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 SOIL SURVEY.

# SOIL SURVEY OF CLINTON COUNTY, IOWA,

BY

H. W. HAWKER, OF THE U. S. DEPARTMENT OF AGRICULTURE, IN CHARGE, AND F. B. HOWE, OF THE IOWA AGRICULTURAL EXPERIMENT STATION.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets, Field Operations of the Bureau of Soils, 1915.]

WASHINGTON
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1917.

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U. S. DEPARTMENT OF AGRICULTURE,

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# LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
*Washington, D. C., November 11, 1916.*

SIR: I have the honor to transmit herewith the manuscript and map covering the survey of Clinton County, Iowa, and to request that they be published as advance sheets of the field operations of the Bureau of Soils, 1915, as authorized by law.

The selection of this area was made after conference with the State officials cooperating with the bureau in the work of surveying and classifying the soils of Iowa.

Respectfully,

MILTON WHITNEY,
*Chief of Bureau.*

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

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MAP.


Soil map, Clinton County sheet, Iowa.

# SOIL SURVEY OF CLINTON COUNTY, IOWA.

By H. W. HAWKER, of the U. S. Department of Agriculture, In Charge, and F. B. HOWE, of the Iowa Agricultural Experiment Station.—Area Inspected by THOMAS D. RICE.

## DESCRIPTION OF THE AREA.

Clinton County, Iowa, lies along the Mississippi River, about midway between the northern and southern boundaries of the State. It is bounded on the north by Jackson County; on the east by the Mississippi River, which separates it from Carroll, Whiteside, and Rock Island Counties, Ill.; on the south by the Wapsipinicon River, which separates it from Scott County; and on the west by Cedar and Jones Counties. The area is approximately a rectangle, the two river boundaries causing it to be slightly irregular. Its greatest width north and south is approximately 21 miles and its greatest length east and west about 39 miles. The total area of the county is 691 square miles, or 442,240 acres.

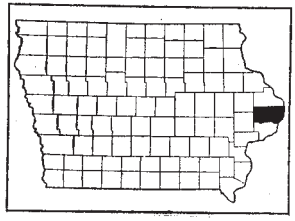


FIG. 1.—Sketch map showing location of the Clinton County area, Iowa.

Three general divisions of the surface with regard to physiographic and topographic features may be made. The most extensive and most elevated is the Kansan drift upland, with its surficial covering of the Mississippi loess. This extends along the entire northern part of the county in a wedge-shaped body, widening toward the east, and constitutes approximately 55 per cent of the total area of the county. South of this is the Iowan drift plain, which is intermediate in position between the loessial upland and the alluvial deposits in the valleys of the Mississippi and Wapsipinicon Rivers.

The loessial upland, as viewed from a distance, is a generally smooth, even plain, with a gentle slope toward the south and southeast from the northwestern corner of the county. The greater part of this plain, however, is locally dissected by the erosion to which it has been subjected since its formation and consists mainly of slopes and ridges with intervening drainage ways. The smoothest and least dissected areas occur in a belt extending from Delmar westward for several miles, and also in a southeasterly direction to Petersville

and southward from that place to Welton. Another prominently smooth, level area occurs in the vicinity of Elvira, mainly south and east of that place. In these areas the topography is very gently rolling.

The loessial upland occurs in two main bodies in the county. The larger extends from the northern boundary of the county to a line drawn from a point 4 miles south of its northwestern corner, in a general southeast direction, to a point 2 miles northwest of Camanche, giving a wedge-shaped area across the northern end of the county, widening toward the east. In the southwestern corner of the county there is another area which is detached from the main body but similar to it. Several smaller areas occur in the Iowan drift plain north of Wheatland and Dewitt. Some of these small islandlike areas may, perhaps, be classed as paha, a term adopted by McGee, who first described them, to designate the loess-capped ridges, elongated in character, and having a northwest-southeast trend, which are mentioned in geological reports covering Clinton and Cedar Counties.[1] Paha also form a noticeable surface feature along the boundary between the loessial upland and the drift plain.

The maximum elevation of the upland occurs in the northern part of the county, elevations of 920 feet[2] being reached in the northwestern corner in a long ridge along the Brookfield-Sharon Township line, 2 miles south of the northern county line, and on several small, isolated hills east and north of Delmar. Along the line of juncture with the drift plain the elevation varies from 780 feet at the western edge of the county to 740 feet south of Welton and 700 feet at its most eastern point. Where the loessial upland merges with the alluvial bottoms of the Mississippi River the elevations vary from 780 to 840 feet.

The Iowan drift plain follows the Wapsipinicon Valley and is bounded on the north by the loessial upland just described and on the south and east by the alluvial bottoms of the Wapsipinicon and Mississippi Rivers. This plain is the result of the incursion of the Iowan glacier from the west and has been designated as the Clinton lobe of the Iowan drift.[3] By far the greater part of this plain is smooth and almost level. South of Malone, Dewitt, and Grandmound are the most noticeable topographic variations—eskerlike ridges of glacial material rising to a considerable height above the general level of the plain. Ridges and rounded hills, made up largely of sandy material, are quite prominent in that part of the plain directly east and north of the Wapsipinicon lowlands in the

[1] Reports of the Iowa Geological Survey, Vols. XI and XV.

[2] Elevations quoted in this report taken from the sheets of the United States Geological Survey covering Clinton County and from Gannett's Dictionary of Altitudes in the United States.

[3] Geology of Cedar County, by William Harmon Norton.

western part of the county. In the vicinity of Bliedorn and in the area of the drift adjoining the loessial uplands north and south of Wheatland, where the drift plain is only slightly lower than the loessial upland, the drift occupies a well-dissected plain. These areas are considerably higher than the average of the drift plain.

The main body of the drift plain occurs north and east of the Wapsipinicon River at Toronto, south of the loessial upland, continuing eastward to the Mississippi River. A detached area lies south of the Wapsipinicon River at Toronto, and smaller areas occur on each side of Yankee Run between the alluvial areas along this stream and the loessial uplands on the north and south. The boundary between the drift plain and the loessial upland in Clinton County is generally well defined, being marked by a distinct drop in elevation, the relationship between the two plains suggesting that of terrace and upland. North of Bliedorn and west of the Wapsipinicon, where the plains have almost similar elevations, differentiation is sometimes difficult, as is also the case south of Elvira, where the loessial upland merges gradually into the glacial plain. The boundary between the drift plain and the alluvial bottoms is not everywhere distinct, no marked difference in elevation existing between the two in some instances.

The maximum elevation of the Iowan drift plain in Clinton County is 800 feet above sea level, this elevation occurring near the western boundary of the county, northwest of Wheatland. North of Bliedorn the elevation is approximately 780 feet. At Calamus and Grandmound the elevation is 710 feet, at Dewitt 687 feet, at Malone 663 feet, and at Low Moor 647 feet, showing a slope from the west and north to the east and south, like that of the loessial upland.

In the extreme northeastern corner of the county there is a very narrow fringe of bottom land, which widens downstream to about three-fourths mile, and south of the juncture of the Elk River with the Mississippi to about 2 miles, narrowing gradually to a point north of Lyons, below which the bluffs again occur contiguous to the river. The greater part of the alluvial bottoms is separated from the mainland in periods of high water by a slough near the base of the precipitous limestone bluffs. The bottom land divides near Lyons, extending around the base of a loessial upland area, which at one time probably formed an island in the river. North of Camanche the alluvial bottoms widen out to about 3 miles, Harts Mill Creek entering the bottoms at this point. At the juncture of the Mississippi with the Wapsipinicon the bottom land is about 1¼ miles wide.

Where the Wapsipinicon River enters Clinton County on the west its bottom land is scarcely more than one-quarter mile in width.

Eastward it quickly widens, ranging from 1 mile to 3 miles in width until it passes the loessial uplands just north of the Scott and Clinton County line, its maximum width being attained east of Toronto. East of Buenavista the bottom is very narrow, ranging from about a hundred yards to three-eighths mile in width, but it again widens out and averages a mile or more in width to the juncture of the river with the Mississippi. The upland again closely approaches the river south of Malone. The alluvial bottoms of the two rivers are without relief, except for the presence of relatively small terrace remnants, the largest of which occur in the vicinity of Elk River Junction, Camanche, and Folletts. Abandoned channels and slight depressions occur in places.

Preglacial drainage has had a marked effect on the topography of the county, and added a large part of the alluvial material in the county. The largest of the old channels enters the county about 12 miles west of the northeastern corner and extends almost due south, entering the Wapsipinicon River south of Malone. It ranges in width from three-fourths mile to 1½ miles or more from the northern county line to a point where the Iowan drift plain crosses it south of the Cherry Creek channel, below which the alluvial material is restricted to the modern valley of Brophys Creek. This is called the Goose Lake Channel by Udden in his report on the geology of Clinton County, and is said by him and others to represent an old channel of the Mississippi River. Modern valleys have been made in this old channel by Deep Creek and Brophys Creek, the former flowing north and the latter south, the divide occurring in the vicinity of Goose Lake. Two lakes formerly occupied a part of the channel near Goose Lake, these having recently been drained. The modern valleys and the lake beds present the only relief in this old channel, the former being in some instances defined by scarps 5 to 8 feet or more in height.

Sugar Creek, Prairie Creek, Cherry Creek, Deep Creek, and Silver Creek occupy channels apparently too wide to have been caused by the erosion of those streams, and have modern valleys lower than the remainder of the alluvial plain, this constituting the only relief. The old channel of Silver Creek joins with that of Deep Creek, and no well-marked divide occurs between the tributaries of these streams. However, only the modern valley of Silver Creek occurs south of the boundary between the loessial upland and the Iowan drift plain, the old channel having apparently been filled with drift material. North and east of Low Moor there occurs an old alluvial plain which probably connected at one time with the old Goose Lake channel, but was isolated by the Iowan drift. Yankee Run probably also falls within the class of streams occupying preglacial valleys, though the entire valley is subject to overflow, and there is little, if any, relief. This

stream is said by Norton to occupy "an ancient valley whose floor of rock is buried an unknown distance below the surface."[1]

The greater part of the drainage of the county is through the Wapsipinicon River. The channel of this stream is narrow and shallow in proportion to the amount of water it carries. Yankee Run and Rock, Barber, Silver, Ames, Cherry, and Brophys Creeks and an extensive system of drainage ditches south and southeast of Lost Nation and in the vicinity of Calamus constitute the main tributaries and drain the central part of the county. Where the sources of these streams occur in the loessial upland, their channels to the point where they emerge upon the drift plain are deeply eroded, and the slopes to the streams are often quite steep and abrupt, and the currents of the streams quite rapid. On reaching the belt of drift, which generally lies considerably below the loessial upland and has a gentle slope toward the river, the streams suddenly lose their velocity, and flow in tortuous courses through broad, shallow valleys instead of deeply cut channels. The streams heading in the glacial drift belt also follow broad, shallow, tortuous valleys. In the drift plain the supplementary drainage channels are not well defined, and interstream areas have sluggish natural drainage, even this being lacking in some instances, necessitating the use of tiles and ditching to establish drainage. Ponded areas, entirely surrounded by higher lying lands, are occasionally encountered.

A north-and-south line through Bryant approximately indicates the western boundary of the drainage which finds its way into the Mississippi River on the east. Elk River and Harts Mill Creek constitute the principal drainage ways here, and there is a large number of short, intermittent streams. The loessial upland in the northern part of the county is from 150 to 200 feet above the flood plain of the streams, and the valleys of these streams are deeply cut, the slopes are steep to precipitous, and the streams are rapid. The bluff from the upland to the Mississippi bottom from Lyons northward has an average height of 100 to 150 feet, sometimes being precipitous, with exposures of the underlying limestone and shale formations. The streams of the Mississippi system draining the Iowan drift plain have the same character as those of the Wapsipinicon system from that belt.

A narrow strip along the northern edge of the county in the western part and an area of about 75 square miles in the north-central part are drained through Prairie Creek, Sugar Creek, Deep Creek, Deer Creek, and their tributaries northward into the Maquoketa

[1] Norton, Geology of Cedar County, Iowa Geological Survey Rept., Vol. XI, p. 288.

River in Jackson County. These streams head in the loessial upland, and occupy well-defined, deeply cut channels, maintain a good current, and like the other streams occupying this upland are well able to carry all the drainage of their respective basins.

The first-bottom lands along the streams are subject to occasional overflow, but the water remains on the flood plains for only a short time.

Although Marquette entered eastern Iowa as early as 1673, the region remained under the dominion of the Indians until after the close of the Black Hawk War in 1832, when the Government acquired by treaty a strip of territory 50 miles wide along the Mississippi River for almost the entire length of the State. Iowa was originally a part of the Louisiana Purchase, and the strip acquired through the Black Hawk treaty is known as the "Black Hawk Purchase." This strip was later divided into two counties, Dubuque to the north and Des Moines to the south. Clinton County was originally a part of the former county.

The actual settlement of the county began in 1835, when several squatters took up land on the site of the present town of Lyons. Immigration was rapid. The eastern part of the county was settled first. By 1839 settlements had been made as far west as Elwood. Lyons, Camanche, and Dewitt were among the earliest towns. The settlers were mainly from the South and East, coming overland and up the river. They were largely pioneers from the more thickly settled areas of the East, the greater proportion being of English and German descent. The nationalities represented in the present population are mainly German, Irish, Danish, and English, with some Norwegians, Swedes, and Austrians.

Descendants of German stock probably predominate in Spring Valley, Hampshire, Center, Elk River, Deep Creek, and Spring Rock Townships and are more or less numerous in other parts of the county. The population of Washington, Berlin, Waterford, Liberty, and a part of Welton Townships is largely Irish, while that of the remainder of the county, excepting Olive Township, in which Norwegians and Danes constitute by far the greater part of the population, is predominantly English.

The population of Clinton County in 1910 was 45,394, an increase of about 1,500 over that of 1900. Of this number 25,577 are classed as urban and 19,817 as rural. The population is well distributed over the county.

Clinton, the county seat, is the largest town in the county. Its population is reported in the 1910 census as 25,577. It is a commercial center and one of the important manufacturing cities of the

State. Lyons, the first established city in Clinton County, has been made a part of Clinton. Dewitt, centrally located and formerly the county seat, is a thriving town of somewhat over 1,600 population. Camanche, Lost Nation, Wheatland, Delmar, Charlotte, and Grandmound are among the larger of the towns, and small trading centers and villages are distributed throughout the county.

Transportation facilities are good in all parts of the county. The main lines of two important railways traverse the county. The double-track line of the Chicago & North Western Railway to Chicago, Omaha, and other points enters the county at Clinton and extends almost due west through the county. This was the first railroad built in the county, being constructed in 1858. The double-track line of the Chicago, Milwaukee & St. Paul Railway which extends westward from Chicago enters the county from the north at Browns and passes through the northwestern part. A branch line of the latter enters the county at the northeastern corner and extends southward along the Mississippi River. South of Clinton the tracks of this line are used jointly with the Chicago, Burlington & Quincy Railroad, which crosses the river at Clinton. A short line, connecting the main line of the Chicago, Milwaukee & St. Paul with a branch, runs from Elk River Junction through Teeds Grove, meeting the main line just northeast of Browns. Another branch of the same railroad enters the county northeast of Delmar and passes southward through the center of the county, and still another crosses the southwestern corner. Clinton is the eastern terminus of a branch line of the Chicago, Rock Island & Pacific Railway which passes along the southeastern corner of the county. A branch line of the Chicago & North Western enters Clinton County from the northwest, passing eastward to the Mississippi, then southward to Clinton. The Iowa & Illinois Railway operates an electric line between Clinton and Davenport. Few points in the county are situated more than 6 miles from a railway station.

There is an extensive system of public roads in the county, and most of the roads are kept in good condition. Gravel is used almost exclusively for surfacing, especially in the southern part of the county, where pits containing a good quality of gravel are numerous. The transcontinental Lincoln Highway enters the county at Lyons and crosses it from east to west. All parts of the county are supplied with rural mail delivery, and the telephone is in general use. Rural schools and churches are conveniently located throughout the county. Several electric transmission lines extend through various parts of the county and supply current for both light and power.

Clinton is the principal local market for farm, truck, and dairy products, with Davenport next in importance. Chicago, about 140 miles from the county, is the most important outside market for stock and general farm crops. Stock is shipped also to Kansas City and Omaha.

## CLIMATE.

The climate of Clinton County is temperate and healthful, and well suited to agriculture. While hot and sultry periods are experienced in the summer months and periods of rather severe weather in the winter, these periods are rare and of short duration. Hailstorms are unusual, and rains of torrential character are infrequent. Droughts of varying duration sometimes occur in the summer, but the character of most of the soils in the county is such that with proper cultivation crop injury or loss from this source is easily prevented.

The mean annual precipitation, according to the records of the Weather Bureau station at Clinton, covering a period of more than 40 years, is about 36 inches, which is ample for the needs of all the crops grown. Nearly two-thirds of the rainfall occurs in the months April to August, inclusive, when it is most needed for crop growth. It is generally well distributed, and occurs as local showers or slow and moderate rains. The average precipitation of the fall months is low, making conditions for harvesting favorable. There is considerable snowfall, and the snow is sometimes blown in deep drifts, causing delays in traffic. Sudden thaws in the early spring sometimes cause dirt roads to be impassable. Winds are prevailingly from the northwest. In long stretches of prairie trees are set out in places to provide artificial windbreaks. The topography has no important influence on the climate of the county, except that the valleys afford protection from the wind and the hilltops are sometimes swept clear of snow, permitting the freezing out of the winter crops.

No temperature records are available for the station at Clinton. The mean annual temperature, as recorded at the Weather Bureau station at Davenport, is about 49° F. At this station the average date of the first killing frost in the fall is October 13 and of the last in the spring April 22, giving an average growing season of 174 days. The date of the earliest killing frost in the fall is September 18 and that of the latest in the spring is May 22. In an ordinary season farm crops are sufficiently matured to escape damage by the light early fall frosts.

