Series 1936, No. 6 Issued March 1941

Soil Survey

Jackson County Iowa

By
G. A. SWENSON
United States Department of Agriculture, in Charge
and
H. C. DEAN, DALLAS HAYS, D. F. MOINE, and E. W. TIGGES
Iowa Agricultural Experiment Station

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SOIL SURVEY OF JACKSON COUNTY, IOWA

By G. A. SWENSON, Division of Soil Survey,[1] Bureau of Plant Industry, United States Department of Agriculture, in Charge; and H. C. DEAN, DALLAS HAYS, D. F. MOINE, and E. W. TIGGES, Iowa Agricultural Experiment Station

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United States Department of Agriculture in cooperation with the Iowa Agricultural Experiment Station

CONTENTS

COUNTY SURVEYED

Jackson County is in the most eastern part of Iowa, midway between the northern and southern boundaries of the State (fig. 1). The Mississippi River, flowing from northwest to southeast, forms the eastern boundary. The northern, western, and southern boundaries are straight lines. The greatest length east and west is approximately 39 miles, and the greatest width north and south is 24 miles. Maquoketa, the county seat, is in the southwestern part, about 30 miles south of Dubuque and 35 miles northwest of Clinton. The county has a total area of 647 square miles, or 414,080 acres.

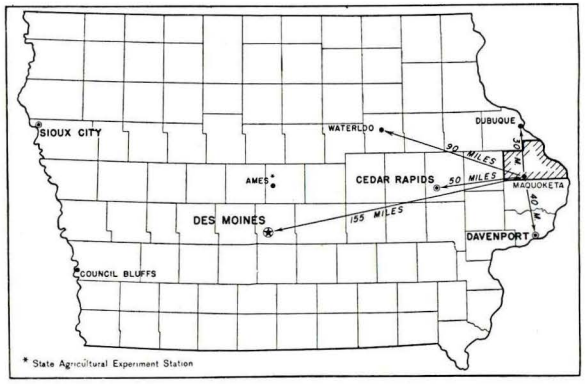

FIGURE 1.—Sketch map showing location of Jackson County, Iowa.

[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

The surface configuration of the greater part of the county ranges from gently to sharply rolling or broken. When first raised above the sea it was a nearly level plain, but during a long period of time the ancient rocks were subjected to erosion. Some of the valleys, although buried by later deposits, still modify the surface features. The next great change in the surface features was brought about by the Kansan ice sheet. The drift material is entirely absent over a part of the county, but it is believed that at least a thin sheet of ice overspread the entire county. The Kansan drift is deepest in the southern and western parts. A narrow lobe of ice moved southward and invaded a few square miles of the northwestern part during the Iowan stage of glaciation. This deposit has modified the relief and furnished the parent material for small areas of soil. Nearly all of Jackson County was later covered by a deposit of loess, ranging from 2 to 30 feet in thickness. This material, supposed to have been laid down by wind, covered hills and valleys, bedrock, and glacial drift, where present, and modified but did not entirely obliterate the old landscape. Extensive preglacial valleys are southwest of Maquoketa and in the vicinity of Preston. Since deposition, comparatively rapid erosion has dissected the surface of the loess mantle. The prairie areas in the southern part and to less extent in the north-central part of the county, indicated on the soil map by the Tama and Muscatine soils, have been least affected by erosion and are nearly level or gently rolling. The loess, though trenched and thinned by erosion, is not entirely removed over the greater part of the county. In most parts, especially in the extreme northeastern part, streams have cut through the loess and exposed the underlying beds of limestone and, in places, the thin layers of glacial drift. The limestone exposures are indicated on the soil map by the areas of rough stony land bordering the streams.

The sketch map (fig. 2) shows the location and relative areas of land having six more or less distinct types of relief. Over the areas indicated as 1, the loess over the dolomitic limestone formation forms a mantle of greater or less thickness and is dissected by stream action to produce a relief that ranges from that of nearly level plains to that of an extremely broken and rugged terrain. This type covers more than four-fifths of the county. Area 2 is a small valley-like area in the northwestern part, with a relief ranging from gently undulating to rolling. This small area is the only part covered by glacial drift. Areas numbered 3 are relatively flat alluvial plains, Areas indicated by 4, in the northeastern part, are small and have a relief that ranges from gently to strongly sloping. The underlying material is a bed of Maquoketa shales, which outcrops in many places, but in other places the limestone formation outcrops. No. 5 shows the location and approximate extent of the preglacial valleys, one southwest of Maquoketa and the other near Preston. These valleys occupy distinctly lower elevations than the true uplands and have a decidedly smoother terrain, the relief ranging from undulating to gently sloping. The surface material is largely light silty clay with more or less admixture of glacial drift, and stream dissection is poorly developed. No. 6 denotes several small areas of medium sand or fine

sand material, with gently rolling to rolling relief. Many of the drainageways terminate in small depressions with no surface outlets, but the depressions are not sinkholes common in areas underlain by a limestone formation. They may occur more or less singly but in many places are in a disconnected chain.

The relief in all parts of the county is modified as a result of the thorough stream dissection, except on the alluvial plains, the preglacial valleys, the sandy areas, and to less extent the small areas of modified glacial outwash in the northwestern part. Nevertheless, even in the areas underlain by the Niagara formation, the ruggedness varies in different parts of the county. In the western part the land surface is very rugged, especially along the Maquoketa

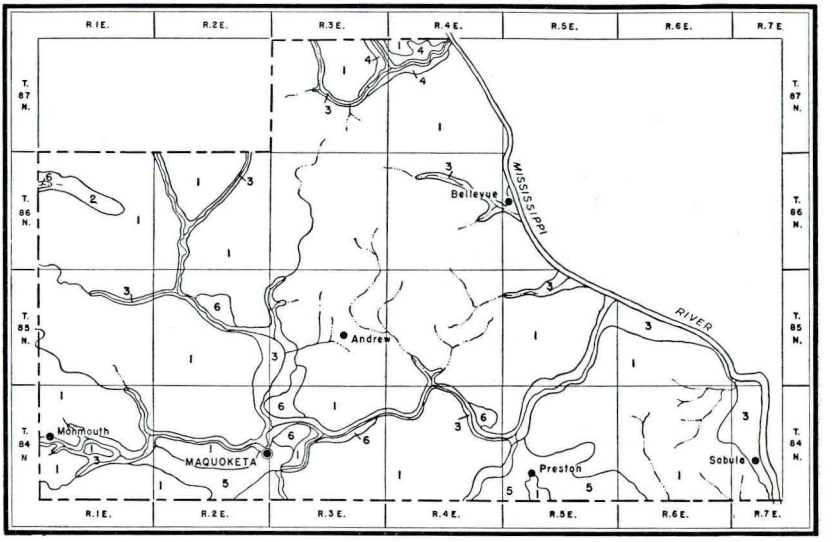

FIGURE 2.—Sketch map of Jackson County, Iowa, showing the superficial deposits with the corresponding types of relief: 1, Loess over dolomitic limestone formation; 2, area covered by glacial drift; 3, alluvium on flood plains; 4, loess and alluvium over Maquoketa shales; 5, preglacial valleys covered by loessial or light silty clay material modified by glacial drift; and 6, medium sand or fine sand, largely residual from highly siliceous limestone and modified by the action of wind and water.

River and its tributaries, north and west of the junction of the North Fork with Lytle Creek along both streams and their branches, along Bear Creek in the southwestern part, and along Brush Creek east of Andrew. The rock outcrops that border nearly all of the streams and lateral drains in those locations present bold, practically unweathered, almost vertical bluffs of limestone rising from 10 to more than 100 feet to the top of the ledge, and continuing, at first steeply but farther up more gently, to the top of the ridge or plateau. Farther east in the county, where the weathering processes have been active for a longer time, the high bluffs are more rounded and in many places form continuous slopes from the top of the ridge

to its base. The more precipitous slopes are midway between the top and the base and are not so continuous as they are farther west.

The unconsolidated material overlying the limestone formation in the eastern part of the county is much thinner than it is farther west, in the central and western parts. This material ranges from less than 20 feet in thickness on the ridges and small plateaus in the eastern part to more than 40 feet on similar positions in the central and western parts. Near St. Donatus in the northern part the stream valleys are cut through the Niagara formation into the softer Maquoketa shales formation, many of the slopes above the limestone outcrop are steep, the outcrop is blufflike, and most of the slopes below are smoother and more gentle.

Because of the variations in surface features the scenery in Jackson County is far from monotonous. The gorgelike valleys are beautiful, and only with difficulty can certain valleys be selected as more beautiful or more picturesque than others. The lower 2 or 3 miles of the Otter Creek Valley, the valley of a small stream entering Cline Branch from the west about a half mile north of Cedar Grove School, the valley of a small stream entering North Fork from the north about 1 mile east of the Jones County line, and parts of Bear Creek Valley in the southwestern part are a few of the most interesting.

The Maquoketa Caves State Park is located in section 6 of South Fork Township. The caves consist of a series of three natural bridges formed by a small stream finding an underground passage through the limestone formation and cutting away fairly large quantities of rock. The upper passage is called the natural bridge. It is about 150 feet long across the gorge, 60 feet wide, and 90 feet from the top of the bridge to the stream below. The second passage is the longest but is so filled with rocks, driftwood, and silt that it is difficult to follow. The third passage has a ceiling about 300 feet long, ranges from 40 to 75 feet in width, and is from 5 to 25 feet high. The narrow gorges both above and below the caves are very picturesque. The Bellevue State Park occupies a high bluff south of Bellevue. Its chief point of interest is the beautiful view of the Mississippi River.

Jackson County is drained by tributaries of the Mississippi River, nearly all of which are dendritic in form. The Maquoketa River is the main tributary in this county and, together with its branches, drains almost four-fifths of the area. The rest is drained by small creeks and short drainageways directly into the Mississippi River. Surface drainage is good in most parts of the county except in the preglacial valleys and in the bottom lands along the rivers, creeks, and smaller streams. In the preglacial valleys, both external and internal drainage range from good to poor, and in the bottom lands from fair to poor.

Elevations above sea level range from 1,190 feet near the middle of section 6 in Prairie Springs Township to 576 feet at low-water stage of the Mississippi River at Sabula. The drop from 1,190 feet in section 6 to 740 feet in the valley of Tete des Morts Creek occurs within a distance of approximately 2 miles. The highest ridge tops and small plateaus between the North Fork and the Maquoketa River are more than 980 feet, and the elevations drop to about 700 feet at the water level of both streams a little more than 2 miles away. The divide

between Lytle Creek and Farmers Creek reaches an elevation of 1,060 feet, and the stream beds from 2 to 3 miles distant lie at an elevation of slightly less than 700 feet. The elevations in the preglacial valley in the southwestern part range from 740 feet at Monmouth to about 680 feet near Maquoketa. The elevation of the preglacial valley of Goose Lake is 660 feet at Preston, and it ranges from 640 feet to 680 feet at other points. The small area of modified glacial drift in the northwestern part, south of Garry Owen, ranges in elevation from 980 feet in the eastern part to 860 feet in the western part. Maquoketa is about 700 feet above sea level; Gordons Ferry, at the railroad station, 610 feet; Bellevue, 618 feet; Green Island, 599 feet; Lamotte, 911 feet; and Andrew, 870 feet.[2]

Most of Jackson County originally supported a forest cover consisting chiefly of white, bur, red, and black oaks, together with scattered stands of hickory and ironwood on the ridgelike divides. In the deep narrow gorges and along the more broken bluffs, butternut, black walnut, red elm, white elm, basswood, cottonwood, and scattered oaks were common, with a few scattered red cedars growing among the thinly covered limestone rocks and crags. In some places the forest consisted chiefly of hard maple, and in still others elm and basswood predominated. Some of the wider ridge tops were more or less open prairies with grass vegetation or scattered white oaks and hazel brush predominating. The low, wide, flat bottom lands were covered with willow, cottonwood, red elm, white elm, black walnut, butternut, shellbark hickory, black hickory, black ash, white ash, soft maple, birch, boxelder, sycamore, hackberry, and some oaks.

Good drinking water can be obtained in most parts of the county from wells, which range in depth from 20 to 300 feet. Windmills are the most common source of power for pumping water to supply household and livestock needs. Springs that furnish an abundant supply of good water for household and livestock use are fairly common in many of the valleys. Many of the streams are fed by springs and supply an abundance of good water for the livestock the greater part of the year.

The area now constituting Jackson County came under the jurisdiction of the United States through the Louisiana Purchase in 1803. It was included in the district of Louisiana in 1803, the Territory of Louisiana in 1805, the Territory of Missouri in 1812, the Territory of Michigan in 1834, the Territory of Wisconsin in 1836, the Territory of Iowa in 1838, and the State of Iowa in 1846. Marquette, while exploring the Mississippi River and adjacent lands in 1673, was the first white man to visit this part of the continent. About 1812 a small outpost of the United States Army was established near the river near the present site of Bellevue, but it was abandoned. No permanent settlement or trading posts were established by the white people in Jackson County until the lands had been opened for settlement by a treaty between the Sac and Fox Indians and the United States Government, in September 1832. This was known as the Black Hawk Purchase, which opened to white settlers a strip about

[2] Elevations are based on U. S. Geological Survey data and data taken from the following publication: SAVAGE, T. E., GEOLOGY OF JACKSON COUNTY. Iowa Geol. Survey 16 (Ann. Rpt. 1905): [563]–619, illus. 1906. See p. 583.

