

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; P. E. BROWN, ASSOCIATE IN CHARGE.

SOIL SURVEY OF LOUISA COUNTY,
IOWA.

BY

L. VINCENT DAVIS, OF THE U. S. DEPARTMENT OF AGRICULTURE,
IN CHARGE, AND J. AMBROSE ELWELL, OF THE
IOWA AGRICULTURAL EXPERIMENT STATION.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1918.]



WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., June 12, 1920.

SIR: In the extension of the soil survey in the State of Iowa during the field season of 1918 a survey was undertaken in Louisa County. This work was done in cooperation with the Iowa Agricultural Experiment Station, C. F. Curtiss, Director.

I have the honor to transmit herewith the manuscript report and map covering this work and to request their publication as advance sheets of Field Operations of the Bureau of Soils for 1918, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

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

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MAP.

Soil map, Louisa County sheet, Iowa.

SOIL SURVEY OF LOUISA COUNTY, IOWA.

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

DESCRIPTION OF THE AREA.

Louisa County lies in the southeastern part of the State of Iowa, and is bordered on the east by the Mississippi River, which separates it from the State of Illinois. Its greatest dimension from east to west is 28 miles, and from north to south 24 miles. The area is 396 square miles, or 253,440 acres.

In general, the county consists of two areas of upland drift plain and two belts of low bottom land. One of the lowland belts, the Mississippi bottoms, occurs along the eastern margin of the county; the other traverses the county in a northwest-southeast direction along the Iowa River and separates the two areas of upland plain.

At the northern boundary of the county the Mississippi River bottoms are 5 miles wide, but they gradually narrow southward, and are only $1\frac{1}{2}$ miles wide on the south line of Township 75. In Township 74 the width is from $1\frac{1}{2}$ to 2 miles, but to the south the width increases again to about 5 miles which is constantly maintained to the county boundary. An elevation known as Great Sand Mound extends into the county in sec. 4, T. 75 N., R. 2 W., from Muscatine County. It rises abruptly about 30 feet above the surrounding bottoms. It is a remnant of an old terrace. Its area in Louisa County is approximately 1 square mile. With the exception of this mound and another, very small and less elevated, in the eastern part of sec. 18, T. 75 N., R. 2 W., practically the entire area of the Mississippi bottoms would be subject to overflow were it not for the levee. Numerous sloughs occur throughout these bottoms, the largest of which is Muscatine Slough, which extends into the county on the north near the outer edge of the bottom. This slough finally empties into the Iowa River 2 miles north of Toolesboro. The depressed areas known as Lake Klum, formerly a lagoon connecting with Muscatine Slough, and Lake Odessa, an enlargement of the same slough, have been drained by artificial ditches. The topography of the

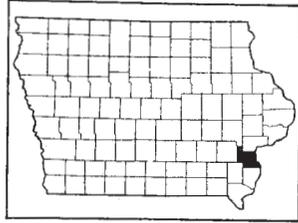


FIG. 1.—Sketch map showing location of the Louisa County area, Iowa.

Great Sand Mound is undulating, while the remainder of the first bottom, with the exception of a small area in the vicinity of Hope-well School, which is undulating, is level.

The lowlands along the Iowa River vary from 2 to 6 miles in width, the maximum being reached in T. 76 N., R. 5 W. Another large expansion occurs in the vicinity of Wapello. These lowlands consist of first-bottom land, subject to overflow, and second bottoms or terraces, lying entirely above the highest floods. The first bottom, with the exception of the two lobelike extensions in T. 76 N., R. 5 W., caused by former meanderings of the river, occurs as a strip ranging from three-fourths mile to 2 miles in width, intersected by many sloughs and old ox-bow lakes. The terrace occurs in three main areas, namely, west of Cedar River and north of the Iowa River; northeast and southeast of Fredonia; and northwest, west, south, and southeast of Wapello to a point beyond Elrick. The terraces are traversed in places by the valleys of streams issuing from the uplands. In the extreme northwestern part of the county, on the east side of the Iowa River, both first bottom and terrace contain numerous knolls and ridges, and in places the line of separation as drawn between first bottom and terrace is of necessity rather arbitrary. In other places, particularly east and northeast of Fredonia and south and southwest of Wapello, a ridge occurs near the margin of the bluff and this also makes the boundary between terrace and upland somewhat indefinite. Elsewhere, with the exception of a few slight ridges and knolls on the terrace, both terrace and first bottom are nearly level. For the most part the terrace rises abruptly about 20 feet from the bottom, but the narrow strips of terrace occurring within the first bottom are only 8 to 15 feet above the latter, and rise from it in a rather gentle slope.

The eastern upland area or drift plain is a southern extension of the Illinoian drift plain in Muscatine County.¹ On the northern county boundary it is about 9 miles wide, but it gradually tapers to a width of about 2 miles northeast of Wapello, whence a tongue projects about 8 miles farther southeast. The plain has an average elevation of about 100 feet above the lowlands. It is moderately dissected, the topography varying from level to broken. The more broken areas occur on the steep slopes leading to the Mississippi River bottoms. In general the topography is gently rolling. The general slope is toward the west, with the exception of the northeastern part of Grandview Township, which slopes toward the east. The east bluff rises very abruptly to an elevation of 100 to 150 feet above the lowland and is broken only by two small creeks which flow out across the Mississippi bottoms, one leaving the upland one-half mile south of the north county line and the other about 6 miles

¹ See *Geology of Louisa County*, by J. A. Udden, Iowa Geol. Survey, Vol. XI, 1900, p. 62.

farther south. On the west side of the plain the bluffs are 40 to 90 feet in height and the slopes are longer and more gentle. In secs. 4, 5, 23, 24, and 25, T. 75 N., R. 4 W., and in secs. 9, 10, and 15, T. 74 N., R. 3 W., the margin of the upland is 10 to 30 feet higher than the surrounding upland and has an uneven dunelike appearance. These elevations are probably the result of wind action. In the northeast half of Grandview Township there are several broad, swell-like elevations lying about 30 feet higher than the surrounding upland and having a northwest-southeast trend, while in Jefferson Township several wide, shallow valleys with a northeast-southwest trend occur.

The western drift plain occupies the southwestern part of the county. It is terminated on its eastern border by a well-defined bluff extending along the Iowa River in its entire southeastward course through the county. The elevation of the bluff above the lowland varies from 125 feet north of Columbus Junction to less than 75 feet along the west side of the Wapello Prairie. The bluff line is broken by numerous streams leaving the upland and traversing the bottoms. This plain, like the east plain, varies from level to broken in topography, but is predominantly gently rolling to rolling. An undulating to gently rolling surface characterizes the more recently dissected parts of the plain, while a steeply rolling to broken surface is general in the parts more completely dissected, as along the lower courses of the streams. In Marshall Township and to the northwest the creek valleys are wider, and have longer slopes that merge more gradually into the upland plain than in Morning Sun Township and southeast, where the valleys are narrower and V-shaped, with steeper slopes that normally break sharply from the upland plain. As is almost always the case in this latitude, where the streams run east and west, the south slopes of the valleys are more steep and blufflike than the north slopes. A noticeable feature of the western upland is a depression resembling a shallow drainage valley beginning at the eastern border just north of Columbus Junction, extending southwest about 3 miles, thence south to the southeast corner of Elm Grove Township and thence south into Henry County.² This depression has an average width of $1\frac{1}{4}$ miles, and where best defined its bottom lies about 40 feet below the surrounding upland. Where it crosses Long Creek the banks are very indistinct. A smaller branch depression, about one-fourth to one-half mile in width, leaves the main depression at the northeast corner of Elm Grove Township and extends southwest and out of the county at the southwest corner of the same township. These valleylike depressions are not drainage valleys at present, but are crossed in places by small streams. It

² See *Geology of Louisa County*, by J. A. Udden, Iowa Geol. Survey Vol. XI, 1900, pp. 63, 64.

is supposed that these depressions are vestiges of the channel held by the Mississippi River at the time of the Illinoian glaciation, when the river followed the western edge of the ice sheet. Another noticeable feature of the western upland is two more or less pronounced swells lying east of and roughly paralleling the depression just described. These are each about 1 mile wide. In secs. 17, 18, and 21, T. 73 N., R. 3 W., are a few small sink holes, about 20 feet deep and 5 to 8 rods wide, due to holes or caverns in the underlying limestone.

The highest point in the county is in the southeastern part of Morning Sun Township, where an elevation of nearly 900 feet above sea level is reached. The elevation at Port Louisa, on the Mississippi River, in the eastern part of the county, taken at mean low water is 526 feet, while across the river at Keithsburg, Ill., $1\frac{3}{4}$ miles north of the southern boundary of the county, the elevation is 523 feet.

The eastern upland, with the exception of about 12 square miles, drains into the Iowa River. The divide between the Iowa and Mississippi Rivers follows the Mississippi bluffs in Jefferson and Port Louisa Townships, north of which it turns back and runs about 2 miles west of the bluffs. The eastern slope is drained by short, V-shaped gulches and ravines, often with precipitous slopes. Only two streams of any length occur. These are in Grandview Township, the northern one being known as Whisky Run. The western slope is drained by longer watercourses, with more rounded and gentler valley walls. The fall of the highland from east to west, with the exception of the northern part, where it is less, is 20 feet per mile. Several main creeks, the largest of which is Indian Creek, have developed. This stream has a bottom land one-eighth to one-fourth mile in width.

The drainage of the western upland, with the exception of the southwest half of T. 73 N., R. 4 W., and the extremesouthwestern corner of Elm Grove Township, which drain west and eventually into the Skunk River, is tributary to the Iowa River. In the southern tier of townships the streams run in a general northerly direction, while over the remainder of the eastern slope the general direction is east. Some of the north-flowing creeks have their beds partly in limestone, and here their valleys become relatively narrow.

In both the eastern and western drift plains, with the exception of a few small level areas, ample surface drainage is afforded by widely ramifying branches and streamlets. Even in the level areas there is probably no farm without a natural drainage outlet. The terraces are for the most part sufficiently drained for cultivation. In sandy areas the rain water readily soaks into the ground. Where the soil is heavier and underlain by a heavy substratum, the run-off is usually taken care of by tile and ditches connecting with the

streams crossing the terrace from the upland. Along the margin of the terrace there is in some places, adjoining the bottom or a lower lying terrace, an area that is very marshy as a result of seepage from the lower strata underlying the terrace. These seepy areas generally occur as narrow strips and are frequently mucky.

Drainage conditions in the first bottoms are somewhat varied. In the small narrow stream bottoms the land is generally wet and used for pasture, but along the larger creeks the bottoms are in many places sufficiently well drained to allow cultivation, as overflow either does not happen during the crop season or occurs so rarely that it does not make cultivation unprofitable. In the Iowa and Mississippi first bottoms, though practically all the land is naturally subject to overflow, levees and ditches have made it possible to cultivate the greater part.

The first white settlement in this territory was made in 1834, near the mouth of the Iowa River. The early settlers came from Ohio, Indiana, Kentucky, Virginia, Pennsylvania, and New York. Since then the proportion of German settlers has become large, and there have also been many settlers from the Scandinavian countries. Most of the early settlers located on the edge of the forest, where the sod was more easily broken, where fuel and building material were available, and where there was protection from the fires that swept the prairies. As time passed settlement gradually spread to the prairies. The early settlers came mostly by boat on the Mississippi and Iowa rivers. From 1841 to 1860 the Iowa River was navigable as far as Iowa City, a distance of about 90 miles. The population of Louisa County in 1850 was 4,939, and in 1860, 10,805. Since the latter year the increase has been slower, with occasional setbacks. The census for 1910 gives the population as 12,855, or 32.5 persons per square mile. As none of the towns within the county exceed 2,500, the entire population is classed as rural. Outside the towns the population is well distributed.

Wapello, with a population in 1910 of 1,532, is the largest town and the county seat. Columbus Junction is the next largest town, with a population of 1,107. Morning Sun, Letts, Oakville, Grandview, Columbus City, and Fredonia are credited with populations of 904, 456, 416, 375, 390, and 200, respectively. Cotter, Toolesboro, Wyman, Cairo, Newport, Marsh, and Elrick are smaller towns.³

Louisa County is well supplied with transportation facilities, five lines passing through the county and no farm lying more than 6 miles from a railroad. The wagon roads are generally in good condition.

³ Since this report was written the preliminary announcement of population of Louisa County, Iowa, and its civil divisions in 1920 has been issued by the Bureau of the Census, as follows: Louisa County, 12,179; rural, 12,179; Columbus City, 346; Columbus Junction, 988; Cotter, 100; Grandview, 341; Letts, 417; Morning Sun, 751; Oakville, 466; Wapello City, 1,480.

There is only one stretch of surfaced road in the county, but the highways are in general well graded and frequently dragged, and kept in good condition. Several automobile routes pass through the county.