Following is a table showing the normal monthly, seasonal, and annual temperature, with absolute maximums and minimums, as recorded at Davenport, Scott County, Iowa, and the normal monthly, seasonal, and annual precipitation, with total amounts for the wettest and driest years, at Clinton:

*Normal monthly, seasonal, and annual precipitation at Clinton and temperature at Davenport.*

| Month. | Temperature at Davenport. | | | Precipitation at Clinton. | | | |
|---|---|---|---|---|---|---|---|
| | Mean. | Absolute maximum. | Absolute minimum. | Mean. | Total amount for the driest year (1901). | Total amount for the wettest year (1869). | Snow, average depth. |
| | ° *F.* | ° *F.* | ° *F.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* |
| December | 27.6 | 65 | −22 | 1.82 | 0.88 | 2.70 | 3.5 |
| January | 21.4 | 63 | −27 | 1.89 | 1.35 | 1.65 | 7.2 |
| February | 24.0 | 67 | −25 | 2.06 | 1.40 | 5.31 | 10.5 |
| Winter | 24.3 | 67 | −27 | 5.77 | 3.63 | 9.66 | 21.2 |
| March | 35.5 | 82 | − 8 | 3.02 | 3.86 | 1.65 | 5.9 |
| April | 40.1 | 87 | 14 | 3.00 | .80 | 4.71 | .8 |
| May | 61.1 | 90 | 29 | 4.67 | 1.72 | 4.60 | 0 |
| Spring | 45.6 | 90 | − 8 | 10.69 | 6.38 | 10.96 | 6.7 |
| June | 70.2 | 98 | 39 | 4.42 | 3.17 | 5.80 | 0 |
| July | 75.1 | 106 | 49 | 4.19 | 4.26 | 6.45 | 0 |
| August | 72.8 | 98 | 44 | 3.69 | .48 | 8.45 | 0 |
| Summer | 72.7 | 106 | 39 | 12.30 | 7.91 | 20.70 | 0 |
| September | 65.4 | 99 | 28 | 3.27 | 2.52 | 4.00 | 0 |
| October | 53.4 | 90 | 17 | 2.35 | .81 | 1.50 | .5 |
| November | 38.5 | 78 | −10 | 1.87 | .82 | 2.15 | 2.8 |
| Fall | 52.4 | 99 | −10 | 7.49 | 4.15 | 7.65 | 3.3 |
| Year | 48.8 | 106 | −27 | 36.25 | 22.07 | 48.97 | 31.2 |

## AGRICULTURE.

The early agriculture of Clinton County was similar to that practiced in the regions to the east from which the pioneers migrated to this section. Corn and wheat were the chief crops, oats, barley, and rye also being grown, but to a far less extent. The prairies in their native condition furnished luxuriant pasturage, and the raising and feeding of cattle, to which a large part of the grains produced was fed, became an important industry. The development of improved machinery made it possible to cultivate larger acreages and to harvest and thrash the crops. More of the land was made to produce crops, and the acreage devoted to pasturage was diminished; as a result the feeding of locally raised cattle decreased. Hog raising gained in importance, as little pasturage was required for this purpose and the corn produced could easily and profitably be used for feeding.

The early statistics of the county show 19,008 acres of improved land in 1850, as against 391,365 in 1880. The production of wheat is reported in 1850 as 61,945 bushels, and in 1880 as 411,522 bushels. A total of 94,050 bushels of corn is reported in 1850, with 5,885,760

bushels in 1880, the latter being probably the high mark for corn production in the county. These figures show the extensive development of agriculture from 1850 to 1880, and the importance of wheat and corn. No mention of oats is made in the earlier statistics covering the county, but in the 1880 census a yield of 1,279,070 bushels is reported, with 32,015 bushels of rye, and 241,771 of barley. Potatoes constituted the chief special crop, a production of 191,395 bushels being reported in the 1880 census.

The present agriculture of Clinton County may be divided into two classes; first, that in which hog and cattle raising is the major farming pursuit; and, second, that in which grain farming is the main object, with hog and cattle raising of secondary importance. Roughly the boundaries between the areas in which these two classes of farming prevail are coincident with the boundaries between the areas of loessial and glacial soils in the county. This line may be roughly described as extending from the south limits of the village of Lost Nation, through points several miles south of Welton and Elvira, and about 1 mile north of Camanche, the loessial soils of the county occurring largely north of this line. Leaving out of consideration the alluvial soils of the county, it will be found that Bloomfield, Brookfield, Deep Creek, Elk River, Hampshire, Lincoln, Spring Valley, and Waterford Townships are made up of loessial soils, and that Berlin, Camanche, Dewitt, Eden, Olive, and Orange Townships are made up largely, if not entirely, of glacial soils, while in Center, Liberty, Sharon, Spring Rock, Washington, and Welton Townships these general groups of soils occur in varying proportion. The loessial belt as a whole, taking into consideration its generally rolling character, the steep and eroded nature of the areas along the larger streams, and the originally large forested tracts, is less well adapted to a system of intensive general farming than are the glacial soils in the southern part of the county, which are gently rolling to nearly flat in topography, and were almost entirely prairie in their native condition. Therefore the character of the topography largely accounts for the greater development of the animal industry in the northern part of the county.

The table on page 15 shows the status of the agriculture of Clinton County on January 1, 1915, by townships. It is compiled from data furnished by the Executive Council, Des Moines, Iowa, the figures being gathered by the township assessors in compliance with Iowa law.

The largest number of hogs per farm in the county is found in Elk River, Deep Creek, Center, and Hampshire Townships, and in a large number of cases the smallest number per farm is in townships made up of glacial soils. Similarly it is found that the average per farm of cattle is mainly greater in townships made up entirely or

*Acreage and yield of crops in Clinton County, 1914, with numbers of live stock on farms, January 1, 1915.*

| Townships.[1] | Number of farms. | Total acres rmed. | Corn. | | Wheat. | | Oats. | | Barley. | | Rye. | | Tame hay.[2] | | Wild hay. | | Alfalfa. | | Hogs on farms Jan. 1, 1915. | Milch cows on farms Jan. 1, 1915. | Other cattle on farms Jan. 1, 1915. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | *Acres.* | *Bushels.* | *Acres.* | *Bush.* | *Acres.* | *Bushels.* | *Acres* | *Bush.* | *Acres.* | *Bush.* | *Acres.* | *Tons.* | *Acres.* | *Tons.* | *Acres.* | *Tons.* | | | |
| Berlin | 123 | 22,376 | 7,088 | 329,350 | 292 | 5,517 | 2,346 | 68,670 | 842 | 23,650 | 242 | 3,605 | 2,431 | 3,067 | 457 | 469 | 20 | 26 | 5,202 | 764 | 2,801 |
| Bloomfield | 141 | 22,069 | 6,901 | 378,190 | 57 | 897 | 3,019 | 88,195 | 213 | 5,760 | ..... | ..... | 3,688 | 5,219 | ..... | ..... | 4 | 10 | 4,350 | 815 | 2,989 |
| Brookfield | 113 | 19,353 | 5,849 | 308,390 | 197 | 4,268 | 2,219 | 64,110 | 189 | 4,800 | 72 | 750 | 3,513 | 4,378 | ..... | ..... | 5 | 10 | 2,903 | 722 | 2,185 |
| Camanche | 98 | 13,638 | 3,923 | 177,770 | 93 | 2,635 | 1,186 | 33,675 | 346 | 7,232 | 146 | 2,330 | 1,847 | 2,486 | 211 | 259 | 17 | 42 | 3,212 | 997 | 1,655 |
| Center | 151 | 26,461 | 8,176 | 421,630 | 145 | 3,185 | 2,196 | 68,000 | 1,270 | 33,177 | 42 | 460 | 4,223 | 5,385 | 133 | 165 | 18 | 50 | 7,509 | 966 | 3,915 |
| Deep Creek | 124 | 23,302 | 6,006 | 326,770 | 166 | 3,375 | 2,142 | 69,905 | 563 | 16,180 | 5 | 100 | 3,719 | 4,811 | 90 | 155 | 4 | 16 | 10,116 | 687 | 3,815 |
| De Witt | 199 | 30,084 | 10,698 | 475,795 | 192 | 4,755 | 3,080 | 99,693 | 341 | 10,250 | 119 | 1,700 | 3,872 | 4,682 | 231 | 337 | 23 | 84 | 6,034 | 1,233 | 2,864 |
| Eden | 117 | 19,469 | 5,700 | 262,740 | 121 | 2,535 | 1,983 | 64,010 | 497 | 12,454 | 75 | 1,025 | 2,700 | 3,169 | 41 | 49 | 22 | 67 | 3,802 | 751 | 3,423 |
| Elk River | 162 | 25,996 | 6,796 | 369,385 | 195 | 3,710 | 3,059 | 95,240 | 587 | 18,550 | 79 | 1,472 | 4,783 | 5,558 | 212 | 202 | 14 | 70 | 14,175 | 1,285 | 3,976 |
| Hampshire | 123 | 18,104 | 4,300 | 181,870 | 382 | 8,700 | 2,150 | 62,732 | 580 | 16,060 | 6 | 90 | 3,286 | 3,247 | ..... | ..... | ..... | ..... | 5,299 | 801 | 1,689 |
| Liberty | 114 | 21,617 | 5,690 | 247,685 | 32 | 560 | 2,206 | 63,135 | 142 | 3,325 | 288 | 4,243 | 2,414 | 2,425 | 248 | 264 | ..... | ..... | 4,634 | 819 | 2,135 |
| Lincoln | 85 | 10,441 | 2,708 | 142,530 | 33 | 1,000 | 622 | 20,465 | 338 | 9,650 | 23 | 500 | 1,844 | 2,389 | ..... | ..... | 18 | 37 | 2,662 | 633 | 1,122 |
| Olive | 184 | 25,549 | 9,425 | 410,190 | 380 | 7,500 | 4,219 | 144,220 | 191 | 6,005 | 94 | 1,407 | 2,870 | 2,856 | 560 | 596 | 5 | 25 | 5,916 | 964 | 2,752 |
| Orange | 118 | 18,174 | 5,937 | 245,017 | 235 | 4,133 | 1,952 | 58,995 | 365 | 7,854 | 137 | 2,124 | 2,304 | 2,317 | 281 | 332 | 22 | 18 | 1,412 | 688 | 1,582 |
| Sharon | 140 | 21,984 | 6,220 | 286,075 | 246 | 4,564 | 2,546 | 62,741 | 205 | 5,361 | 27 | 446 | 4,304 | 4,153 | 54 | 58 | 3 | 7 | 5,623 | 994 | 2,407 |
| Spring Rock | 122 | 18,283 | 5,027 | 240,520 | 109 | 2,294 | 1,887 | 55,325 | 272 | 6,556 | 72 | 1,190 | 2,823 | 3,573 | 155 | 170 | 2 | 4 | 3,967 | 804 | 2,631 |
| Spring Valley | 67 | 5,694 | 919 | 45,340 | 60 | 982 | 574 | 17,090 | 44 | 1,135 | 8 | 184 | 979 | 1,158 | 490 | 648 | 16 | 75 | 815 | 325 | 416 |
| Washington | 97 | 18,214 | 5,587 | 264,900 | 30 | 545 | 1,918 | 51,665 | 375 | 9,180 | 32 | 580 | 3,579 | 3,925 | ..... | ..... | 4 | 7 | 3,742 | 683 | 2,425 |
| Waterford | 111 | 18,247 | 3,971 | 187,365 | 100 | 1,417 | 2,091 | 58,532 | 173 | 3,612 | 20 | 400 | 3,648 | 3,786 | ..... | ..... | 1 | 3 | 1,926 | 1,035 | 1,738 |
| Welton | 124 | 19,272 | 6,482 | 334,720 | 100 | 1,699 | 2,128 | 61,923 | 540 | 14,506 | 3 | 50 | 2,810 | 3,486 | 52 | 60 | 1 | 1 | 5,105 | 703 | 2,737 |
| Clinton [3] | 28 | 1,354 | 453 | 17,760 | ..... | ..... | 77 | 2,960 | 45 | 1,400 | 20 | 500 | 315 | 349 | 8 | 14 | 3 | 7 | 225 | 189 | 177 |
| Total | 2,541 | 399,681 | 117,856 | 5,653,992 | 3,165 | 64,271 | 43,600 | 1,311,281 | 8,118 | 216,597 | 1,510 | 23,156 | 61,952 | 72,419 | 3,223 | 3,778 | 202 | 559 | [4] 98,629 | 16,858 | [5] 49,434 |
| Average per acre | ..... | ..... | ..... | 47.9 | ..... | 20.3 | ..... | 30.8 | ..... | 25.5 | ..... | 15.3 | ..... | 1.17 | ..... | 1.17 | ..... | 2.77 | ..... | ..... | ..... |
| Average per farm | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 38.8 | 6.6 | 19.4 |

[1] Townships include incorporated villages within their borders.

[2] Includes clover, timothy, millet, and Hungarian-grass acreage for county, being 12,137, 49,530, and 285; the total yield, 15,022, 56,944, and 453 tons; and the average yield per acre 1.24, 1.15, and 1.59 tons, respectively.

[3] Clinton Township includes Clinton and Lyons.

[4] Includes 17,816 swine under 6 months old.

[5] Includes calves under 1 year, 17,722; steers 1 year and under 2, 8,861; steers 2 years and under 3, 9,664; steers 3 and over, 959; bulls 1 and over, 1,449; heifers 1 and under 2, 6,516; cows not kept for milk, 2 and over, 4,263.

largely of loessial soils, Deep Creek, Elk River, Center, and Washington Townships leading. Eden Township is an exception, ranking second in the average number of cattle per farm. It is found that a greater percentage of the total acres farmed is devoted to grain crops in the townships consisting entirely or largely of the glacial soils, Olive, Orange, Berlin, and Welton Townships leading in this respect.

The chief changes in the agriculture of the county from 1880 to the present time are (1) an important development of the animal industry, this, according to local information, being more rapid some years ago when the profits were larger, and (2) a marked decrease in wheat production, the area in this crop being reported in 1880 as 38,372 acres, and in 1890 as 2,779 acres, with very little change in the acreage since that time. This decrease was due, according to local information, to the low acreage yields obtained and the ravages of various parasitic and insect pests. Hay and oats show gains in acreage from 1880 to 1890 sufficient to offset the reduction in wheat acreage.

Corn is by far the most important crop in Clinton County, and has been ever since agriculture has been firmly established. The present acreage is twice as large as that occupied by the other cereal crops. The census statistics of 1880 report 129,544 acres in corn, with an average yield of about 45 bushels per acre. The 1910 census reports 121,879 acres in this crop, with a slightly lower acreage yield, an average of 44 bushels per acre. In 1914, according to the table above, 117,856 acres were devoted to corn, producing 5,653,992 bushels, or an average of about 48 bushels per acre for the county. Dewitt, Center, and Olive Townships lead in total corn production. Notwithstanding this large yield, statistics furnished by the railway lines traversing the county[1] indicate that it was necessary to import about 2,800 carloads of corn in 1914, while only 510 carloads were shipped out of the county, the crop being fed to beef cattle and hogs. The northeastern part of the county does not produce enough corn for its needs, while the southern and central sections produce a slight excess. Reeds Yellow Dent is the most popular variety, some Silver Mine, Boone County White, and other varieties being less popular.

Oats rank next in importance of the cereal crops, the acreage having increased from 1880 to 1890, while that of wheat decreased. In the 1880 census 34,158 acres are reported in oats; in 1890, 53,345 acres; in 1890, 59,673 acres; and in 1910, 41,199 acres. In 1914 oats were reported on 43,600 acres. The 1914 production is given as

[1] Figures furnished by the freight-traffic department, Chicago & North Western Railway Co.; general-freight department, Chicago, Milwaukee & St. Paul Railway Co.; traffic department, Chicago, Burlington & Quincy Railroad Co.; and general-freight department, Chicago, Rock Island & Pacific Railway Co.

1,311,281 bushels. Railway statistics show that only about 10 per cent of the 1914 yield was exported, the remainder being fed to stock. Olive, Dewitt, and Elk River Townships lead in oat production. Silver Mine, Early Champion, and Swedish Select are the most popular varieties, probably ranking in the order named.

Barley occupies the next largest acreage of the cereals produced, yet its total acreage in 1914 was only 8,118, with a production of 216,597 bushels. In 1880 barley is reported on 11,830 acres and in 1890 on 3,968 acres. The acreage decreased to 3,259 in 1900, and the crop is reported on 9,924 acres in the census of 1910. Silver King probably is the leading variety.

The acreage in wheat, which ranked next to corn in importance up to 1880, decreased from 38,372 acres in 1879 to 2,779 acres in 1889. Wheat is reported on 2,771 acres in the 1900 census and on 2,823 acres in the 1910 census. The production in 1914 was 64,271 bushels from 3,165 acres. Only 10 to 15 per cent of the crop is spring wheat. Of the winter wheat, Turkey Red is the favorite variety throughout the county. The present production is inadequate to meet local needs, railway statistics showing that more than 50,000 bushels of wheat are imported into the county every year, in addition to large quantities of flour. Washington Township is said to have been the wheat center of the county prior to 1880, and Wheatland village is said to have derived its name from the large acreage devoted to this cereal in that vicinity.

Very little rye is grown at present in Clinton County, and according to the census reports it has never been very popular. Its most extensive production was from 1890 to 1900. In the census of 1880 it is reported on 1,653 acres, in 1890 on 2,604 acres, and in 1900 on 3,267 acres. Only 1,102 acres are reported in the 1910 census, and 1,510 acres are reported in 1914, with a total yield of 23,156 bushels.

The 1910 census reports 66,288 acres in tame or cultivated grasses, with a yield of 112,231 tons of hay. Of this about 29 per cent was timothy alone, 3 per cent clover alone, 65 per cent timothy and clover mixed, and 3 per cent millet or Hungarian grass. In addition to this, wild hay was cut from 2,288 acres, producing 3,279 tons, and coarse forage from 2,253 acres, with a production of 11,562 tons. The acreage devoted to hay production in 1914 does not differ greatly from that of 1909. Elk River Township, which leads in the average number of cattle per farm, also leads in the production of hay. A little over one-half the area farmed in Clinton County was devoted to hay and pasturage in 1913. The hay and forage is consumed within the county, railway statistics showing the annual exports from the county to be less than 500 tons. The acreage devoted to alfalfa is very small, but is increasing rapidly.

Of ensilage, 6,775 tons are reported cut in 1914, Camanche, Lincoln, and Olive Townships leading. More than 30 per cent of the ensilage was cut in Camanche Township. It is used for feeding dairy stock.