50 miles wide west of the Mississippi River in what was then the Territory of Missouri.

The Fox Indians, who occupied the area, moved farther west after the treaty, and few Indians except the Winnebagos were seen in Jackson County after the first immigration of white settlers. The Sioux Indians maintained a claim to the lands of this area but gave no trouble after the settlers came.

The first settler to take up land within the county was James Armstrong, who arrived in 1833 and settled about a mile south of Bellevue. In 1834 William Jonas settled just north of where Bellevue is now located, and later in the same year Alexander Reed and William Dyas settled to the south and west of this town. Bellevue is named for John D. Bell, who, in 1836, settled on land now within the village limits. Other settlers located in various parts of the county. Sabula was settled in 1836. The first house in Maquoketa was built in 1838. The early settlers came from Illinois, New York, and Kentucky, but as immigration continued they came from all the more settled States farther east.

The lands west of the Mississippi River had been divided into two counties, Dubuque and Des Moines. Jackson County was created from a part of Dubuque County in 1837 by an act of the Legislature of the Territory of Wisconsin, meeting at Burlington from November 10, 1837, to January 20, 1838. The county originally included Jones and Linn Counties, but Linn County was taken off in 1837, and Jackson County assumed its present boundaries when Jones County was established on November 12, 1838. The county seat was first at Bellevue, where it remained until it was moved to Andrew in 1841. In 1848 it was returned to Bellevue, where it remained until 1861, when it was again moved to Andrew. In 1873 it was moved to Maquoketa, the present county seat.

The population of Jackson County, as reported by the United States census in 1930, is 18,481, of whom 14,886 are rural and 3,595 urban. The rural population consists of 9,596 people living on farms and 5,290 living in small villages and towns. Of the total population, 94.3 percent are native born, and 27.5 percent of the native-born whites are of foreign or mixed parentage. The foreign element is more than 60 percent German, about 10 percent Irish, and 5 percent English, together with small numbers of Scotch, French, Scandinavian, and Canadian people.

Maquoketa, the county seat and largest city, has a population of 3,595, according to the 1930 census. Bellevue, Sabula, Preston, and Miles are important villages. The villages, except Lamotte and Andrew, are located in the preglacial valleys or along the Maquoketa and Mississippi Rivers.

Monmouth, Baldwin, Nashville, and Maquoketa, on the Chicago & North Western Railway, and Preston, Miles, Sprague ville, Green Island, Bellevue, and Sabula, on the Chicago, Milwaukee, St. Paul & Pacific Railroad, are local trading centers and shipping points for farm products. Lamotte, Zwingle, Andrew, Canton, Fulton, Emeline, Ironhills, South Garry Owen, Springbrook, Sterling, and St. Donatus are small local trading points without railroad connections.

Railroad transportation is available in the southern and eastern part of the county, but the central and northern parts do not have railroad connections. A branch line of the Chicago & North Western Railway furnishes transportation facilities for the villages in the valley southwest of Maquoketa and, together with a spur of the Chicago, Milwaukee, St. Paul, & Pacific Railroad, which joins the main line at Delmar in Clinton County, furnishes rail connections for Maquoketa. The Chicago, Milwaukee, St. Paul, & Pacific Railroad has lines crossing the southern and eastern parts of the county. The first railroad to enter or pass through the county, the Clinton, Dubuque & Minnesota Railroad, was built through the eastern and southeastern parts and was completed in 1872. It is now a part of the Chicago, Milwaukee, St. Paul, & Pacific Railroad.

Prior to 1872 the only direct transportation facilities available to the people of this county were the steamboats on the Mississippi River. Although more or less river transportation was maintained from the time of the earliest settlements, no available records show when the first regular schedule was maintained. However, in the fifties and through the sixties up to the time when the railroads became well established, a regular schedule of one steamboat each way daily was maintained from early spring to late fall. These boats carried the mail and provided transportation for passengers and freight. After the railroads began to carry the mail and most of the passengers and freight, transportation by steamboat declined until it was practically eliminated by 1885. Many attempts have been made to restore river transportation, and when the 9-foot channel is completed river traffic may revive. Lock and dam No. 12, located at Bellevue, is a unit in the 9-foot channel project adopted by Congress. The lock was finished in 1935, but construction of the dam has not begun.

Two United States highways extend north and south across the county. United States Highway No. 61 extends from the Clinton County line south of Maquoketa to the Dubuque County line at Zwingle. United States Highways Nos. 67 and 52 coincide from the Dubuque County line to Sabula, where No. 52 crosses the river over a toll bridge and No. 67 continues south toward Clinton. This highway is gravel surfaced, but preparations are being made to pave it. State Highway No. 117 is paved with concrete from the Jones County line to Maquoketa and surfaced with asphalt from Maquoketa to Sabula. Several graded and graveled county roads extend into other sections. Many parts of the county are reached only by dirt roads, which are kept in good condition during the drier parts of the year. All the roads have been improved greatly during the last few years.

Jackson County is favorably located with respect to large markets. Chicago is the principal market for all farm products, but many of the smaller markets take considerable quantities.

Rural schools and churches are conveniently located, and all the principal towns and villages have high schools, graded schools, and churches. Telephone lines reach all parts of the county, and most farm homes have telephone service. Rural delivery of mail is universal.

The most important nonagricultural industries are crushing limestone for road gravel and industrial purposes and the production of

pearl buttons from the shells of river clams. A few small commercial fisheries are located on the Mississippi River.

CLIMATE

Jackson County has a wide range in temperature. The range differs somewhat from year to year, but the maximum over a period of years is from −32° to 106° F. The average frost-free season is 151 days. The average date of the latest killing frost is May 3, and the average date of the earliest is October 1, but the date of the latest on record is May 26, and of the earliest is September 11. The average annual precipitation is 33.17 inches, the lowest on record is 20.81 inches, and the highest is 46.01 inches. Most of the rain falls from May to September, inclusive, which coincides with the period of greatest plant growth. Droughts ranging from 2 to 4 weeks may occur during the summer and fall, causing considerable damage; but, according to a statement of the United States Weather Bureau, more damage has resulted from excess moisture than from lack of it, and in no year has there been total loss of crops due to drought.

Much of the precipitation, except in winter, comes in the form of slow general rains, and part of it comes as gentle to heavy showers; but occasionally a heavy rainfall of more than 4 inches within 24 hours or less has occurred. The period of lowest precipitation is from November to March, inclusive, when only about 20 percent of the annual amount falls. Most of the precipitation during this period is in the form of snow, which is the best form for the protection of grasses, perennial legumes, fall-seeded grains, berrybushes, plants, and flowering shrubs.

In general, the summers are warm and have a large percentage of sunshine with occasional short periods of almost tropical heat. The winters generally are divided into periods of considerable severity and periods of more moderate and pleasant weather. Blizzards are rare and when they do occur cause little damage, except in delaying railroad traffic and in blocking the highways and country roads for short periods. The ground commonly remains frozen for about 3½ months and in most places is covered with snow the greater part of that time. In some years dirt roads and lightly covered graveled roads become impassable or practically impassable in the spring when the frost leaves the ground suddenly.

The greatest variations and the most sudden changes in temperature come in the early spring and late fall. Once in a great while, generally in May, June, and July, typical tornadoes strike this area. Although hailstorms are not uncommon, very heavy and destructive hailstorms are rare. The damage usually is light or limited to narrow strips.

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation as recorded at the United States Weather Bureau station near Maquoketa. These data are representative of climatic conditions for the county as a whole.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation near Maquoketa, Jackson County, Iowa*

[Elevation 692 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum [1]	Absolute minimum [1]	Mean	Total amount for the driest year (1897)	Total amount for the wettest year (1902)
	°F.	°F.	°F.	Inches	Inches	Inches
December	24.7	67	−24	1.26	1.01	2.35
January	18.9	63	−32	1.14	2.65	.73
February	22.2	67	−31	1.16	1.15	1.31
Winter	21.9	67	−32	3.56	4.81	4.39
March	34.4	86	−12	2.16	2.31	2.23
April	47.9	88	14	2.85	3.24	1.69
May	59.9	94	26	4.09	1.40	5.73
Spring	47.4	94	−12	9.10	6.95	9.65
June	69.0	99	39	3.96	2.54	8.67
July	72.9	106	40	3.62	2.12	8.80
August	70.4	100	40	3.80	.93	3.57
Summer	70.8	106	39	11.38	5.59	21.04
September	63.9	97	24	4.24	2.11	6.39
October	51.5	89	15	2.83	.29	2.37
November	37.0	78	−12	2.06	1.06	2.17
Fall	50.8	97	−12	9.13	3.46	10.93
Year	47.7	106	−32	33.17	20.81	46.01

[1] Taken from the records of the United States Weather Bureau station at Dubuque, Iowa.

AGRICULTURAL HISTORY AND STATISTICS

The agricultural history of Jackson County began with the arrival of the first settlers in 1833 and 1834. They settled on the high river and wide creek terraces and on the bottom lands near where Bellevue is located. By 1836 settlers had scattered into many parts of the county and had selected both upland and lowland sites for their farms. Most of the county was covered with forest consisting of a great variety of deciduous hardwood and softwood trees, except a few prairie areas. The more important prairie areas were near Lamotte, near Miles, east of Preston, southwest of Maquoketa, east and north of Otter Creek, and north of Andrew. A considerable part of the forest land was rough and broken. Available records do not show the size of the farms established by the settlers, but, from local information, some of the larger farms contained from 1,000 to more than 2,000 acres. Some of the smaller ones contained less than 40 acres, but the majority ranged from 75 to about 200 acres. As most of the farms, except those on the prairies, contained more or less rough broken land, many of the settlers chose to build their homes in the valleys, where an abundant supply of good water was easily obtainable and where considerable protection from the cold winter winds was afforded.

The settlers' first concern, after establishing their homes, was to produce those crops that would supply the family with food and provide feed for the domestic animals. The more common crops were wheat, corn, oats, potatoes, and a few garden vegetables. Many settlers brought a few cattle, hogs, and chickens to their new homes or obtained them soon after they became established. Some brought horses or oxen for draft purposes. In addition to the meat supply from animals raised by the settlers, a considerable supplement of meat was obtained from the abundance of wild game.

Wheat was the most important crop and remained the principal cash crop up to the seventies. Several factors led to the decline in production of wheat, such as the low price for wheat after the Civil War, the increased transportation facilities made available to the farmers by the completion of the first railroad in 1872, thereby opening new markets for hogs, beef cattle, and dairy products; and the ravages of chinch bugs, which were very destructive to wheat in the late seventies and early eighties. Wheat and oats were shipped by boat to St. Louis and other river towns as early as 1840. Some of the wheat was ground at local flour mills for a home supply of flour and for export to other markets. Two of the largest flour mills were located at Bellevue. The first one, built in 1849 or 1850, and the second in 1860, were operated by water power and had a capacity of 130 barrels a day. The flour was packed in barrels and shipped to Galena and Savanna, Ill., Clinton and Lyons, Iowa, and other river towns.

Cattle and hogs were raised mainly to supply home and local demands for meat and dairy products, before the coming of railroads, although some were sold to outside markets. A few of the cattle were shipped by boat to markets farther south on the Mississippi River and an outlet for dairy products was afforded in the same markets. Considerable numbers of hogs were dressed and sold to packers, but the real incentive to an increased production of hogs did not take place until buyers began to ship them by rail to Chicago. About that time corn became the most important field crop, and the increased markets for cattle, together with the building of creameries about 1880 caused cattle to assume an important role in the agriculture of this county.

In the early period of settlement two or three sawmills run by water power were built, the oldest and largest at Bellevue in 1849 or 1850. These mills cut local timber to supply the home demand, but specialized in oak, black walnut, basswood, and other woods for the furniture factories at Galena, Ill. The sawmill at Bellevue was in operation until 1908, and during the last 30 or 40 years pine logs were brought down the Mississippi River in rafts from the forests of northern Minnesota and Wisconsin. The daily output of pine lumber was about 35,000 board feet. Much of the standing timber was cut into cordwood and sold locally or to the steamboats on the river. One resident reported that his father sold from 2,000 to 3,000 cords of wood each year from 1856 to 1871, to steamboats. The price was $4 a cord for softwood and $5.50 for hardwood.