Telephone service extends throughout the county, and practically every farm has telephone connection.

Educational facilities throughout the county are good. There are at present five consolidated schools.

The principal markets and shipping points within the county are Wapello, Columbus Junction, Morning Sun, Letts, Oakville, and Grandview. Each of these towns has a grain elevator. Chicago and St. Louis are the leading markets for grain, and Chicago the principal market for hogs and cattle.

CLIMATE.

The climate of Louisa County, while including a considerable range of temperature, is moderate and healthful. The highest temperature recorded is 106° F., while the lowest is -24° F. The mean annual temperature is 49.8° F. Periods of extreme heat in summer or cold in winter seldom last more than two or at the most three weeks.

The average annual precipitation is 34.07 inches. The greater part of this falls during the growing season, and is ample to supply the needs of the crops commonly grown in this latitude. Occasional droughts occur which are of great damage to crops on porous soils, but total crop failures are unknown. The average annual snowfall is 26.8 inches. Snow aids materially in preventing winterkilling of the fall-sown small-grain crops.

The normal growing season, or the period from the average date of the last killing frost in the spring, April 24, to that of the first in the fall, October 16, is 175 days. This is ample for maturing all the crops commonly grown in this region. Late-maturing varieties of corn, however, are occasionally caught by frost. The latest recorded date of killing frost in the spring is May 23, and the earliest recorded date in the fall, September 22.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded by the Weather Bureau station at Columbus Junction. The snowfall data are taken from the record of the Weather Bureau station at Washington, Washington County, and are doubtless representative of conditions in Louisa County.

Normal monthly, seasonal, and annual temperature and precipitation at Columbus Junction.

(Elevation, 595 feet. Length of record, 16 years.)

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year. (1901).	Total amount for the wettest year. (1902).	Snow, average depth. ¹
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	27.7	58	-17	1.31	1.96	2.16	6.0
January.....	22.0	66	-24	1.24	.92	.46	7.4
February.....	24.8	64	-18	1.59	1.23	.92	7.8
Winter.....	24.8	66	-24	4.14	4.11	3.54	21.2
March.....	36.4	85	-10	2.06	3.00	2.06	4.3
April.....	50.7	88	19	2.94	1.69	2.32	.5
May.....	62.4	93	29	4.10	1.95	4.81	T.
Spring.....	49.8	93	-10	9.10	6.64	9.19	4.8
June.....	71.0	99	38	4.16	1.05	7.77	0.0
July.....	75.0	106	49	3.91	1.82	10.90	0.0
August.....	72.7	102	40	5.23	1.73	15.47	0.0
Summer.....	72.9	106	38	13.30	4.60	34.14	0.0
September.....	65.3	100	30	3.16	2.54	4.00	0.0
October.....	52.9	87	19	2.51	1.34	4.77	T.
November.....	37.5	78	2	1.86	.80	3.16	.8
Fall.....	51.9	100	2	7.53	4.68	11.93	.8
Year.....	49.8	106	-24	34.07	20.05	58.80	26.8

¹ Snowfall record for Washington, Washington County.

AGRICULTURE.

From the time of the first settlement by white persons, agriculture has been the sole industry of Louisa County. During the early years of settlement grain farming was followed almost exclusively, wheat, corn, oats, and flax being grown. As the population increased live-stock farming grew in importance.

The corn acreage in 1910 was slightly higher than in 1880, that of rye slightly less, and that of wheat only two-thirds as large, while oats and hay each more than doubled in acreage. The area in barley increased from less than 100 acres to 766 acres. Practically no change is shown in the acreage devoted to Irish potatoes and sweet potatoes. From 1900 to 1910 the value of dairy products decreased from \$122,105 to \$79,104, while that of animals sold or slaughtered

increased from \$983,374 to \$2,132,345, and that of poultry products from \$68,025 to \$215,262.

At the present time the agriculture consists of live-stock farming supplemented by grain and truck farming. For the year 1909 the value of all crops approximately equaled that of all live stock and live-stock products. Corn is the principal crop, followed by oats, hay, winter wheat, rye, white potatoes, sweet potatoes, sweet corn, and barley. Alfalfa and spring wheat are grown to a small extent. Potatoes are practically the only subsistence crop, although some corn is ground locally. The money crops are wheat, part of the corn crop, part of the oat crop, and a small part of the hay crop (timothy and clover). All the stock is shipped except for a small number of hogs and cattle butchered for home consumption. Local butchers get about one-half their supply from the county.

Live-stock farming is carried on in practically all parts of the county except the more sandy areas of the terrace, the Mississippi bottoms in the vicinity of Hopewell School, and the section around Oakville. On the basis of value of products the cattle industry is the most important, followed by the raising of hogs, horses, and sheep. The census reports 1,330 calves, 19,111 head of other cattle, 51,268 hogs, and 3,086 sheep sold or slaughtered in 1909, and 1,297 horses and mules sold. The Iowa Yearbook for 1916 reports 27,878 head of cattle, 61,519 hogs, 9,978 horses, and 1,510 sheep on farms.

About 85 per cent of the farmers raise cattle, but not over 20 per cent of them finish the stock for market. Cattle are generally sold in the fall as feeders. About half the animals that are fed are purchased from the markets of Kansas City, Omaha, St. Paul, and Chicago. The feeding period ranges from 60 to 120 days. The usual feed is corn and ensilage with the addition of a concentrate which is generally cottonseed meal, and less frequently molasses feed. The principal breeds of cattle raised are, in the order of their importance, Shorthorn, Aberdeen Angus, and Hereford. Most of the cattle are grades, but the purebred beef-cattle industry is of considerable importance. There are at the present 25 purebred Shorthorn and Polled Durham herds and 4 each of Aberdeen Angus and Hereford.

Dairying has scarcely been undertaken on a commercial scale. One farm, which ships cream, has a herd of about 30 cows, but on most farms only a small number of cows are milked. These are kept mainly to supply milk for home use, the surplus being sold in the towns in the form of milk, cream, or butter. The leading breeds of dairy cows are grade Shorthorn, grade Jersey, and grade Holstein. There are probably no purebred dairy cows in the county.

Hogs are raised on about 90 per cent of the farms, and about 80 per cent of the farmers who raise hogs fatten their own stock. Of

the hogs sold in the county about 90 per cent are home raised and 10 per cent are shipped in to be fattened. All the farmers who feed steers keep hogs, to follow the cattle. The average length of the feeding period is 100 days. Corn and tankage are the principal feeds. A small percentage of the corn crop is harvested by being hogged down, and this practice will probably become increasingly popular in the future. The raising of purebred hogs is quite an important industry, although it is less developed than the raising of purebred cattle and horses. There are 12 breeders of purebred Poland-China, 7 of Duroc-Jersey, and 3 of Chester White hogs.

Horse raising is carried on as a side line by most farmers, who make a practice of selling their surplus colts. The principal breeds represented are Percheron and Shire. The grade horses are almost all Percherons.

There are three or four flocks of grade Shropshire sheep in this county. The remainder are western sheep shipped in to be fattened. Lambs weighing about 40 pounds are bought and turned in the corn fields and sold when they reach a weight of 60 to 80 pounds. In some cases corn is fed during the fattening period.

Corn, the principal crop, is grown in all parts of the county. Very little is shipped out of the county, however, except from Oakville. A considerable quantity changes hands from grower to feeder, and the remainder is fed on the farms where produced. In 1916, out of 58,822 acres in corn, according to the Iowa Yearbook, about 1,500 acres were cut for 111 silos. The number of silos and consequently the acreage cut for ensilage has doubled since then. About 80 per cent of the corn grown is yellow, the remainder being for the most part white. The length of maturing period of the varieties grown is 100 to 120 days. The varieties of yellow corn most commonly grown are Reids Yellow Dent, Leaming, Golden Glow, Goldmine, Pride of the North, and Minnesota No. 13. The last two are especially early. The leading white varieties are the Silvermine, Silver King, and J. K. Brown, and the leading mixed varieties Bloody Butcher and Calico.

About two-thirds of the oats produced is shipped out of the county, the remainder being fed on the farms. Almost the entire quantity shipped from the county is first sold to local elevators, as producers seldom ship directly to the grain centers. Only spring oats are grown. The early varieties predominate, since with late oats the hot weather generally prevents the proper filling of the heads. The principal early varieties are the Iowa 103, Texas Red, Kherson, and Iowa 105; the principal late varieties, the Silvermine and Green Russian.

Practically no hay is shipped from the county. Timothy and medium red clover predominate over all the other hay crops. Alfalfa

is next in importance. In 1916 it occupied a total of 150 acres, according to the Iowa Yearbook. Small areas of alsike clover, millet, and cowpea hay are produced. Millet is seeded where corn has been drowned out. The production of cowpea hay is largely confined to the sandy areas near Fredonia.

All the wheat produced is sold to the elevators. There are three leading varieties of winter wheat, among which Turkey is by far the most extensively grown. Next in importance is Iowa 404, which normally occupies 500 to 600 acres; and then Malakoff, occupying 400 to 500 acres. The leading varieties of spring wheat are Early Java and Marquis.

Of the rye produced, two-thirds is shipped out of the county. The barley, however, is all used for feed. The Oderbrucker (six-rowed) is practically the only variety grown.

A considerable acreage is devoted to crops for canning. A factory at Columbus Junction, which manufactures catsup, gets its supply of tomatoes from about 400 acres fairly evenly distributed in the vicinity. A factory at Wapello is primarily engaged in the canning of sweet corn, although this year (1918) they have also canned string beans. All the sweet corn produced in the county, except that grown in gardens for home consumption, is taken by the canning factory. The factory obtains part of its raw material from an area of about 250 acres which it farms, the remainder being contracted for with farmers. In 1918 the contract price was \$14 a ton, in the shuck, delivered at the factory. The farmers buy their seed from the factory. During the 1918 season corn and beans from about 2,800 acres were canned. The leading varieties of sweet corn are the Country Gentleman and Evergreen.

Orcharding is carried on to a very small extent. There are seven or eight commercial apple orchards, averaging about 10 acres each. One is situated near Newport, another near Cairo, and the rest near Columbus Junction. The fruit is for the most part sold within the county. Probably two-thirds of the farms have home orchards, which seldom are over one acre in size. The orchards consist mainly of apple trees, though there are many cherry trees and smaller numbers of peach, pear, and plum. Only the winter varieties of apples are grown commercially, and these are chiefly the Ben Davis, Grimes, Jonathan, and Gano. Some strawberries, raspberries, blackberries, and grapes are grown.

Trucking may be said to be limited to the sandy parts of the terraces and the sandy part of the Mississippi bottoms in the vicinity of Hopewell School. Melons have given good results, but lately they have been largely displaced by sweet potatoes. Some water-melons and a smaller acreage of cantaloupes are still grown, two-thirds to three-fourths of the crop being consumed within the county.

About 1,000 acres are devoted to melons, 200 acres to sweet potatoes, and 200 acres to cabbage.

There are several cooperative concerns for the buying and selling of farm products and supplies. The Farmers Union Exchange at Columbus Junction buys products such as butter, eggs, and poultry and sells groceries, farm implements, coal, and feed. The Farmers Union Elevators at Wapello, Morning Sun, and Marsh sell flour, mill feeds, and concentrates.

Owing to the lack of variation from place to place, soil and topography have comparatively little influence on the distribution of crops. Orchard fruits are known to do best on slopes, where the air drainage is good. On Muck areas the small grains in general and oats in particular have been found to produce an excessive growth of straw which causes lodging before time for harvest. Farmers recognize some soils as best adapted for the production of certain crops. Sandy soils are considered best suited for the growing of melons, sweet potatoes, rye, early varieties of corn, and truck crops in general. The light-colored, naturally forested bluff soils are preferred for growing wheat, and the dark-colored prairie upland soils for corn and oats. Alfalfa has been found to give best results on soil high in lime and where the subsoil is well, though not excessively, drained. There seems to be no assignable reason for the approximate restriction of winter wheat to the first bottoms and terraces and the upland east of the Iowa River.

About 60 per cent of the land for corn is plowed in the fall, to a depth of 5 to 6 inches, and left rough over winter. In spring plowing, the land is frequently disked before plowing and harrowed afterwards; otherwise it is plowed, harrowed, and then disked. Planting is usually done between May 10 and June 1. About 95 per cent of the corn is checked, the balance being drilled. None is listed. Of that drilled, the greater part is grown for fodder and is drilled close, about 1 foot apart in the row. Checking is usually 3 feet 6 inches each way, but sometimes 3 feet 8 inches on the wire. After planting, a harrowing is given within a week, or before it rains. This breaks the crust and prevents erosion in the planter marks, the latter being especially important on rough ground. The crop is cultivated an average of three times, the first two cultivations being deeper than the last. Level cultivation, with very little ridging, is generally practiced. Six-shovel cultivators (three to a gang) are commonly used. In harvesting the crop, approximately 75 per cent is husked from the standing stalks, 10 per cent is cut for ensilage, 10 per cent for fodder (of which about 20 per cent is shredded), and the remaining 5 per cent is "hogged down." In the last few years soy beans have been grown with corn on a few farms. They are seeded in the hill at the time the corn is planted. The seed is generally mixed in the planting hopper, which is set to drop two beans and two kernels per hill.