The total acreage of grasses grown for seed in the county is comparatively small. Clover leads with 1,282 acres in 1909, averaging about 1⅓ bushels per acre. Timothy was grown for seed on about 600 acres, producing 2,361 bushels, an average of slightly less than 4 bushels per acre. In the north-central part of the county some attention is given to the growing of sweet clover. It is estimated that about 250 acres were devoted to this crop in 1915. Yields are locally estimated at 3 to 10 bushels per acre, averaging probably about 5 bushels per acre. Sweet clover is considered a soil renovator and is used as a cover crop on hillsides to prevent erosion, and as a pasturage and hay crop.

Irish potatoes are the most important special crop of the county, the production in 1909 from 1,584 acres being 149,425 bushels. The potatoes are consumed at home or sold at local markets. Some sweet potatoes are grown on the sandy soils in the vicinity of Camanche. Here also some attention is paid to the production of strawberries, and watermelons and cantaloupes are grown in a small way. These are disposed of mainly at local markets. There are some peach orchards and vineyards in this section, and peaches and grapes are grown for home use throughout the county. In general, apples and cherries are the predominating fruits in the county, plums and peaches being of secondary importance. Commercial fruit growing is not practiced to any extent, except in the vicinity of Dewitt.

The importance of the animal industry in Clinton County is indicated by the fact that more than one-half the farmed area of the county is devoted to pasturage and the production of hay and forage, and that for its maintenance the industry demands corn in excess of the large production within the county, together with a large part of the other grains produced. Of the various phases of this industry work stock for use and sale, including horses and mules, ranks first in value; cattle for beef and other purposes second; swine, third; dairy stock, fourth; and sheep, fifth. The values of these different classes on January 1, 1915, according to county statistics, were, respectively, $1,437,067, $1,292,188, $790,389, $606,007, and $14,880. The numbers of these classes reported are, respectively, 18,233, 49,434, 98,629, 16,858, and 3,879. Ranked according to value, work stock and beef cattle are said to change positions during the summer and fall months while cattle feeding is at its height. As a rule, a large percentage of feeders has been marketed by January. The value of the animal industry increased greatly from 1880 to 1910, the valuation for 1915 being somewhat less than that reported in 1910.

The value of live stock in the county is reported in the 1880 census as $2,616,994. In the 1890 census the value of domestic animals on farms is given as $3,332,430. In the 1900 census the value of domestic animals, including poultry and bees, is reported as $3,959,715, and in 1910 it is given as $5,699,364. According to the county statistics the value of domestic animals was $4,304,524 in 1915.

The following table, compiled from the 1910 census, indicates the relative value of farm products in Clinton County:

| | |
|---|---|
| Cereals | $3,532,399 |
| Other grains and seeds | 9,048 |
| Hay and forage | 1,134,190 |
| Vegetables | 125,539 |
| Fruits and nuts | 46,552 |
| All other crops | 76,376 |
| Live stock and products: | |
| Animals sold and slaughtered | 3,738,030 |
| Dairy products, excluding home use | 626,117 |
| Poultry and eggs | 387,634 |
| Wool, mohair, and goat hair | 4,422 |
| Total value | 9,680,307 |

The horses and mules in the county are mainly of the heavy draft type necessary for the agriculture practiced. The desirability of mules as work stock is becoming recognized and they are being used in larger numbers. The percentage of horses and mules raised for sale is comparatively small, shipments being made mainly to neighboring States. Little attention is paid to improved breeding in the county.

While at one time the extensive natural-prairie pasturage in the county permitted the raising of all the cattle sold for beef, it is estimated that at present from 70 to 80 per cent of the beef cattle sold are shipped in as feeders. There are some purebred herds of beef cattle in the county, mainly Shorthorns, Herefords, and Aberdeen Angus (see Pl. I, fig. 1). Most of the cattle, however, are grades. Chicago and Omaha are the chief cattle markets.

Dairying is relatively unimportant in the county. Creameries are maintained at Clinton, Dewitt, Wheatland, and Toronto. Clinton and Dewitt constitute the local markets for milk. Some large dairy herds are found in the vicinity of the former place. Considerable cream is shipped out of the county. The dairy herds consist mainly of graded stock, with some purebred Holstein and Jersey animals. According to county statistics the value of dairy products for 1914 is $644,428.

Hog raising is a very important and popular phase of the animal industry of the county. But little pasturage is required for its maintenance. While the ravages of hog cholera in recent years have

caused large losses, the control of this disease through vaccination is causing much more interest to be taken in the hog industry. Many purebred hogs are kept in the county, though most of the herds consist of grade animals. Poland China, Duroc Jersey, Chester White, and Hampshire are the leading breeds, ranking in about the order named.

The sheep industry of the county is comparatively unimportant, only small flocks being kept and on comparatively few farms.

While no particular attention is given to poultry raising as a separate industry, chickens, geese, turkeys, and ducks are kept on most of the farms in the county, and the total value of poultry on January 1, 1915, is reported as $163,978. Eggs produced in 1914 amounted to 1,345,160 dozen, valued at $240,603.

The farmers of Clinton County recognize the Muscatine silt loam and the Carrington silt loam in their natural condition as best suited to the production of corn, and under good drainage conditions the Clyde silt loam, the Clyde silty clay loam, and the silt loam of the Bremer series are favored for this crop. The Memphis silt loam and Carrington loam also are popular for corn, though the greater part of these soils is probably used for small grains and for pasturage and hay crops. The sharply rolling areas of the Memphis silt loam, where erosion occurs, and the forested areas are used for pasturage. The soils of the Wabash, Sarpy, and Cass series are mainly used for pasturage, especially where subject to frequent overflows, and hence unsuited to crop production. The light soils of the Buckner series at Camanche are used mainly in the production of truck and special crops. Farmers on areas of the Carrington fine sand and fine sandy loam, which are inclined to drift, recognize the necessity of keeping the land covered as much of the time as practicable, and they are used mainly for pasturage. When cultivated they are devoted mainly to rye, which does well on the lighter soils.

Modern methods are followed by the farmers of Clinton County to effect an improvement in the agriculture. Formalin solutions are used to treat oats in the prevention of smut, and results are said to be good. Seed selection is also practiced, especially in the case of corn, and germination tests are made in some instances before planting. Vaccination against hog cholera has proved popular, and the loss in 1914 was only 50 per cent of that reported in 1913, in which year more than 20,000 hogs were lost in the county. The steeper slopes are mainly kept seeded to cover crops or left in pasture to avoid damage by erosion, and dams of stone and concrete and other means are used to prevent the formation of large gullies and to save the large quantities of sediment lost through wash. Rape is intertilled with corn for forage, and the practice of "hogging down" corn in the fields by sections is quite common. The value of tile

drainage in the flat areas is appreciated, and large areas are being tiled. In an effort to learn the varieties of grains best suited to the different soils, and the treatment through which the largest yields may be obtained, experimental plots have been established in different parts of the county by a farmers' cooperative organization. In some sections of the county cow-testing associations have been formed in an effort to make the dairy industry more profitable, and there are several other organizations working toward a more profitable agriculture in its various branches in the county. A county agricultural fair is held annually at Dewitt, and short courses in agriculture are given at that place in the winter under the auspices of the farmers' cooperative organization.

Farm buildings are generally substantially built and of modern construction, and are kept painted and in good repair. The dwellings are well equipped, some with running water, electric or gas lights, and telephones, and have well-kept lawns and gardens. The barns are large, with ample space for the storage of farm products and machinery. Many are built with stone basements for the protection of cattle and work stock from the severe winter weather. The fences are very good, many of them of woven wire.

The work stock consists mainly of heavy draft horses, with some mules. The machinery of the farm includes walking, sulky, and disk plows, straight and spring-tooth harrows, cultivators, grain drills and seeders, corn planters and harvesters, binders, mowing machines, rakes, tedders, hay loaders, and wagons. Slings and hay forks are found in almost every barn. Cream separators are common in the dairy sections, and the gasoline engine is in general use on farms throughout the county. Thrashing machines, clover hullers, corn huskers, and hay-pressing and wood-cutting outfits travel about the county serving the farmers.

Thorough cultivation is of primary importance in the agriculture of the county, and fall plowing is generally practiced, the land being tilled to a depth of 5 to 8 inches. A good tilth is secured by dragging and harrowing before seeding. Corn is cultivated 3 or 4 times or more, depending on the season and moisture conditions. Crop rotations are recognized throughout the county as necessary to the maintenance of the productiveness of the soils. Generally some definite system is employed. The most popular of these systems is one covering 5 years, corn being grown for 2 years, small grain, seeded with grass, 1 year, followed by hay and pasturage for 2 years. This is sometimes reduced to a 4-year rotation by having the field in hay or pasturage only 1 year. It is frequently increased to 6 years by growing an additional crop of corn. A few farmers practice a rotation covering 7 years, consisting of corn 3 years, small grain 1 year or 2 years, and grass 2 or 3 years.

Experiments with commercial fertilizers in the county have shown them to be unprofitable. All the manure produced on the farm is applied to the land for fertilizing purposes, additional quantities being obtained from the cities. Lime is generally used where the soils are acid, particularly where alfalfa and sweet clover are to be grown, and has been applied in a few cases with good results for the general farm crops. The application is generally from 2 to 4 tons of finely crushed limestone per acre.

The local supply of farm labor about meets the ordinary demand, though it is necessary to bring in laborers in the haying, harvesting, and corn-husking seasons. The farm labor consists mainly of American-born white men. The census of 1910 shows the average expense for farm labor to be $306.33 per farm, making a total expenditure of $466,840 for the county. Farm laborers are paid $30 to $45 a month, with room and board. Day laborers are paid $1.50 to $2 per day, except during harvest time or when labor is scarce, when $2.50 is frequently demanded. When paid by the bushel corn huskers receive from 2½ to 4 cents, depending on the crop. As high as 5 cents was paid during the season of 1915, owing to the poor crop and the scarcity of labor.

The average size of the farms is reported in the census of 1910 as 148.9 acres. The farms, however, vary greatly in size, ranging from 40 acres, which, aside from small patches near the cities and villages, is about the minimum, to 400 acres or more, the largest tracts generally occurring in the wide river bottoms and consisting of pasture lands. Most of the farms range in size from 80 to 200 acres. There has been no marked change in the average size of the farms of the county since 1880, at which time it is reported as 152 acres.

The percentage of farms operated by tenants in Clinton County increased steadily from 24 per cent in 1880 to 39 per cent in 1900. In 1910 the percentage is reported as 38.6, practically all the remainder of the farms being operated by the owners. County statistics for 1914 show that 46.6 per cent of the cultivated acreage of the county is leased and that only 14.2 per cent of the leased acreage is farmed on a share basis. Cash rent for farm land varies from $4 to $8 or more per acre, depending mainly on the character of the land and the improvements. Share rents vary from one-third to one-half the cultivated crop. Pasture lands on farms rented on a share basis are generally rented for cash. The large areas of pasture land in the Wapsipinicon and Mississippi bottoms are leased for cash, the rent being rated either per head of cattle by the month or season or per acre. Where a charge per head is made the rate ranges from 75 cents to $1 a month, or from $3 to $4.50 a season. Where an acreage charge is made it varies from $1.50 to $2.50.

Land values depend upon the nature of the soil, condition of the buildings and other improvements, drainage, elevation with regard to streams in the case of alluvial lands, acreage improved, location with regard to cities and markets, and other factors. In the northern part of the county land values range from $133 to $250 an acre. First-bottom lands subject to overflow are valued at $50 to $100 an acre, and where never or rarely overflowed at $100 to $175 an acre or more. The presence of the sandy areas in the western part of the county is considered to decrease the value of the lands, the amount of depreciation depending on the extent of such areas. Values range from $40 to $100 or slightly more an acre. The value of land in the drainage areas north and east of the Wapsipinicon River varies mainly according to soil conditions and the effectiveness of the drainage. It ranges from $100 to $150 an acre. The soils in the glacial belt are valued at $150 to $225 an acre. The value of the sandy soils at Camanche depends upon the use to which the land is put, the strawberry soils commanding high prices. Around Clinton the value of the land is enhanced by its location near markets, and in some cases it has a speculative value.

The average value of farm land in the county is reported in the 1910 census as $86.73 an acre, which is a decided increase over the value in 1900, reported as $46.36 an acre. In many cases land is said to have doubled and in some cases to have trebled in value in the last 10 to 15 years.

## SOILS.

Almost all the soils of Clinton County are derived through weathering from three classes of transported materials—loess, glacial drift, and alluvium.

The deposition of the loess is ascribed by most geologists to eolian agencies, its fine silty texture and the absence of coarse material indicating an origin different from that of the underlying coarse drift material. In the eastern and northwestern parts of the county, and in some cases along the edge of the Iowan drift, it is deeper than in the interior, where the drift occurs in some places within 3 feet of the surface in level areas and where the underlying limestone sometimes outcrops. The greater depth of the material along the Mississippi bluffs suggests that the source of the material is the bottoms of that river, from which it was transported by wind to the adjoining uplands. (See Pl. I, fig. 2). The loess in its original unweathered condition consists of a light-brown or buff-colored, even-grained material, composed largely of silt, with a small percentage of clay. It is loosely cemented and has a tendency to erode in perpendicular bluffs, often with a columnar structure. Although slightly coherent where undisturbed, it breaks up readily into a loose, floury

dust. The presence of a large percentage of lime in the lower subsoil would seem to indicate that the material was originally highly calcareous and that the upper soil has been leached of its lime to a large extent by percolating water. This material is extensively distributed over a vast area in the central States bordering the Mississippi River and its larger tributaries. The loess soils show considerable variation in different localities, dependent upon the age of the loess and the conditions under which weathering has taken place.

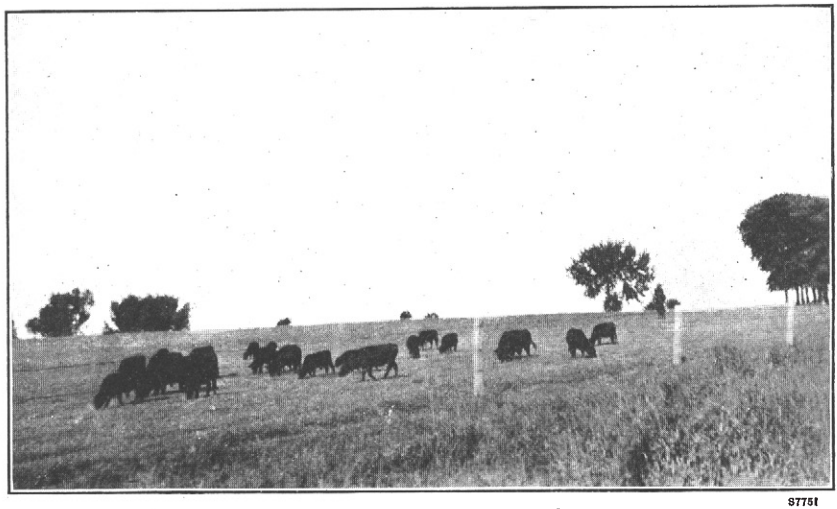
The loess of the more nearly level areas where the processes of weathering have not been interrupted by erosion has been modified in a marked degree. The most noticeable changes are the accumulation of organic matter as indicated by the black color of the surface soil and the concentration of clay in the subsoil, giving a compact structure. There has also been a leaching of the lime from the upper weathered zone. The black loessial soil has been mapped as the Muscatine silt loam.

In the rolling country bordering the Mississippi, where the loess is believed to be of more recent distribution and where its surface has been removed by erosion, the black surface soil has not yet developed, and a light-brown soil with a slightly lighter colored subsoil is encountered. Where a compact subsoil heavier in texture than the surface soil is present, this material is classed with the Memphis series.

On the loessial upland along the Mississippi there are ridges of sandy material deposited by wind action after the deposition of the loess. The presence of a small quantity of fine sand and very fine sand in the surface soil of the loessial upland areas adjacent to and back from the Mississippi River in the northern part of the county may also be due to the same agency, the material being derived from deposits of sand by the Mississippi River.

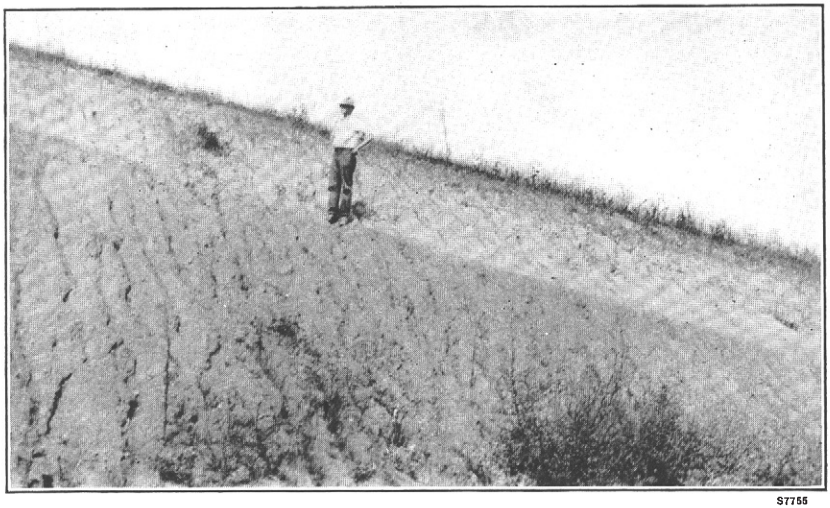
The glacial material of Clinton County represents two stages of deposition separated by long periods of time. The lower and older beds occasionally exposed in the uplands in the northern, eastern, and southwestern parts of the county are accredited to the Kansan stage of glaciation, while the plain of later deposition in the southern part of the county belongs to the Iowan.

