The drainage is good, owing to the loose sandy nature of the subsoil. This soil is not important agriculturally because of its small acreage, though it is fertile and produces excellent yields of all crops common to this region. Melons and other truck crops do especially well.

Its value is about the same as that of the Sarpy fine sandy loam.

SARPY SILT LOAM.

The surface soil of the Sarpy silt loam is a brown silt loam, having a uniform, smooth texture, and typically about 12 to 14 inches deep. It rests upon a subsoil which is lighter than the surface in texture and color, being generally a light-brown loam, loamy sand, or fine sand. This lighter textured subsoil is the particular characteristic that distinguishes the type from the Genesee silt loam, a closely associated soil. Several small patches of a heavier Sarpy soil have been included with the silt loam.

The Sarpy silt loam is developed typically along the Des Moines River, north and east of Bellefontaine, $1\frac{1}{4}$ miles west of Fosterdale, and one-half mile west and northwest of Eddyville. There are a few smaller areas along the North Skunk and South Skunk Rivers.

The surface of the Sarpy silt loam varies from level to slightly undulating, marked here and there by low sandy ridges or by depressions in which the soil is of heavier texture. The drainage is good.

The type occurs in the first bottoms and is subject to overflow. It occurs normally on or near the banks of the streams and in places forms a natural levee.

The Sarpy silt loam is of small extent and has little influence on the agriculture of the county. It is, however, a very desirable soil in years of sufficient rainfall to overcome a slight tendency to drought. The land is productive, but crops are uncertain because of the occurrence of overflows.

Corn is the leading crop. Oats, timothy, alfalfa, and clover are grown to a small extent. Melons and truck crops do well and are produced for local use. Some of the type is used as pasture land.

Land of the Sarpy silt loam is usually sold with other types of soil. The estimated selling price is \$50 to \$175 an acre, depending upon improvements, location, and exposure to floods.

RIVERWASH.

Riverwash consists of recently deposited alluvial material. As mapped in this area it consists mainly of heaps of loose, fine sand, sand banks, and low-lying sand bars. The material is a grayish-brown to gray sand varying widely in texture. Some waterworn gravel occurs in small areas.

Riverwash occurs along the Des Moines River between bends, and is subject to frequent overflow. It may or may not have a sparse growth of brush, willow, and grasses. The type is practically non-agricultural. A few attempts have been made to farm small patches, with indifferent results.

SUMMARY.

Mahaska County is situated about the center of the southeastern quarter of Iowa. It has an area of 568 square miles, or 363,520 acres. The uplands range from level to rolling. There is a large acreage of bottom and terrace land.

The county is drained by three main streams that flow parallel and diagonally across the county from northwest to southeast. These are the Des Moines, North Skunk, and South Skunk Rivers.

The 1920 census shows a total population of 26,270. Oskaloosa, the largest town and the county seat, had a population of 9,427 in 1920. New Sharon, Barnes City, Fremont, Rose Hill, Eddyville, Cedar, Evans, Leighton, and Wright are towns of less importance.

The county is well equipped with railroads, which supply direct transportation to Des Moines, Minneapolis, St. Paul, Omaha, St. Louis, and Chicago.

Mahaska County has a mean annual temperature of 49° F. and an average rainfall of 29 inches. The normal growing season is 169 days.

The agriculture is based on general farming. Some farmers specialize in live-stock raising, while others prefer grain farming. Corn,

oats, wheat, and hay are the principal crops. Bluegrass does well and is used extensively for pasture.

About 94 per cent of the area of the county is in farms, and 85.9 per cent of all farm land is improved. The average size of the farms in 1920 is reported as 122.9 acres.

Twenty-two soil types, one phase, and one miscellaneous soil are correlated and mapped in Mahaska County.

The Grundy, Tama, and Putnam series include the dark-colored prairie soils. These are well suited to corn and hay. They occupy level to slightly rolling uplands between the stream valleys.

The Clinton is a light-colored series of loessial origin and supports some forest growth. It occurs on the margin of the prairie soils and between them and the stream valleys.

The Lindley silt loam occupies rather rough and rolling areas. It originated from glacial material. This soil is used largely for pasture land.

The Knox fine sand is of small extent. It is used largely for the production of melons and truck crops.

The Union silt loam is composed of residual material from limestone and shale. Its development is small and unimportant.

The Calhoun silt loam is a brown soil occupying old, high-lying terraces. General farm crops are grown on it.

The Plainfield loamy fine sand occupies only a small acreage and is agriculturally unimportant.

The Bremer soils are black in color and occupy river terraces. They are very productive where well drained.