No winter oats are grown in this county. Spring oats are generally sown on corn stubble without any preparation of the land before seeding. A small acreage is drilled in, but most of the crop is broadcasted with an end-gate seeder at the rate of 3 bushels per acre. Seeding generally takes place between March 25 and April 15. After sowing, the land is double disked and harrowed. Most of the crop is thrashed from the shock, probably not over 1 per cent being stacked. Not over 5 per cent of the straw is baled, and little of this is shipped out of the county. The greater part of the straw is used for bedding and feed.

Timothy and clover are customarily broadcasted after the disking of oat fields, and before harrowing. Very little timothy and clover is grown without a nurse crop. When oats are used as a nurse crop, only 2 bushels, instead of the customary 3, are seeded per acre. The rate of seeding for mixed timothy and clover is 6 pounds of timothy and 8 pounds of clover per acre. Either medium-red or alsike clover is grown. Grown separately, the rate of seeding is 12 to 14 pounds of medium-red clover, 8 to 15 pounds of alsike clover, or 10 to 12 pounds of timothy. Hay is not cut the first year, though sometimes a little pasturage is obtained late in the fall. The next year one cutting of red clover is obtained for hay, and a second lighter cutting for hay or seed. With either alsike clover or timothy only one cutting is obtained, which may be used for either hay or seed. Very little alsike is hulled for seed, but about 2 per cent of the medium-red clover and about 5 per cent of the timothy is thrashed. Of the total clover crop, about 10 per cent is alsike, which is grown on the lower wetter and more acid soils. Very little hay is baled.

Winter wheat usually follows oats or winter wheat, more often the former. The ground is plowed in the fall to a depth of 5 inches, disked, lap disked, and harrowed. The seed is drilled in at the rate of 5 to 6 pecks per acre between September 10 and October 10. After September 25 danger from the Hessian fly is supposed to be past.

Rye is sown almost exclusively on sandy soils, generally following oats or rye. The seed bed is prepared as for winter wheat but with less disking and harrowing. The crop is seeded at the rate of 5 pecks per acre between September 20 and October 20. Barley is seeded about 10 days later than oats, as it is not as hardy. It is always broadcasted, and is sown on land in corn the preceding year. Spring wheat is seeded before oats and also on land last in corn, generally between March 15 and April 5.

Potatoes usually follow oats though sometimes corn. The crop is in most cases followed by corn. The ground is usually fall plowed, allowed to lie rough over winter, and in the spring disked, lap disked,

harrowed, and lap harrowed. Planting of the early crop is done between April 20 and 30, and of the late crop between May 15 and 30. Planters are used by some farmers, but in most cases the rows are marked off with a plow and the seed dropped by hand. The crop is either dug with a potato digger or plowed out. About August 15 the early crop is harvested, while the late crop is gathered between September 15 to October 15.

In growing sweet corn the same methods are used in seed-bed preparation, planting, and cultivating as in the case of field corn, except that the date of planting is a little later. Sweet corn is frequently the crop used in replanting bottomlands. The ears are snapped in the field and hauled to the canning factory, the stalks being used later for pasturage or cut for fodder.

About 5 per cent of the alfalfa grown in the county is started with the aid of a nurse crop, which is generally oats but sometimes rye. The seed bed is well prepared and frequently summer fallowed and harrowed repeatedly before seeding, to get rid of the weeds. If a nurse crop is used seeding is done in April, otherwise in June or August. The blue-flowered Kansas or Nebraska common seed or the Grimm variety is used and sown at the rate of 15 to 20 pounds per acre. If a nurse crop is used one cutting is made for hay, otherwise the crop is not cut the first year. After the first year three or four cuttings are obtained annually. The first cutting is made between June 1 and June 10, the second about July 15, the third about August 25, and the fourth about September 15.

On a majority of the farms in Louisa County the buildings include beside the house a horse barn, cattle barn, corn crib, hog houses, granary, poultry house, machine shed, garage, and hay rack. The machinery usually includes a gas engine for pumping, grinding, and similar work; walking, sulky, and gang plows; disk harrow, spike-tooth harrow, corn sheller, end-gate seeder, grain drill, binder, mower, and dump rake. About 20 per cent of the farms have silos. There are a few double-row cultivators in use, and five or six tractor cultivators. Corn binders are found on about 30 per cent of the farms. There are a few shredders, 60 to 75 ensilage cutters, and several side-delivery rakes and hay loaders. Manure spreaders are found on 50 per cent or more of the farms. There are numerous orchard-spraying outfits, about 70 thrashing outfits, 7 or 8 clover hullers, and 80 to 100 tractors, mostly of the 2, 3, and 4 bottom sizes. The work stock is of good quality. Much emphasis has been placed in recent years on the desirability of good stallions. Only about 3 per cent of the work stock consists of mules. The horses average medium to heavy, weighing 1,200 to 1,500 pounds.

Most of the farmers of Louisa County follow a more or less definite rotation. About 60 per cent use a rotation consisting of corn, corn, oats and clover or wheat and clover, and clover. Of the remainder about 20 per cent use the following rotation: Corn, corn, oats, wheat, and clover. Another 20 per cent rotate corn and oats, with an occasional change to clover. Where winter wheat is grown the crop sequence is generally corn, corn, wheat, wheat, and clover. On especially sandy soils corn, rye, and clover are often grown in rotation.⁴

The census reports that only 1.4 per cent of the farms used commercial fertilizer in 1909, at a total cost of \$815. A considerable quantity of lime, which is used for correcting soil acidity, is shipped in each year. In 1918 about 1,000 tons were imported. Barnyard manure is generally applied to sod following removal of the hay and before plowing for corn.

Farm laborers in this county are white, and mostly of American birth. Before the war demands created unusual conditions the supply was abundant. Wages for a single man were ordinarily \$30 to \$40 a month and board; for a married man, \$40 to \$50 and the use of a house, garden, a cow or poultry, and sometimes fuel; and for day labor, \$1.50 to \$3. Corn husking was paid for at the rate of 3 to 6 cents a bushel, depending on the season, yield, and other conditions.

The 1910 census gives the number of farms in the county as 1,543, practically the same as in 1880. The range in size is from 40 acres to about 1,600, with an average in 1910 of 153.6 acres. Of the area of the average farm, 80.6 per cent, or 123.7 acres, consists of improved land.

The census shows a steady decrease in the percentage of farms operated by owners, from 77.5 per cent in 1880 to 64.4 per cent in 1910. Of the farms operated by tenants, only about 15 per cent are rented for cash. In most cases the tenant furnishes the live stock, implements, one-half the seed, and pays \$5 to \$7 per acre for pasture; the land owner furnishes one-half the seed, and receives one-half the crop.

The average assessed value of farm land as shown by the census increased from \$36.56 an acre in 1880 to \$90.78 in 1910. At the present (1918) land values range from \$40 or \$50 an acre for very sandy or unimproved, undrained land to \$300 an acre for the best improved, well-located upland. The average valuation of upland farms at the time of writing is about \$150 to \$175 an acre.

⁴ One farmer is building up some sandy land in a profitable manner by following sweet corn with rye, put in with a one-horse drill at the last cultivation; the whole crop is pastured. This process is repeated each year.

SOILS.⁵

On the basis of origin and processes of accumulation of the soil material, the soils of Louisa County may be divided into three principal groups, namely, loessial, glacial, and alluvial.

Loess, which is the parent material of the most extensive soils, forms a mantle over the glacial drift of the entire upland except where it has been removed by erosion. It is thickest over the eastern part of the upland, being about 20 feet thick along the bluffs of the Mississippi River and thinning out toward the west. In places south of Elrick and along the west bluff of Iowa River it is 15 feet thick, but a mile west of these bluffs it thins down to 8 feet and continues toward the west at that thickness or a little less. The loess is usually thicker along the slopes of the larger valleys. When the bluffs face the west, the edge of the upland is frequently bordered by a ridge of fine sand. A good example of this is seen north of Wapello, northwest and southeast of Hog Back.

The loess in its unweathered condition is an even-grained material composed largely of silt. The color ranges from light grayish brown to yellowish brown. The material is slightly coherent where undisturbed, but breaks down readily into a loose, floury dust. Under erosion it has a tendency to maintain vertical banks, and these often show a columnar structure. A number of distinct soils have been derived from the loess in this area. Differences in their color and composition are due in part to variations in the original material, but probably to a greater extent to the different conditions under which weathering has taken place and to the unequal periods of time during which the processes of weathering have operated. The most noticeable changes that have taken place are the accumulation of organic matter in the surface soil, the concentration of clay in the subsoil, and the leaching and partial removal of lime from the weath-

⁵ The southwestern part of Louisa County, joins the northeastern corner of Henry County. Small areas in Henry County were mapped as Marion silt loam but in Louisa County the adjoining areas were mapped as Clinton silt loam. The only difference between the two soils consists in the lighter color of the Marion. In the more recent mapping of Louisa County these areas were not considered light enough in color for inclusion in the Marion series.

In several places along the boundary between the two counties the Grundy soils in Henry County abut against Tama soils in Louisa County. This is due to the creation of the Tama series since the Henry County map was completed. The Tama soils differ from the Grundy in having more penetrable and lighter textured subsoils.

When Muscatine County was mapped a large part of the area known as Muscatine Island was mapped as low terrace, on the ground that it was thought to lie above possible overflows. When Louisa County was surveyed several years later it was learned that during stages of extreme high water the area overflows, and so the same soil was mapped as an alluvial bottom-land type rather than a terrace type. On the Muscatine map they are shown as Buckner soils and on the Louisa map as Cass, the difference being that the Buckner soils occur on terraces above overflow and the Cass soils at a lower level and subject to at least occasional flooding. The more detailed work done in Louisa County shows the presence of a loam where it was mapped as sand in Muscatine County.

ered upper zone. In the more nearly level upland areas, weathering under conditions of imperfect drainage has resulted in a mottled lower subsoil. The accumulation and retention of the black organic matter that imparts the dark color to these soils has been favored by their prairie condition, topography, abundant vegetation, and probably by an adequate supply of lime. The light-colored soils derived from the loess were originally wooded, and owing to their more rolling surface, which made erosion, leaching, and oxidation more active, conditions for the accumulation of organic matter were much less favorable.

In this area the darker colored loessial soils are divided into three series, the Grundy, Tama, and Muscatine. The light-colored loessial soils are classed with the Clinton and the Knox series. The Putnam series has a rather dark surface soil but has a lighter gray subsurface layer.

Beneath the loess and overlying the bedrock are beds of glacial drift composed of rock débris left by successive invasions of the continental ice sheets. Three beds of different age have been identified in this area, but the two older are covered by the later or Iowan sheet. The drift is exposed only along deep stream valleys, and the soil derived from it is of small extent. It is correlated as the Lindley silt loam.

The bedrock of the area, consisting of shale and limestone, is exposed only to a very slight extent and its weathered products affect the composition of the soils only over very small areas, none of sufficient extent to indicate on the soil map.

The alluvial or stream-deposited soils fall into two broad groups, terrace soils, covering the benches or second bottoms, and first-bottom or flood-plain soils. The terraces lie above the present limit of overflow from the streams, but the first bottoms are subject to occasional or frequent inundations except where artificial protection has been provided. The more thorough weathering, aeration, and leaching of the older terrace soils justifies their separation from the newer soils of the present flood plains.

The Grundy soils are dark brown to black and underlain by a rather heavy, mottled dark-brown, drab, yellowish-brown, and rusty-brown subsoil. Frequently the lower part of the surface layer is slightly lighter colored than the upper part, suggesting a gray subsurface layer. The topography varies from level to rolling, but is predominantly gently rolling.

The Muscatine soils are dark brown to black, overlying dark-brown, light brownish gray, grayish-brown, and yellowish-brown subsoils. Below a depth of 24 inches the subsoil is heavier in texture and brown or yellow mottled with gray. This material extends to a depth of 3 feet or more, though sometimes the lower 6 inches of the 3-foot section gradually becomes looser than that immediately above.

These soils occupy level to slightly undulating prairie. They are similar to the Grundy in general appearance, but typically they have a subsoil little heavier than a heavy silt loam and mottling occurs at 24 to 30 inches below the surface. In this county the subsoil is heavier and more compact as the series gradually passes into the Grundy. Going north from Lee and Henry Counties to Muscatine and more northern counties, the difference between the two series is well marked, but in this county the separation is rather arbitrary. It was found that the Iowa River marks the dividing line between the two soils, and accordingly the prairie soils of the eastern upland were mapped in the Muscatine series and those of the western upland in the Grundy series.