The land has remained in use from the early period of settlement to the present time in what is commonly called general farming, with special attention to the production of meat and dairy products. Agriculture was never limited to the one-crop system, although wheat was at one time the main cash crop. Wheat ranked third in the

acreage of cultivated crops in 1879, according to the Federal census report of 1880. Corn led with 74,591 acres, oats were second with 33,396 acres, and wheat occupied 25,008 acres. The census report for 1880 is the only census in which the acreage of wheat is important. The later reports show that wheat has fallen into the group of minor crops. The wheat acreage has ranged from 5,020 acres in 1889 to 1,165 acres in 1929, with the exception of a temporary increase in the demand for wheat during the World War, which caused a sudden increase in the wheat acreage to 7,437 acres in 1919. The smallest wheat acreage reported by the census was 775 acres in 1934.[3]

The acreage of corn has remained more or less constant since 1879, although the general trend has been a decrease since 1899. When the acreage of wheat dropped from first place in the seventies, corn came into first place and remained there until 1929, when it was replaced by hay. The latter has been a close second since 1909. An average acre yield of 45.5 bushels of corn was reported in 1879, and an average yield of 42.9 bushels was reported for 1899. The largest acreage planted and the largest quantity harvested were reported for 1899. The acreage in oats has remained the most constant for any crop reported by the census since 1879. Hay has shown an increase from 32,439 acres in 1879 to 64,630 acres in 1929. In the early periods only the total acreage for all hay was reported, but from 1899 to the present time the trend has been toward a decided increase in the acreage of legumes. Clover was reported grown on 513 acres in 1899 and increased to 16,091 acres in 1929. Alfalfa was reported on 4 acres in 1899, on 3,377 acres in 1929, and on 14,120 acres in 1934. The latter figure is very significant, because during the dry spells occurring in the last 10 or 12 years the farmers have been convinced of the value of alfalfa. Another significant figure for 1934 is that 19,436 acres of clover and timothy yielded 10,193 tons of hay, whereas 14,120 acres of alfalfa produced 22,286 tons.

Table 2 gives the acreages of the principal crops in the census years 1879 to 1934, inclusive.

TABLE 2.—*Acreages of the principal crops in Jackson County, Iowa, in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	74,591	69,758	82,740	67,771	63,145	59,696	48,773
Oats	33,396	41,926	46,575	27,957	29,372	35,026	27,267
Wheat	25,008	5,020	2,706	1,709	7,437	1,165	775
Rye	2,590	2,659	3,284	707	1,000	494	395
Barley	1,149	315	2,460	7,370	2,562	2,991	1,637
Buckwheat	493	452	391	202	130	10	----------
Potatoes	----------	1,896	1,705	1,402	661	797	1,133
Hay, all kinds	32,439	58,336	50,579	68,051	61,697	64,630	48,443
Clover and timothy	----------	----------	----------	31,350	49,107	44,015	19,436
Clover alone	----------	----------	513	1,049	4,194	16,091	393
Timothy alone	----------	----------	----------	33,420	6,904	----------	----------
Alfalfa	----------	----------	4	37	221	3,377	14,120

The minor crops that have always been more or less important are barley, rye, and potatoes. Other crops have been fairly im-

[3] Nearly all crop acreages reported for 1934 are unusually small because of the very severe drought. The census reported only the number of acres harvested, and the reported acreage, therefore, does not include all the land seeded. Many acres of crops, especially the small grains, were so seriously damaged that they were not harvested. The only crop that showed a real increase for that year was alfalfa.

portant in some years but are grown on rather small acreages in others. Sweetclover was grown on 496 acres for pasture in 1929.

Fruits are produced for home use and to a small extent for local sale, but none are produced on a commercial scale. Many varieties of apples are grown. Grapes rank second among the fruits grown, but very few growers produce more than enough for their own use. Strawberries and raspberries are produced for the home and to supply the local demand in season. Other fruits grown to some extent include peaches, pears, plums, and cherries.

Although the agriculture of Jackson County continues on the basis of general farming, the tendency of most farmers is to specialize either in the production of beef cattle or in dairying. The United States census for 1935 showed that 51,751 cattle were on the farms and ranges. Of this number more than two-thirds were raised predominantly for the production of beef and the rest kept for the production of dairy products. The number of beef cattle increased from 27,381 in 1880 to 48,051 in 1920, the latest year in which the census reported beef cattle and dairy cattle separately. The most popular beef breeds are the Aberdeen Angus and the Hereford. Most farmers use purebred bulls with grade cows, but a few maintain purebred herds. In addition to the beef cattle raised, several carloads are shipped in as feeders and finished on concentrates for market. About 1,500 carloads of cattle are shipped to market annually. The number of dairy cattle has remained fairly constant since 1880, but the value of dairy products has shown a steady increase. The reported income from dairy products for 1899 was $244,609; for 1909, $526,637; for 1919, $778,607; and for 1929, $1,187,265. A part of the increase can be attributed to the higher prices received for the products in the later years, but most of it is due to increased production. The average size of the dairy herds, according to the county agent, is about 15 cows, and the most common breeds are Holstein-Friesian, Guernsey, and Jersey. Most of the commercial dairy farms are around Maquoketa, Preston, Sprague ville, and in the vicinity of the creamery east of Nashville. Other localities, such as Lamotte, St. Donatus, Green Island, and other centers produce some dairy products for market. Most of the dairy products are marketed through cooperative creameries and produce companies.

The farmers who are either beef or dairy producers also raise hogs. The number of hogs reported by the census shows an increase from 95,784 in 1880 to 122,783 in 1900 and then an irregular but decided drop to 87,459 in 1930 and to 48,651 in 1935. The 1935 figures are slightly more than one-third of the high in 1900. The county agent states that even since 1935 hog production has shown a slight increase. The most popular breeds are Poland China, Duroc-Jersey, and Chester White.

Poultry is kept on nearly every farm, although there are no strictly poultry farms. The common plan is to maintain a fairly large farm flock of chickens. The average-sized flock kept from year to year is about 150 hens. According to the 1930 census, the production for 1929 was 407,770 chickens, which was nearly twice as many as were kept over, and the report for 1934 indicates a production of about 1½ times the number kept. The numbers of turkeys, geese, and ducks fluctuate to a larger extent from year to year than do the numbers of chickens,

but, according to local reports, the numbers of ducks and geese are more constant than those of turkeys.

Because of the wide program followed in the production of cattle, hogs, chickens, sheep, turkeys, geese, and ducks, it is necessary for the farms to be well equipped with suitable buildings to house the animals and store the grains and other feed. It is also necessary to have adequate machinery for preparing, seeding, and harvesting the numerous crops. Many of the farms are equipped with tractors and tractor outfits, but most of the farm work is done by horsepower.

Commercial fertilizers are not commonly used. The county agent has estimated that an average of only 20 tons are used annually on the farms. Barnyard manure is the main soil amendment, but the use of crushed limestone in preparing the land for the production of alfalfa has become very important. Many farmers have reported the use of more than 100 tons in 1 year on their farms, and the total used annually for the last few years has been well into the thousands of tons. More than 85 percent of the farmers have at least a few acres limed, and many have all the tillable land limed.

The extra help employed on farms can be divided into two classes: (1) Those employed by the month and (2) those hired by the day. Most of the farm help employed is from local sources, and all the laborers are white. During the last few years help has been fairly abundant, but at times during rush seasons the farmers find it somewhat difficult to obtain adequate help. Most of the help is efficient and fairly well trained. Many retired farmers hire out for extra work during the rush seasons.

The size of farms, as reported by the census for 1935, ranges from less than 3 acres to more than 1,000 acres, 3 operators reporting less than 3 acres and 3 more than 1,000 acres. About 100 operators had less than 20 acres, 400 had between 20 and 100 acres, and 1,300 had between 100 and 260 acres. The total number of farms reported in 1935 was 2,208.

Table 3 gives the number of farms reported in each census year from 1880 to 1935, the average size of farms, the number of farms operated by owners, tenants, and managers, and the percentage of owner-operated farms.

TABLE 3.—*Number of farms, average size, and farm operation, in Jackson County, Iowa, in stated years*

Year	Farms	Average size	Farms operated by—			Owner operators
			Owners	Tenants	Managers	
	Number	*Acres*	*Number*	*Number*	*Number*	*Percent*
1880	2,628	140.0	2,245	383	----------	85.4
1890	2,419	155.0	1,996	423	----------	82.5
1900	2,637	149.6	2,070	552	15	78.5
1910	2,400	162.4	1,869	515	16	77.9
1920	2,327	168.6	1,692	606	29	72.7
1930	2,207	173.6	1,453	746	8	65.8
1935	2,208	172.0	1,462	738	8	66.2

The trend has been for the size of farms to increase slightly as the number decreased. Although the number of farms has decreased, the number of tenants has increased, and the percentage of owner operators dropped from 85.4 percent in 1880 to 65.8 percent in 1930.

The 1935 farm census states that Jackson County ranked third highest in the State, with a total of 66.2 percent owner-operated farms. The county agent estimated that about 10 percent of the tenants rented for cash in 1935, and 90 percent rented on shares. The cash rent ranged from $2 to $9 an acre, depending on the type of land and the improvements. Pasture land rented for about $3.50 an acre for improved pastures and bottom lands, but considerably less for the rough stony land pastures.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soil survey of Jackson County was made to map the distribution and location of the soils suitable for cropping, for grazing, and for forestry or for recreational purposes, in order that farmers may more readily adapt for use on their own lands those crops and methods that have proved successful on similar soils elsewhere; and in order that governmental agencies may furnish more specific suggestions concerning the use and improvement of the soils in the different parts of the county.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [4] and its content of lime and salts are determined by simple tests.[5] Drainage, both internal and external, and other external features, such as the relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics, soils are grouped into mapping units. The three principal units are (1) series, (2) type, and (3) phase. Some areas of land, such as coastal beach or bare rocky mountainsides, have no true soil, and these are called (4) miscellaneous land types.

The most important of these groups is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may differ within a series. The soil series are given names of places or geographic features near which they were

[4] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[5] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

first mapped. Thus, Muscatine, Wabash, and Tama are names of important soil series in Jackson County.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Wabash silt loam and Wabash silty clay are soil types within the Wabash series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is recognized for the separation of soil within a type, differing in some minor soil characteristic, which may, nevertheless, have an important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion frequently are shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important differences in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The soils of Jackson County are predominantly of silt loam texture. They have developed from loess, a light silty clay or silt loam material, presumably deposited by the action of wind over the limestone formation in the driftless area and over the boulder clay in other places. The loess, ranging from less than 15 feet to more than 30 feet in thickness, forms a mantle that covers all the higher plateaus and ridges, the slopes above the outcropping limestone formation, and, in places, the slopes below the rock outcrop. Silty material has also been carried down from the loess area by erosion and deposited in the form of alluvium on the flood plains of the creeks and rivers. As alluvium, the reworked loess is the parent material of most of the soils on the terraces and the present bottom lands. The silt loam types and phases are the most uniformly developed soils in the county; the loamy fine sands are next in this respect; and the sandy loams, the fine sandy loams, and the loams are the least uniformly developed. The lack of uniformity in texture and profile development in the sandy loams can best be explained by describing the position they occupy in respect to the silt loams and the diversity of the material from which they are derived. Such descriptions are given in detail in this section, where each type and

phase is discussed individually. It will be sufficient to mention here that no soil type or phase in the county is developed entirely from glacial till. The nearest approach to true glacial material is the modified glacial outwash in an area about 1 mile south of Garry Owen, but in other areas where glacial drift occurs the soil material consists of a light silty clay or silt loam material modified by glacial drift containing some granitic gravel and a few boulders. Soils of areas influenced by glacial drift or the sands of the bordering loamy sand areas differ extremely in texture or in the thickness and position of the sandy layers.

Soils and surface features determine to a large extent the type of agriculture commonly practiced. Because of the large extent of rough broken land, the number of deep ravines, and narrow alluvial bottoms, much of the land can be used to best advantage for pasturing beef or dairy cattle. The wider and more uniformly covered alluvial bottoms are used almost exclusively for growing corn. In the preglacial valleys, where the farms are practically free of rough stony land and, therefore, more compact, dairying is favored over livestock raising, but in other parts of the county livestock raising predominates. Melons are grown on some of the loamy sand areas north of Maquoketa to supply the local demand.

On the basis of use, the various soils in Jackson County can be arranged in two general groups: One group of tillable soils used chiefly in the production of general farm crops, and another of soils used mainly for the production of pasture grasses and timber, and to a much smaller extent for recreational purposes. The tillable soils can be divided into two subgroups according to the color of their surface soils. The first subgroup is made up of those soils with light-colored surface soils, and the second includes the soils with dark-colored surface layers. Marked differences in productivity are the result of the different content of organic matter. The larger content of organic matter imparts the dark color to the soils of the second subgroup.