The Waukesha silt loam is a dark-colored soil occupying high terraces of the main streams. It is strong and productive.

The Jackson silt loam is light-brown terrace soil used to produce general farm crops.

The Buckner loam is a Des Moines River terrace soil of brown color. Melons and truck crops principally are grown on it.

The Judson silt loam, while of small extent, is a desirable soil. It is dark-colored and occupies a terrace position above overflow.

The Wabash soils are dark-colored types occurring in the first bottoms along streams. They are naturally productive and are considered good grain and hay soils where drainage is well established.

The Genesee silt loam is a brown first-bottom soil. It is productive and is used for general farming.

The Sarpy soils are located in the first bottoms and are subject to overflow. They are naturally productive.

Riverwash is a miscellaneous soil consisting of sandy material of recent deposition, usually on the immediate banks of the stream.

[PUBLIC RESOLUTION—No. 9.]

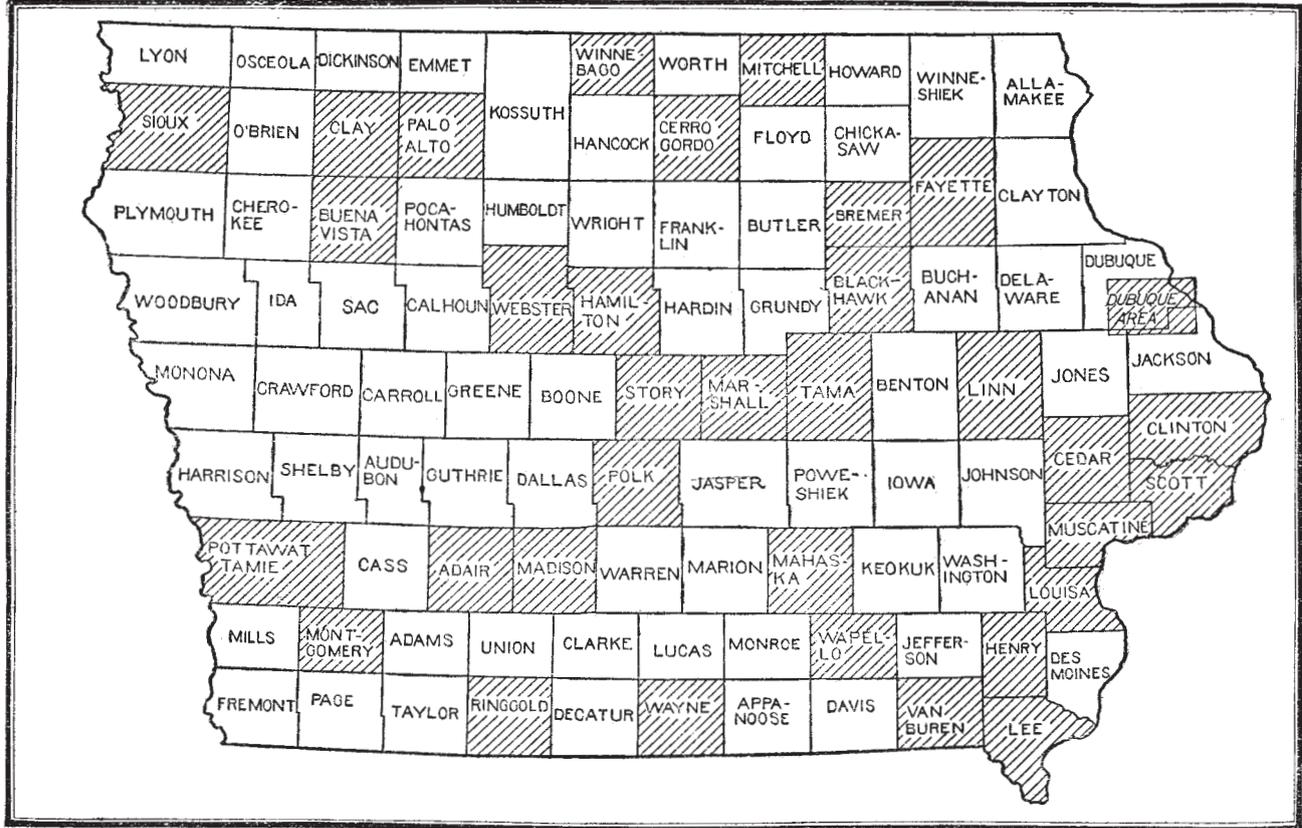
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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

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

Approved, March 14, 1904.

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



Areas surveyed in Iowa.

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