The Clinton series is characterized by gray or dark-gray surface soils, underlain by light-brown or yellowish-brown compact subsoils. The topography is rolling to broken, and surface drainage is well established. These soils occur in areas that were forested in the virgin state.

The Tama soils are dark brown, underlain by yellowish-brown, moderately friable subsoils. The members of this series occupy rolling areas which were predominantly prairie in their natural state. They are intermediate in characteristics between the Clinton, on the one hand, and the Grundy and Muscatine, on the other.

The Knox soils are brown, with light-brown or yellow, friable subsoils. The topography ranges from gently rolling to sharply rolling. These soils are derived from wind-laid material.

The Putnam soils are light brown or medium brown to a depth of 6 to 12 inches, where they are underlain by a gray layer little if any heavier than the surface soil and extending to a depth of 12 to 20 inches. Here there is encountered a heavy, plastic clay, mottled dark drab and yellowish brown. The transition from the subsurface layer to subsoil is quite abrupt. The lower subsoil is mottled dark brown, drab, and yellowish brown, and is generally lighter in texture than the upper subsoil, though no lighter than the surface soil. The topography of the Putnam soils is smooth. They closely resemble the Grundy, but differ in the presence of the subsurface gray layer and in the slightly lighter color of the surface soil. The one member of this series mapped in this county is found principally around the heads of drainage ways and where the prairie and forest meet.

The glacial soil in this county is derived from the Kansan or Illinoian till according to the part of the county in which it occurs. Only one glacial series, the Lindley, has been mapped in this county. The Lindley soils are generally yellowish brown, ranging from gray to brown, and are typically shallow, the dark silt surface layer seldom extending to a greater depth than 8 inches. They are underlain by yellowish to yellowish-brown, or occasionally reddish-brown,

subsoils, in most places free from mottling but here and there faintly mottled with gray. The subsoil is heavier than the surface soil, though generally containing considerable sand or gravel. Small rock fragments are in most areas present throughout the 3-foot section, and iron concretions occur in the subsoil. The topography is for the most part rather rough. The Lindley soils are naturally forested.

The terrace soils are thought to be derived from alluvial materials, capped with a thin veneer of loess.⁶ Those along the Iowa and Cedar Rivers are supposed to have been built up at the time of the Iowan ice invasion, while those along the Mississippi River, in the north-eastern corner of the county, represent deposits from the drainage waters of the Wisconsin ice.⁷ The soils on the terraces are grouped in four series, namely, the Bremer, Buckner, Waukesha, and Calhoun.

The soils of the Bremer series are black and underlain by gray to black, heavy-textured subsoils, mottled with drab and yellowish brown. The subsoils are as heavy as the surface soils, or heavier, to a depth of 3 feet or more, and in the heavier members of the series are tough and plastic. In their natural state the drainage is fair to poor. The series is distinguished from the Wabash in lying above overflow.

The Buckner series includes brown to dark-brown surface soils underlain by lighter colored, friable subsoils, having a texture similar to that of the soil. These types are composed of reworked loessial material frequently mixed with sediments from glacial and residual soils. The drainage is good and occasionally slightly excessive.

The Waukesha soils are dark brown to black and underlain by a light-brown to yellow, friable subsoil. The latter, while heavier than the surface soil, is not compact or impervious. The Waukesha soils are naturally well drained.

The members of the Calhoun series have gray to grayish-brown surface soils, and a gray or drab, heavy clay subsoil. The latter is tenacious, waxy, and impervious, and generally contains iron concretions. In places the substratum consists of sandy material. The Calhoun soils occupy poorly drained, or what were at one time poorly drained, flats. While they lie above overflow, water generally stands in the hollows after rains, owing to the impervious nature of the subsoil. Many of the areas occupied by these soils are naturally forested.

The first-bottom soils consist of alluvium deposited in comparatively recent times by the streams they adjoin. They include two series, the Wabash and Cass, and in addition the miscellaneous types of Muck and Riverwash.

⁶ Geology of Louisa County, by J. A. Udden, Iowa Geological Survey, Vol. XI, 1901, p. 113.

⁷ Idem, pp. 113-114.

The Wabash series includes dark-brown to black soils, high in organic matter, underlain by a heavy subsoil ranging in color from dark brown to dark drab or gray, and mottled with yellowish brown. The alluvium has been derived principally from loessial and silty glacial uplands. Except where protected by levees, the Wabash soils are subject to overflow. Natural drainage is well established in some places, but here and there it is rather imperfect.

The Cass series is characterized by dark-brown to black surface soils, underlain by a lighter textured subsoil. In places the subsoil passes into loose sand or gravel within the 3-foot section, while in other places, after passing through material coarser than the surface soil, it is underlain by heavier textured material. While these soils are subject to overflow unless protected by levees, they are in most cases, owing to the porosity of the subsoil layer, naturally well drained. They differ from the members of the Wabash series in their lighter textured subsoil.

The following table gives the name and the actual and relative extent of the various soils mapped in Louisa County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Clinton silt loam	43,200	17.0	Buckner fine sand.....	3,136	1.2
Tama silt loam.....	26,688	10.5	Cass silty clay loam	2,944	1.2
Grundy silt loam.....	26,432	10.4	Riverwash.....	2,496	1.0
Muscatine silt loam	22,464	8.9	Cass sand	1,984	0.8
Lindley silt loam.....	19,328	7.6	Buckner sand	1,408	0.5
Wabash silty clay loam	18,496	7.3	Calhoun silt loam	1,344	0.5
Wabash loam	13,568	5.4	Buckner silt loam	128	0.5
Waukesha silt loam	10,752	4.2	Colluvial phase.....	1,152	
Wabash clay.....	10,240	4.0	Bremer clay.....	1,216	0.5
Cass loam	9,088	3.6	Muck	1,216	0.5
Buckner fine sandy loam.....	9,024	3.6	Knox fine sand	640	0.3
Buckner loam.....	7,872	3.1	Putnam silt loam.....	384	0.2
Bremer silty clay loam	5,248	2.1	Muscatine silty clay loam.....	256	0.1
Bremer silt loam	4,864	1.9			
Grundy silty clay loam	4,544	1.8	Total.....	253,440
Cass sandy loam	3,328	1.3			

GRUNDY SILT LOAM.

The surface soil of the Grundy silt loam is a dark-brown to black, friable silt loam, extending to a depth of about 12 inches. The subsoil is a dark-brown to black, heavy silt loam to silty clay loam, passing at 18 to 20 inches into a dark-brown silty clay loam slightly mottled with yellowish brown. At about 24 inches this in turn passes into a heavy silty clay loam to silty clay which is strongly mottled dark brown, bluish gray, and yellowish brown. The dark brown soon disappears and the material becomes heavier and more compact with

depth. The lower subsoil is frequently very tenacious. The bluish-gray tone is in some places rather light and in others rather dark, the latter seeming to be the case where the soil is wet.

This is the predominant soil on the western upland. It occupies, with the exception of the most nearly level areas, the less dissected portions of the upland back from the bluffs, and in some cases extends uninterruptedly for several square miles. It generally adjoins the Grundy silty clay loam and Tama silt loam, but occasionally borders the Lindley silt loam or Clinton silt loam, and in some cases extends down a gentler slope. One of the more noticeable of the slope areas adjoins the old Illinoian River channel.

The topography varies from almost level to gently rolling. Both surface run-off and underdrainage are good over the greater part of the type, though a few places on slopes are slightly seepy. While tiling is not essential to crop production, many farmers have put in tile and consider the investment profitable.

The Grundy silt loam is one of the most important soil types in the county. Between 90 and 95 per cent of it is in cultivation, the remainder being used for building sites, feed lots, barn lots, and temporary pasture. The type is preeminently a corn soil, and one of the best in the corn belt. Other important crops grown are oats, hay, and wheat. Cattle raising and feeding and the other less important branches of live-stock farming are well developed on this soil.

Corn yields ⁸ range from 35 to 75 bushels per acre and average about 45 bushels. Higher yields have been made in a few instances. Oats yield 35 to 75 bushels, with an average of about 50 bushels. Clover and timothy range in yield from three-fourths ton to 2 tons, with an average of 1½ tons. Spring wheat yields 10 to 40 bushels, with an average of about 25 bushels. By following the proper methods, alfalfa can be grown, and it is produced to a small extent. The average yield for the season is about 2¾ tons per acre.

Land of this type sells at \$150 to \$300 an acre,⁹ with an average of \$180 an acre. The price varies with the improvements and the nearness to towns and lines of transportation.

GRUNDY SILTY CLAY LOAM.

The Grundy silty clay loam has a surface soil of dark-brown to black silty clay loam, underlain at a depth of 12 inches by a black, heavy, plastic silty clay, which at 18 inches becomes dark gray, mottled with pale grayish yellow and rusty brown. With increased depth the subsoil becomes increasingly heavy and plastic and the pale

⁸ Yields for this and other soil types are estimated from State crop reports, U. S. Census data, and the observations of field men during the progress of the survey.

⁹ Land values as stated for this and other soil types are based in part on reported land sales and in part on observations of the field men during the progress of the survey.

grayish yellow to light-gray mottlings increasingly abundant. In the area mapped just south of the town of Morning Sun, the surface soil is perceptibly heavier than typical, more nearly approaching a silty clay.

The type occurs for the most part on the level divides between the Iowa and Skunk Rivers and between the more important creeks. It also occurs at the heads of gently sloping draws (though it is generally of too small extent to be mapped in these positions) and in low-lying, depressed areas, the largest and most typical example of which is in sec. 36, T. 74 N., R. 5 W., in the old Illinoian River channel. The type occurs in areas varying in size from a few acres to several hundred acres. The largest area lies about 3 miles southeast of Wyman, the town itself being situated on a slightly smaller area. The type is almost always surrounded by Grundy silt loam.

Surface drainage is naturally deficient, but draws have cut back to such an extent from the other soil types that an outlet for ditching or tile, with ample fall, is available. In spite of the compact structure and heavy texture of the subsoil, tile drains, when properly spaced, seem to have no difficulty in carrying off the surplus water.

Although not so extensive as the Grundy silt loam, this type is very important agriculturally, being, where well drained, fully as productive and probably having greater inherent fertility. Between 85 and 90 per cent is in cultivation, the remainder being in lots and building sites, with a rather small area in pasture. This type is sometimes left in pasture until a tile drain has been installed. It is naturally prairie, none of the areas being forested. Like the Grundy silt loam, it is particularly a corn soil, the other important crops being hay, oats, and, on some farms, wheat. On account of the absence of hollows, which makes this type so admirably suited for cultivation, the different branches of live-stock farming are not as well developed as on the Grundy silt loam.

Corn ranges in yield from 35 to 80 bushels, with an average of about 50 bushels per acre; hay from 1 to 2 tons, with an average of 1½ tons; oats from 35 to 80 bushels, with an average of about 50 bushels; and wheat from 8 to 35 bushels, with an average of 20 bushels.

Owing to its heavy texture, this soil tends to stick to cultural implements when wet, and if handled in such condition it tends to bake and clod upon drying. Barnyard manure is practically the only fertilizer used. The application of lime, as on other types, is coming into more general use.

This land sells for \$150 to \$250 an acre, with an average of about \$170. Prices depend upon the improvements and the nearness to towns and transportation lines.

The productiveness of the Grundy silty clay loam can be increased by the application of lime, the incorporation of all the vegetable matter possible through the plowing under of a green-manure crop whenever feasible, and a greater depth of plowing to be attained gradually.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Grundy silty clay loam:

Mechanical analyses of Grundy silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
332461.....	Soil.....	0.0	0.8	0.4	2.4	4.4	60.4	31.9
332462.....	Subsoil.....	.0	1.6	.9	5.1	6.2	53.8	32.8

MUSCATINE SILT LOAM.

The surface soil of the Muscatine silt loam is a dark-brown to black, friable silt loam, extending to a depth of 12 inches, underlain by a dark-brown or medium-brown, heavy silt loam, which soon passes into a silty clay loam. At 22 to 24 inches the subsoil becomes mottled light bluish gray and yellowish brown with a lesser amount of rusty brown, and contains some dark-brown to black iron concretions. In the lower part of the 3-foot section the texture frequently approximates silty clay, but the type never becomes as heavy and compact as the Grundy silt loam. The type as it occurs in this county is quite uniform. In some of the less well drained places the light bluish gray color in the subsoil is displaced by dark bluish gray.

The Muscatine silt loam is the predominant type of the eastern upland. With the exception of a few included areas of Muscatine silty clay loam, it occupies the greater part of the upland back from the bluff and back from the better drained sections. The type generally adjoins the Tama silt loam, but occasionally the Clinton silt loam, and very rarely the Lindley silt loam. The topography is level to gently rolling. Both surface run-off and underdrainage are generally good, though there is a slight inclination to seepiness in some places.