The glacial drift material, beneath the loessial layer and the layer of silty material derived from the upper portion of the Iowan drift plain, is composed of a heterogeneous mass of sands, silts, and clays of various grades and containing rock fragments ranging in size from pebbles to large bowlders. In the north-central part of the county, especially, granite bowlders of sufficient size to protrude through a comparatively thick layer of loess occur, their depth in the underlying glacial drift, of which they are a part, being unknown. A large part of the rock fragments in the Kansan drift is composed



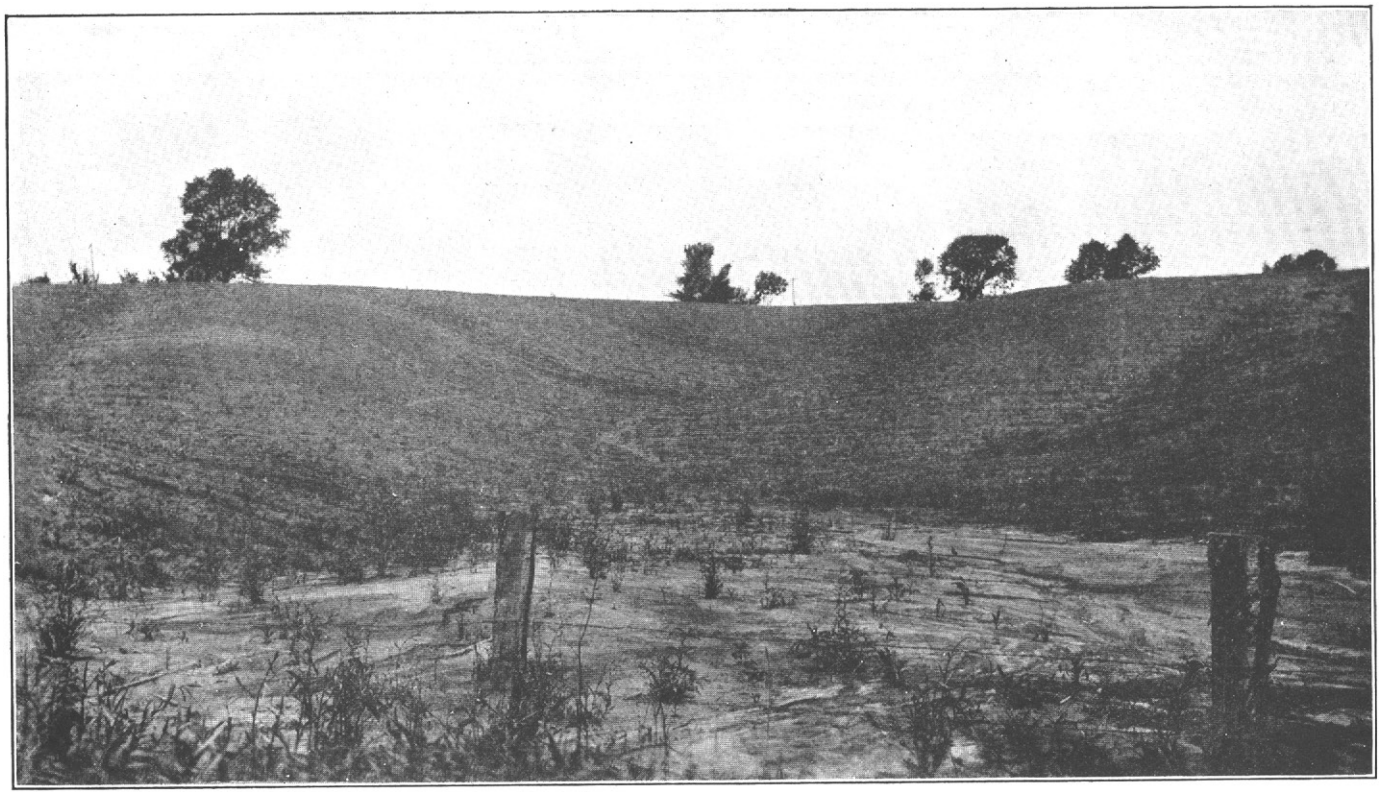
S7751

FIG. 1.—HERD OF ABERDEEN ANGUS CATTLE.



S7755

FIG. 2.—SECTION IN RAILROAD CUT EAST OF LOST NATION, SHOWING DISTINCT LINE OF DEMARCATION BETWEEN THE LOESS AND THE UNDERLYING KANSAN DRIFT, THE LOESS LAYER FOLLOWING THE CONTOUR OF THE RIDGE.



S7757

COLLUVIAL WASH, DUE TO RAINS, IN CULTIVATED AREAS OF THE MEMPHIS SILT LOAM.

of granite, greenstone, diabase, gabbro, quartzite, and dolomitic limestone. In the Iowan drift the rocks consist mainly of granite, gneiss, gabbro, diorite, quartzite, and dolomite. The fine material composing the Kansan drift, except in local occurrences of sand, is generally a loam to clay, which is also true of the Iowan, except for the extensive occurrence of sand in the vicinity of the Wapsipinicon River. The source of the material is not definitely known, but it is probably derived in large part from the limestones, sandstones, shales, and other rocks lying to the northwest of the area. The sand and gravelly material of the Kansan drift where exposed has entered largely into the composition of the Lindley silt loam. The Iowan drift has weathered into the black soils of the Carrington and Clyde series.

The underlying rocks of the area are limestones and shales of Paleozoic age. These formations are so deeply covered by transported materials that no large areas are exposed to weathering and no extensive soil type is derived from them. Narrow exposures occur along the deeper valleys, but in only a few areas are they of sufficient extent to be shown satisfactorily on the soil map. The Niagara limestone outcrops in various parts of the county, and in a few places small areas of the resulting stony land are mapped as the Union stony loam. Narrow exposures of the shale occur along the bluffs and in deeply cut stream valleys north of Clinton, but they have not weathered in areas of sufficient size to be mapped.

The alluvial soils adjoining the Mississippi and Wapsipinicon Rivers were laid down by those streams under conditions similar to those now prevailing, while the material in the Goose Lake channel and the valleys of Yankee Run, Prairie, Cherry, and some other creeks in the county is due largely to deposition by larger streams which are supposed formerly to have had their courses in these valleys. Only a comparatively small part of the alluvial material in these latter valleys can be ascribed to modern drainage, but there has been some influence due to the addition of sediments of small streams draining the uplands, and of colluvial wash from adjoining higher areas. The bottoms of the Mississippi are restricted in width at the north county line and above and below Clinton by the occurrence of the limestone bluffs and the upland; in other places they reach a width of 2 miles or more. One-half mile west of the western boundary of the county the Wapsipinicon emerges from a rock-bound channel, but in Clinton County it occupies a well-developed bottom ranging from one-half mile to 3 miles in width, except in a few places, where the upland infringes upon the stream. The greater part of the Goose Lake Channel varies from 1 mile to 2 miles in width, and the other old channels above mentioned vary from one-fourth to 1 mile in width.

The original source of a large part of the alluvial sediments lies in the drift sheets. The lighter soils are made up mainly of quartzitic material, while the heavier soils are composed mainly of the material derived from limestone and shale. The deposition of some of the alluvial material must have occupied a long period of time, that occurring in Yankee Run and some of the other valleys extending to an unknown depth.

The upland plains are dissected by stream valleys of preglacial and postglacial age, the width of the valleys and the amount of alluvial material in them depending mainly on the size of the streams and the length of time they have worked. This alluvial material occurs as first bottoms and terraces and is derived from the various drift sheets of Pleistocene age to the north and from the underlying Paleozoic sediments.

The soils of Clinton County are divided into series, the soils of each series having the same color and similar subsoils, the same topography and drainage, and a common origin. The soil types are separated on the basis of texture, or the relative percentage of clay, silt, and sand composing the soil material. Soils of silty character predominate in the county, the texture of nearly all the loessial upland and a large proportion of the drift-plain soils being a silt loam. The alluvial soils also are largely silt loams.

The series comprising soils of loessial origin are the Muscatine and Memphis and the Union, which is in part loessial; those including soils of glacial derivation are the Lindley, Carrington, and Clyde. The alluvial soils occurring on the terraces are classed with the Bremer, Buckner, and Calhoun series, while the overflow lands are mapped with the Wabash, Sarpy, and Cass series. The miscellaneous soils are classed as Muck and Riverwash.

The Muscatine series includes the dark-colored loessial upland soils. These soils are high in organic-matter content and are underlain by brown to yellowish-brown subsoils. Between the soil and subsoil there is generally a gradational layer of dark-brown to black material of slightly heavier texture than the surface soil. These lands were originally prairie. The Muscatine series is represented in Clinton County by one type, the silt loam, which occurs in extensive areas.

The types included in the Memphis soils have light-brown to yellowish-brown silty surface soils and compact, light-brown to yellowish-brown subsoils. They were originally forested. Two members of this series—the very fine sandy loam and silt loam—are mapped in Clinton County, the latter occurring in extensive areas.

The Lindley series includes soils typically yellowish brown in color, but ranging from gray on the one hand to brown on the other. They are usually shallow, not more than 8 inches deep, and rest on

a subsoil usually heavier than the soil, and yellowish to yellowish brown, sometimes reddish brown, in color. The topography is in most places rather rough. The silt loam is the only type of this series occurring in Clinton County.

The Carrington series comprises soils derived through weathering of the glacial till, with little or no modification by admixture of loessial material. The soils are of dark color, and the subsoils are brown or light brown, with yellowish brown sometimes occurring in the lower part of the 3-foot section. Four types are mapped in the county—the Carrington fine sand, fine sandy loam, loam, and silt loam.

The Clyde series includes dark-gray or dark-brown to black soils, with dark-drab or drab and yellow mottled subsoils. These soils are derived from glacial till, usually reworked and deposited in depressions and weathered under conditions of restricted drainage. The topography usually is almost flat, and natural drainage is poor. The Clyde silt loam and silty clay loam are found in this county.

The Bremer series comprises soils of dark-brown to black color, overlying dark-brown to black, heavy subsoils. There is a substratum of gray or drab material, mottled with brown and ocherous yellow. The silt loam is the only member of this series mapped in Clinton County. The material occurs in a terrace position and is of alluvial origin.

The Buckner soils are brown, with subsoils which are lighter in color and frequently lighter in texture. The Buckner fine sand and sandy loam are mapped in this county.

The Calhoun series includes soils of gray color, with subsoils heavy in texture, tenacious and waxy in structure, and of gray or drab color. The silt loam occurs in Clinton County. The material is alluvial in origin and occupies a terrace position.

The soils of the Wabash series have a dark-brown to black color and a high organic-matter content. They overlie subsoils of brown, drab or gray color. These soils occur in the first bottoms along the larger streams of the county. Four types are recognized—the loam, silt loam, silty clay loam, and silty clay.

The soils of the Sarpy series are similar to those of the Cass series, except in the color of the soil, these soils ranging in color from light brown to dark brown. The subsoils are light brown and are lighter in texture than the soil, often grading with increase in depth into sand or gravel.

The Cass series includes dark-brown to black soils, overlying subsoils of lighter color and texture. These soils occur in the first bottoms of streams, the material being alluvial in origin. Two types are encountered in Clinton County, the loam and silt loam.

The surface soils of the Union series are brown to grayish brown, with yellowish-brown, friable subsoils. These soils probably are of loessial origin, but they are shallow and overlie limestone. Only one type, the stony loam, is mapped in Clinton County.

Muck represents accumulations of well-decomposed and finely divided organic matter. The material is black and occurs generally in depressions and in low-lying, poorly drained situations along drainage ways.

Riverwash comprises the unconsolidated material, mainly of coarse texture, occurring in and along streams as sand banks and sand-bar islands. It is in process of deposition and subject to overflow.

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

*Areas of different soils.*

| Soil. | Acres. | Per cent. | Soil. | Acres. | Per cent. |
|---|---|---|---|---|---|
| Memphis silt loam | 129,088 | 29.2 | Wabash silty clay | 2,432 | 0.6 |
| Muscatine silt loam | 98,176 | 22.2 | Muck | 2,304 | .5 |
| Carrington silt loam | 75,456 | 17.1 | Carrington fine sand | 2,240 | .5 |
| Wabash silt loam | 31,680 | 7.8 | Buckner fine sand | 1,984 | .5 |
| Colluvial phase | 3,008 | | Wabash loam | 1,728 | .4 |
| Carrington loam | 22,912 | 5.2 | Sarpy sandy loam | 1,664 | .4 |
| Bremer silt loam | 15,424 | 3.7 | Buckner sandy loam | 1,472 | .3 |
| Light phase | 512 | | Cass loam | 832 | .2 |
| Heavy phase | 256 | | Memphis very fine sandy loam | 576 | .1 |
| Clyde silt loam | 15,616 | 3.5 | Union stony loam | 576 | .1 |
| Wabash silty clay loam | 8,640 | 2.0 | Riverwash | 448 | .1 |
| Clyde silty clay loam | 8,448 | 1.9 | Calhoun silt loam | 320 | .1 |
| Carrington fine sandy loam | 6,400 | 1.4 | Total | 442,240 | ..... |
| Cass silt loam | 5,504 | 1.2 | | | |
| Lindley silt loam | 4,544 | 1.0 | | | |

MUSCATINE SILT LOAM.

To a depth of 12 to 16 inches the soil of the Muscatine silt loam consists of a mellow, friable silt loam of dark-brown to nearly black color. In the eastern part of the county the soil contains small quantities of fine sand and very fine sand. On the crests of ridges in the type and on some of the steeper slopes the soil is generally somewhat shallower than the typical, and where cultivated included areas in such locations may be of slightly lighter color, due to an admixture of the lighter colored underlying material with the surface soil. The subsoil consists of a yellowish-brown or light-brown silty clay loam, generally quite stiff and compact in structure. In some places the lower part of the subsoil is mottled with light gray. The subsoil is separated from the soil by a gradational layer of dark-brown to nearly black, heavy silt loam to silty clay loam which

becomes slightly lighter in color with depth, grading into the typical subsoil. This layer varies in thickness generally from 4 to 6 inches, though in the less rolling areas it may be thicker. In areas where the topography is almost flat, as at the heads of streams, and on the flat-topped divides between streams, where drainage is not well established, the surface soil grades into a dark-brown to black silty clay loam which extends to a depth of about 20 to 24 inches, below which the material is generally a yellowish-brown silty clay loam mottled with gray and in places is dingy brown or brownish drab mottled with gray and sometimes brown. In these areas iron concretions are generally present, especially in the lower part of the subsoil. In rare cases the lower subsoil is a brown and gray mottled silty clay.

The boundaries between this type and the types with which it is associated are generally quite distinct. However, in some areas there is a gradation between this soil and the Memphis silt loam which extends over a wide area, and it is necessary to include some soil slightly lighter than the typical with this type. In the western part of the county and in the vicinity of Bliedorn, where the glacial and loessial uplands merge and occupy similar elevations, the presence of fine quartz and mica particles in the soil of the Carrington silt loam, the glacial counterpart of the Muscatine silt loam, and the presence of occasional small gravel in the subsoil of the former constitute the only bases for separation of the two types, the soils being very similar in most respects. In the north-central part of the county, where the loessial covering is thinnest, the material of the underlying Kansan drift sometimes occurs within the 3-foot section. This material is generally composed of a yellowish brown to slightly reddish brown clay loam, though in places it is a silty clay loam of compact structure. These areas are small, and their separation is impracticable.

The type also includes small areas adjacent to drainage ways and at the heads of streams, in which the soil is composed of a black, heavy silt loam to silty clay loam, generally about 8 inches in depth, which passes through a dark-brown silty clay loam into a brown to light-brown or yellowish-brown silty clay loam. The total area of silty clay loam is not great enough to warrant the establishment of a separate type.

The Muscatine silt loam is associated mainly with the Memphis silt loam of the loessial upland. It occurs in large areas in the Kansan drift upland, the covering of loessial material composing the type having been deposited over the till of that stage of glaciation. In the upper part the soil has been modified by weathering and the addition of organic matter through the decay of grasses. The lower subsoil of the typical areas has been but slightly modified and does not differ greatly from the material as originally deposited.

Extensive areas of this type occur in the county, usually on the divides between the main streams. The soil usually is encountered at the edge of the Iowan drift plain, with which it in some instances merges almost imperceptibly. Generally, however, it occupies a distinctly higher elevation than the drift plain and has a different topography. The type seldom adjoins the larger drainage ways of the county. The largest separate area extends from a point northeast of Dewitt northward beyond the county line, its continuity being broken only by the comparatively narrow bottom of Deep Creek.

The topography varies from rolling in some areas to undulating in others, and the surface is almost level on the divides and at the heads of streams. Where it occurs in the vicinity of well-developed drainage ways the type is sometimes strongly rolling to hilly, and at the edge of the drift plain it is in some places much dissected. In general the type is comparatively level, the relief being afforded by the drainage ways and the paha previously described as occurring in the loessial upland, mainly at the edge of the Iowan drift plain. The average elevation of the plain on which this soil occurs is about 800 feet above sea level, the highest elevations occurring in the northwestern part of the county and the lowest in the southeastern part of the loessial upland.

The greater part of the Muscatine silt loam is devoted to farming. The rougher areas and those in pasture as a part of a rotation are used for grazing. Owing to the mellow, friable nature of the soil, the type is easily cultivated, even in the slightly heavy areas, if care is taken to maintain a high organic-matter content. Drainage is nearly everywhere well established. In the flatter areas tiling and ditching are practiced to provide adequate drainage. Both the soil and subsoil are retentive of moisture, and crops suffer only from droughts of long duration. This type is preferred to the forested silt loam of the upland and to the Carrington silt loam of the Iowan drift plain, being regarded as a more durable, stronger, and on the average more productive soil. The topography is rarely unfavorable to the use of modern farm machinery. Heavy farm equipment and draft horses are necessary for thorough tillage. It is estimated that 70 per cent or more of the type is in cultivation.

Litmus-paper tests indicate that a large part of the type is acid. The application of lime is an effective means of correcting this condition. Where limestone has been applied to crops beneficial results have been noted, particularly in the case of alfalfa.[1]

Corn is the principal crop grown on the type, with wheat and oats the chief small-grain crops. Considerable hay is produced, consist-

[1] The Iowa Agricultural Experiment Station has made analyses of a number of samples of Mississippi loess soils to determine their acidity and lime requirements, and the results are published in Bulletin 150 of the Iowa State College of Agriculture and the Mechanic Arts, Ames, Iowa.

ing mainly of clover and timothy. Alfalfa is grown in a comparatively small way. Corn yields average from 45 to 50 bushels per acre,[1] though yields of 60 to 80 bushels, and in some instances more, are reported. Wheat yields average 20 to 25 bushels per acre, and the average acreage yield of oats is between 30 and 40 bushels. Some barley and rye are grown, the former yielding about 18 to 25 bushels and the latter 15 to 20 bushels per acre. Hay yields from 1 ton to 1½ tons per acre. From three to four cuttings of alfalfa are obtained on the type, yielding an average of three-quarters to 1 ton per acre per cutting. Some sweet clover is grown around Welton, two cuttings for hay or one for hay and one for seed being obtained after it has become established. The type produces a good growth of bluegrass, and is naturally well adapted to grazing. Considerable cattle and hog raising is practiced, the cattle industry being confined mainly to the production of steers, except in the vicinity of Lyons and Clinton, where some attention is given to dairying.