In the following pages the soils of Jackson County are described in detail and their agricultural relationships are more fully discussed; their location and distribution are shown on the accompanying soil map; and table 4 gives their acreage and proportionate extent.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in Jackson County, Iowa*

Soil type	Acres	Per-cent	Soil type	Acres	Per-cent
Clinton silt loam	69,824	16.9	Carrington loam	704	0.2
Clinton silt loam, slope phase	140,224	33.9	Bremer silt loam	3,968	.9
Clinton silt loam, shallow phase	26,944	6.5	Chariton silt loam	3,520	.8
Clinton fine sandy loam	4,224	1.0	Judson silt loam	256	.1
Lindley sandy loam	2,368	.6	Wabash silt loam	4,736	1.1
Lindley loam	1,216	.3	Cass loam	256	.1
Jackson silt loam	5,440	1.3	Rough stony land	59,456	14.4
Jackson fine sandy loam	1,152	.3	Gasconade loam	4,864	1.2
Genesee silt loam	21,120	5.1	Ray silt loam	1,536	.4
Sparta sand	5,504	1.3	Wabash silty clay	11,136	2.7
Tama silt loam	20,288	4.9	Alluvial soils, undifferentiated	18,816	4.5
Tama fine sandy loam	640	.2	Riverwash	64	(1)
Muscatine silt loam	4,352	1.0	Gravel pits	64	(1)
Muscatine silt loam, slope phase	1,408	.3	Total	414,080	

[1] Less than 0.1 percent.

LIGHT-COLORED SOILS USED FOR GROWING CULTIVATED CROPS

The light-colored soils used for the production of tillable crops comprise a large part of the county. Clinton silt loam and its phases occupy more than 50 percent of the total area; Clinton fine sandy loam, Lindley loam, and Lindley sandy loam are upland soils; Jackson silt loam, Jackson sandy loam, and Sparta sand are developed on the terraces; and Genesee silt loam occupies the bottoms. The surfaces of these soils range from nearly flat on the wide bottoms and terraces, to sharply sloping on the eroded uplands. The soils are, for the most part, retentive of moisture and well drained, and the surface layers are free from troublesome quantities of stone.

Clinton silt loam.—Clinton silt loam has developed under forested conditions. In a virgin state the topmost inch or two in most places contains enough organic matter to produce a medium dark gray color, but under cultivation nearly all of the organic matter disappears, leaving the surface soil light grayish brown or ash gray. Most of this soil has been under cultivation for such a long time that few areas retain their organic matter. As in most of the upland soils where erosion has been active, the thickness of the surface soil differs greatly, but it is more uniform than in either the slope phase or the shallow phase that are described later.

The surface soil, to an average depth of 7 inches, is an ash-gray loose very friable almost structureless silt loam. When wet it appears dark grayish yellow or grayish brown. The next lower layer is dark grayish-yellow or grayish-brown very friable silt loam, which breaks into rather large clods, but they crush readily into finely granular particles. In many areas the surface soil is thin, owing to the loss of much of the original surface material by erosion. In such areas it is grayish brown, and the texture is considerably heavier. Below a depth of about 12 inches, in many places, is a thin transitional layer between the lighter surface soil and the heavier subsoil, which consists of grayish-brown very friable silt loam grading into yellowish-brown friable silty clay. In places the color is somewhat marbled grayish brown and yellowish brown. A heavy layer, between depths of about 14 and 30 inches, consists of dark yellowish-brown somewhat stiff light silty clay, which breaks into small angular fragments, or a nut structure. When dry these fragments become fairly hard. The outside coating is darker than the interior of the fragments, and the fragments generally are separated by a thin floury layer of grayish-white very fine sand or particles of silt. Locally, this horizon is referred to by many as yellow clay.

Below a depth of 30 inches and continuing to a depth of about 48 inches is light grayish-brown heavy silt loam or light silty clay, faintly mottled with shades of yellow and light brown and streaked with gray. The material in this layer is more friable than that in the layer above and has a small to medium nut structure. The fragments are sharply angular, like those in the layer above, but the cleavage lines are less distinct and the coatings are much thinner. The nut structure disappears with depth, and the lower part of this layer breaks into rather large blocks, which can be crushed easily to a powdery mass. The vertical cleavage lines are continuations of deep vertical cracks and are very distinct, but the horizontal

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cleavage lines are very indistinct, if present at all. Below a depth of 48 inches and continuing to a depth of about 96 inches is mottled yellow and gray heavy silt loam splotched with rust brown, which breaks into large sections along vertical cracks but has no horizontal cleavage lines. The mottlings of yellow and brown diminish with depth, but the gray increases. The material in this layer is very friable and mellow and breaks into a very loose and powdery floury mass. This layer is transitional between the true soil above and the parent material below. The material has been leached of the carbonates but in other respects shows very little influence of the soil-forming processes. Several tests made in various parts of the county to determine the depth to the unleached material revealed that in most places this material is at a depth ranging from 8 to 12 feet below the surface, but in some areas in the southeastern part it lies at a depth of about 70 inches, and in the central-northwestern part it continues below a depth of 12 feet.

Clinton silt loam is distributed over all parts of the county and occupies undulating to gently sloping plateaus, broad gently rounded ridge tops, and the more gentle slopes occurring chiefly on the divides that separate one drainage valley from another. Each valley sends many lateral ravines projecting into the adjoining uplands so that the main divides are cut into a series of fingerlike ridges extending out from the main ridge. This soil is derived from a deep loessial covering that has been deposited over the limestone formation. In the northeastern part near St. Donatus some small areas of this soil occupy the gentle slopes below the rock outcrop. The typical soil covers only the undulating and more gently sloping areas, as the more sloping to steeply sloping areas are separated as a slope phase and a shallow phase described later.

Clinton silt loam is rather uniform and typical except in the areas bordering the upland soils with dark surface soils, where a narrow band of a transitional soil is between the areas with a light-colored surface soil and those with a dark-colored surface soil. The change is very gradual and may extend, in places, more than a mile, so that an arbitrary boundary line must be drawn between these soils; but in other places or in other directions the change from one to the other may be very abrupt and the boundary very definite. Areas including considerable transitional soil are near areas of Tama silt loam east of Otter Creek, southeast of Zwingle, northeast of Miles, and north and northeast of Lamotte; also near areas of Muscatine silt loam south of Lamotte and northwest of Andrew. When wet the surface soil in these transitional areas appears very dark grayish brown or nearly black, but when dry its color is definitely gray or brownish gray. The depth of the surface soil is somewhat greater in the transitional areas than in the areas of typical Clinton silt loam, but it is shallower than in the areas of typical Tama silt loam or Muscatine silt loam.

Included with Clinton silt loam areas as mapped are small bodies of Tama silt loam, Muscatine silt loam, and some Clinton silt loam, slope phase, and in areas bordering Sparta sand there are small bodies of Clinton fine sandy loam and Sparta sand.

This soil has many good qualities that make it a desirable farm soil. It has a moderately thick surface soil that is mellow and fairly easy to

till. It has a comparatively wide range in optimum moisture content; that is, it can be worked without becoming cloddy under a wider range of moisture conditions than some of the other soils, but the range is not so great as it is in the lighter textured soils. The soil is permeable to the movement of moisture and penetration of roots. It has a fairly heavy subsoil with good water-holding capacity, without being deprived of good aeration and good internal drainage. In its virgin condition it is low in organic matter, and under cultivation the organic content is rapidly diminished, but with proper rotation of crops and the addition of barnyard manure when possible, the organic content can be increased, especially in fields that have been limed. It is important to use care in selecting and tilling the crops to be grown so as to prevent excessive erosion. On the typical soil, erosion is not unduly serious; but where this soil borders the slope phase or the shallow phase, not only may improper methods of tillage cause serious damage to the soil of the phases, but the damage may extend into the areas of typical soil. A high content of organic matter in the soil is beneficial both for increasing the crop yields and for holding the soil in place. Therefore, any method of farm management that will increase the organic matter at a reasonable cost should be of economic interest to the farmer who wishes to increase crop yields and at the same time reduce the erosional loss of soil material.

Clinton silt loam is the most important agricultural soil in the county, because it constitutes more than 75 percent of the tillable land. Some of the other soils are more productive or are better adapted for the production of certain crops, but the number of farmers that depend mainly on the Clinton soil for a livelihood is greater than the number that depend on the rest of the soils combined.

Approximately 90 percent or more of this soil is under cultivation, and all the general farm crops commonly produced are grown on it. Corn, oats, and hay are the main crops. Average corn yields are about 45 bushels an acre, and oat yields average more than 35 bushels. The principal hay crops are timothy and clover, or clover alone. The yield of clover is about 1½ tons an acre from the first crop, and on many farms the second crop is cut for seed. Within the last few years much of this soil has been limed to prepare it for growing alfalfa, and the average yield is estimated to be about 3 tons an acre. Many of the farmers make three cuttings a season. Most of the farmers on this soil have from 10 to 25 percent of their land limed, some have limed practically all of it, and only a few have done no liming. Other crops grown are potatoes for home use and to supply the local demand; wheat and barley for home use and an additional feed supply; sorghum mainly for additional roughage but some for sirup; Sudan grass for pasture and hay; and soybeans, which are not so commonly grown but are used as a catch crop to improve the soil and supply additional feed.

Most of the feed crops are fed to beef or dairy cattle and hogs, but a few farmers produce a surplus for the market. Practically every farm has a vegetable garden that produces a great variety of vegetables. Home orchards, especially of apples, are common on this soil. Although very little of the land is forested at present, it was covered originally with hardwood forest consisting of white, bur, red, and black oaks, hickory, ironwood, and some poplar. Some basswood, elm, and black walnut grow on this soil, but they are more common on the rough land or in the valleys.

Clinton silt loam, slope phase.—Clinton silt loam, slope phase, is similar to the typical soil in the color and texture of the surface soil, and in the color and largely in the texture of the subsoil and the material below the subsoil; but it differs from the typical soil in its relief, the variation in thickness of the surface soil, and the heavy layer is not so thick or so well developed in structure. This is the most extensive soil in the county, and 219.1 square miles are mapped. It is more widely distributed than the typical soil and to a large extent surrounds areas of the typical soil. It occupies the slopes extending from Clinton silt loam to the outcrop of the limestone formation, and in places it covers the narrow and more rounded ridge tops. Near St. Donatus some of the more deeply covered slopes below the rock outcrop are occupied by soil of this phase. This soil is derived from the same loessial material as the typical soil and is nearly as free from other material, except where it approaches the upper limits of the rock outcrop, and here it contains a mixture of chert fragments.

Nearly 75 percent of this sloping soil is under cultivation or in improved pastures. The cropping system differs only slightly from that practiced on typical Clinton silt loam, as the same crops are produced on both, but many farmers seed the slopes to hay instead of cultivated crops. Many hillsides have been limed for growing alfalfa or allowed to grow up to bluegrass pastures. Clover and timothy or clover alone occupy others, but too many of the hills are plowed annually, and a fairly large acreage is planted in cultivated crops. The labor cost of growing a crop is greater and the acre yields average less on this soil than on the typical soil. The areas not under cultivation are either unimproved pastures or forest. The predominating pasture grass is Kentucky bluegrass, along with Canadian bluegrass, redtop, ryegrass, white clover, and quackgrass. Soil erosion is much more active on this soil than on the smooth land. Severely gullied slopes are not uncommon, but only here and there is an area too far gone to be returned to productive pasture land by checking the active gullying. Several good methods of checking gullying have been used for many years by progressive farmers, and the Civilian Conservation Corps organization has demonstrated others. The forested areas support fair to good stands of white, bur, red, and black oaks, hickory, ash, ironwood, basswood, cottonwood, boxelder, black walnut, hawthorn, and plum, with an underbrush cover of hazel, dogwood, and briers.

Clinton silt loam, shallow phase.—Clinton silt loam, shallow phase, differs from Clinton silt loam, slope phase, chiefly in the thickness of the soil material from which it is derived and the greater quantity of chert and limestone fragments present throughout the soil profile. Much of this shallow soil has no true profile development, probably owing to the rapid erosion to which the soil has been subjected. The present surface layer consists largely of the exposed material from below the original subsoil.

This soil occurs mainly in the northeastern part and to smaller extent in the eastern and southeastern parts of the county where the limestone formation has been exposed to the forces of weathering for a greater period of time. In those parts, the surface of the rock formation has weathered down to a sloping position and the soil covering is a comparatively thin accumulation of soil material washed down from the loess mantle, with fragments of chert and limestone

intermixed. Most of the limestone fragments have disappeared through leaching, but the chert remains. The depth of the soil material over the broken surface of the limestone formation ranges from a few inches to more than 6 feet, but the average depth is about 24 inches.

Most of this soil is or has been under cultivation. Erosion is more serious on the soil of the shallow phase than on the soil of the slope phase, because where the soil material is removed the exposed limestone is all that remains. More areas of this shallow soil have been abandoned than of Clinton silt loam, slope phase. The abandoned areas commonly are used as permanent pastures, but such areas are not productive because of the thin covering of soil.