As previously stated, this soil and the Grundy silt loam differ almost imperceptibly, the former being mapped in the eastern upland and the latter in the western, the Iowa River being taken as the boundary. This somewhat arbitrary separation is necessitated by the gradual lightening of the color and texture of the subsoil to the north.

The principal crops grown on the Muscatine silt loam are corn, oats, hay, and, to a lesser extent, wheat. Winter wheat is grown on the eastern upland almost to the exclusion of spring wheat. Yields

range from 15 to 40 bushels, with an average of about 25 bushels per acre. Yields of other crops, the methods of handling the soil and land values are about the same as in the case of the Grundy silt loam.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Muscatine silt loam:

Mechanical analyses of Muscatine silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
332419.....	Soil.....	0.2	0.2	0.3	1.6	14.2	60.2	23.4
332420.....	Subsoil.....	.1	.5	.9	4.2	17.9	53.6	22.9

MUSCATINE SILTY CLAY LOAM.

The Muscatine silty clay loam has a surface soil of black silty clay loam, underlain at a depth of 10 inches by a black silty clay, which at 16 inches becomes tinged with gray and at 22 inches changes to light gray or light bluish gray, mottled with yellowish brown. The subsoil becomes heavier textured and more plastic with depth, and at about 32 inches the mottled color generally gives way to uniform gray. With the exception of one small area near the headwaters of Johnny Creek, this type is confined to the eastern upland, where it occurs in small areas, the largest of which is probably not over 50 acres, within areas of the Muscatine silt loam. In most places it occupies level flats on drainage divides, but in a few instances occurs in low, depressed flats. Natural drainage is only poor to fair, but, owing to the smallness of the areas and the nearness to slopes and hollows, ditching and tiling provides good drainage.

This type is of small extent, but it is very important agriculturally. Except for the substitution of winter wheat in place of spring wheat, the crops, yields, cultural methods, and land values are the same as in the case of the Grundy silty clay loam. The same suggestions should be adopted for the improvement of farm practices.

Mechanical analyses of samples of soil and subsoil of the Muscatine silty clay loam gave the following results:

Mechanical analyses of Muscatine silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
332421.....	Soil.....	0.0	0.5	0.3	4.2	11.0	63.4	20.6
332422.....	Subsoil.....	.0	.8	1.3	4.2	12.4	59.4	21.6

CLINTON SILT LOAM.

Clinton silt loam consists of a light yellowish or grayish-brown to buff, velvety silt loam, extending to a depth of 12 inches and underlain by a moderately friable silty clay loam. In the lower subsoil a very faint gray mottling is sometimes observed. In several places particularly in the vicinity of Bethel Church, numerous patches, too small to map separately, of fine sandy loam are encountered. In the southeast corner of sec. 15, T. 75 N., R. 4 W., a small area of the type occupies a rather level position below the general elevation of the upland plain, somewhat resembling a terrace. The type is derived from the same loess formation as the other loessial types, but differs from them in physical properties and in topography. Owing to the pronounced surface relief and the consequent better aeration, the subsoil is more oxidized and unmottled, while the color of the surface soil is lighter, owing to the forest growth, which prevented such an accumulation of organic matter as characterizes most of the prairie soils. The type is locally referred to as "mulatto" soil.

The Clinton silt loam is well distributed over both the east and west upland. It occurs near the edge of the bluffs and main drainage ways of recent development, where the draws are steep and V-shaped. It generally occurs between the Tama, Grundy, or Muscatine soils and the Lindley, terrace, or first-bottom soils in an irregular strip, varying from a fraction of a mile to 2 or 3 miles in width. Frequently it merges gradually with the Tama silt loam, so that the division between the two types is rather arbitrary. This is particularly true $1\frac{1}{2}$ and $2\frac{1}{2}$ miles north of Cotter.

The type is steeply rolling to broken, though including some level areas between hollows, and is well drained. It is quite important agriculturally, the greater part being in cultivation and the remainder, aside from that used for lots and building sites, in pasture, generally woods pasture. All of the type was originally forested, the growth consisting of white oak, post oak, black oak, shagbark hickory, elm, ash, hawthorn, and elderberry.

This soil is used for all the farm crops commonly grown, mainly wheat, rye, oats, corn, and hay. It is preeminently a wheat soil, as wheat seems to be better adapted to it than any other crop. Rye is grown more extensively than on any other upland type. Corn, while quite generally grown, does not yield as heavily as on the other dark-surfaced upland types. The different branches of live-stock farming are fairly well developed on this soil. Corn yields 25 to 50 bushels per acre with an average of 35 bushels; oats, 30 to 60 bushels, with an average of 35 bushels; hay, one-half ton to $1\frac{1}{4}$ tons, averaging three-fourths ton; winter wheat, 15 to 45 bushels, averaging about 28 bushels; spring wheat, 10 to 40 bushels, averaging about 22

bushels; and rye, 10 to 25 bushels, averaging 18 bushels. Alfalfa does quite well, and yields about the same as on the Grundy silt loam.

Land of this type sells at prices ranging from \$75 to \$175 an acre, and averaging about \$115 an acre.

Barnyard manure and green-manure crops should be plowed under whenever practicable in order that the humus supply may be built up. Contour plowing on slopes will reduce soil washing and tend to prevent the forming of gullies. The more general sowing of alfalfa, which is grown more extensively on the same character of soil in other localities, would doubtless prove profitable and beneficial to the soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Clinton silt loam:

Mechanical analyses of Clinton silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
332417.....	Soil.....	0.1	0.3	0.2	0.9	16.7	68.3	13.6
332418.....	Subsoil.....	.3	.7	.4	2.0	12.7	58.8	25.2

TAMA SILT LOAM.

The Tama silt loam is a dark-brown silt loam, with a depth of 14 inches, underlain by a dark-brown silt loam tinged with yellowish brown, which gradually becomes more distinctly yellowish brown and at 18 inches changes to a silty clay loam. Frequently dark-brown to black concretions occur in the lower subsoil. In a few locations, as about 1 mile east of Bethel Church, surface wash has caused the surface soil to assume the texture of a loam or fine sandy loam, but these areas of coarser texture are too small to map separately. Along depressions within the areas of this type small patches of Grundy silt loam and silty clay loam frequently occur.

This type generally occupies strips along the slopes of drainage channels, intermediate between the Grundy or Muscatine and the Clinton or Lindley. Where the Clinton and Lindley are absent it separates the flat upland soils from the first-bottom or terrace soils. It occurs on slopes where the angle is such as to permit sufficient aeration to oxidize the subsoil and give it a solid yellowish-brown color without mottling, but where the encroachment of the timber has not caused the surface soil to have a light color. Both as to position and composition the type may be said to be intermediate between the Grundy or Muscatine silt loam and the Clinton silt loam. The topography is gently rolling to rolling, and drainage is well established.

Although not as extensive as the Grundy, Muscatine, and Clinton silt loams, the Tama silt loam is of considerable importance agricul-

turally, as almost all of it is in cultivation. Like the Grundy silt loam, it is essentially a corn soil. Other principal crops are oats, hay, and wheat. Corn yields 30 to 70 bushels, averaging 40 bushels, per acre; oats, 30 to 70 bushels, averaging 45 bushels; hay, three-fourths ton to 1 $\frac{3}{4}$ tons, averaging 1 $\frac{1}{4}$ tons; winter wheat, 15 to 42 bushels, averaging 26 bushels; spring wheat, 10 to 40 bushels, averaging 23 bushels; and rye, 10 to 25 bushels, averaging 15 bushels. No special industry is engaged in on this type.

This land ranges in price from \$135 to \$250 an acre, with an average of about \$165 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Tama silt loam:

Mechanical analyses of Tama silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
332453.....	Soil.....	0.1	0.7	0.4	1.5	17.0	63.1	17.1
332454.....	Subsoil.....	.0	.6	.4	2.4	13.4	65.4	17.9

KNOX FINE SAND.

The typical Knox fine sand is a brown fine sand throughout the 3-foot section. There is no sharp line of distinction between surface soil and subsoil, but a slightly yellowish cast appears with depth.

This soil includes a greater range in variation than any other in the county. In some places the surface soil is distinctly grayish brown when dry. The type includes small patches where the surface texture is a medium sand, while in other places the surface texture may be a very fine sand, or may approximate closely a loam. In these latter variations the subsoil is usually of the same texture as the surface soil, and yellowish to yellowish brown in color. The type is supposed to be derived from material blown up by the wind to its present position.

This type is confined to rather narrow ridges along the western edge of the eastern upland with the exception of a small area lying partly in sec. 4 and partly in sec. 9, T. 75 N., R. 4 W., on the crest of a broad ridge projecting above the general elevation of the rest of the upland and lying 3 $\frac{1}{2}$ miles back from the edge of the upland. The type is most typically developed 2 miles directly north of Wapello. The area 1 mile northwest of the one just mentioned has a more grayish color, and the soil seems to be shifted about by the wind at the present time. The same is true of a considerable part of the two areas in the vicinity of Sandy Grove School northeast of Fredonia. The area 1 $\frac{3}{4}$ miles east of Wapello occupies a ridge and is a very fine sand in texture.

Drainage of the Knox fine sand is ample or excessive. Owing to the great porosity of the subsoil, crops are apt to be affected by droughty periods.

The total extent of the type is small, and, as less than half of it is cultivated, its agricultural importance is slight. The uncultivated parts, where the surface is more or less shifted by the wind from year to year, support practically no vegetation aside from sandbur and are practically worthless. A small part of the uncultivated land is forested with black oak and post oak. On the cultivated areas of the type, corn, rye, and truck are the principal crops. Rye is the best adapted of the grain crops to such sandy land as this. For best results on this type, it is suggested that it be used chiefly for rye and truck crops and that winter cover crops be sown to prevent drifting as far as possible.

Probably no farm occurs wholly on this type, but its selling price is estimated to range from \$40 to \$100 an acre.

PUTNAM SILT LOAM.

The surface soil of the Putnam silt loam is a dark grayish brown silt loam extending to a depth of 6 inches, and underlain by a gray to grayish-brown, silty layer, which is usually very dry and powdery. The silty layer extends to a depth of 12 inches, and is underlain by very compact, yellowish-brown silty clay loam which passes at about 26 inches into a gray compact silty clay loam mottled with rusty brown and to a lesser extent with yellowish brown.

The Putnam silt loam occurs in small areas between the Clinton silt loam and the Grundy or Muscatine silt loams, and generally occupies positions at the heads of drainage courses. Some patches of this type too small to map separately are included with the Grundy and Muscatine silt loams. Surface drainage is generally fair, though underdrainage, owing to the impervious subsoil layer, is naturally poor.

Probably no field occurs exclusively on this type, though practically all of it is in cultivation. It is handled and cropped in the same manner as the Grundy or Muscatine silt loams, and is best adapted to the same crops, though it produces slightly lower yields. It is probable that on the average the price of land of this type is about one-third less than that of the Grundy silt loam.

LINDLEY SILT LOAM.

The surface soil of the Lindley silt loam is a light yellowish brown silt loam extending to a depth of 10 inches. The top 2 to 3 inches is sometimes dark brown. The subsoil to a depth of 20 inches is a brown silt loam to loam, with a reddish cast, underlain by a gritty silty clay of the same color. Scattered throughout the 3-foot sec-

tion are pebbles and small bowlders, of chert, quartz, limestone, limonite, granite, granite gneiss, and dolomite, such coarse material constituting between 5 and 10 per cent of the soil mass.

This type occupies steep slopes leading to the Iowa and Mississippi River valleys, in the latter occurring in a very irregular strip. It lies between the first bottom or terrace soils and the Clinton silt loam, or, where the Clinton is absent, between the first-bottom or terrace soils and the Tama, Grundy, or Muscatine silt loam. The topography is steeply rolling to broken, and the run-off is generally excessive, causing washing and gullyng.

Approximately one-fourth of the type is in cultivation, the remainder being in pasture, generally woods pasture. All the type is naturally forested with black oak and shagbark hickory.

Where the slope is sufficiently gentle to permit cultivation, this soil is farmed in practically the same manner as the Clinton silt loam. Since so great a proportion of the type is used for pasture, it is probable that live-stock farming is better developed, relatively, than for the county as a whole.

Land of this type ranges in selling value from \$60 to \$150 an acre, with an average of about \$80.

Below are given the results of mechanical analyses of samples of the soil and subsoil of the Lindley silt loam:

Mechanical analyses of Lindley silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
332413.....	Soil.....	0.4	1.6	1.4	9.4	13.4	59.2	15.0
332416.....	Subsoil.....	2.9	8.5	10.1	24.5	7.6	23.6	22.6

BREMER SILT LOAM.