In general, a progressive type of farming is practiced on this type. Crops are commonly rotated and manure is applied, generally in quantities ranging from 5 to 12 tons per acre. The methods of farming are designed to maintain the productiveness of the type and to conserve soil moisture and at the same time to produce maximum crop yields. The farm improvements are generally of a high order. Modern farm machinery is in common use, and the farm implements are well cared for. Some of the best farms in the county are found on this type.

Land values generally range from $175 to $250 an acre, although where most favorably located with respect to markets, railroads, etc., the land is held for higher prices.

### MEMPHIS VERY FINE SANDY LOAM.

The Memphis very fine sandy loam, to a depth of 4 to 10 inches, consists of a light grayish brown to light brownish gray very fine sandy loam to fine sandy loam, fairly loose and friable, and in places rather silty. This is underlain by a brown to light-brown or yellowish-brown silty clay loam, which contains more or less very fine sand to fine sand in the upper part, but otherwise does not differ essentially from the subsoil of the silt loam of the series. The subsoil is generally quite stiff and compact, and is retentive of moisture.

Only a small total area of this soil is mapped. The largest area occurs northwest of Camanche, where it occupies the crest of a ridge at the edge of the loessial upland and the slope to the drift plain. Smaller areas are mapped in the eastern and southern parts of the county, occupying mainly the crests of ridges. The soil is

[1] The crop yields given in the discussion of this and subsequent soil types are based on the estimates of farmers and other information obtained in the field.

generally deficient in organic matter. The topography is sharply rolling to gently undulating. Drainage is good to excessive, and erosion is quite active.

Crop yields are lower than on the Memphis silt loam. The typical very fine sandy loam occurs in small, scattered areas, which usually are farmed in connection with adjoining soils, so that crop yields and land values can not be definitely given for this type separately.

A variation of the Memphis very fine sandy loam is found on small ridges in the Memphis silt loam areas. The soil is very similar to that of the typical Memphis very fine sandy loam, consisting of a grayish-brown or light grayish brown very fine sandy loam, underlain by a brown to light-brown, heavy loam which passes into a clay loam of similar color. Small gravel or pebbles, mainly angular in shape, are frequently seen on the surface and in the soil section, indicating a glacial origin, but owing to the small area of this material its separation is not considered advisable.

This variation occurs in small, scattered areas throughout the Iowan drift plain, generally in association with the Memphis silt loam. It was originally forested, and a large part of it still supports a forest growth consisting mainly of oak and elm, with other trees common to the county. The light color of the surface soil is due to a lack of organic matter. The greater part of the variation is in meadow or pasture, the forested areas being used for grazing. Corn is the chief crop of the cultivated areas, and yields about 25 to 35 bushels per acre. Rye is grown to some extent, the yields ranging from 12 to 18 bushels per acre. Both timothy and clover do well.

### MEMPHIS SILT LOAM.

The soil of the Memphis silt loam to a depth of 6 to 10 inches consists of a light brownish gray to light grayish brown or yellowish-brown, mellow silt loam. It is only fairly well supplied with organic matter. In the eastern part of the county, especially near the Mississippi River, the soil contains fairly large quantities of very fine sand, so that in some instances it is a very fine sandy loam rather than a silt loam. Where cultivated and exposed to the weather for some time the soil is light gray to almost white. On some of the slopes the soil has been entirely or almost entirely removed in places, leaving the underlying material exposed. These areas are locally termed "gall spots" or "points." Sometimes the underlying material is brought to the surface in plowing, giving the surface soil a light-brown color.

The soil passes abruptly into a subsoil consisting of light-brown or yellowish-brown silty clay loam, usually quite stiff and compact, but not especially impervious to the passage of moisture. Where

OATS OVER 4 FEET HIGH ON MEMPHIS SILT LOAM.

the subsoil is light brown in the upper part it generally becomes yellowish brown before a depth of 24 inches is reached, though the light-brown color sometimes continues throughout the soil section. There are a few areas of very small extent where the subsoil is a heavy, compact silt loam, usually of yellowish-brown color throughout. Grayish mottlings are present in the lower part of the soil section in local areas, and in a few instances the lower material closely approaches a silty clay in texture. In the north-central part of the county, where the loess covering is comparatively thin, and on some of the slopes where it has been removed by erosion, the subsoil in the lower part of the section is sometimes composed of the yellowish-brown to slightly reddish brown clay loam to silty clay loam of the Kansan drift material. In places large granite bowlders project from the underlying drift through the loess, extending from 4 to 6 feet above the surface.

In some parts of the county there are no sharp lines of separation between this type and the Muscatine silt loam, and the boundaries are necessarily arbitrary. In such locations the soils grade imperceptibly into each other through a zone from one-quarter to one-half mile in width, and it is necessary to include some soil slightly darker than the typical with this type.

The original material from which this type is derived is similar to the parent material of the Muscatine silt loam, consisting of the silty material of the loess cap deposited over the Kansan drift plain, but it has been much more thoroughly modified by weathering. The type occupies land that was originally forested, and about 25 to 35 per cent of the type now supports a timber growth.

This type occurs in large areas in Clinton County, back from the Mississippi bluffs and along the larger streams issuing from the upland. The topography of the greater part of the type ranges from hilly to gently rolling, the gently rolling areas occurring on the divides between the streams. As the larger streams traversing the type and the bluff on the east are approached, the type becomes more dissected, and the topography ranges from hilly to broken. The streams have cut deep channels. In the eastern part of the county the streams extend only a comparatively short distance from the bluff line, and their grade is steep. The modern streams have developed very little bottom land along their courses, though comparatively wide bottoms occur in the preglacial valleys. The structure of the soil and subsoil is such as to permit active erosion, even the smaller intermittent drainage lines having formed deep gullies (see Pl. II). The drainage is good to excessive.

The predominating forest growth is oak, mainly white, red, scarlet, black, and bur oak, with some post oak and pin oak. Walnut, hick-

ory, elm, locust, hard and soft maple, basswood, and a number of other trees common to the section are also present. Large areas of the type were originally covered with a heavy growth of hazel brush, which is still quite common in some of the forested areas, and this and sumac, grapevine, wild berries, Virginia creeper, and other vines form the common undergrowth.

Owing to its friable, mellow character, this soil is easily cultivated and maintained in a good condition of tilth. Both soil and subsoil are retentive of moisture, and crops do not suffer from drought except in prolonged dry periods. The type is more subject to drought, however, than the Muscatine silt loam. It warms up early in spring, permitting early cultivation and planting. In general productiveness and durability this soil ranks slightly lower than the Muscatine silt loam.

From 35 to 50 per cent of the cultivated area of the type is generally planted to corn, with average yields, in seasons of well-distributed rainfall, of 35 to 45 bushels. Oats probably rank next in acreage and produce from 30 to 35 bushels per acre (see Pl. III). Rye yields about 15 to 20 bushels per acre, and barley from 20 to 25 bushels. Some spring wheat is grown on the type, the yields ranging from 18 to 25 bushels per acre. Winter wheat gives about the same yield. Little difficulty is experienced in obtaining a good catch of clover on this type. Yields of clover and timothy hay range from 1 ton to 1½ tons per acre. Alfalfa is grown to some extent, yielding 3 or 4 cuttings per year, and averaging from three-quarters to 1 ton per acre per cutting. Northwest of Welton sweet clover is produced on the type, and this crop when cut for hay yields one crop the first year and two thereafter, averaging from 1 ton to 1½ tons per acre. One cutting of hay and one for seed is generally made the second season. Some trucking is done on the type, mainly in the vicinity of Clinton and Lyons. Orchards on the type contain apple, pear, plum, and cherry trees, with some peach trees. There are no large commercial orchards on the type. Some berries of different kinds are grown.

Litmus-paper tests show a large part of the type to be acid and in need of lime. The type is also low in organic matter, the application of barnyard manure being largely depended upon to remedy this condition. The sharp slopes are generally kept forested or in pasture to prevent erosion.

Owing to the rough condition of a large part of the type, the raising of live stock, chiefly beef cattle and hogs, with some dairying near Lyons and Clinton, is practiced, and this is probably the best use that can be made of these areas of unfavorable topography. The stock raising is generally carried on in connection with grain farm-

ing, but insufficient grain is produced on the type to supply the local demand for feed.

The agriculture on this type is generally progressive, and the farm improvements are good. Rotations are generally practiced, and manure is applied to supply organic matter. This type is well populated.

Farms on this soil are valued at $175 to $225 an acre where well improved and favorably located with respect to markets. In the vicinity of Clinton higher prices prevail. Unimproved tracts, with more or less uncleared land, vary greatly in value, the less desirable areas being valued only as pasture land.

The Memphis silt loam, as mapped, includes a variation similar in color, texture, and other characteristics to the main type, but differing in the presence of glacial gravel and bowlders, indicating a derivation, at least in part, from drift. This soil is found generally in association with the Carrington soils, and usually occurs in quite extensive areas between those soils and the bottom soils of the Wapsipinicon River and the larger creeks draining the Iowan drift plain. The largest areas are those along Ames and Silver Creeks, near Dewitt, and smaller areas adjoin the bottoms of the Wapsipinicon River, from Folletts to the western county boundary, and along some of the larger drainage ways. The general elevation of the areas is the same as the average of the drift plain, but in the western part of the county they occur at an elevation equal or almost equal to that of the loessial upland.

The topography is mainly undulating to rolling, and in a few instances hilly, with sharp slopes. The drainage usually is good. In the flatter areas, owing to the compact silt layer and the impervious nature of the lower subsoil, the drainage is poorly developed, and ditching and tiling are necessary for good crop yields.

### LINDLEY SILT LOAM.

The soil of the Lindley silt loam consists of a light-brown to grayish-brown silt loam of varying depth. It is of loessial origin and modified to a large extent by colluvial action. Sand, varying in texture from fine to medium, is occasionally present, sometimes in sufficient quantities to make the soil a sandy loam rather than a silt loam. This sandy material is due mainly to wash from the Kansan drift material underlying the loess, which forms the subsoil of the type, and consists of a brown to yellowish-brown or slightly reddish brown clay loam to silty clay loam. It is quite stiff, compact, and impervious, and contains small gravel and pebbles, and occasionally large bowlders, generally angular or subangular in outline. On some of the sharper slopes the loessial covering has been entirely

removed, and the till forms the surface soil as well as the subsoil material. On the steepest slopes there are some areas of Rock outcrop, the rock consisting generally of limestone. North of Clinton the limestone is exposed in a sheer bluff 100 feet or more in height. The sharp slopes from the loessial uplands to the streams are occupied by this soil, but owing to their small extent and narrow width they can not be shown satisfactorily on the soil map.

The type is mainly forested, the tree growth being the same as that on the Memphis silt loam, with which this soil is associated.

The Lindley silt loam is suited only to forestry and pasture, as the rough topography is unfavorable to farming operations. The type is not farmed.

### CARRINGTON FINE SAND.

The soil of the Carrington fine sand consists of a dark-brown to grayish-brown, slightly loamy, loose and friable fine sand to a depth of 18 to 24 inches. The subsoil is lighter in color than the surface soil, grading through a light-brown into a yellowish-brown and in some cases a brownish-yellow fine sand. The material usually is not loamy below a depth of 12 inches.

Angular and subangular pebbles and small gravel are generally scattered over the surface and throughout the soil section. A high content of medium sand is sometimes present, and the material of small areas consists of sand rather than fine sand. This material is commonly referred to as "blow sand," since it is subject to drifting, and large blow-outs are common on the sides and tops of the ridges.

The type is mapped in small, scattered areas on the drift plain in the western part of the county. The largest areas adjoin the bottoms of the Wapsipinicon River. The type occurs mainly as mounds and ridges having moderately steep slopes and is associated with the other types of the Carrington series. The topography of the larger areas varies from hilly to rolling on the slopes and from slightly rolling to undulating on the tops of the ridges. The areas are not badly dissected. Owing to its porous character, the type is absorptive of moisture, and there is little run-off over the surface. Drainage is generally excessive, and the type is droughty.

A small part of the Carrington fine sand is cultivated generally in association with some of the heavier soils of the series. The greater part of the type is kept in pasture or meadow since cultivation renders it subject to drifting. Rye is the chief crop, yielding 10 to 15 bushels per acre. Corn and the small grains give low average yields. Good hay crops are obtained. A small part of the type is forested. The timbered areas are mainly along the Wapsipinicon bottoms. Oak is the chief tree growth, with some elm and

hickory. There is an undergrowth, principally of wild berries and sumac, in some places in the forested areas.

The type does not occur in areas sufficiently large to comprise individual farms, but its presence lowers the value of farms on which it occurs.

A variation of this type occurs in two areas several miles west and slightly north of Dewitt and in one area near Clinton. The soil to a depth of 18 to 24 inches consists of a grayish-brown to brown, slightly loamy fine sand, somewhat coherent where more loamy, and slightly compact where uncultivated and covered with grass. Below this depth the material has the same texture, but becomes slightly lighter in color, grading through light brown into yellowish brown at 33 to 36 inches. The subsoil does not have the loamy character of the surface soil, and is loose and incoherent. The material of this variation owes its origin to the deposition by winds of material originally derived from the bottoms of the Mississippi River and to the reworking of glacial deposits of sandy character by the same agency.

In the eastern part of the county the variation occurs mainly as low knolls and ridges, some of which are quite long and attain an elevation of 25 feet or more above the level of the surrounding lands. Areas of this soil on the glacial upland in the western part of the county are subject to wind action. This sand drifts mainly from west to east.

Where cultivated the soil frequently drifts badly, causing large "blow holes" on the sides and crests of the ridges. The variation is largely kept in meadow or pasture to prevent drifting, and in some instances trees, mainly oak, soft maple, and osage orange, have been planted to serve as windbreaks.

The best use of this soil is for pasture, or the production of truck crops adapted to such light soils, such as watermelons and cantaloupes. Some corn is grown, and rye is the principal small grain. Crops are likely to suffer severe injury by the midseason droughts, and average yields are low.

The incorporation of large quantities of organic matter makes the soil more loamy, prevents blowing to some extent, and serves also to increase the moisture-holding capacity. Such treatment is necessary for best crop yields. The occasional plowing under of a crop of cowpeas or rye is an effective means of adding organic matter. The plowing under of the crab grass common to this soil supplies organic matter and also aids in the extermination of the weed.

The total area of this variation is comparatively small, and it does not occur in areas sufficiently large to make up separate farms.

CARRINGTON FINE SANDY LOAM.

The Carrington fine sandy loam, to an average depth of 15 to 24 inches, consists of a dark-brown, dark grayish brown or brown, loose, friable fine sandy loam. This is underlain by a brown to dark-brown loamy fine sand which grades in the lower part of the soil section into a light-brown to brown loamy fine sand, and in some cases into a yellowish-brown fine sand. In a few places the soil is more than 3 feet deep. Included areas of small extent have a substratum of brown to yellowish-brown silty clay loam to clay loam identical with the typical subsoil of the heavier soils of this series. Small areas of medium-textured material also are included with the type. Pebbles and small gravel, mainly of subangular shape, occur on the surface and throughout the soil section.

This type occurs mainly in association with the Carrington loam. Along the eastern edge of the Wapsipinicon lowlands in the vicinity of Calamus there is an almost unbroken area of the type 4 miles or more in length and varying in elevation from 10 to 20 feet or more above the remainder of the plain. The smaller areas also generally lie higher than the associated soils. The topography of a small part of the type is flat to only gently sloping. The ridges and mounds have sharp to medium slopes, and the larger areas on the tops of the ridges are gently undulating to rolling. The drainage is good to excessive.

The greater part of the large area adjoining the Wapsipinicon lowlands is forested, the growth consisting principally of oak, hickory, and elm, with an undergrowth of blackberry, sumac, and other shrubs in some places. The remainder of the type originally was largely prairie, and the organic-matter content is slightly higher than in the originally forested areas. The addition of organic matter is generally necessary on this type to maintain its productiveness, increase its moisture-holding capacity, and make it less subject to wind action. Large blow-outs are frequently seen on the tops and sides of ridges. Cultivated areas are particularly subject to wind action. The soil frequently is removed from the roots of plants, and in the spring the seed bed is so disturbed at times that the seeds are left exposed. Owing to its tendency to drift, the type is best left in meadow or pasture. Good crops of hay are obtained, and a fair quality of blue-grass thrives on the type.

The friable character of the soil makes its cultivation easy, and a large part of the type is devoted to agriculture. The chief grain crops of the county are produced, the average yields, however, being rather low. The average yield of corn in seasons of well-distributed rainfall is from 25 to 30 bushels per acre, that of oats from 20 to 25 bushels, of rye from 12 to 18 bushels, and of wheat from 15 to 20

bushels. Yields of hay range from three-quarters to 1 ton per acre. The forested areas are used for grazing.

This type, where of sufficient extent to comprise individual farms, is valued at $40 to $60 or slightly more an acre.

### CARRINGTON LOAM.

The surface soil of the Carrington loam consists of 7 to 12 inches of dark-brown or nearly black to grayish-brown loam, containing some sand, chiefly of medium texture. The soil is friable and easily cultivated. The subsoil consists of a dark-brown, compact clay loam, which either passes into a brown clay loam or grades into a brown, compact silty clay loam at depths varying from 15 to 20 inches. Between the soil and subsoil there is occasionally a gradational layer of dark-brown, heavy loam, usually not more than 8 inches in thickness. Frequently at a depth of 28 inches or more a brown clayey loam is encountered. This passes into a sandy loam of light-brown color, which is in turn underlain by a yellowish-brown loamy sand to clayey sand. Local areas are encountered in which the limestone, which everywhere underlies the drift, occurs within 2½ feet of the surface. These areas are of small extent and do not differ materially in agricultural value from the areas where the limestone occurs at great depths. Small angular to subangular gravel and pebbles occur on the surface and throughout the soil section. On some slopes they occur in such quantity as to make the soil a gravelly loam. Bowlders, mainly of granite, occur on the surface of the type, but rarely in large quantities.