Many of the slopes in the northeastern part of the county are divided into two parts by the clifflike outcropping of the limestone formation about midway between the base of the slope and the top. Clinton silt loam, shallow phase, occupies positions on the slopes above the rock outcrop similar to the positions occupied by Clinton silt loam, slope phase, and also occurs on the slopes below the rock ledges. The soil material on the slopes above the rock outcrop is more uniform in thickness and contains a larger proportion of chert fragments than that in the areas below. In the lower positions, chert fragments may occur in the soil profile and blocks of limestone are not uncommon. In places a reddish-brown heavy clay, residual from weathered limestone, occurs within areas of this shallow soil. Although fragments of limestone may be present, the fine soil material is acid and requires liming before alfalfa can be grown.

Approximately 42.1 square miles of this soil are mapped, and more than 50 percent of the land is under cultivation. The crops grown are about the same as those grown on Clinton silt loam, slope phase, but a somewhat lower average yield may be expected. On areas with a fairly deep covering of soil material, yields are about the same as on areas of the slope phase. Good management is required to prevent serious erosion if this soil is to remain in cultivation for any length of time. The areas not under cultivation are commonly forested or are uncleared pastures. The same varieties of trees growing on the slope phase are common on this soil.

Clinton fine sandy loam.—Clinton fine sandy loam resembles Clinton silt loam in color and differs from it in the texture of the surface soil, as it is developed from material higher in sand content than the loess from which Clinton silt loam has developed. Clinton fine sandy loam occupies areas adjacent to Sparta sand and Gasconade loam or, in places, surrounds areas of Gasconade loam. Most of it occupies small plateaus, ridge tops, small benchlike areas on the slopes, or gentle slopes that lie at lower elevations than Clinton silt loam and higher than Sparta sand. The relief is undulating or gently rolling, but some areas with steep slopes are included on the soil map because they are too small to separate.

This soil is so variable in its profile that no one description will represent it over any large area. In most places it has a thin covering of loamy fine sand or light fine sandy loam, ranging from a few inches to more than 20 inches in thickness, overlying a stiff light silty clay subsoil similar to the subsoil of Clinton silt loam. In other places the surface soil to a depth of about 7 inches and the subsurface soil to a depth

of about 14 inches are almost identical with the surface soil and subsurface soil of Clinton silt loam, but the subsoil consists of brownish-yellow friable light sandy clay grading with depth into loamy fine sand. The following description of a profile is representative of the soil in areas having more or less of the sandy material throughout the entire soil.

The surface soil, to a depth of 7 inches, is light brownish-gray fine sandy loam containing considerable very fine sand or silt. The subsurface soil, to a depth of about 14 inches, is grayish-brown fine sandy loam containing considerable silt, and it is a little heavier and more compact than the surface layer. The heavy layer, between depths of about 14 and 28 inches, is yellowish-brown very friable light fine sandy clay, which is somewhat compact in place but breaks easily into sharply angular small-nut structure particles. The cleavage lines are not so distinct or so heavily coated as in the subsoil of Clinton silt loam. With depth, the material of the subsoil increases in sand content and, below a depth of 28 inches, consists of alternating layers of fine sand and light sandy clay, somewhat streaked with shades of grayish yellow and brownish yellow. When moderately dry the material in this layer is compact in place, but it crumbles readily to a single-grain structure when broken loose and lightly crushed. At a depth of about 36 inches the material is loose medium sand, fine sand, or loamy sand. As Sparta sand areas are approached the depth to this layer decreases until it outcrops at the surface.

In the areas bordering or surrounding areas of Gasconade loam, the surface soil of Clinton fine sandy loam is somewhat darker than it is in the areas adjacent to Sparta sand. The material from which this soil has developed is very shallow in many places near areas of Gasconade loam, but it increases in thickness until it reaches a depth of 20 feet or more. This soil has developed under a tree vegetation, but where the soil material was shallow the stand of trees was thinner and more grasses covered the intervening spaces, which accounts for the darker color of the surface soil.

This is not an extensive soil. The largest areas are from 2 to 5 miles northeast of Maquoketa, and other bodies are west and northwest of Fulton; west, northwest, and northeast of Spragueville; southeast of Baldwin; west of Otter Creek; and southeast of Garry Owen.

Perhaps 70 percent of this soil is in cultivation or in improved pastures, and the rest is mainly in unimproved pastures and forest. The cropping system and the type of farming are similar to those practiced on Clinton silt loam, but the variation in crop yields is greater. The areas that have a fine sandy loam surface soil with a light silty clay subsoil and silty material below the subsoil compare very favorably with Clinton silt loam in yields, but those areas with loose sandy material below the upper subsoil layer, especially where the surface soil also is sandy, produce comparatively small yields except in very favorable years. The forest cover ranges from the light scattered stands of trees similar to those on Sparta sand and Gasconade loam to stands similar to those on Clinton silt loam.

A variation of Clinton fine sandy loam, differing from the typical soil only in relief, occurs about 1½ miles southeast of Fulton; several areas are 1 mile north of Maquoketa, and one area is 4 miles east of Maquoketa. There is not more than 1 square mile of this included soil, and less than 40 percent of it is under cultivation or in improved

pastures. The rest is in unimproved pastures and forest. The areas occupying the more favorable relief are under cultivation, and the crops grown are the same as those grown on the typical soil. Erosion is more severe on this land than on the typical soil because of the greater slope.

Lindley sandy loam.—Lindley sandy loam is derived from modified drift outwash or a mixture of loess and glacial drift materials deposited in old valleylike areas that occupy positions considerably lower than the surrounding loess-covered plateaus. Granitic gravel, water-worn pebbles, and a few boulders indicate the presence of glacial influence, and chert fragments on the surface and throughout the profile indicate that local material has been intermixed. In places the soil material is more assorted and consists of an admixture of coarse sand with the silt loam derived from the loess.

This soil occurs mainly in a large fairly continuous body extending from the Jones County line for nearly 5 miles eastward and 1 mile south of Garry Owen. Smaller areas are 3 miles west of Andrew, 3 miles south of Andrew, north of Sprague ville, and southeast of Preston. The land is gently rolling, gently undulating, or nearly flat. The body southeast of Preston appears to have developed from a thin coating of glacial drift deposited over a thin layer of loess and residual deposits more or less mixed, as indicated by granitic gravel and pebbles and numerous chert fragments scattered on the surface and throughout the soil.

Lindley sandy loam has developed under forested conditions. The surface soil in a virgin or uncleared area is medium dark gray very friable and loose sandy loam containing considerable organic matter in the topmost 1- to 4-inch layer. In a cultivated field the original organic content is readily lost and the color of the surface soil becomes light gray or brownish gray. The surface soil to plow depth is nearly single grain in structure, and the texture is loose, very friable sandy loam, in most places containing more or less gravel, pebbles, and chert fragments in the soil or strewn on the surface. The subsurface layer, to a depth of about 11 inches, is grayish-brown sandy loam, generally somewhat heavier in texture than the layer above. The subsoil, reached at a depth of about 11 inches, consists of yellowish-brown friable sandy clay containing coarse material similar to that in the surface and subsurface layers. Except for the concentration of clay in this layer, no definite structure has developed. The upper subsoil layer continues to a depth of about 20 inches, where the color becomes more or less mottled brownish yellow and grayish yellow. The texture continues a sandy clay, but more of the material occurs in pockets and becomes less uniform with depth. Below a depth of 34 inches it is mottled grayish-yellow and brown light sandy clay, which in places grades into loamy sand. In some places the surface soil and the subsoil contain more silt and approach a silt loam in texture.

Most of the land is in cultivation. General farming with either livestock raising or dairying is practiced, according to the type of farming that is common in the vicinity where the soil is located. Lindley sandy loam is not so strong a soil as Clinton silt loam, but in years when the rainfall is favorably distributed throughout the growing season, yields on this soil compare very well with those on

Clinton silt loam. The predominating crops are corn, oats, and hay, principally clover and timothy; but many areas have been limed and seeded to alfalfa with very successful results. Yields of alfalfa average about 3 tons an acre, which is somewhat less than on heavier soils. According to local information, better quality potatoes are produced on this soil than on the heavier silt loam soils, and selected areas are used for vegetable gardens in preference to the more silty soils.

Lindley loam.—Areas of Lindley loam are scattered over different parts of the county but are more numerous northwest of Andrew and north of Sprague ville. The soil is not typical Lindley loam, as occurring in other counties of Iowa. It is not derived entirely from glacial drift but is developed on gentle to steep slopes where erosion has entirely removed or greatly thinned the covering of loessial material, and the underlying glacial drift either is exposed or brought near the surface. Over the greater part of the county some loess remains over the surface of the drift, but small gullies and shallow drainageways have been cut through the loess and exposed the drift, and on the steeper slopes the drift is exposed, mainly in narrow strips. The soil profile differs widely, even within short distances, according to the thickness of the loess and the degree of slope, and in some uneroded areas, which have been included with this soil in mapping, the loess may have a thickness of several feet. These variations could not be shown on a map of the scale used.

As developed in this county, Lindley loam consists of grayish-brown or light-brown loam of variable thickness, containing, in places, a large proportion of silt. This is underlain by yellowish-brown loam or clay loam, which grades, at a depth of about 30 inches, into weathered glacial drift, consisting of gravelly sandy clay. Small boulders and gravel are present in small quantities through the part of the soil derived from drift. The exposed drift material ranges from heavy sticky clay, in some places, to light gravelly loam in others, but the light gravelly texture predominates.

In Jackson County this is a soil of small extent and is not important agriculturally. It has developed under a tree vegetation that was similar to the tree growth on Clinton silt loam, slope phase, which it adjoins, and the crops grown and cultural methods are the same as those practiced on that soil, but the yields are smaller. Less than 50 percent of this soil is under cultivation at present, although nearly all of it has been in cultivation at some time. Most of that not under cultivation has been abandoned because of the severe gullying that has taken place, and a small acreage remains in forest. Many of the abandoned areas are lying idle, but others have been placed in permanent pastures. Most of the areas still in cultivation should be used for hay crops as much as possible, in order to reduce rapid destruction by erosion.

Jackson silt loam.—Jackson silt loam occupies terraces, or second bottoms, along the rivers, creeks, and smaller drainageways. It is similar to Clinton silt loam of the uplands in color and texture and largely in profile development, except that the subsoil in general is more friable and the lower part of the subsoil may be somewhat more mottled with shades of gray, grayish brown, and rust brown. This soil occupies fairly large areas along Deep Creek and Copper Creek

near Preston, along Mill Creek and Pleasant Creek near Bellevue, and south and west of Baldwin along Bear Creek. Smaller areas are along Maquoketa River, Lytle Creek, and several other creeks and small drains. Included with Jackson silt loam are several small areas along the Maquoketa River, which are underlain with gravel or gravel and sand. In these areas the soil is typical Jackson silt loam near the bluffs or abrupt slopes of the rough stony land, but it thins out until the gravel or sand is exposed on the surface near the outer edges of the areas.

This soil has developed under forest vegetation in positions that have good external and internal drainage. In some of the larger areas it is closely associated with Chariton silt loam and occupies the better drained positions, but in places small areas of Chariton silt loam are included on the soil map. Along Beaver Creek the terraces are composed largely of silty clay or clay material, and the soils are a complex of silty clays, but they are mapped as Jackson silt loam or Chariton silt loam according to the predominating profile.

The surface layer of Jackson silt loam is gray, medium dark gray, or grayish-brown fairly mellow and very granular silty loam containing some organic matter in the topmost few inches of virgin areas. The subsurface soil continues to a depth of 10 or 12 inches below the surface and is dark grayish-yellow or grayish-brown friable and granular silty loam. The heavy layer is reached at a depth of about 15 inches below the surface. Between the subsurface layer and this layer is a transitional layer where the texture changes gradually from silt loam to heavy silty loam or light silty clay. The upper part of this layer resembles the lower part of the subsurface layer, and the lower part approaches the texture and color of the layer below. The heavy layer is dark grayish-yellow friable heavy silt loam or light silty clay, which breaks along definitely formed cleavage lines into a sharply angular small-nut structure. The fragments are thinly coated with colloidal clay that is somewhat darker than the interior, and a cut surface or the crushed mass is considerably lighter in color than that of the unbroken fragments. With depth the fragments become larger and the coatings thinner. At a depth of about 28 or 30 inches below the surface the material becomes a little lighter in texture and the color in most places is faintly mottled with gray, yellow, and brown. In the better drained areas very few mottlings appear above a depth of 48 inches. Below a depth of 4 or 4½ feet the material in most areas is more or less stratified, and in places the stratification is very pronounced.

Between 8 and 9 square miles of this soil is mapped, and all the land is tillable except the abrupt slopes from the edge of the terrace to the bottom land or in places where an area is cut through by a deep gully or drain. More than 85 percent of this soil is either under cultivation or in improved hay land and improved pasture. The crops produced are about the same as those grown on Clinton silt loam, but on the flatter areas they may suffer during wet years. The main crops are corn, oats, clover and timothy, and clover alone. Other crops grown to less extent are wheat, barley, alfalfa, and soybeans. The soil requires about 3 tons of crushed limestone an acre to prepare it for growing alfalfa. Timothy seed was at one time an important crop on this soil, but at present only a little timothy

is harvested for seed. The second crop of clover frequently is cut for seed.