The Bremer silt loam consists of a dark-brown to black silt loam, with an average depth of 10 inches, underlain by a dark-brown to black silty clay loam, which at about 18 inches becomes slightly mottled with rusty brown and soon passes into a dark bluish gray silty clay, mottled with rusty brown. At 30 to 32 inches the subsoil becomes light gray mottled with yellowish brown and rusty brown, and contains some dark-brown or black and yellow concretionary material.

Locally there is some variation in the type. Occasionally a gray layer is encountered between the surface soil and subsoil, similar to that in the Calhoun series, from which the Bremer differs in the dark color of the surface soil. This gray color doubtless has been caused by poor drainage in these particular locations. In one or two places,

as the southeast corner of sec. 18, T. 74 N., R. 3 W., a layer of coarse gray sand is observed between the silt loam surface layer and the silty clay subsoil. Along the county ditch in secs. 32 and 33, T. 74 N., R. 3 W., a small strip of the type is mapped within an area of Bremer silty clay loam. This has been formed within the last few years by overflow from a very small ditch that was constructed to carry the water from an upland creek and was too small for the purpose.

The Bremer silt loam occurs on the level terraces, usually nearer the upland than the first bottom. It is the best drained, naturally, of the Bremer soils, and tiling and ditching in most places have remedied any defect in drainage.

The total extent of the type is not great, but most of it is in cultivation, the remainder, excluding that used for building sites and farm lots, being in pasture. Corn is the principal crop, followed by oats, hay, and wheat. Corn yields range from 30 to 75 bushels, with an average of 45 bushels, per acre; oats yield 35 to 80 bushels, with an average of 50 bushels; hay 1 to $1\frac{3}{4}$ tons, with an average of $1\frac{1}{2}$ tons; and winter wheat from 10 to 40 bushels, averaging 25 bushels.

Land of this type sells for \$145 to \$220 an acre, with an average of about \$160 an acre.

The soil is farmed under the ordinary methods prevailing throughout the country. The usual number of live stock is kept. Like the other types of the series it could be improved by the more extensive use of lime, the growing of legumes, and deep plowing.

BREMER SILTY CLAY LOAM.

The surface soil of the Bremer silty clay loam is a black silty clay loam extending to a depth of 15 inches, underlain by a dark-brown very heavy silty clay loam to silty clay. This passes into a typical silty clay, dark brown in color, but mottled with brownish yellow and bluish gray. The dark brown soon disappears and the bluish gray becomes lighter and more predominant with depth. Iron concretions are generally found in the lower subsoil, which is very heavy and plastic. A few small patches where the surface has been overlain with sand to a depth of 2 to 3 inches are included with the type. Both this soil and the Bremer clay are known to some farmers as "gumbo" and to others as "black muck."

The type occurs on the terraces near the upland bluff. It usually adjoins one of the other Bremer types, or the Buckner loam, Waukesha silt loam, or Lindley silt loam. The type has a level surface and lies slightly lower than the surrounding soil, unless the latter happens to be the Bremer clay. Drainage is naturally poor, but can be improved artificially.

This type is not of great extent, but it is very productive. The greater part is in cultivation, but a considerable area is in pasture, probably because so many of the farmers are engaged in cattle raising and feeding. The type is preeminently a corn soil, oats, hay, and winter wheat being the other main crops. Corn yields average slightly higher than on the Bremer silt loam, while oats, hay, and wheat give about the same yields.

The selling price of land of this type ranges from \$135 to \$220 an acre, with an average of about \$140. The price depends on the improvements, particularly in drainage, and the nearness to towns and transportation lines.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Bremer silty clay loam:

Mechanical analyses of Bremer silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
332401.....	Soil.....	0.1	0.8	0.4	3.7	4.0	59.7	21.3
332402.....	Subsoil.....	.3	2.0	2.3	6.8	12.9	56.8	19.0

BREMER CLAY.

The Bremer clay has a surface soil of black silty clay to clay, tough and plastic in nature, extending to a depth of 13 inches, and underlain by a black clay faintly mottled with yellowish brown. This soon changes to black tinged with dark bluish gray. At about 24 inches there is reached a dark bluish gray clay, mottled with rusty brown to yellowish brown, and this continues to the bottom of the 3-foot section, bluish gray predominating.

The type occurs on the terraces, above overflow, near the upland bluff. Like the Bremer silty clay loam which it closely resembles except for its heavier surface soil, it occupies level areas generally depressed below the surrounding terrace types. It is naturally rather poorly drained and requires tiling and ditching for best results under cultivation. In tiling both this type and the Bremer silty clay loam, it is a common practice to place gravel or trash over the tile in order to make the latter draw well. In ponds, a catch basin draining into the tile is generally put in.

The Bremer clay is the least extensive of the three Bremer soils. Its crop adaptations and yields are like those of the Bremer silty clay loam, and land values are practically the same.

Both types are inclined to stick to cultural implements when wet, and to bake and clod if worked when too wet. The use of lime and the incorporation of all the organic matter possible are methods suggested for the loosening up and aerating of the soil.

BUCKNER SAND.

The Buckner sand throughout the 3-foot section is a brown, medium sand, grayish brown when dry. The only change in the 3-foot section is a tendency toward a slightly lighter color in the lower part. In some places the soil is rather loamy, and much of it has considerable fine interstitial material, though not enough to change the texture.

This is a terrace type, lying above overflow. It occurs to some extent about 4 miles north of Columbus Junction, but its principal occurrence is on the Great Sand Mound in the northeastern corner of the county. Along the eastern slope of the mound there is a considerable acreage (approximately 60 acres) in which the soil is looser than typical and gives evidence of being shifted from year to year more than the remainder, though all of it is likely to blow to some extent. The surface here has a considerably lighter appearance, owing, in part at least, to the fact that it supports no vegetation.

The topography of the Buckner sand is level or gently rolling. Drainage is ample, the greater part of the rain water sinking into the ground where it falls. Owing to the porosity, the type is easily affected by drought.

Of the part of the type that occurs on the Great Sand Mound over half is not cultivated. Some areas now unused may have been in cultivation previously and abandoned on account of the blowing of sand or unprofitable yields. The part in cultivation is principally devoted to corn. The type elsewhere in the county is nearly all in cultivation, the chief crops being corn, rye, and truck. Corn ranges in yield from 15 to 35 bushels, averaging 20 bushels per acre.

While some of the land on the eastern slope is practically worthless, in general the land of this type brings an average price of \$65 an acre.

For the improvement of the Buckner sand it is necessary to add all the organic matter possible by the use of barnyard manure and the turning under of green manures. The growing of winter cover crops will materially assist in preventing drifting.

BUCKNER FINE SAND.

The Buckner fine sand is a brown fine sand, with a grayish tinge when dry. The only change throughout the 3-foot section is a slightly lighter color with more of a yellowish-brown tinge below 28 inches. The type is subject to drifting before the wind to a certain extent.

This soil occurs on the terraces of the Iowa River, generally near the first bottom, though in a few instances it is mapped on low ridges near the upland north and northeast of Fredonia. It occurs in rather

small areas, and is generally surrounded by Buckner fine sandy loam. The topography is undulating and drainage is adequate. Owing to the porosity of the entire 3-foot section and the substratum, crops are apt to be affected by drought.

The total extent of the type is not great, and it is not very productive. None of it is forested. The greater part of the type is in cultivation, mainly to corn and rye. One or two small areas are devoted to growing catalpa trees for fence posts. Corn yields range from 20 to 35 bushels, averaging 25 bushels, per acre, and yields of rye from 5 to 20 bushels, averaging 10 bushels.

While no farm lies wholly on this type, it is estimated that the price ranges from \$60 to \$140, with an average of \$90 an acre.

The use of barnyard manure, the turning under of green-manure crops, and the use of winter cover crops are recommended for the improvement of this type.

BUCKNER FINE SANDY LOAM.

The Buckner fine sandy loam is a brown fine sandy loam throughout the 3-foot section, except for a slightly lighter and more yellowish-brown color and a very slightly coarser (though still a fine sandy loam) texture below 30 to 32 inches. The 3-foot section is very uniform wherever the type occurs in this county, except that two or three sandy loam areas are included on account of their small total extent. A few swales occupied by the Bremer silt loam, silty clay loam, or Buckner loam also are included.

This type occurs in numerous relatively small areas near the margin of the terraces adjoining the first bottom in the Iowa River Valley. One area, comprising about 40 acres, is mapped on the Great Sand Mound, where it is surrounded by Buckner sand. Generally the type adjoins the Buckner fine sand, Buckner loam, Waukesha silt loam, or Bremer silt loam. In the latter two cases it generally occupies a ridge at a slight elevation above the surrounding type. The topography is level to undulating, and drainage is adequate.

The total extent of the Buckner fine sandy loam is small, though it is a fairly valuable soil. In the immediate vicinity of Wapello some of the type is used for the production of beans and sweet corn, but elsewhere it is devoted to the general farm crops. Owing to its relatively coarse texture, the type is seldom used in the production of hay. The farms which include it have pasture and meadow on other soils. Corn ranges in yield from 25 to 40 bushels, averaging 30 bushels, per acre; oats from 20 to 50 bushels, averaging 30 bushels; winter wheat 10 to 25 bushels, averaging 20 bushels; and rye 8 to 23 bushels, averaging 12 bushels.

Land of this type sells for \$115 to \$180 an acre, with an average of \$125.

Results of mechanical analyses of samples of the soil and subsoil of the Buckner fine sandy loam are given below:

Mechanical analyses of Buckner fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
332409.....	Soil.....	0.1	4.4	12.8	56.0	12.6	2.6	11.5
332410.....	Subsoil.....	.1	4.1	11.5	56.8	14.0	7.3	6.1

BUCKNER LOAM.

The surface soil of the Buckner loam is a brown to dark-brown, moderately friable loam, 14 inches deep, underlain by a brown to dark-brown loam to fine sandy loam which in the lower part of the 3-foot section is slightly coarser textured and lighter colored. Ordinarily there is no sharp line of distinction between the surface soil and subsoil, though in a few small spots the subsoil is a gray fine sand or coarse sand, mottled with yellow.

This type occurs in numerous areas of varying size, scattered over the terraces adjoining the Iowa River bottoms. The topography is level to undulating, and the drainage good.

This is the second most extensive of the Buckner soils, and is considered a good terrace soil. Corn, oats, hay, wheat, and rye are grown. Under the prevailing farming methods corn yields 30 to 70 bushels per acre, averaging 40 bushels; oats 30 to 70 bushels, averaging 45 bushels; hay three-fourths ton to 1 $\frac{3}{4}$ tons, averaging 1 $\frac{1}{2}$ tons; winter wheat 10 to 38 bushels, averaging 23 bushels; and rye 8 to 23 bushels, averaging 15 bushels.

Land of this type sells for \$135 to \$210 an acre, averaging \$150 an acre.

BUCKNER SILT LOAM.

The surface soil of the Buckner silt loam is a dark-brown friable silt loam, in many places high in organic matter and occasionally slightly gritty. At a depth of about 11 inches it is underlain by a brown very fine sandy loam, which soon changes to grayish brown mottled with yellow. Below 24 inches the color becomes light gray, mottled with yellow to yellowish brown, and below 30 inches the texture changes to a fine sandy loam. In some places the color and texture of the subsoil vary from typical.

Only a few small areas of this type are mapped. It occurs in association with the other Buckner soils. The topography is level, but the drainage is good. The soil is farmed in the same way as the Buckner loam, and produces practically the same yields.

Buckner silt loam, colluvial phase.—The Buckner silt loam, colluvial phase, is a dark-brown silt loam, with a depth of 18 inches, underlain by a dark-brown, heavy silt loam to silty clay loam, tinged with brown, soon changing to a distinctly brown slightly mottled with rusty brown. The surface material is moderately friable. The phase as mapped includes areas of considerable extent where the texture of both surface soil and subsoil is a loam.

This phase occurs on moderate colluvial slopes between the upland bluffs and the terrace or first bottom. The soil has been deposited in its present position by gravity and washing from the slopes. Although the slopes are gentle, care is necessary in places to prevent erosion and gulying by water coming from the bluffs.

The greater part of the phase is in cultivation, being devoted to the common crops. It is chiefly adapted to the production of corn, the other main crops being oats and wheat. Corn yields 30 to 70 bushels, averaging 40 bushels, per acre; oats 30 to 70 bushels, averaging 45 bushels; and winter wheat 10 to 40 bushels, averaging 25 bushels.

While no farm consists exclusively of this phase, it is estimated to be valued at \$125 to \$200, with an average of \$140 an acre.

For the improvement of this soil organic matter should be added to the especially loamy spots. Where there is a tendency to erode diversion channels should be cut or contour plowing practiced.

WAUKESHA SILT LOAM.