Small areas of a lighter colored loam, generally brownish gray, overlying a subsoil of light-brown clay loam to silty clay loam, are included with this type. The soil material of these areas is low in organic matter, in contrast with the typical Carrington loam, which is well supplied with this material.

The Carrington loam is closely associated with the silt loam of the series. It generally has a slightly higher elevation than the silt loam type, occurring as low mounds and ridges. This type is extensive in Clinton County. The largest areas occur around Low Moor and Malone, while smaller areas are distributed throughout the drift plain. The topography of the larger areas is generally rolling to slightly undulating, the slopes of the individual mound and ridge areas generally being gentle in character. On the crests of the higher ridges a fine sandy loam or sandy loam frequently is encountered, due to the washing out of the finer particles.

The drainage of the type is generally fair to good, especially in the rolling areas. In the more nearly level areas ditching and tiling are practiced in some instances to assist natural drainage. Both soil

and subsoil are quite retentive of moisture. The material within 3 feet of the surface rarely is calcareous; litmus-paper tests frequently show both the soil and subsoil to be acid.

By far the greater part of this type was originally prairie, only small areas being forested. The chief tree growth is oak, with some hickory and elm, and a scattering of the other trees common to the region. An excellent growth of bluegrass is obtained in uncultivated areas. Sweet clover frequently is seen on the type along roadsides and in pastures, and on the raw subsoil material exposed in road cuts.

Owing to the friable nature of the soil material, its general productiveness, its good drainage, and other general characteristics, this type is highly esteemed for farming. A highly developed system of agriculture is practiced, including crop rotation, the application of manure, liming to correct acidity, and such methods of cultivation as are thought necessary to maintain the productiveness of the type.

The farm improvements are good, and indicate a highly successful and progressive agriculture.

Corn is by far the most important crop grown on the type, and yields probably average between 40 and 50 bushels per acre, larger yields frequently being reported. Oats do well, averaging between 30 and 35 bushels and in some years as high as 40 bushels per acre. Wheat yields from 18 to 25 bushels, and rye and barley from 18 to 22 bushels per acre. Clover and timothy are the chief hay crops, yielding from 1 ton to 1¼ tons per acre. Some alfalfa is grown, lime generally being applied and the soil inoculated. A good stand is obtained on the type, with three or four cuttings a year, averaging about 1 ton per acre per cutting. The acreage value of this type ranges from $175 to $225.

A sandy loam variation of this type occurs in small, scattered areas in the Iowan drift plain. It occupies rounded ridges within areas of the typical Carrington loam. It does not differ essentially from the typical soil except in having a slightly sandier texture.

### CARRINGTON SILT LOAM.

The soil of the Carrington silt loam to a depth of 8 to 12 inches consists of a dark grayish brown to black or dark-brown, friable and generally mellow silt loam to fine loam. In places some very fine to fine sand, with very small quantities of medium sand, is present. The soil is underlain generally by a dark-brown heavy silt loam, which grades almost immediately into a slightly compact silty clay loam of the same color. In some cases the gradational layer of heavy silt loam is entirely absent. The dark-brown silty clay loam may continue without much change throughout the section, a characteristic typical of the more poorly drained areas of the type, in which

case some gray mottling generally occurs in the lower part of the soil section, and black oxide of iron concretions usually are present. Typically, however, the dark-brown silty clay loam grades at depths of 15 to 24 inches into a brown, compact silty clay loam, which may continue throughout the section, or may grade below about 30 inches into light-brown or yellowish-brown material of similar texture. In a few instances, mainly where the type occupies the tops of ridges or where a part of the original material has been removed by erosion, there is encountered at about 30 inches a substratum of light-brown clayey loam or loam which generally grades into a sandy loam or loamy sand of light-brown or yellowish-brown color. In such areas occasionally the lower layer is reddish brown, indicating a ferruginous character.

The type was originally in a prairie condition, the decay of the heavy growth of prairie grasses accounting for the high content of organic matter. Small forested areas are included with the type, apparently representing a gradation to the glacially derived areas included with the Memphis silt loam, the soil being slightly lighter in color, and possessing a smaller percentage of organic matter. The subsoil of these timbered areas generally consists of a brown to yellowish-brown, heavy silt loam below 8 to 12 inches, which grades at about 20 inches into a yellowish-brown silty clay loam. The subsoil of some of the forested areas, however, is not essentially different from the typical. The timber growth consists mainly of oak, with some hickory, hawthorn, elm, linden, and various other trees common to Clinton County.

A large part of the type is underlain by gravel, and a number of gravel pits are encountered. On the tops of some of the ridges the underlying gravel is sometimes found within 3 feet of the surface, and on some of the steeper slopes the soil in places is a gravelly loam. Some pebbles and gravel, mainly subangular, frequently are found on the surface and throughout the section. Huge bowlders, mainly of granite, occur on the type, though these are rare. In the triangular section of the county west of the Wapsipinicon River, and in the vicinity of Bliedorn, where the loessial and glacial uplands occupy plains of almost identical elevation, the only basis on which a boundary can be drawn in places between the Carrington silt loam and the Muscatine silt loam, its loessial equivalent, is the presence in the former of minute grains of quartz and mica, which generally retain their angular outline. Though fine sand is present in the Muscatine silt loam in the eastern part of the county, this material has lost its angular outline.

Fifty per cent or more of the total area of glacial soils in Clinton County is included with the Carrington silt loam, which occurs in

extensive areas over the entire Iowan drift plain. It is mainly associated with the Carrington loam and the Clyde silt loam. The type occupies a topographic position intermediate between the higher lying Carrington loam and the Clyde silty clay loam. In the vicinity of Bliedorn and Wheatland, and in the eskerlike formations previously mentioned, the type lies higher than the remainder of the drift plain. The topography is mainly undulating to gently rolling and rolling, except in the case of the high ridges, which have well-rounded crests and fairly sharp slopes. Drainage is fair to good. Ditching and tiling are resorted to in the small flat areas. Both soil and subsoil are retentive of moisture, and crops rarely suffer from drought.

A large part of the type is under cultivation, the areas used for pasture and meadow largely occupying places in the systems of rotation that are generally practiced. The soil is easily cultivated and maintained in a good condition of tilth. It is naturally highly productive, and is considered one of the best agricultural soils in the county. A progressive type of farming is practiced, and the farm improvements are good and well cared for, indicating a generally prosperous agriculture.

Corn is the chief grain crop. It averages from 40 to 50 bushels per acre. Oats ordinarily yield from 30 to 35 bushels or more per acre, wheat from 18 to 25 bushels, barley from 18 to 20 bushels, and rye from 15 to 20 bushels. Clover and timothy do well, no apparent difficulty being experienced in securing a stand of the former. Yields of 1 ton to 1¼ tons of hay are obtained. Considerable alfalfa is grown, from 3 to 4 cuttings per year, depending on the season, generally being obtained. Alfalfa averages about 1 ton per acre per cutting. Inoculation of the soil, and liming to correct acidity commonly are practiced. The rank growth of sweet clover in some pastures and along roadsides, with its growth on the raw subsoil in road cuts, indicates that this crop could be grown on this type with as good results as on the upland silt loams.

Some grazing is practiced on the type, the cattle industry being confined mainly to beef production, except in the region around Low Moor and Dewitt, where dairying is of some importance. The type seems best adapted to grain farming, to which it is largely devoted.

### CLYDE SILT LOAM.

The soil of the Clyde silt loam consists of 6 to 12 inches of a black to dark grayish brown, friable silt loam ranging to a heavy, compact silt loam in the flat or depressed areas. The subsoil varies widely, largely because of differences in the drainage. The typical subsoil is a dark-brown to nearly black, generally compact and impervious

silty clay loam, which grades at about 18 inches into a brown or dark-gray, heavy, compact and impervious silty clay loam. At depths of 24 to 30 inches a mottled brown and gray or light-brown and gray, stiff, compact silty clay is encountered, and this generally continues throughout the soil section without change. The lower lying heavy stratum is locally referred to as hardpan. The subsoil material varies in minor areas from a heavy loam to clay loam or silty clay loam, and from brown through gray and drab to black, with mottlings mainly of gray, drab, rusty brown, and ocherous yellow. Iron concretions commonly are present and in some locations they are very abundant. Small gravel and pebbles frequently are present; these are mainly angular or subangular. The type includes small areas of sandy material transported by local drainage from higher lying types.

The type occurs throughout the Iowan drift plain. A few small areas are included with the Carrington silt loam. Where the glacial plain merges into the Wapsipinicon bottoms south of Lost Nation and in the vicinity of Calamus and Buenavista, arbitrary lines were sometimes necessarily drawn between this soil and the Wabash silt loam, since there was an almost imperceptible change in elevation and in the soil material. The type is poorly drained, and in depressed areas tiling and ditching usually are necessary.

This type was originally prairie, and the surface soil has a high content of organic matter resulting from the decay of the rank growth of prairie grasses.

A peculiar characteristic of the type is the occurrence of small poorly drained areas, which are locally called alkali spots.[1] Small crystals having the appearance of common salt occur on the surface, apparently having been left by the evaporation of the water in which the material composing the crystals was carried in solution. Samples analyzed in the Bureau of Soils laboratories were found to contain small quantities of alkali. Corn seems to be the only crop affected by this condition, the natural growth stopping when the corn reaches a height of 18 to 24 inches. The alkali-resistant small grains, especially oats, do not seem to be affected. Thorough drainage by ditching and tiling, supplemented by the plowing under of coarse manures and litter to open up the soil, has in some cases brought this material into a productive state. Experiments with potash gave increased yields for several seasons, but the improvement did not seem to be permanent.

Corn is the chief crop on the type, the small grains common to the region also being grown to a considerable extent. In seasons of low, but well-distributed rainfall, good yields are obtained, but in wet

[1] Statements regarding alkali spots are based on information obtained from several progressive farmers who have tried to make these spots productive.

years crops suffer because of the poor drainage of the type. The soil can be cultivated only under a narrow range of moisture conditions, and heavy farm equipment is necessary.

Corn yields from 35 to 40 bushels per acre, oats from 25 to 30 bushels, and wheat from 18 to 20 bushels. Very little rye and barley are grown. Clover and timothy do well, average yields of 1 ton of hay per acre being obtained. The type supports a good growth of bluegrass, and a large part is in pasture.

The type is valued at $150 to $175 or slightly more an acre, depending mainly on drainage conditions, improvements, and location with respect to markets.

A loam variation of this type is encountered in a few small, scattered areas. The soil of this variation consists of 8 to 10 inches of slightly dark brown to grayish-brown loam, carrying some medium sand. This generally grades into a rusty-brown to dark-brown heavy loam to light clay loam, which extends to various depths. Where it continues throughout the soil section it is mottled with brown, rusty brown, drab or ocherous yellow in the lower part of the section. Generally, however, this material passes at about 24 inches into a drab or mottled light-drab and rusty-brown compact clay loam, which continues to a depth of more than 36 inches.

This soil is similar in origin to the typical Clyde silt loam. It has a flat topography, and tiling and ditching usually are necessary to provide good drainage. Crop yields are lower on the variation than on the typical soil. The variation supports a good growth of bluegrass, and a large part is devoted to grazing.

### CLYDE SILTY CLAY LOAM.

The soil of the Clyde silty clay loam to a depth of 10 to 16 inches consists of a black to nearly black silty clay loam of heavy, compact, tough, impervious character, overlying a subsoil of dark-drab to drab, heavy, compact silty clay loam to silty clay, which maintains the same texture, but becomes dark gray or gray below about 18 to 24 inches. The subsoil in places is mottled with rusty brown or ocherous yellow, especially in the lower part. Black and brown oxide of iron concretions are common, and in some instances abundant in the lower subsoil. The type as mapped includes areas in which the soil material is a silty clay or clay loam, but these areas are too small to be mapped separately. The angular rock fragments common to the Clyde soils and the bowlders occurring on the other glacial soils are present in places on this type.

The type occurs throughout the Iowan drift plain, mainly at the heads of and along the drainage ways and in slightly depressed areas without drainage outlets. Tiling and ditching usually are necessary to provide adequate drainage.

This is a strong, productive soil, and in seasons of favorable rainfall good yields are obtained on areas that are suited to cultivation. Heavy farm equipment is necessary to the proper tillage of this soil. The type puddles and bakes if plowed when too wet and breaks into intractable clods if cultivated when too dry. Owing to its sticky, plastic nature the type is locally termed "gumbo."

The Clyde silty clay loam is chiefly devoted to corn and pasturage. The small grains lodge badly. Good crops of timothy and clover hay are obtained, the yields ranging from 1 ton to 1¼ tons per acre. Corn averages from 40 to 45 bushels per acre, though very much higher yields are reported in a few cases. The type supports a good growth of bluegrass.

### BREMER SILT LOAM.

The soil of the Bremer silt loam, to a depth of 6 to 12 inches, consists of a dark-gray to black silt loam which is generally friable, though in places somewhat heavy and compact. The subsoil consists of a black, rather stiff and compact silty clay loam, which may continue throughout the remainder of the 3-foot soil section or may grade at from 24 to 30 inches into a drab to dark-drab silty clay loam to silty clay, which is sometimes mottled with rusty brown and ocherous yellow. Iron concretions are frequently quite numerous, especially in the more poorly drained areas. The soil is easily tilled, though the heavier areas can be plowed only within a narrow range of moisture conditions. If worked when too wet the soil puddles and bakes and forms intractable clods. In small areas of this type the subsoil below about 10 or 12 inches consists of a brown, or brown mottled with gray, heavy silt loam, extending without change in texture to a depth of 3 feet or more, the color of the lower part of the subsoil, however, changing to mottled gray and brown or gray or drab mottled with brown. These areas are poorly drained.

In some areas where the drainage is well developed the soil consists of 8 to 12 inches of a mellow, friable silt loam, underlain by a brown, compact silty clay loam. This continues throughout the section, with gray mottlings in the lower part. Such areas constitute only a very small percentage of the type as mapped.

The Bremer silt loam is associated with the Wabash silt loam and silty clay loam in the Goose Lake channel, where it occurs in a terrace position. It occupies a position intermediate between the upland and the Wabash silt loam. Considerable colluvial material has been added to the type through wash from the upland. The type occurs also on terraces along the Mississippi and Wapsipinicon Rivers. The areas of the type along the Wapsipinicon bottoms are of small extent and widely scattered. They sometimes merge into material of the drift upland, so that the boundaries are largely arbitrary. A small

area of the type occurs on the east end of Big Beaver Island, where it occupies a position, in common with the remainder of the type, above ordinary overflow. In some cases it is necessary to draw arbitrary boundary lines between the terraces and first bottoms, owing to the merging of the one into the other.

The topography is generally flat, with an almost imperceptible slope toward the stream. The natural drainage is poor as a rule on account of the flat topography and the impervious character of the subsoil material. Tiles and surface ditches are used to improve the drainage with good results.

Good farm practices prevail on this soil, manure being heavily applied and crop rotations practiced to keep up the productiveness. Corn is the chief crop grown, and the average yield is between 40 and 45 bushels per acre. Oats average 25 to 30 bushels and wheat 15 to 20 bushels per acre. The small grains are not popular on account of their tendency to lodge. Clover and timothy hay yield 1 ton to 1½ tons per acre. The type supports a good growth of bluegrass, and considerable grazing is done, especially in the poorly drained and forested areas.

The selling price of this land varies from $150 to $200 an acre, depending on location, improvements, drainage, and other local conditions.

*Bremer silt loam, light phase.*—The soil of this phase to a depth of about 7 to 12 inches consists of a dark-brown to black loam. It grades generally into a brown to dark-brown heavy loam to clayey loam, which continues to a depth of about 18 to 20 inches, passing into a brown to dark-brown or mottled brown and gray clay loam, generally quite stiff and compact in structure. This clay loam is sometimes absent, the heavy loam continuing to a depth of 24 to 28 inches, below which the material is lighter in texture, consisting of a brown sandy loam to loamy sand, which may extend to a depth of 3 feet or more, or may grade into a yellowish-brown loamy sand. Occasionally this lighter material also forms the substratum of the clay loam subsoil. The surface soil is generally friable, and cultivation of the phase is comparatively easy except in small included areas of heavy loam. The heavier subsoil usually is quite impervious. Small, waterworn gravel is sometimes found on the surface and in the soil and subsoil, and in the more poorly drained areas iron concretions are quite common.

The total area of this phase in Clinton County is very small. It occurs on the terrace remnants of the Wapsipinicon and Mississippi Rivers, and lies above overflow. The largest area is encountered west of Camanche. The topography is flat with only a slight slope toward the streams. This soil is associated mainly with

the Buckner soils in the county. Drainage is naturally poor, especially where the clay loam subsoil occurs and ditching and tiling are necessary for best results with crops.

Corn is the chief crop, the small grains also being grown. Small areas, chiefly where poor drainage obtains, are used for pasture. Crop rotations are practiced, and manure is used to maintain productiveness. Corn gives an acreage yield ranging from 30 to 40 bushels, oats yield from 25 to 30 bushels per acre, wheat from 18 to 20 bushels, and rye from 12 to 16 bushels. Clover and timothy are grown for hay, and yield an average of about 1 ton per acre. A good growth of bluegrass is generally found on the type.

The phase rarely occurs in areas sufficiently large to be given a separate value. It was recognized in the field work that this soil was a loam rather than a silt loam, but on account of its small extent it was mapped as a light-textured phase of the Bremer silt loam rather than as a separate type.

*Bremer silt loam, heavy phase.*—The soil of the Bremer silt loam, heavy phase, consists of 6 to 10 inches of a black, generally compact and heavy, silty clay loam. The subsoil is a black or dark-drab sticky, compact, impervious silty clay loam, slightly mottled with rusty brown. This may grade at about 20 inches into a drab or gray, stiff, compact, and impervious silty clay loam, mottled with rusty brown or ocherous yellow, or may pass into a silty clay, of heavy, stiff, and impervious structure, and having the same color. Iron concretions are common throughout the soil and subsoil.