Jackson fine sandy loam.—Jackson fine sandy loam occupies terraces somewhat similarly located with respect to the bottom lands as does Jackson silt loam except that the position above the bottom lands averages much lower. Many of the areas are only slightly above the bottom lands that they border, and no area is as high as that of the higher lying areas of Jackson silt loam. The parent material is sandier than that of Jackson silt loam, and the color and texture of the soil material or the development of the soil profile is not so uniform in this soil as in Jackson silt loam.

The surface soil of Jackson fine sandy loam, to a depth of 8 inches, is gray or medium dark gray light fine sandy loam. The texture ranges from loamy fine sand to heavy fine sandy loam, containing a large amount of silt, not only in the different areas, but very commonly within the same area. When the soil is wet, the gray areas have a brown cast and the medium dark gray areas appear nearly black. The subsurface layer, between depths of 8 and 18 inches, is very friable yellowish-brown or grayish-brown fine sandy loam, which generally contains very little organic matter. In most areas the subsoil below a depth of 18 inches is considerably heavier, ranging from light fine sandy clay to heavy silt loam. No definite structure development is apparent in the soil profile. At a depth ranging from 30 to about 48 inches, the lower part of the subsoil is mottled with shades of gray and specked with brown.

The total area of Jackson fine sandy loam mapped is small. The largest body is about 4 miles north of Bellevue, and a number of small areas are along North Fork southeast and northwest of Fulton and at and north of Hurstville. One small area is 2½ miles northwest of Sabula, and others are northwest of Spragueville.

All this soil is under cultivation. Corn, oats, potatoes, and hay are the main crops grown. The quality of the potatoes on this sandy soil is said to be better than of those produced on the silt loam. Yields, especially of corn, average less than on the heavier soils.

Genesee silt loam.—Genesee silt loam is a light-colored first-bottom soil, derived from material carried down from the uplands during heavy rains and deposited as alluvium over the flood plains of the rivers and creeks during periods of overflow. This material is predominantly light colored because it comes largely from the surrounding areas of Clinton silt loam, and most of it, to a depth of several feet, has been deposited since the uplands were cleared and placed under cultivation. The texture, structure, and, to a large extent, the color are nearly the same throughout the entire depth of the deposit. The surface soil, to a depth of 10 inches, is mellow very friable gray or grayish-brown silt loam. Between depths of 10 and 30 inches the material is more streaked and partly stratified in layers of light gray, medium dark gray, and grayish brown. In places the different shades of gray are more or less mottled or specked with brown. Below a depth of 30 inches the stratification is more distinct and the material is more mottled with brown or, in the wetter places, with shades of bluish gray.

On the whole, this soil is rather uniform in texture, but small areas here and there are influenced by the addition of various

amounts of sand. Two or three small areas in the Maquoketa River bottom lands above Sprague ville and between Sprague ville and Green Island consist almost entirely of sand, and other areas in the same locality have a thin overwash of sandy material deposited on the silt loam. Northwest of Fulton, where the bottom lands receive the wash from Sparta sand, various quantities of sand may occur in the surface soil or as thin layers beneath the surface soil; but the sandy areas are not continuous, so it was impracticable to attempt a type separation.

Perhaps 50 percent or slightly more of this soil is under cultivation. Corn is the principal crop and on some areas is the only crop grown. It is reported that some areas of this soil have been planted to corn every year for more than 70 years. The yield of corn is exceptionally good. Some of the areas in the lower part of the valley of the Maquoketa River are reported to have yielded from 80 bushels to more than 100 bushels an acre, but as a whole the cultivated areas will not average 80 bushels an acre, because some of the areas are subject to greater losses from flooding during the growing season or early in the fall before the crop can be harvested. Most of the remainder of this soil is used for permanent pasture and for the production of hay. Kentucky bluegrass is the predominating pasture grass.

The reaction is slightly acid to nearly neutral throughout the soil mass, but in few places does the soil require liming to prepare it for alfalfa. Although the land is subject to more or less frequent flooding, the stream channels are cut sufficiently deep to provide good surface and internal drainage. The porosity of the soil is exceptionally good, a condition that greatly aids in the removal of surplus surface water and the excess water in the soil through downward percolation or lateral movement in areas that are so nearly flat that drainage otherwise would be slow.

Sparta sand.—Sparta sand is derived from beds of medium or fine sand, which are deposited in scattered areas along the Maquoketa River, and especially along the North Fork, and south of the river below its junction with the North Fork. More or less isolated areas occur at various points—one along the Maquoketa River about 6 miles west of Maquoketa, one about 3 miles northwest of Sprague ville, one about 3 miles southwest of Garry Owen, one east of Lytle Creek about 1 mile north of its junction with the North Fork, and one small area south of Canton. The positions occupied by this sandy material indicate that at least parts of these areas are remnants of old terraces; but the outcropping of the limestone formation, in places, on the higher points in the areas and the presence of highly siliceous limestone fragments, pockets, or layers in the outcrops indicate that locally the limestone formation was highly siliceous and that the sand in these areas is residual, with more or less modification by wind or water action.

The relief ranges from undulating to rolling, and there is considerable range in elevation from the highest to the lowest points in some areas. Drainage is good, but many of the drains empty into small depressions with no surface outlet. Some of the depressions occur in a chainlike arrangement, which indicates that the drainage is more or less connected, but the surface outlets are broken.

The thickness of the sand varies considerably. Some small areas have a covering of sand less than 24 inches thick over partly weathered limestone, but most of the areas have a covering of sand or loamy sand, which is more than 42 inches thick, and may be more than 20 feet in places. In the large area 2½ miles northwest of Fulton the sand has blown into two dunelike knolls. Similar but smaller knolls have formed in other areas, and in some places the sand has been carried by the wind and deposited over the higher lying silt loam areas to form a thin coating of sand over the silt loam or has collected into fairly high sandy knolls on the relatively higher points.

Sparta sand has developed under a combination of tree vegetation consisting mainly of a thin stand of bur oak and an undergrowth of hazel brush, buckbrush, plum bushes, briers, and many coarse tall grasses in the more open spaces. In other places the land supported such trees as aspen, birch, elm, various oaks, hawthorn, and cedar. The cedar trees grow only in the areas where the limestone either outcrops or approaches very near the surface. In virgin areas the surface soil, ranging in depth from 3 to 8 inches, in places is dark grayish-brown or very dark grayish-brown loose mellow loamy fine sand containing a fairly high percentage of organic matter, but under cultivation the organic matter is readily lost. In a cultivated field the surface soil, to a depth of 9 inches, is light grayish-brown or brownish-gray loamy fine sand with single-grain structure. The subsoil shows very little if any textural development. The organic color which is carried down from the surface soil gradually fades with depth. Below a depth of 36 inches and continuing to a depth of 60 or more inches, the material is loose incoherent pale grayish-yellow medium sand or fine sand practically free from organic color. The reaction is medium acid throughout the entire soil mass; but in places where the limestone formation is at a depth of 2 to 3½ feet, the reaction may range from slightly acid to neutral just above the limestone and be slightly alkaline in places where limestone fragments are mixed with the lower soil material.

About 80 percent of this soil has been improved and under cultivation at some time or other, but at present only about 50 percent remains in cultivation or seeded to tame hay. Much of the land once under cultivation has been abandoned as cropland and turned into permanent pasture, but some of the more recently retired cropland is lying idle. Some rye, potatoes, soybeans, and sorghum are grown on this soil, but the main crops are corn, oats, and hay. Corn yields range from nearly complete failure in dry hot years to 35 or more bushels an acre in favorable years. In the very dry year of 1934, most of the oats were too short to harvest, but during favorable years, yields on well-tilled farms may exceed 40 bushels an acre. The most common hay crops are mixed clover and timothy, or clover alone. Yields of 1½ tons an acre from clover are not uncommon, but in very dry years the crop is short. Some farmers who have limed this soil and seeded it to alfalfa report very satisfactory returns. Loamy sand with a profile similar to this soil has given very satisfactory returns from alfalfa in central and northern Minnesota; therefore, further trials with alfalfa on this soil may prove very satisfactory to those farmers who have failed to obtain a stand. On

light soils it is recommended that the soil be clean cultivated until late in June or July, then seeded to alfalfa, without a nurse crop, whenever moisture conditions are favorable.

A variation of Sparta sand occupies terraces along the Mississippi River north of Bellevue and northwest of Sabula. These terraces are remnants of old sand and gravel bars formed by the Mississippi River during the melting of the glaciers, when the river was flowing at a much higher level than it is today. A few small areas similar in profile but occupying lower terraces about 3 miles southwest of Garry Owen are included with this soil as mapped. One of these lower terraces, about 4 miles north of Green Island, is only slightly above the surrounding bottom land and is flooded when the river is at a very high flood stage, but in other respects it is typical. The 12-inch surface soil is grayish-brown loamy fine sand containing some organic matter. The subsoil between depths of 12 and 30 inches is brownish-yellow or yellowish-brown loamy fine sand of single-grain structure. Below a depth of 30 inches and continuing for several feet, the material is mixed medium sand and fine sand with very little or no finer materials and practically free from any organic matter. The total area of this variation of Sparta sand is about 2 square miles. Practically all of it is open and can be tilled, but not more than 60 percent is under cultivation because of its droughty character. The lighter areas have been abandoned. North of Bellevue and northwest of Sabula are areas underlain by gravel, which have been worked as gravel and sand pits. At a depth of several feet the material is laid down in strata and each stratum is more or less assorted. In some strata containing gravel the size ranges from coarse gravel to small cobblestones more than 3 inches in diameter. The southern part of the area north of Bellevue is more or less mixed with gravel in the surface soil, whereas parts of the northern half have a light sandy loam surface soil that contains sufficient organic matter to give it a dark-gray color. The main crops are corn, potatoes, soybeans, and hay; some small grains are also grown. Yields are low except in favorable years. This soil requires frequent rains.

DARK-COLORED SOILS USED FOR GROWING CULTIVATED CROPS

The dark-colored soils used for the production of cultivated crops do not cover so extensive an area as do the light-colored soils, but they include some of the most productive soils of the county. The soils belonging to this group have accumulated rather large quantities of organic matter and have thicker and darker surface layers than the light-colored soils. The upland soils have developed in comparatively smooth areas where erosion is less active and where a grass vegetation originally covered the surface. The Tama and the Muscatine soils are developed from loess under different conditions of moisture. Carrington loam is derived from glacial drift under good drainage. The Bremer, Judson, and Chariton soils on the terraces, and the Wabash and Cass soils, also belong with this group. The well-drained upland soils are especially productive of corn, and oats rank second in importance. Bremer silt loam, Wabash silt loam, and in places Chariton silt loam and Muscatine silt loam, are poorly drained and require artificial drainage before they can produce the best yields.

Tama silt loam.—Tama silt loam is a dark-colored upland soil derived from the well-drained loessial material and developed under a

grass vegetation. In Jackson County it occupies two distinctly different positions—one on the high plateau and ridges where the loess is thick, and the second on the low nearly flat divides in the preglacial valleys where the covering is comparatively shallow. In the first position it occupies the fairly broad ridges northeast of Otter Creek and northwest and northeast of Lamotte and the wide gently sloping area northeast of Miles; in the second position it occupies the preglacial valleys southwest of Maquoketa and near Preston, from which point it extends eastward toward Miles. In the deeply covered areas the loess is free from any glacial drift; but in the valleys the material, although predominantly silt loam, may contain traces of glacial debris in the form of granitic gravel, water-worn pebbles, or a few boulders, which are noticeable only in the very thinly covered places. The soil profile in both positions is similar, except in spots in the valleys where the soil material over bedrock is very thin. Included with this soil on the soil map are small areas of Muscatine silt loam in the flatter positions on the higher ridges northeast of Otter Creek and near Lamotte, a few small areas of Clinton silt loam, and in the vicinity of Preston a shallow phase of Tama silt loam. The included areas are too small to indicate on a map of the scale used.

The surface soil of Tama silt loam, to a depth of 8 inches, is dark grayish brown, very dark grayish brown, or nearly black mellow finely granular silt loam. The subsurface soil is a continuation of the surface soil except that the dark color gradually fades out with depth. The light-colored material is most commonly reached at a depth of about 18 inches below the surface, but in some areas the dark color disappears at a depth of about 14 inches, and in other places it continues to a depth of 22 inches or more where the material has been accumulated by the washing in or blowing in of the surface material from adjoining fields. The upper part of the light-colored layer is yellowish-brown friable heavy silt loam or light silty clay, which breaks into angular fragments along cleavage lines thinly coated with dark-brown colloidal clay. In places the fragments are separated by a thin floury layer of grayish-white very fine sand or coarse silt. Below a depth of 28 inches the fragments constituting the nut structure are less definite, the cleavage lines are indistinct, the coatings are thin, and the material is somewhat more easily crushed to a floury mass. The color is faintly mottled gray, yellow, and brown, and the mass color is lighter than in the upper part of the subsoil. In places the heavy brown coatings continue down through this layer. At a depth of about 48 inches the color becomes more uniform and considerably lighter but is faintly mottled with shades of yellow, brown, and some gray. The texture is loose friable silt loam or heavy silt loam, and the material is somewhat stratified or streaked. Below a depth of 65 inches the color becomes still more uniform and the material is brownish-yellow silt loam, which is more easily crushed to a loose floury mass. The reaction becomes neutral with depth, and calcareous material is reached in places at a depth of 6 feet, but in most places is not reached at a depth of less than 8 feet below the surface.