The surface soil of the Waukesha silt loam is a dark-brown, friable silt loam with a depth of 12 inches, underlain by a dark-brown silty clay loam which passes at 18 to 20 inches into a yellowish-brown, moderately friable silty clay loam. In some places the surface soil is slightly deeper. A few areas, too small to map separately, have a loam surface soil and a subsoil of grayish-brown sandy clay or silty clay loam to silty clay with considerable medium to coarse sand. Some of the patches having a loam surface soil have the typical yellowish-brown silty clay loam subsoil. Some areas of Calhoun silt loam, too small to map separately, also are included. On the Wapello Prairie west of Wapello the Waukesha silt loam and the Bremer silt loam grade together in such a manner as to make the location of the separating boundary very arbitrary.

The Waukesha silt loam occurs in areas of varying size, many of them quite large, on the Iowa River terraces, where it is the most extensive type. It generally adjoins the Buckner loam, Bremer silt loam or silty clay loam, or Lindley silt loam. The topography is level, but the drainage is good.

The Waukesha silt loam is one of the most, if not the most, valuable of the terrace types. None of it was originally forested. The greater part is in cultivation, the remainder being used for farmstead sites

and pastures. The type is preeminently adapted to the production of corn. The other leading crops are oats, hay, and wheat. The different branches of live-stock farming are fairly well developed. Corn yields 30 to 70 bushels, averaging 40 bushels, per acre; oats, 30 to 70 bushels, averaging 45 bushels; hay, three-fourths ton to $1\frac{3}{4}$ tons, averaging $1\frac{1}{4}$ tons; and winter wheat, 10 to 40 bushels, averaging 25 bushels.

Land of this type sells for \$140 to \$250 an acre, averaging about \$175.

CALHOUN SILT LOAM.

The Calhoun silt loam is a brown to grayish-brown silt loam, 10 inches deep, underlain to 16 inches by a gray silt loam sometimes tinged with brown. This passes abruptly into a dark-brown silty clay loam, mottled slightly with yellowish-brown, which is underlain by a dark yellowish brown, heavy plastic, impervious silty clay to clay, mottled with bluish gray. In places the heavy subsoil, which is locally known as hardpan, is pale greenish gray to grayish brown in color. In one or two patches near the margin of the terrace the surface soil has been largely removed by erosion and the heavy stratum lies close to the surface.

The Calhoun silt loam occurs at, or near, the margin of the Iowa River terraces, in relatively small areas. It also borders the lower course of Long Creek. The topography is level, and there is evidence that the areas were once poorly drained, though at present, with the exception of a few small patches, the drainage is fair or good. The extent of this type is small, and it is of comparatively little importance. About half of it is cultivated. It seems to be naturally forested with post oak, black oak, and hickory, though only a part of the uncultivated land is wooded at present. All the untilled land is used for pasture. The type is handled and cropped in the same general manner as the Waukesha silt loam, though care must be taken not to plow it when too wet, since this causes baking and clodding. The principal crops grown are corn, oats, and rye. Corn yields 20 to 40 bushels per acre, averaging about 30 bushels; oats 15 to 50 bushels, averaging 30 bushels; and rye 5 to 20 bushels, averaging about 10 bushels.

While no farms occur exclusively on this type, the selling price is estimated to range from \$60 to \$150 an acre, averaging about \$95,

For the improvement of this type deep plowing and the incorporation of organic matter are suggested.

WABASH LOAM.

The Wabash loam, in different parts of the area, has a rather wide range in the character of the surface soil, particularly in texture. The type is usually a grayish-brown to dark-brown loam to silt loam to a depth of about 12 inches, underlain by a brown to yellowish-

brown, heavy silt loam to silty clay loam. The surface soil is uniformly mellow and friable, and the subsoil is seldom more than semiplastic. In some places in the river bottoms and generally in the small stream bottoms the brown to yellowish-brown color in the subsoil is replaced by dark brown to black, which in the lower subsoil may be mottled slightly with bluish gray, rusty brown, and brown. Dark-brown concretionary material may be present. In a few places, particularly about $1\frac{3}{4}$ miles northwest of Port Louisa, a small area has been covered with a sandy wash from a stream whose channel has become choked. In a few very small spots the subsoil is seen to have a distinctly reddish cast.

This type occurs in the first bottoms of the Mississippi and Iowa Rivers in areas of varying shape and size. With the exception of a small area which is Wabash silty clay loam, it is the only type mapped in the small stream bottoms. Here it has a more silty soil and contains many areas of silt loam.

The type is naturally well drained, except for overflows where it is not protected by levees. It is said that a few places in the Iowa River bottoms did not overflow even before the construction of levees or when the levees were broken, but they lie so little above the remainder of the type that no separation has been attempted.

The Wabash loam is one of the most extensive and important of the bottom-land types. In some of the larger creek bottoms it is cultivated, as overflows generally do not occur during the growing season. The rest of the type in the small stream bottoms is left in pasture. In the river bottoms the type is practically all in cultivation. Corn is the chief crop, the type being preeminently adapted to its production. Other main crops are oats, wheat, and hay. Corn yields 35 to 75 bushels per acre, averaging about 45 bushels; oats 35 to 75 bushels, averaging 45 bushels; winter wheat 15 to 40 bushels, averaging 25 bushels; and hay three-fourths ton to 2 tons, averaging $1\frac{1}{2}$ tons. Where the type occurs in the river bottoms it supports almost no stock farming.

This type has a considerable range in value. In the small stream bottoms no farm occurs wholly on it, and an allowance in the farm's valuation is doubtless made for the land subject to overflow. In the river bottoms, where protected from overflow, it is very productive and is highly valued. It sells at prices ranging from \$75 to \$275 an acre, depending on the protection from overflow and the other common factors influencing land values.

WABASH SILTY CLAY LOAM.

The Wabash silty clay loam is a black silty clay loam, with a depth of 12 inches, underlain by a dark-brown to black silty clay loam, mottled with bluish gray and yellowish brown, which at 20

inches passes into a silty clay of the same color and mottling, this material continuing throughout the 3-foot section. In some places the subsoil has a uniform yellowish-brown color. In a very few areas, too small to be mapped separately, a shallow layer of sand has been deposited over the surface. In many places the subsoil, as in the other types of this series, contains considerable sand, giving it in some cases a sandy clay texture. In this condition the type resembles the soils of the Cass series, which differ from the Wabash only in having a subsoil lighter in texture than the surface soil.

The Wabash silty clay loam occurs in areas of varying sizes, many of them large, in the first bottoms of the Iowa and Mississippi Rivers and to a less extent in narrow strips in the small stream bottoms. Natural drainage is only fair, but is easily improved by artificial means. All of the type is subject to overflow unless protected by levees.

This is one of the most extensive of the bottom-land types. It occupies the greater part of the bottoms in the vicinity of Oakville. Part of the type south of Port Louisa and north of the Iowa River is forested and not in cultivation. With this exception, almost all the type in the river bottoms is farmed. Like the Wabash silt loam, it is preeminently a corn soil. When well drained it is very productive. It is farmed in the same way and gives about the same yields as the Wabash silt loam. On account of its heavier texture, it should not be worked when wet, as clodding and baking result. That part of the type occurring in the small stream bottoms is generally used as pasture.

Land of this type ranges in price from \$75 to \$100 an acre for areas that are poorly drained or subject to overflow to \$275 an acre for the best improved and best located farms.

WABASH CLAY.

The Wabash clay is a black silty clay, with a depth of 10 inches, underlain by a dark-brown silty clay mottled with bluish gray. This soon changes to dark drab mottled with rusty brown, and the same color accompanies an increasingly heavy texture to the bottom of the 3-foot section. The lower subsoil is very compact.

In places the dark-brown to black color continues with slight mottling to the bottom of the 3-foot section. On the east margin of what was formerly Klum Lake, 2 miles northwest of Port Louisa, but which is now traversed by a drainage ditch, there is a sloping bank 8 to 10 feet high overlain by about 6 inches of very fine sand. But for its small extent this would have been mapped as a distinct type.

The Wabash clay occurs only in the first bottoms of the Iowa and Mississippi Rivers, and chiefly along the latter stream. Many of the

areas now occupied by the type were formerly lakes or ponds, and all the areas lie at a lower elevation than most of the surrounding types. The greater part of the type lies near the upland or terrace bluff, but in places it extends to the river and even occurs on the adjacent islands. As the type, which is composed of the finest of soil particles, could only be deposited in comparatively quiet water, it is probable that the areas now close to the river were some distance back from it when formed. Where not cleared the type is generally forested and more or less cut up by sloughs. Where it occupies a former lake or slough bed there is only a growth of coarse grasses.

Unless protected by levees, this type is subject to overflow. It is naturally poorly drained, but much of it has been, and probably all can be, reclaimed by ditching and pumping the drainage water over the levees.

This is an extensive bottom-land type, and about one-half of it is in cultivation at the present time. East of Oakville there is a large area, comprising between 2,000 and 3,000 acres, the greater part of which is in cultivation. North of the Iowa River and south of Port Louisa is another large body, of approximately the same size, of which only a very small part is cultivated. Corn is the principal crop, timothy, wheat, and oats being grown to a less extent. With good drainage, yields are practically the same as on the Wabash silty clay loam. Where not cultivated the type is used as range for cattle, hogs, and horses. As with the silty clay loam, care must be taken not to work the land when too wet. The selling price has practically the same range as in the case of the Wabash silty clay loam.

CASS SAND.

The Cass sand is a dark-brown to brown medium sand 10 inches deep, underlain by a lighter yellowish brown medium sand, passing into a coarse sand containing some fine gravel. In places the subsoil is less coarse than typical. One small area on the east of the Great Sand Mound shows the effects of wind action.

This type occurs in many rather small areas in the Iowa and Mississippi River bottoms. It generally lies slightly higher than the surrounding soils and is well drained. Where it is protected by levees the greater part of it is cultivated, but the unprotected areas are used chiefly for pasture. Corn, the principal crop, yields about 15 to 38 bushels per acre.

A soil coarser than the typical Cass sand is included with it, on account of the slight difference in texture and the small extent of both types. It consists of a coarse sand throughout the 3-foot section, but the color, which is dark brown to brown in the upper part, becomes slightly lighter and has a more reddish tinge with depth.

Small pebbles are present throughout the 3-foot section. This soil is confined to two areas, totaling about 2 square miles, in the Mississippi bottoms in the northeastern corner of the county. Drainage is ample, and owing to the porosity of the subsoil the type tends to be droughty, though to a less extent than would an upland or terrace soil of the same texture, as the river keeps the water table relatively high under all the bottoms. This soil is protected from overflow by levees, and all of it is in cultivation. Corn is the principal crop, followed by rye and wheat. Some truck crops are grown. Corn ranges in yield from 15 to 35 bushels per acre, rye from 5 to 20 bushels, and wheat from 10 to 20 bushels.

CASS SANDY LOAM.

The surface soil of the Cass sandy loam is a dark-brown to brown sandy loam, with a depth of 12 to 17 inches, underlain by a brown sandy loam to sand which passes into a light yellowish brown sand to coarse sand. In some situations the coarse sand is confined to the extreme lower part of the 3-foot section, or is absent. There is no sharp line of demarcation between surface soil and subsoil. A few areas of very fine sandy loam, too small to map separately, are included with the type, as well as two areas of coarse sandy loam, the latter occupying about 2 square miles in the northeastern corner of the county. The soil has a tendency to drift somewhat during high winds.

The Cass sandy loam occurs in many areas in the first bottoms of the Iowa and Mississippi Rivers. It is generally slightly elevated above the surrounding soils. Drainage is ample, and during periods of drought crops are somewhat damaged. Unless protected by levee the type is subject to overflow.

Owing to its small total extent, this is a relatively unimportant soil. Where it is cultivated corn and rye are the main crops. Corn yields 15 to 45 bushels per acre, and rye 5 to 22 bushels. Formerly the coarser areas were used to some extent for the production of truck crops, particularly watermelons and cantaloupes. The total acreage in these crops has now decreased, but sweet potatoes are grown on a larger acreage than formerly.

The estimated selling price of this land is \$80 to \$180 an acre, depending largely on the degree of levee protection.

CASS LOAM.

The surface soil of the Cass loam is a dark-brown to black loam, with a depth of 10 inches. The subsoil is a dark-brown loam to sandy loam, tinged with reddish brown, passing into brown and then into yellowish-brown sandy loam. In the lower part of the 3-foot

section the texture is a sand to coarse sand. In several locations, as in the river bend $1\frac{1}{2}$ miles north of Gladwin, there are patches where sand has been deposited over the surface by overflow waters.

In secs. 5 and 6, T. 75 N., R. 2 W., there is an area which varies from the type as it occurs elsewhere. Here the surface soil is high in organic matter, which for the most part is well decomposed, but the proportion is not sufficiently high to class the soil as Muck. The surface soil is shallow and underlain with gray, yellowish-brown, or mottled gray and yellow, coarse sand. The area is lower than the land to the northwest or southeast and is traversed through its approximate center by a drainage ditch. To the southwest the subsoil seems to become heavier, and the soil there is mapped as the Wabash loam.