This phase occurs mainly in two small areas in the Goose Lake channel. It occupies a terrace position, and its total area is very small. The topography is flat, and the type is poorly drained. A small part of the phase has been tiled.

A heavy type of farm equipment is necessary for the cultivation of this soil. Corn is the chief crop grown; the small grains lodge badly. The average acreage yield of corn is about 45 to 50 bushels. The phase supports a good growth of bluegrass, and uncultivated areas are used for pasture.

This soil is the typical Bremer silty clay loam, but on account of its small total area, it is mapped as a heavy phase of the Bremer silt loam.

### BUCKNER FINE SAND.

The surface soil of the Buckner fine sand consists of a dark-brown loamy fine sand about 12 to 20 inches deep. It has a loose, friable structure, and is easily cultivated. This is underlain by a brown fine sand, which is less loamy than the surface material, and grades in the lower part of the soil section into a light-brown or yellowish-brown fine sand. Small, water-rounded gravel is sometimes scat-

tered over the surface, and through both soil and subsoil. When dry the surface material is generally grayish brown.

This type has a small total area in Clinton County. The greater part of the type occurs in the vicinity of Camanche, where it occurs on the terrace of the Mississippi River. About two miles west of Camanche there is an area of this type which occupies a position higher than the surrounding terrace material, adjoining the glacial upland. The material of this area apparently is glacial outwash, but it is not essentially different from the typical Buckner fine sand.

Included with this type in the vicinity of Camanche and on the terrace remnants along the Wapsipinicon River are a number of small areas of Buckner sand. The surface soil of the Buckner sand to a depth of 14 to 18 inches consists of a brown to dark-brown loamy sand of medium texture and loose, friable structure. The subsoil consists of a brown to slightly grayish brown, somewhat loamy medium sand, containing generally a small percentage of coarse material and more loose and incoherent than the surface soil, grading at about 28 inches into a light-brown or yellowish-brown medium sand, which in places passes into a fine sand of similar color before the bottom of the section is reached.

The topography of the Buckner fine sand is flat, but drainage is good, owing to the porosity of the soil and subsoil material. It is said that areas of this type, especially those smaller areas included with other types, are supplied with moisture by capillarity from the underlying water table, which is constantly maintained at the river level, probably not more than 15 to 20 feet below the surface. Crops on some areas of the type suffer in long periods of drought. Where the soil is least loamy or least well supplied with organic matter it is subject to drifting.

The Buckner fine sand is well adapted to the production of watermelons, cantaloupes, strawberries, and other truck crops, to which a large part of it is devoted. Small areas are used for the production of corn and small grains, chiefly rye, which is also grown in rotation with truck crops. The incorporation of large quantities of organic matter is necessary for best yields, and barnyard manure is used extensively. Crab grass, which grows profusely on the type, is plowed under in order to add organic matter and eradicate the weed.

Corn yields average about 20 to 25 bushels per acre, and rye yields about 12 to 15 bushels. Watermelons, cantaloupes, and strawberries are highly profitable. There are some peach trees on the type, and these make a good growth and bear profusely. The special products are sold mainly at Clinton.

Land of this type is valued at $150 to $200 an acre, the small areas especially suited for strawberry production having a considerably higher value.

BUCKNER SANDY LOAM.

The soil of the Buckner sandy loam consists of a dark brown to almost black sandy loam, which extends to a depth of 12 to 18 inches. The subsoil consists of a brown loamy sand, which becomes slightly less loamy and lighter brown in color with depth, in some instances being a yellowish-brown sand of medium texture and loose structure, at a depth of 3 feet. Both the soil and subsoil are friable. The lower part of the subsoil frequently contains small quantities of coarse material. The soil in places contains sufficient loamy material to cause it to become slightly compact if stirred when wet and to hold water on the surface for long periods after rains.

Only a small total area of this type is found in Clinton County, the greater part occurring southwest of Dewitt on terrace remnants along the bottoms of the Wapsipinicon River. The type has a flat topography, with only slightly elevated areas and slight depressions. The former are generally occupied by a more sandy soil, and the latter by a soil heavier than typical, frequently a loam. Such areas would have been mapped as the sand and loam members of the Buckner series had they been of sufficient extent. The drainage is good, owing to the porous character of the soil and subsoil material. Soil moisture is retained fairly well by both soil and subsoil, though crops suffer from prolonged droughts.

The soil is generally manured heavily to supply needed organic matter and to increase its moisture-holding capacity.

Corn is the chief crop grown on the type, with some rye, wheat, and oats. Very little attention is paid to trucking, except to supply the home demand, though the type is naturally well adapted to that industry. In seasons of well-distributed rainfall corn yields an average of 25 to 30 bushels per acre, and rye from 12 to 18 bushels. The average yield of oats ranges from 25 to 30 bushels, while that of wheat is probably about 18 to 20 bushels per acre.

Land values on the Buckner sandy loam range from $125 to $175 an acre.

A fine sandy loam variation of this type occurs on the terraces of the Mississippi and Wapsipinicon Rivers. It consists of 12 to 20 inches of a dark-brown, friable sandy loam, underlain by a dark-brown loamy fine sand. Below 30 inches the material in places is a light-brown or yellowish-brown fine sand. The largest bodies of the variation occur southwest of Elk River Junction and at Folletts. Small areas of this soil occur on Big Beaver Island, lying well above normal overflow. There is also an area on the outwash plain west of Camanche.

This soil is utilized for the production of corn and small grains. Watermelons, cantaloupes, strawberries, and other truck crops also are grown, mainly in the vicinity of Camanche.

### CALHOUN SILT LOAM.

The surface soil of the Calhoun silt loam is a dark-brown, dark grayish brown or gray, friable silt loam, from 6 to 10 inches in depth. This is underlain by a compact layer of silt, varying in color from ashy gray to gray or buff slightly mottled with brown in the upper part and generally from 8 to 12 inches in thickness. The subsoil consists of a dark-gray, heavy, compact, stiff silty clay, which is highly impervious and mottled with rusty brown. The material is slightly lighter in the lower part of the soil section, generally consisting of a gray to rusty-brown or yellowish-brown, mottled silty clay.

One area of this type is mapped along an old channel of the Wapsipinicon River west of Toronto, one at the point of emergence of Mill Creek from the upland, one along Elk River, and one north of Lyons. In all the areas except the first named the underlying limestone occurs within the soil section in places, and in these locations as well as in exposed areas where the limestone occurs at considerable depth, the subsoil directly above the limestone is gray.

Along the former channel of the Wapsipinicon River and along Mill Creek the type occupies a terrace position. The topography is flat, and this together with the impervious subsoil material and the layer of compact silt between the soil and subsoil causes the drainage to be poorly established.

The type in the eastern part of the county is forested, the timber consisting mainly of oak, elm, and hickory. The area west of Toronto is being brought under cultivation.

Owing to the small extent of the type, it is impracticable to give its separate value or an estimation of crop yields.

The area of this type along Elk River and the area 2 miles north of Lyons differ from the typical. The soil to a depth of 4 to 8 or 10 inches consists of a dark-gray, stiff, heavy, compact silty clay to silty clay loam. The slight depth of the soil is due to the removal of material by erosion. The subsoil is gray, generally possessing a brownish cast, and consists of a stiff silty clay of compact and impervious structure. Mottlings of rusty brown, ocherous yellow, and pinkish red occur in the subsoil, the former generally in the upper part and the ocherous yellow and pinkish red in the lower part.

With cultivation this soil breaks into small particles, giving rise to the local designation of "buckshot." Corn is the chief crop grown. The small grains lodge badly. The average yield of corn is approximately 40 bushels per acre.

### WABASH LOAM.

To a depth of about 8 to 12 inches the soil of the Wabash loam consists of a dark-brown to black loam, generally quite friable in structure. The subsoil prevailingly is a dark-drab to dark-gray, usually compact, though occasionally quite plastic, silty clay loam or clay loam, mottled with rusty brown. This grades at about 26 inches into a gray, compact silty clay loam or clay loam, mottled with rusty brown. Iron concretions are quite common, especially in the most poorly drained areas. Pockets and thin strata of sand occasionally are found in the subsoil, and a substratum of sandy material sometimes occurs at about 28 inches. The typical subsoil is generally quite stiff in the lower part and rather impervious. Both soil and subsoil are retentive of moisture, and the soil is well supplied with organic matter.

The total area of this type in Clinton County is small. It occupies a first-bottom position along the larger streams, the greater part of the type occurring in the bottoms of the Wapsipinicon River south of Lost Nation. The higher lying areas have a typical soil but the subsoil below a depth of 8 to 10 inches consists of a brown silty clay loam to clay loam, generally quite stiff and compact, and mottled with gray and rusty brown. This grades at about 28 to 30 inches into a gray to dark-gray silty clay loam, mottled with brown. Iron concretions are common throughout the soil section.

Only one area of this type is mapped in the Mississippi River bottoms. This occurs just north of Camanche at the edge of the terrace remnant. The soil of this area does not differ essentially from the typical, but below about 8 inches the material is a dark-brown clay loam, which grades at about 18 inches into a reddish-brown clay loam. Below this depth the brown gradually disappears, a red clay loam being encountered in the lower part of the 3-foot section. A small area of similar material occurs at the edge of the terrace west of Camanche, on the gentle slope from the terrace to the adjoining first bottom. In addition to these small areas the type as mapped includes several very small areas of other Wabash soils and of soils of the Cass series.

The topography of the type is flat, with only a slight slope toward the streams, and the natural drainage is poor. The elevation of the type above the streams is generally insufficient to permit tiling and ditching.

The greater part of the type lies above ordinary overflow and is used for crop production. In forested areas the tree growth is similar to that of the other members of the Wabash series. The timbered areas are used for pasturage.

Corn is the chief crop grown, with some wheat, oats, and rye. Corn yields from 35 to 45 bushels, wheat from 20 to 25 bushels, oats from 25 to 30 bushels, and rye from 15 to 20 bushels per acre. Clover and timothy yield from three-fourths ton to 1¼ tons of hay per acre.

The value of this type depends mainly on its position with respect to the streams. The higher lying areas are valued at $75 to $150 or more an acre.

### WABASH SILT LOAM.

The surface soil of the typical Wabash silt loam consists of dark-brown to dark grayish brown or almost black silt loam to heavy silt loam 6 to 12 inches in depth. It is generally friable, though in places quite compact, and is well supplied with organic matter. The subsoil consists generally of a dark-drab or dark-gray heavy, compact silt loam, with sometimes a slightly brownish hue and frequently mottled with a rusty-brown color, due to the occurrence of undecomposed organic matter or black oxide of iron concretions. At about 16 inches the heavy silt loam grades into a drab to dark-drab silty clay loam of heavy and compact structure and mottled with rusty brown, and this generally continues throughout the remainder of the soil section. In places, however, at about 28 to 30 inches a tough, impervious, gray and brown, or gray and ocherous-yellow, mottled silty clay is encountered, and in other places a clay loam of drab color mottled with rusty brown occurs, passing quickly into a loamy sand or sand of grayish-brown or brownish-gray color and generally coarse texture. Pockets and strata of sand occur in both soil and subsoil. Small areas of loam, occupying generally a slightly elevated position, and of silty clay loam, which occurs in depressed areas, are included with this type as mapped. Both the soil and subsoil retain moisture well.

In the higher lying areas of the type where the drainage is better, and the aeration and oxidation more thorough, the subsoil differs from the typical in that it consists of a brown, compact, silty clay loam, slightly mottled with rusty brown and gray. This grades at about 28 inches into a gray to dark-gray compact silty clay loam. The surface soil is not essentially different from that of the typical Wabash silt loam. This type is subject to overflow in periods of exceptionally high water.

On islands in the Mississippi River, and along the edge of the first bottoms of that and the Wapsipinicon River, there are some areas which if of sufficient extent and agricultural value to warrant separation would be mapped as a light phase of the type. The material consists of a gray to light grayish brown, loose, friable silt loam, underlain at a depth of 6 to 12 inches by a drab to slightly brownish gray, heavy silt loam, mottled with brown and rusty brown, or a gray

silty clay loam or silty clay, which is compact and quite stiff, and more or less mottled with brown. In places alternating strata of silty clay loam and clay loam form the subsoil. The light-colored material represents the most recently deposited alluvial sediments, to which insufficient organic matter has been added to give it the dark color of the typical soil material. Removal and addition of this material occur with each successive overflow.

The Wabash silt loam is the most extensive of the alluvial types in Clinton County. Large areas occur along the Wapsipinicon River in the western part of the county. Smaller areas occur along the Wapsipinicon and Mississippi Rivers and other streams. Large areas occur along Yankee Run, Brophys and Deep Creeks, and at the juncture of Cherry and Brophys Creeks.

The topography is practically flat, with a slight slope toward the streams. Where the type borders the larger streams it has a slight relief, due to the presence of old channels, oxbow sloughs, and depressions. The sloughs and depressions are filled by overflows, and retain water for long periods. The level topography of the type results in poor drainage, the better drained areas occurring farther from the streams, where they occupy slightly higher positions. Tiling and ditching are sometimes practiced to improve the drainage, but as a rule there is little difference in elevation between the surface of the type and the streams.

The greater part of the Wabash silt loam originally was forested, the growth consisting mainly of elm, sycamore, hard and soft maple, box elder, and cottonwood, with some hickory, oak, hackberry, and hawthorn. Birch and willow grow along the edges of depressions or sloughs. Where the type is timbered, and where it occupies a low position with reference to the streams, it is devoted to grazing. It supports an excellent growth of bluegrass. Some areas along Yankee Run and the Goose Lake channel were originally prairie. Large areas above overflow are utilized for agriculture, and in some locations this soil is preferred to the upland soils. Corn is the principal crop, though the small grains also are extensively grown. Where the soil is heavy the small grains have a tendency to lodge. Care must be taken in the cultivation of these areas to prevent puddling and baking.

The average yield of corn is between 40 and 50 bushels per acre, although yields of as high as 80 bushels or more per acre are reported. Oats yield an average of about 30 bushels, wheat from 20 to 25 bushels, rye from 15 to 20 bushels, and timothy and clover hay, either mixed or separate, from 1 to 1¼ tons per acre.

Areas of this type above ordinary overflow are valued at $100 to $175 or more an acre, depending on local conditions, improvements, percentage of land cleared, and position with respect to the streams.

Timbered areas subject to overflow are valued at $40 and upward, depending mainly on their location.

*Wabash silt loam, colluvial phase.*—The soil of this phase, to a depth ranging from 8 to 36 inches or more, prevailingly is a light-brown or light grayish brown, loose, friable silt loam, containing in places a small percentage of fine sand. Sand of medium texture also is present in some places, sometimes in sufficient quantity to make the type a sandy loam rather than a silt loam. The subsoil is a black silt loam, generally quite heavy and compact in structure, or a rather stiff and compact silty clay loam, or there may be a layer of black silt loam, usually from 6 to 12 inches in thickness, between the typical soil material and the silty clay loam subsoil. The black silty clay loam generally continues throughout the section, though it may be slightly lighter in the lower part and show rusty-brown mottlings.

This soil occurs at the heads and along the courses of streams in the loessial upland where the slopes are sufficiently steep to permit wash. The material is largely colluvial. Small areas of this phase are included with the typical Wabash silt loam. In common with the main type, the phase is subject to overflow. It has a flat topography and drainage is poor.

The areas of the phase are small and scattered. Their total area is comparatively small.

### WABASH SILTY CLAY LOAM.

The surface soil of the Wabash silty clay loam ranges from 6 to 15 inches in depth and consists of a black to dark grayish brown silty clay loam, generally quite compact and heavy in structure, though in places it is moderately friable. In the former condition the term "gumbo" is frequently applied to it. The subsoil is a dark-drab to almost black silty clay loam, which becomes slightly lighter in color with depth, being a drab or gray silty clay loam at about 24 inches, mottled with rusty brown. In some small, local areas there occurs at about 28 inches a substratum of mottled gray and ocherous-yellow, tough, compact, impervious silty clay. In some areas the subsoil consists of alternate layers of mottled gray and rusty-brown fine sandy clay to clay loam and of the typical subsoil material. Below about 28 inches the heavy subsoil sometimes gives way to lighter material, generally a loam or sandy loam. Pockets and strata of sand are frequently present in the soil and subsoil, and iron concretions are not uncommon.

A light variation of this type occurs along the Mississippi River and on islands in that stream. The soil consists of 7 to 10 inches of gray to dark-gray, plastic silty clay loam. The subsoil is a dark-

gray to gray silty clay loam to silty clay, frequently occurring in alternating strata, and more or less mottled with brown and rusty brown, and sometimes having a brownish tinge throughout.

The most extensive areas of this type are mapped along the Mississippi River, on islands in that river, and in the Goose Lake channel. Small areas occur in the bottoms of the Wapsipinicon River and along the courses of the larger creeks. Several quite extensive areas are encountered south of Lost Nation in what appears to be the remnants of old stream bottoms. The type is associated mainly with other members of the Wabash series.

The Wabash silty clay loam occupies a first-bottom position and has a slight slope toward the streams. Near the larger streams the type is frequently well dissected by sloughs and old drainage ways. In times of overflow the depressions in the type become filled with water and remain inundated for long periods. In the lower lying areas there is a constant addition and removal of alluvial material by flood waters.

Owing to the flat topography and the heavy character of the material, the natural drainage is poor. Several large ditches have been constructed through some cultivated areas, but the grade toward the main drainage ways is so slight that these are not very effective. Both the soil and subsoil are retentive of moisture, and farm crops suffer only from droughts of long duration.

The greater part of this type is forested and used for pasturage. The timber growth consists principally of oak, elm, sycamore, soft maple, birch, cottonwood, and willow, with some hard maple, hickory, box elder, scarlet hawthorn, and hackberry. Areas of the type are only rarely subject to overflow, and prairie areas, mainly in the Goose Lake channel, above ordinary overflow are utilized for agriculture. Corn is the chief crop grown, with some wheat, oats, and hay. Corn averages about 40 bushels per acre, though yields of 75 bushels per acre frequently are reported. Wheat averages about 20 to 24 bushels per acre and oats about 30 bushels in average years. Very little rye is grown on the type. The average yield of hay is about 1 ton to 1¼ tons per acre. A good growth of bluegrass occurs on this type and makes good pasturage.