This is one of the most desirable farming soils in the county, and practically all of it is under cultivation. The type of farming does not differ from that on other soils except that dairying predominates over the production of beef cattle, because there is less waste land that

can be used only for pasture. Corn is the leading crop, with an estimated average yield of 70 bushels an acre on the better tilled farms and a general average of more than 60 bushels for the soil as a whole. This yield seems a little high, but many farmers report yields of nearly 100 bushels an acre in favorable years. The acre yields of oats were reported to range from 30 to 50 bushels with maximum yields of more than 80 bushels in favorable years. Clover is the leading hay crop, but it is rapidly being displaced by alfalfa. This is an excellent soil for alfalfa because of its high organic content and good external and internal drainage, but it requires an acre application of about 3 tons of crushed limestone to reduce the acidity before preparing the seedbed.

Tama fine sandy loam.—Tama fine sandy loam occupies undulating to gently sloping areas, most of which are somewhat lower than the adjoining Tama silt loam with which this soil is closely associated. The profile of Tama fine sandy loam varies extremely from place to place, especially as regards the position of the sandy layers. In places the surface soil is dark grayish-brown light fine sandy loam to a depth of 10 inches or more, over dark yellowish-brown heavy silt loam. In other places the surface soil may be fine sandy loam or silt loam over loamy fine sand or light fine sandy clay. The loamy fine sand may constitute a single layer or may occur in alternating layers of loamy fine sand and light silty clay. Many variations occur within a distance of a few hundred feet. The thickness of the sandy layers ranges from a few inches to more than 2 feet. In spots this soil is very droughty during dry hot weather, but, taken as a whole, it is a fair to good crop soil.

The surface soil, to a depth of 7 inches, is dark grayish-brown fine sandy loam containing considerable silt. The subsurface soil is a continuation of the surface soil, but the color becomes somewhat more brown with depth, the texture is slightly heavier and the structure is more or less granular. Below a depth of about 20 inches, the material is brown friable light fine sandy clay faintly mottled with shades of gray and yellow. When broken loose it breaks into small irregular blocks that crumble very easily and have no definitely developed cleavage lines. Below a depth of 33 inches the color is a more uniform yellowish brown and the material is more sandy but contains enough clay to make it slightly plastic. Below a depth of 50 inches is brownish-yellow fine sand interspersed with lenses of very light fine sandy clay. At a depth ranging from 60 to 65 inches the soil material consists of alternating layers of sand, fine sand, silt, and silty clay, which may be streaked or mottled yellow, reddish brown, and pale grayish yellow, with in many places, rust-brown or nearly black stains. The soil is acid throughout and no lime carbonate is present above a depth of 80 inches.

Only 1 square mile of this soil is mapped, practically all of which is in Van Buren Township northeast of Preston. Nearly all of the land is under cultivation. The method of farming this soil is about the same as that of farming the other upland soils. Corn, oats, and hay are the main crops. Other crops are potatoes, sorghum, mainly for roughage but some for sirup, Sudan grass, for additional roughage and pasture, soybeans, and garden vegetables.

Muscatine silt loam.—Muscatine silt loam is a dark-colored upland soil developed under grass vegetation from loessial material. It occupies the broader divides with a flatter surface than Clinton silt loam or Tama silt loam. This soil occupies one large continuous area southeast of Lamotte and a few smaller areas, one of which is north of Lamotte and another northwest of Andrew. All the areas are on the broad ridge tops of the main divide that separates the drainage flowing eastward into the Mississippi River from that flowing south or southwest into the Maquoketa River, except those areas or parts of areas that occupy ridges branching from the main divide.

The surface soil, to a depth of 8 inches, is very dark grayish-brown or nearly black mellow heavy silt loam with a granular structure. The subsurface soil is a continuation of the surface soil, except that the color becomes more mottled and the texture changes to light silty clay. The material is dark grayish-brown light silty clay, which when loosened breaks into small lumps that, with slight pressure, crumble readily to a finely granular mass. This layer commonly is mottled with gray in the flatter positions and with brown in the slightly better drained positions, but in places the mottlings are scarcely noticeable. Under moderately dry conditions the material in this layer becomes stiff, and when dry it becomes hard. At a depth of about 21 inches below the surface and continuing to a depth of about 37 inches the color ranges from dark brownish gray to dark grayish yellow mottled with shades of gray, yellow, and brown, and the texture is only slightly heavier than the texture of the subsurface soil. In exposed cuts the material breaks into a sharply angular small- to medium-nut structure, but the cleavage lines are so indefinite that they cannot be seen in a newly opened exposure. Below a depth of 37 inches the texture becomes a little lighter but still continues a friable light silty clay marbled with shades of yellow and gray and specked with numerous dots of brown. Below a depth of 50 inches it is intricately specked or mottled gray and yellow light silty clay streaked with bright brownish yellow and rust brown. The lower part of this layer is rather impervious to the downward movement of water. The reaction is strongly acid to a depth of 72 inches, and no lime carbonate is reached above a depth of 8 feet.

Practically all of this soil is under cultivation. The principal crops are corn, oats, and hay. Clover and timothy are the main hay crops. Yields of corn average less than on Tama silt loam but better than on Clinton silt loam. Because of the slow internal drainage, tillage is somewhat more difficult than in Clinton silt loam or Tama silt loam. Locally this soil is referred to as gumbo. Yields of oats ordinarily range from 30 to 40 bushels an acre, and occasionally yields as high as 50 bushels are reported. Clover hay yields 1½ tons or more an acre.

Muscatine silt loam, slope phase.—Muscatine silt loam, slope phase, is similar to the typical soil except in relief, as it occurs on very gentle slopes and commonly occupies the heads of drainageways that invade the Muscatine silt loam areas. In these places wash from the higher land frequently is deposited as colluvial-alluvial material on the slopes, and, therefore, the dark color continues to a greater depth in many places than it does in the typical soil. The greater thickness of dark material is not due to the better development of

the soil profile, but to the addition of dark material washed in from higher positions. Nearly all of the small total area of this soil is under cultivation. The crops and yields are about the same as on the typical soil.

Carrington loam.—Carrington loam is a dark-colored upland soil derived from more or less modified glacial drift, ranging from silt loam with an admixture of granitic gravel and coarse sand, to gravelly loam or gravelly clay derived from modified glacial outwash. The soil has developed under a grass vegetation on undulating, gently rolling, or gently sloping relief and has good external and internal drainage.

The surface soil to a depth of 11 inches is dark brownish-gray or nearly black mellow loam containing a high percentage of organic matter. In places the structure is granular, but in the more sandy areas the structure is single grain. In most places a small quantity of granitic gravel and chert fragments occur on the surface and in the surface layer. From a depth of about 11 to 16 inches the subsurface soil is dark grayish-brown heavy loam containing more silt and clay and a smaller quantity of the coarse fragments and gravel than the surface layer. The structure is more massive and the material generally breaks into irregular lumps or clods, but where the texture of the subsurface soil is more nearly a sandy loam this layer is more friable. Beginning at a depth of 16 or 18 inches below the surface and continuing to a depth of about 32 inches the soil material is dark yellowish-brown silty clay containing considerable coarse material. In most areas the material below the subsoil is coarser and more open, but in places it is underlain by the limestone formation, and in such places the lower part of the subsoil contains many chert fragments.

At least 90 percent of this inextensive soil is under cultivation. The type of farming does not differ materially from that on the silt loam soils of the uplands. The main crops are corn, oats, and hay, and other crops and garden vegetables are grown to some extent and yield well. The most common hay crops are clover and timothy, but alfalfa does very well after the soil has been limed. In areas where the texture is more or less coarse, barnyard manure is a useful soil amendment. On most farms either dairying or the raising of beef cattle predominates, and the raising of hogs and poultry is a common practice. Yields of farms crops on the better areas average about the same as on Clinton silt loam and somewhat less on the areas where the soil texture is more open.

Bremer silt loam.—Bremer silt loam is a dark-colored soil that occupies low flat terraces in the preglacial valleys southwest and east of Maquoketa and north and south of Preston; along Duck Creek, south of Bellevue; Little Mill Creek, west of Bellevue; Prairie and Silver Creeks, south of Maquoketa; and a fairly large area 2 miles northwest of Sabula. This soil has developed under poor drainage. In the preglacial valleys it occupies depressions that were known as swamps by the early settlers. According to local information the so-called swamps supported a cover of willow, ash, maple, elm, oak, cottonwood and poplar trees, willows predominating in the lower parts.

The surface soil, to a depth of 7 inches, is very dark gray or nearly black, very mellow, and granular silt loam containing a high per-

centage of organic matter. Below this is an 8-inch layer of dark grayish-brown or very dark grayish-brown silt loam or heavy silt loam, which, although both mellow and granular, is not so mellow or so granular as the surface layer. Under moderately moist conditions this layer is fairly plastic. Between depths of 15 and 23 inches the material is medium dark gray silty clay, more or less mottled with shades of gray and brown. In some places the mottlings are very prominent, and in other places the subsoil is more uniformly oxidized and is of a yellowish-gray or brownish-gray color. The lower subsoil layer to a depth of 36 inches is mottled gray and yellow heavy silty clay splotched with rust-brown stains, and it is rather impervious to the downward movement of water. Below a depth of 36 inches the material is marbled yellowish-gray and blue-gray clay mottled with numerous rust-brown spots.

At least 80 percent of this soil is or has been in cultivation, and the remainder is in permanent pasture. This soil, after being improved by artificial drainage, is considered one of the best in the county for the production of corn, and yields are very high, the average acre yield over a period of years being estimated at 75 bushels. The yield of oats is good in favorable years, but in wet years this crop may suffer damage from lodging. Hay crops are good, but the hay is not easy to cure except under very favorable conditions.

Chariton silt loam.—Chariton silt loam is a moderately dark colored soil occupying nearly flat and generally broad terraces, mainly west and north of Preston along Deep Creek and Copper Creek and south of Bellevue on Duck Creek. Smaller areas lie northwest of Sabula along Beaver Creek and its branches.

As mapped 1 mile west of Preston the typical soil has a 2-inch surface layer of granular or somewhat platy dark-gray silt loam. Between depths of 2 and 9 inches the material is dark-gray or dark grayish-brown loose friable silt loam, which is very definitely platy in structure, and which, when removed, is easily broken to a crumb structure. Between depths of 9 and 17 inches is a layer of ash-gray platy or laminated very friable silt loam. This layer is present in most areas, but in places may be only 1 or 2 inches thick. Between depths of 17 and 23 inches the material is light-gray or ash-gray heavy silt loam, which breaks into an angular nut structure of medium-sized fragments. When dry these fragments are very hard. From a depth of 23 to a depth of 33 inches the material consists of gray heavy silt loam or silty clay mottled with lighter gray and shades of brown. The material in this layer breaks to a sharply angular nut structure that dries out rather hard but when moist is somewhat plastic. Between depths of 33 and 43 inches the material is medium-gray heavy silt loam or silty clay mottled with brown and bluish gray. It breaks into larger blocks than the material in the layer above, the cleavage lines are not so definite, and it is more impervious to the downward movement of water. Below a depth of 43 inches the soil material, in many places, is bluish-gray sticky and plastic heavy silty clay mottled with brown. It is derived from the Maquoketa shale, which outcrops in the areas where this soil is mapped.

Included with Chariton silt loam are many small areas of lighter colored soil, which, if more extensive, would have been mapped as Calhoun clay. These spots are referred to locally as white or gray slick spots. Many of them are not more than 50 feet in diameter, and there are a few larger areas. The clay in these spots is so stiff that it is difficult to plow and it is practically impervious to the movement of water. During hot spells it bakes hard and the vegetation dries.

Because of the flat surface many of the areas of Chariton silt loam must be provided with artificial drainage, both tile and open ditches being used for this purpose. Corn, oats, and hay are the main crops. Clover and timothy are the hay crops most commonly grown. The average yields are somewhat less than on Jackson silt loam.

Judson silt loam.—Judson silt loam occupies slopes between the bottom land and the silty soils of the upland. The soil material has accumulated by the washing down of silt from the higher land and its deposition on the lower slopes. Typically, Judson silt loam is dark-colored silt loam showing little change to a depth of 3 feet, and below this the soil is yellowish brown, well drained, and thoroughly oxidized; but in Jackson County the soil differs from the typical development. In places, poor drainage, due perhaps to seepage, has given the lower part of the subsoil a slightly mottled appearance, approaching Wabash silt loam in character; and in other places fragments of limestone and chert are on the surface and throughout the soil mass.