The Cass loam is developed in the first bottoms of both the Iowa and Mississippi Rivers. It is associated with the Wabash loam or with Wabash or Cass soils of heavier texture. The drainage is naturally fair to good. The surface soil has sufficient coherency to retain moisture quite well, but, owing to the porosity of the subsoil, crops are likely to be affected by periods of prolonged drought. Unless protected by levee the type is subject to overflow.

The Cass loam is one of the most extensive types in the Iowa River bottoms. The greater part of it is in cultivation, the remainder being used for pasture. Corn is the chief crop, followed by oats, wheat, hay, and to a limited extent rye. The methods of handling the type, the crop yields, and land values are practically the same as in the case of the Wabash loam.

CASS SILTY CLAY LOAM.

The Cass silty clay loam, to a depth of 12 inches, is a dark-brown to black silty clay loam or silty clay. Below this depth there occurs a dark-brown silty clay loam, containing considerable sand, mottled with bluish gray, and below this, beginning at about 17 inches, a yellowish-brown sandy loam mottled with gray. The lower part of the subsoil in many places is a sand.

This type occurs in areas of varying size well distributed over the bottoms of the Iowa and Mississippi Rivers. The natural surface drainage is poor to fair, but the underdrainage is in most cases ample, owing to the porous nature of the subsoil and substratum. By ditching and pumping off the drainage water, the land can in most cases be reclaimed, though in a few places, as in sec. 4, T. 76 N., R. 5 W., quicksand, occurring at a depth of 4 to 6 feet and kept saturated by the rise of water from the river, renders the problem more difficult. Unless leveed, all of the type is subject to overflow.

The total extent of the Cass silty clay loam is small. Approximately one-half of it is in cultivation, and the remainder in woods pasture. The forest growth includes black oak, soft maple, elm,

cottonwood, and basswood. The land in cultivation is devoted chiefly to the production of corn, which yields 35 to 80 bushels per acre. Other important crops are oats, hay, and wheat. Oats yield 35 to 80 bushels per acre, hay 1 ton to 1 $\frac{3}{4}$ tons, and winter wheat 12 to 35 bushels. The type is handled under the methods prevailing over the county, except that more than ordinary care is necessary in working the soil, as it bakes and clods badly if stirred when wet.

Land of this type ranges in price from \$75 to \$250 an acre, depending on drainage and other improvements and the nearness to towns and lines of transportation.

MUCK.

Muck consists of black, well-decomposed organic matter, with a small admixture of mineral matter, chiefly silt and a little clay, washed from adjoining slopes. At a depth of 16 to 18 inches the organic layer is underlain by a black, heavy, plastic silty clay to clay, slightly mottled with dark bluish gray. In some parts of the type the surface material is underlain by a coarse sandy loam or coarse sand.

This type occurs in small areas in the Iowa River valley. These lie just below the escarpment of the main terrace and generally between this and the next lower terrace. The areas are above overflow from the Iowa River at any ordinary flood stage, though one area in sec. 7, T. 74 N., R. 3 W., is said to have been overflowed by water from the Iowa River coming down from the northwest in 1851. The soil is generally wet and boggy as a result of seepage from the higher lying terrace.

This type is of small extent and comparatively unimportant. None of it is in cultivation or even artificially drained. It is prized as pasture, as it is said to afford good grazing when the grass in other pastures is "burned up."

RIVERWASH.

Riverwash, as mapped in this county, consists of recent alluvial deposits of varying texture, lying immediately along or in the Mississippi, Iowa, and Cedar Rivers, and shifting and changing in character at each overflow. Some of the type is inundated much of the time and its texture is ever changing with the river currents. Other parts are only overflowed when the river is at flood stage, at which time a layer of sand is usually deposited. The greater part of the material is sandy.

This type occurs on all the islands in the Iowa and Cedar Rivers and on most of the islands in the Mississippi River. In addition, it is mapped in places adjacent to the river banks. At the present time it has practically no agricultural value.

DRAINAGE.

The principal drainage problem of Louisa County lies in protecting the river bottoms from overflow and at the same time taking care of the drainage from the uplands as well as the heaviest precipitation on the bottom lands.

The first bottom along Cedar River is narrow and of comparatively little importance. No attempt has been made either in this county or, as far as known, in the one to the north to construct levees along this stream.

The first bottom of the Mississippi River is protected from overflow by a levee under Government control, which roughly parallels, at a short distance, the bank of the river. This levee occurs in this county in two parts. The northern one comes into the county from the north within a hundred yards of the river bank and, except in a few high places where a levee is unnecessary, continues in a general southerly direction, tying into the upland bluff just north of Toolesboro. The southern part of the levee is an extension of the one along the south side of the Iowa River and roughly follows the bank of the Mississippi River, continuing on into the county south.

The drainage of the bottom inclosed by the northern part of the levee is accomplished by canalizing what was formerly Muscatine Slough and other former ponds, sloughs, and lakes, and by connecting these and other artificial drainage ditches, conducting the water to the pumping station just north of Port Louisa, and there raising it over the levee and into the river. The drainage of the land south of the pumping station is less satisfactory than that of the land to the north, owing to the fact that the natural fall of the land is in the opposite direction from that in which the water must drain to the pumping station. At the point where the levee blocks the Muscatine Slough from flowing into the river, pipes have been constructed which allow water to flow from the slough to the river when the water is lower in the latter and prevent any flow from the river to the slough when conditions are reversed. The construction of a second pumping station in the south end of this district is now under consideration.

Drainage of the land inclosed by the southern part of the levee is accomplished in a similar manner. Iowa Slough is the main drainageway. A pumping station located on the levee 1 mile south of the south county boundary handles the water from this area.

The drainage of the Iowa River bottoms is for the most part in charge of the county board of supervisors. It is organized by districts, each comprising a separate area protected by a levee. The methods of drainage are the same as those used in the Mississippi River bottoms, except that the drainage channels are much smaller and that in some districts, instead of pumping stations, "pipes"

alone are relied on to carry off the water, which is allowed to accumulate in low places, never cultivated, until such time as the pipes remove it.

During the last few years the levees have sometimes broken while the river was at flood stage, ruining a large part of the crops. Such breaks have probably been due to faulty construction of the levee in the first place, or to inadequate measures for its maintainance. Some farmers state that the substratum underlying the Iowa River bottom soils is different and has more quicksand than is the case in the Mississippi bottoms, and that therefore leveeing should not be attempted in the Iowa bottoms. Owing to their small area, the cost, and the damage done to farming land by being cut with channels and covered with sand in the vicinity of a crevasse, when one occurs in the levee, there seems to be some doubt whether it is more profitable to construct levees or to assume the risk of losing the crop by untimely floods.

SUMMARY.

Louisa County lies at the eastern edge of the State of Iowa, in the third tier of counties from the southern boundary. It has an area of 396 square miles, or 253,440 acres.

The county consists of two areas of upland and two areas of lowland. The upland areas are separated by the Iowa River Valley. One of the bottom areas follows the Iowa River Valley while the other lies on the western side of the Mississippi River Valley. The alluvial areas are made up of first bottoms, naturally subject to overflow, and second bottoms or terraces, not subject to overflow. The average elevation of the terraces above the first bottom is about 30 feet, while that of the upland above the terraces is about 100 feet. The first bottoms are generally level, and the terraces level to undulating, while the upland varies from level to sharply rolling or broken.

The highest point in the county, in the southeast part of Morning Sun Township, is nearly 900 feet above sea level. The western upland slopes to the northeast, while the eastern upland, with the exception of a few square miles in the northeast corner, slopes to the west. A small proportion of the eastern upland drains to the Mississippi River. Nearly all the remainder of the county drains to the Iowa River.

The first white settlement was made in this county in 1834. The county was formed in 1836. In 1910 the population was 12,855, or 32.5 persons per square mile.¹⁰ All the population is classified as rural, and settlement is well distributed. The inhabitants are practically all white, and mostly native born.

Transportation facilities are good, five lines of railroad passing through the county. The principal markets within the county are

¹⁰ See footnote, p. 9.

Wapello, the county seat, and Columbus Junction, Morning Sun, Letts, Oakville, and Grandview. Produce is shipped from these points to Chicago, St. Louis, and Boston.

The climate is temperate and healthful. The mean annual precipitation is 34.07 inches. The average annual snowfall amounts to 26.8 inches. The average growing season lasts from April 24 to October 16, or 175 days, and is ample for maturing all the crops commonly grown.

In the early days wheat, corn, oats, and flax were the principal crops grown, and little live stock was kept. At the present time live-stock farming predominates. The principal crops are corn, oats, hay, winter wheat, rye, potatoes, sweet corn, and barley. Cattle, hogs, horses, and sheep are raised in large numbers.

The sandy soils of the county are recognized as best adapted for rye, melons, sweet potatoes, and truck crops; the light-colored bluff soils for wheat; and the dark-colored soils for corn and oats.

The farms are well equipped with up-to-date machinery. Most of the farmers practice a rotation, the most common one consisting of corn, corn, oats and clover (or wheat and clover), and clover. Practically no fertilizer except barnyard manure is used.

The size of farms ranges from 40 to 1,600 acres, averaging 153.6 acres in 1910. Sixty-four per cent of the farms are operated by owners, 35.2 per cent by tenants, and 0.4 per cent by managers. Almost all the farms operated by tenants are rented on the share system.

Approximately 60 per cent of the county is upland, 20 per cent terrace, and 20 per cent first bottom. The loessial upland soils are classed in six series, the Grundy, Muscatine, Clinton, Tama, Knox, and Putnam. Only one glacial soil, the Lindley silt loam, occurs in this county.

The terrace soils are derived from old alluvial material and may have been capped with a thin layer of loess. Ten terrace types are mapped, correlated in the Bremer, Buckner, Waukeshia, and Calhoun series.

The first-bottom soils are derived from recently deposited alluvium. Nine types, classed in the Wabash and Cass series, and the undifferentiated types of Muck and Riverwash, are mapped.

The Grundy and Muscatine are quite similar prairie soils, having dark-colored surface soils and mottled subsoils. They are preeminently suited to corn, but are well adapted to oats and hay, and give good yields of other general farm crops. The Grundy occurs on the western upland, the Muscatine on the eastern.

The Clinton silt loam is a fairly extensive type occurring on both uplands, generally near the bluffs and the major drainage ways where the topography is rather rough. In its natural state the type

is forested. The surface soil is characteristically light colored and the subsoil yellowish brown. The type is particularly adapted to the production of wheat.

The Tama silt loam is another fairly extensive upland type, occurring for the most part on prairie areas. The surface soil is dark colored and the subsoil yellowish brown. The Tama is intermediate between the Grundy or Muscatine and the Clinton. While essentially a corn soil, it also produces good yields of the other farm crops.

The Knox fine sand has a brown surface soil and subsoil. It is of small extent, and much of it is uncultivated, though some corn and truck crops are grown.

The Putnam silt loam is of little importance. It differs from the Grundy and Muscatine soils principally in having a gray subsurface layer.

The Lindley silt loam occurs on the steep slopes where the loessial material has largely been washed off. It has a light-colored surface soil and a yellowish-brown, sometimes mottled, subsoil. Considerable gravel occurs throughout the 3-foot section.

The Bremer series is characterized by dark-colored surface soils underlain by heavier textured subsoils. The members of this series are preeminently adapted to the production of corn.

The Buckner soils are brown, underlain by lighter textured subsoils. The lighter textured members of the series are used to some extent for the growing of rye and truck crops.

The Waukesha silt loam has a brown surface soil and a yellowish-brown subsoil. It is well suited to the production of the farm crops commonly grown, particularly corn.

The Calhoun silt loam has a light-colored surface soil underlain by a very heavy, mottled subsoil. The type is naturally forested and either is or has been poorly drained. It is of small extent.

The members of the Wabash series have dark-colored surface soils and heavier subsoils. They are most extensive in the Mississippi River bottoms in the vicinity of Oakville. They are preeminently corn soils, though they also give good yields of the other common crops. Most of the small stream bottoms are occupied by the Wabash loam, and are used as pasture.

The Cass soils are dark colored, but differ from the Wabash in having subsoils of lighter texture than the surface soils. The members of the Cass series produce good yields of the common crops, particularly corn.

Muck is an inextensive type. It is rarely overflowed, but it is marshy and undrained and is not cultivated. It has a surface layer of organic matter, overlying heavy, plastic clay or in places coarse sand.

Riverwash, while quite extensive, is of no present agricultural value. It consists of material of various textures and is subject to change by river overflows from year to year.

In general, the soils of the county can be improved by the application of organic matter, deeper plowing, the more liberal use of lime, and the more extensive growing of alfalfa.

The greater part of the river first bottoms has been leveed and drained by systems of ditches flowing into the rivers through pipes equipped with flood gates or, in most cases emptied by means of pumps raising the water over the levees.



[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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