The type has a tendency to puddle, and care must be taken to avoid cultivation when wet. The soil cracks badly in dry weather, and this damages the roots of crops. The small grains have a tendency to lodge badly and for that reason are unpopular on the type.

The selling price of land of this type varies from $40 to $100 or more an acre, depending upon improvements, condition, amount cleared, and position with respect to streams by which it is overflowed.

### WABASH SILTY CLAY.

The surface soil of the Wabash silty clay consists of a gray to dark-gray heavy, tough, impervious, compact silty clay, from 6 to 10 inches in depth, sometimes possessing a brownish cast or mottled with brown. The subsoil to a depth of 36 inches or more is a gray to drab silty clay, similar in structure to the soil. The mottling in the subsoil is of rusty brown, accompanied in some places by ocherous yellow in the lower part of the soil section. In a few areas the mottling does not occur below about 28 inches, the material consisting of a drab to gray silty clay. Iron concretions usually are very much in evidence. When wet the soil becomes sticky and plastic, but on drying out becomes hard and intractable and cracks badly. The type is locally referred to as "gumbo."

In a part of the area near the Wapsipinicon River south of Shaffton the soil is almost black, grading through dark drab into the typical subsoil material, which, however, passes into a silty clay loam or clay loam before the 3-foot depth is reached.

This type occurs in depressions in the first bottoms of the Wapsipinicon and Mississippi Rivers, on islands in the Mississippi, and in the Goose Lake channel adjoining the former bed of Goose Lake. The largest area occurs on Big Beaver Island. The type is subject to overflow. The absence of any growth except marsh grasses and other aquatic plants in some areas would seem to indicate that they have recently been or are inundated for considerable periods. Willows generally grow along the edges of the areas. In forested areas the growth is mainly swamp, white oak, birch, soft and hard maple, willow, box elder, and elm. The type is not utilized for agriculture and has no value except for pasture. It has only a small total area in Clinton County.

### SARPY SANDY LOAM.

The soil of the Sarpy sandy loam to a depth of about 8 to 12 inches consists of a dark grayish brown, dark-brown or brown friable sandy loam. The subsoil consists of a brown loamy sand, generally of medium to fine texture, which grades in the lower part of the section into a grayish-brown to brownish-gray sand or fine sand, which is only slightly loamy. In some cases considerable coarse material occurs in the lower subsoil, while in others the soil grades directly into a subsoil of grayish-brown to brownish-gray coarse sand. In some cases the brown fine sand continues throughout the 3-foot section, and in such areas a substratum of light-brown or yellowish-brown fine sand frequently is encountered at depths of 30 to 40 inches. A few areas of dark grayish brown coarse sandy loam, with a subsoil of grayish-brown to brownish-gray coarse sand, are included with this type on account of their small extent, as are several

areas the soil of which is distinctly fine in texture, while the subsoil does not differ essentially from that of the main type. Water-rounded pebbles are occasionally present on the surface and throughout the soil section.

Southwest of Calamus the type includes a fair-sized area in which the soil material consists of a gray to dark-gray loamy fine sand 8 to 10 inches in depth. This grades into a dull-white loamy sand of medium texture, and a sand of the same color is encountered at about 18 inches. This soil occurs along a drainage ditch leading into the Wapsipinicon River and adjacent to areas of the Carrington fine sand and Carrington fine sandy loam.

The Sarpy sandy loam occurs in small, scattered areas in the first bottoms of the Wapsipinicon and Mississippi Rivers, and is subject to overflow. The structure of the soil and subsoil causes the soil to be droughty, and drainage is excessive. Only a small part of the type is used for crop production, and yields are comparatively low. Where forested the growth consists mainly of hawthorn, elm, wild crab apple, birch, and willow, with some oak, hickory, and sycamore. The tree growth is generally stunted, and in the lighter areas the grass growth is somewhat scanty. The type is used mainly for grazing.

Included with this type are several small areas of the Sarpy sand, which on account of their small extent can not be shown separately on the map. The soil of the Sarpy sand to a depth of 6 to 10 inches is a brown to rather dark brown sand. The texture of the greater part of the sand ranges from fine to medium. There usually is sufficient fine material to give the surface soil a slightly loamy character. The subsoil consists of a brown sand, cleaner in appearance than the soil and less coherent by reason of the smaller percentage of clay and organic matter present. The color is lighter and there is a slight reddish tinge.

This soil occurs in a few small areas in the Wapsipinicon bottoms. The largest area is about 1 mile northwest of Stevens Bridge; another occurs near where the Chicago, Rock Island & Pacific Railway crosses the river, and there are several areas of less importance.

Drainage is fair, but the type is subject to frequent overflows. On account of its sandy nature and the occurrence of overflows, the type has little agricultural value.

### CASS LOAM.

The soil of the Cass loam varies from 6 to 12 inches in depth, and consists of a dark-brown to nearly black loam, containing some sand, mainly of medium texture. The structure of the soil material is generally quite friable. The subsoil consists of a loamy sand, of medium texture and brown to grayish-brown color. With increase

in depth the brown color gives way to grayish and the material loses its loamy character, being in the lower part of the section a dull brownish gray or brownish-gray sand of medium or coarse texture. The type includes patches of sandy loam.

The Cass loam occurs along the Wapsipinicon River. It occupies a first-bottom position and is subject to overflow. The areas of the type are small and well scattered, the total area being very small.

The surface of the type is flat, but owing to the porous character of the subsoil material the drainage is good to excessive. Cultivated crops and grass on the type suffer from extended periods of drought. Old sloughs and depressions constitute the only relief in the topography. The soil in these consists of the heavier members of either the Cass or Wabash series, but owing to their small extent they can not be shown satisfactorily on the soil map. The type is forested with the trees common to the alluvial bottoms, and is used mainly for pasture. Only a small part of the type is under cultivation. Corn and rye are the principal crops, the average yield of the former ranging from 20 to 25 bushels, and of the latter from 10 to 12 bushels per acre. Where the coarse sandy subsoil closely approaches the surface the tree growth usually is stunted and the grass growth is sparse.

A heavy variation of this type occurs in areas too small to map. It consists of a black silty clay loam to clay loam, in places slightly mottled with rusty brown, varying in depth from 6 to 12 inches. The subsoil is a grayish-brown to brownish-gray sand to coarse sand, the gradational strata from soil to subsoil consisting of a dark-brown clay loam which grades into a loam and sandy loam of brown color within about 4 to 6 inches. This gradational layer is sometimes absent, a sudden change occurring from the heavy soil material to the light material of the subsoil. Some water-rounded gravel and small pebbles are occasionally found in the soil and subsoil, chiefly in the latter. The subsoil material is loose and incoherent. In depressed areas, old slough bottoms, and small drainage ways the soil is more nearly a silty clay or clay than a silty clay loam. The soil material is quite compact, tough, and tenacious. When wet it is plastic and sticky, but it bakes and cracks on drying.

The topography of the variation is flat, old sloughs, depressions, and old river channels constituting the only relief. The land is frequently overflowed, each flood modifying the surface by erosion and by the deposition and removal of sediment.

The variation is poorly drained, and on account of its position it is not under cultivation. It is forested with the growth common to the alluvial soils of the region. In depressions and along sloughs it frequently supports a growth of marsh grasses, smart weed, and

sour dock. The soil produces a good growth of grass, and its principal use is for pastures. Its total area in Clinton County is very small.

### CASS SILT LOAM.

The Cass silt loam is widely variable. Over a large part of the type the soil is dark brown to black and ranges from a silt loam to heavy silt loam. It is friable to somewhat compact and 8 to 10 inches in depth. The surface soil grades into a brown to dark-brown, heavy silt loam, or in a few cases, into a silty clay loam, of the same color slightly mottled with rusty brown, and containing iron concretions. At about 15 inches this passes into a brown, heavy loam or clay loam, which grades abruptly into a sandy loam or loamy sand of fine to medium texture, and of distinctly brown or tan color. Generally the sandy material grades into a rusty-brown or grayish-brown to brownish-gray sand, of medium texture and only slightly loamy, which becomes slightly coarser as the 3-foot depth is approached. A coarse sand is sometimes encountered at about 3 feet. The difference in color of the lower subsoil seems to be due mainly to the presence of quartz sand; in cuts distinctly stratified layers of almost white and brown sand are seen.

In some areas the surface soil grades at about 10 inches into a sandy loam of dark-brown or brown color, which in turn may pass abruptly into a subsoil consisting of a rusty-brown or grayish-brown loamy sand, generally of medium texture, which grades into a brownish-gray sand to coarse sand before the 3-foot depth is reached. In a few instances the soil grades abruptly into a medium or coarse sand of brownish-gray color.

This type grades into the Wabash silt loam and no sharp boundary can be drawn. The type is also associated with the Cass loam. Areas of the silt loam, too small to map separately, are mapped with the Wabash soils and the Cass loam, and patches of those soils are included with this type.

The Cass silt loam occurs in areas of considerable extent in the bottoms of the Wapsipinicon River. It occupies a first-bottom position, and is subject to overflow.

The topography is flat, with a gentle slope toward the streams, the only relief being afforded by small mounds of sandy material, depressions, oxbow sloughs, old channels, and drainage ways. Overflow waters flow through the old channels. Streams easily form new channels through this type, and the old channels are left in the form of oxbow sloughs and elongated ponds, separated from the main channel by the deposition of soil material. Successive stream overflows add to or remove material so that the nature of the surface soil, especially along the main streams, is constantly changing. Sand

patches, similar to Riverwash, are scattered over the type along streams.

Where the sandy subsoil material closely approaches the surface, the drainage of the type is excessive. Where the soil is deep, or is underlain by the layer of heavy material, the drainage is only fair, and crops on the type suffer from drought only after protracted periods. The material in the latter case is retentive of moisture, the friable structure makes cultivation easy, and in those areas least subject to overflow agriculture is practiced with good results. Where the sandy material lies near the surface the type is used mainly for pasture. This type originally was forested, and a large part is still timbered mainly with the oaks common to the region, soft maple, some hard maple, sycamore, cottonwood, elm, birch, scarlet hawthorn, and wild crab apple. The forested areas are devoted to grazing. Only a small part of the type is under cultivation. Corn is the chief crop. Corn averages 30 to 40 bushels per acre, wheat from 18 to 22 bushels, rye from 15 to 18 bushels, oats from 25 to 30 bushels, and hay from three-fourths ton to 1¼ tons.

Owing to the position of the type with reference to the streams no extensive improvements are found on the greater part of it. Land values vary widely, depending on the character of the material, location, percentage of land cleared, and other factors. Some areas are valued at $40 to $90 an acre.

### UNION STONY LOAM.

The Union stony loam includes those areas where the removal of drift and loess by erosion has exposed the underlying limestone or left it at a very shallow depth. In some instances there is a slight covering of brown to dark-brown sandy material, either remnants of the former drift covering, or perhaps residual material resulting from the weathering of the limestone. This covering as a rule is not more than 2 to 4 inches thick. Fragments of limestone, of varying size and shape and of pitted character, are scattered over the surface.

This type is mapped mainly in the northern part of the county. It does not occur in extensive areas. The topography is almost level to sloping, though where the type includes slopes on which the limestone outcrops the surface is sometimes sharply sloping. The greater part of the type adjoins streams or occurs on the bluffs where the upland breaks toward the bottoms. The Union stony loam has no agricultural value.

### MUCK.

Muck, as mapped in Clinton County, is of two kinds, deep and shallow. On account of their small total area, low agricultural value, and intricate association, these are not separated on the soil map.

The shallow deposit predominates. It consists of 6 to 18 inches of a black, finely divided, well-decomposed muck, sometimes quite silty, which grades into a subsoil of black or dark-drab to drab silty clay loam or silty clay. The subsoil is heavy, stiff, compact, and impervious, is sometimes mottled with rusty brown, and frequently contains iron concretions. In places there occurs between the typical soil and subsoil a layer of dark-brown to black nonfibrous peat, generally not more than 4 to 8 inches in thickness. At the edges of the areas of muck soil material from the surrounding higher lands has been mixed with the surface material.

The Muck where deep consists of 8 to 15 inches or more of black, finely divided, well-decomposed organic matter, which grades into a black to dark-brown nonfibrous peat. This may continue throughout the 3-foot section or it may be displaced in the lower part of the section by a dark-brown to brown, semifibrous and in some places fibrous peat. The heavy clay material underlying the shallow deposits does not usually occur within 36 inches of the surface. The deep areas are generally encountered in the center of the larger areas mapped as Muck. It includes small areas of black, nonfibrous peat, which has the appearance of muck and is well decomposed, but lacks sufficient inorganic matter to be classed as Muck. Some very small areas of typical Peat, generally more than 3 feet in depth, also are included.

The Muck areas occur mainly in the belt of drift material. Muck is the result of the accumulation of organic matter in ponds and depressions and along drainage ways. It occurs also in the bottoms of old lakes which existed in the Goose Lake channel west of Goose Lake prior to the installation of the drainage ditches that removed the greater part of the water. The largest areas are near Calamus and Lost Nation; smaller areas occur at the heads of and adjacent to the minor drainage ways of the county. The largest area of the deep deposits is in the bed of the larger lake west of the village of Goose Lake.

During the rainy season the Muck generally is wet and boggy, and because of its situation and the impervious character of the underlying clay it is poorly drained throughout the year. In some areas fairly good drainage has been established through tiling or ditching, and corn is produced successfully. Crops are subject to damage by the early light frosts. The native vegetation consists mainly of marsh grass, smartweed, and other aquatic plants. Yields of about 1 ton per acre of a fair quality of wild hay are obtained in places.

### RIVERWASH.

Riverwash, as mapped in this county, includes the sand-bar islands and sand banks of the Mississippi and Wapsipinicon Rivers and

areas along the old channels in the flood plains of those streams. It represents recently deposited alluvial material and is composed mainly of grayish-brown to brownish-gray loose and incoherent sand to coarse sand. In some instances the soil section comprises strata of sand of variable texture similar in color to the surface material alternating with thin strata of black, silty, and clayey material. This heavy material sometimes occurs at the surface in a layer an inch or two in thickness. A part of the Riverwash supports a growth of willows and aquatic weeds, the remainder being bare and subject to constant removal and redeposition of the surface material by the streams. It represents the lowest lying material of the alluvial plain and is overflowed by only slight rises of the streams. Riverwash has no agricultural value.

## SUMMARY.

Clinton County is situated in east-central Iowa. It has an area of 691 square miles, or 442,240 acres. The county comprises three physiographic divisions, a plain of Kansan drift covered by Mississippi loess in the northern and western parts of the county, a plain of modified Iowan drift in the southern part, and an alluvial plain adjoining the Mississippi River and its tributaries in the county. The greater portion of the county lies between elevations of 650 and 900 feet above sea level. The county lies within the drainage basin of the Mississippi River, a large part of the drainage being carried by the Wapsipinicon River.

The population of the county is reported in the 1910 census as 45,394, of which about 44 per cent is classed as rural. Clinton, the county seat, is the largest town, with a population of about 26,000. Transportation facilities are good throughout the county. There is an extensive system of public roads, and most of them are kept in good condition.

The climate of Clinton County is temperate, and favorable to agriculture. The mean annual temperature as recorded at Davenport is about 49° F., and the mean annual precipitation, as recorded at Clinton, about 36 inches. There is an average growing season of 174 days.

The early agriculture consisted mainly of the production of grain crops, the animal industry being secondary in importance. In the present agriculture stock raising is the major farming pursuit in the northern part of the county, while that industry is secondary to general farming in the southern part. Corn is the chief crop of the county. It occupies an acreage twice as great as the other grain crops combined, being reported in the 1910 census on about 122,000 acres. About 70,000 acres were in hay and forage crops. More than 50 per

cent of the land in farms was reported as hay and pasturage land in 1913. Most of the crop products of the farm are fed to the stock.

Among the various animals kept, work stock, including horses and mules, rank first in importance, cattle for beef and other purposes second, dairying third, hogs fourth, and sheep fifth. The value of live stock and products is reported in the 1910 census as about $4,750,000, as compared with the value of cereals produced, about $3,500,000, and of hay and forage, somewhat over $1,000,000.

There are 2,844 farms in the county, of an average size of about 149 acres, about 96 per cent of the area of the county being in farms. Of the land in farms, about 88 per cent, or an average of 131 acres per farm, is reported as improved. About 61 per cent of the farms are operated by the owners, and practically all the remainder by tenants. The average value of farm land is given as $86.73 an acre.

The soils of the county are derived mainly from loess, glacial drift, and alluvial deposits. The loessial soils are found mainly in the northern part of the county and are classed with the Muscatine and Memphis series. The glacial soils occur in the southern part of the county and are mapped as the Lindley, Carrington, and Clyde. The alluvial soils occur along the Mississippi and Wapsipinicon Rivers and in the valleys of their larger tributaries. Those above overflow are classed with the Bremer, Buckner, and Calhoun series, and those subject to overflow with the Wabash, Sarpy, and Cass series. Muck and Riverwash constitute the miscellaneous types found in the county. The Union series is comprised of soils which are in part loessial.

The Muscatine series is represented by a single type, the silt loam, which is the dark-colored originally prairie soil of the loessial upland. The Memphis series includes the light-colored originally forested soils, and the Lindley series represents a rough, gullied condition in the Memphis silt loam where the gravelly drift is exposed or is near the surface.

The Carrington series includes the greater part of the area of glacial soils and comprises the dark-colored soils, for the most part originally prairie.

Of the alluvial soils of the county occurring in a terrace position, those of brown to dark-brown color, with subsoils of generally lighter texture, are classed with the Buckner series, while the Bremer series includes the dark-gray to black soils, the subsoils of which are heavier and more compact than the surface material. The Calhoun series comprises gray to brown soils, overlying heavy, compact subsoils of gray or mottled brown and gray color, with sometimes an intervening layer of gray or buff silt between the surface soil and subsoil.

The Wabash series includes first-bottom alluvial soils, mainly of dark-brown to black color, the subsoils of which are generally heavier and more compact than the surface soils. The Cass series includes dark grayish brown to black soils, overlying light-textured subsoils.

Muck includes areas of decaying vegetable matter in an advanced stage of decomposition, mixed with some mineral matter. River-wash occurs mainly as sand-bar islands in and sand banks along the Mississippi and Wapsipinicon Rivers and along former channels of these streams.

[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved, March 14, 1904.

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

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