With the exception of a few rather steep slopes and some small colluvial fans that contain exceptionally numerous fragments of chert and limestone, most of this soil is under cultivation. Corn is the predominating crop, but this soil is used for most field crops and for vegetable gardens, orchards, berries, and vineyards. All this inextensive soil is northeast of Preston. Small bodies occur in many places at the bases of steep slopes within the areas of rough stony land, but such areas are too small to map. Most of them are used for vegetable gardens, apple orchards, or vineyards. One such area is at the base of the bluff in the northwestern part of Bellevue.

Wabash silt loam.—Wabash silt loam is a dark-colored soil of the first bottoms occurring along the streams that pass through or originate in areas of the Tama or Muscatine soils. The main areas are southwest of Maquoketa, northeast and southeast of Preston, and in the vicinity of Miles. Several smaller areas are around Lamotte, west of Fulton, and in the vicinity of Baldwin.

The 12-inch surface soil is very dark gray or nearly black mellow silt loam containing a high percentage of organic matter. The subsoil between depths of 12 and 18 inches is dark grayish-brown silty clay which is somewhat tough and sticky. The material becomes grayer with depth as the organic content decreases and is mottled more or less with brown, and below a depth of 18 inches it is fairly compact and stiff grayish-brown silty clay that gradually becomes more gray with depth. At a depth of about 40 inches it is medium dark gray or bluish-gray silty clay mottled with brown. At this depth it is sticky and rather impervious to the movement of moisture but is less compact than the material in the layer above.

Of the total area of 7.4 square miles perhaps not more than 25 percent is under cultivation. The principal tilled areas are in the preglacial valleys. The rest of the land is largely in improved permanent pastures with a cover mainly of bluegrass and white clover. When improved by drainage this soil is very desirable for growing corn, which is the main crop on the cultivated areas, and yields are very satisfactory. This is a stronger soil than Genesee silt loam, but, because internal drainage is slow, yields may equal, but seldom exceed, those on Genesee silt loam.

Cass loam.—Cass loam is a bottom-land soil occurring adjacent to the better drained areas of Wabash silty clay east of Green Island. It occupies a few slightly elevated ridges that are made up of alternating layers of fine sand, medium sand, coarse sand, and silt, in which no uniformity exists in the arrangement of the sandy layers. In places the sand lies near the surface, and other areas have a covering of silt loam over the sand. The surface soil ranges from loamy sand to silt loam, but the most common occurrence is fine sandy loam or silt loam with strips of loamy sand cutting through the areas in the form of sand bars. Except in the sandy strips, which are too narrow to show on the soil map, the surface soil is dark brownish-gray or dark grayish-brown very friable loam to a depth of 10 inches. Below this depth the soil is more gray and the texture generally is more sandy. At a depth of about 16 inches and continuing to a depth of 24 inches the material is dark-gray very friable sandy loam mottled with brown. Below this the material in general becomes heavier and more gray with depth, but in places it is mottled gray and brown loamy sand. Below a depth of 36 inches the material is bluish-gray sandy clay or silty clay. In the areas of sandy soil no heavy material occurs above a depth of 3½ feet, and in the areas with loamy sand occurring at a depth of about 24 inches the loamy sand or sandy layer continues to a depth of more than 3½ feet.

All this inextensive soil is in cultivation, mainly to corn, but oats, barley, and clover are grown to some extent. Yields are variable, especially in dry years.

SOILS USED MAINLY FOR FOREST AND PASTURE

In the group of soils used mainly for forest and pasture are placed the extensive but comparatively unimportant soils that, by reason of rough relief or poor drainage, cannot be used for the production of cultivated crops. Rough stony land and Gasconade loam are unsuited for farming because of their unfavorable relief. Ray silt loam, Wabash silty clay, riverwash, and alluvial soils, undifferentiated, are for the most part poorly drained, and only a small proportion of their total acreage is farmed. Wabash silty clay includes the larger proportion of cultivated land. The rough upland soils are forested for the most part, and it is not advisable to clear and cultivate such land as erosion is active and rapid.

Rough stony land.—Rough stony land includes all those areas that have as their chief characteristic an outcropping of the limestone formation, either in vertical walls or in steep blufflike slopes with more or less of the bedrock exposed in places, constituting a rough broken terrain where the surface covering is not adaptable to tillage.

The areas of this land include all the precipitous slopes along the rivers, smaller streams, intermittent drainageways, and short lateral ravines in nearly all parts of the county except the preglacial valleys southwest of Maquoketa and near Preston. The surface features differ to some extent. In the western and central parts the rock outcrop is bolder and more rugged, many of the drainageways are gorgelike, enclosed on both sides by perpendicular or nearly perpendicular walls of limestone, and a larger proportion of the exposed rock is in the form of vertical cliffs ranging from a few feet to more than 100 feet in height. In the eastern part the cliffs have disappeared to a great extent, and more rounded slopes have been formed, owing to the greater length of time these slopes have been exposed to weathering. Here, less of the rock is exposed and more of the surface is covered with fragments of rock, especially chert. The bedrock occurs just below the surface with a thin covering of soil material consisting of loess or residual sand, silt, or clay mixed with chert and limestone. In the northeastern part, where the streams have cut into the softer Maquoketa shales underlying the limestone formation, cliffs of bedrock are exposed about halfway up the slopes. In places these cliffs are not continuous but are separated by narrow slopes extending from the base to the top with no intervening rocky cliff barrier. Large blocks of limestone have become separated from the ledges and have slid a considerable distance down the slope, some of them remaining in a fairly upright position, but most of them being tilted or tipped on edge.

The cliffs and other exposed rocks do not support vegetation, but very little of the included area is barren of plant life. Scrubby oaks, cedars, plum trees, briers, and buckbrush thrive wherever their roots have obtained a foothold in the cracks and crevices; grasses of various kinds grow on those areas that are too thinly covered with soil material to support a tree growth; but most of the areas are forested, the trees ranging from the poor stands of scrubby oaks and cedars through fair to very good stands of mixed hardwoods consisting of red, white, black, and bur oaks, shellbark hickory, black hickory, black walnut, butternut, soft maple, hard maple, red and white elms, ironwood, basswood, hackberry, white and red ash, cottonwood, and some poplar. In places the tree growth consists mainly of oaks, or oaks and hickory; whereas in other places maple, elm, and basswood, or black walnut and butternut predominate. In many places black walnut, butternut, and elm predominate in the narrow bottoms at the foot of the cliffs and abrupt slopes, or in small benchlike positions on the lower halves of the slopes, and oaks and hickory are more common on the upper halves of the slopes, but none of the species grows in any definite position or location. With very few exceptions the present stand of trees is light compared with the heavy stand that the early settlers found growing on these same slopes. Most of the areas have been cut over, and the best sawlogs have been removed. A considerable amount of the tree growth suited for cordwood still stands, and in places the second growth, if protected from fires and overpasturing, will soon produce timber suitable for sawing. In general the north and east slopes are more heavily forested than the south or west slopes owing to more favorable moisture conditions. The south and west slopes receive the direct rays of the midday and

afternoon sun, thereby intensifying the heat and the rapidity of evaporation.

The relative elevation of this land everywhere is lower than the loess-covered plateaus and ridges with which it is closely associated. The soil materials are largely silt loam carried from the loess areas by the action of water or wind, but are partly residual. In the areas having the more shallow covering of soil the material commonly is mixed with fragments of chert and, in places, with fragments of chert and limestone. In other places various-sized blocks of limestone are scattered irregularly over the surface with the intervening spaces filled with alluvial or colluvial deposits of silty clay material from the loess areas above, and to some extent by silty material brought in probably since the higher lying areas of loess have been placed in cultivation. The residual material may be sticky clay, silt, or sand. Many areas of this land bordering areas of Sparta sand contain spots of loamy fine sand and sandy loam, but the predominating texture of the soil covering is silt loam. The depth of the soil material ranges from a mere film to several feet and is very irregular. It may be more than 3½ feet in one place with the tops of the limestone blocks or bedrock projecting through the surface a few feet away. The color and profile structure of the soil is similar to that of Clinton silt loam where the soil covering is sufficiently thick, but where the covering is thin the color generally is darker and in places may be nearly black. The thinly covered areas commonly have a larger proportion of chert fragments and limestone fragments intermixed with the soil material than in the more deeply covered areas. The reaction of the soil in the deeply covered spots is acid, whereas in the shallow spots it ranges from slightly acid to slightly alkaline.

This land is not tillable. It includes the rough areas and limestone outcrops below the smooth tillable soils of the upland and extends to the tillable slopes or bottom lands below the outcrops. Where the ravines are V-shaped or narrow gorges with no bottom land or only very narrow bottom land, rough stony land extends from the tillable soil on one side of the ravine or gorge to the tillable soil on the other side. In general, the range in elevation from the upper boundary of an area to the lower boundary is from 30 to about 200 feet, but in places it may be less than 30 feet and in other places may be nearly 300 feet. Some areas of rough stony land, as mapped, include very narrow ridge tops that more properly would be classed with Clinton silt loam, shallow phase, but the areas are too small to show separately on a map of the scale used.

Rough stony land covers a total area of nearly 100 square miles. If this land could be treated as a unit the best possible use for it would be the production of timber, and a part of the forest could be used as an upland game preserve, with small selected areas set aside as parks for recreational use. As it occurs as a part of nearly every farm in the Clinton silt loam areas, however, the individual farmer must use the land according to his needs. Under such conditions the land is divided into smaller areas that lend themselves to more selective use. In places where the surface is very rough, with abrupt slopes, and the area consists entirely of rough stony land, the

best use is timber production; but where tracts of bottom land, smooth terraces, or fairly gentle slopes are included it is best to use the land as combined pasture and farm wood lot. Because either dairying or livestock raising is a part of nearly every farmer's program the most common use of this land is for permanent pasture combined with farm wood lots. Where timber production is of first interest it is better not to use the land for pasture. Even where pasture is of primary interest it is not advisable to clear the land of all trees as the increased loss of soil material through erosion would, in a very short time, reduce the production of grass to less than it would be were the tree growth preserved. Practically none of this land is used for the production of tilled crops, although a few small spots near farm homes have been selected for the production of garden vegetables, potatoes, or corn. Such areas are few and too small to be mapped as separate soils.

Gasconade loam.—Gasconade loam occupies small undulating or gently sloping areas where the bedrock of the limestone formation lies so close to the surface that it is not uncommon for jagged points of limestone and chert to project through the soil material. The texture ranges from silt to loamy sand. In the areas more closely associated with Clinton silt loam or Tama silt loam the texture is silt loam, but most of it contains sufficient chert fragments, ranging in size from fine to coarse gravel, to give the surface soil a gravelly or gritty feel. In those areas of Gasconade loam surrounded or closely associated with Sparta sand the texture of the surface soil ranges from fine sandy loam to loamy fine sand, and here, although the chert fragments are not so abundant, they are generally present. The soil material in a few small areas 2½ miles southwest of Garry Owen have a small admixture of granitic gravel in addition to the chert fragments. The areas mapped as Gasconade loam from 1 to 2 miles northwest of Fulton have a loamy sand or fine sandy loam texture. North and northeast of Preston are several large areas in which the soil is predominantly silt loam, but they contain very large quantities of cherty gravel and chert fragments and in spots more or less fine sand and medium sand.

Most areas of Gasconade loam have no profile development below the A horizon, which rests on bedrock. The surface soil has developed under grass vegetation, with a few scattered bur oak, hazel brush, and briers in places. The color ranges from dark gray or nearly black in the silt loam areas to dark grayish brown in the sandy loam and loamy sand areas. In most places the depth to bedrock is not more than 6 inches, and in many places it is difficult to find a thickness of soil material of more than 4 inches. In a few areas the soil material is deeper and a thin layer of red clay intervenes between the surface soil and bedrock. The principal use of this soil is for pasture. In periods of ample moisture supply the land supports an abundant growth of Kentucky bluegrass and other grasses, but during the heat of summer and especially during prolonged dry spells the soil dries completely.

Ray silt loam.—Ray silt loam is a mixture of two soils. It is developed in low bottoms where Wabash silt loam has become buried under a deposit of recent alluvium composed mainly of material carried

down from the surrounding light-colored upland soils. The color of the newly deposited material is gray or grayish brown, and the thickness ranges from about 4 to more than 24 inches. Most of the areas of Ray silt loam are south of Monmouth, near Baldwin, north of Preston, and 2 miles northeast of Miles. The thickness of the surface layer is somewhat greater in the eastern part of the county than in the areas near Baldwin and Monmouth, but considerable variations occur in this soil in all localities.

The normal profile of Ray silt loam consists of a 14-inch layer of grayish-brown or gray mellow silt loam, overlying dark grayish-brown or nearly black heavy silt loam, which continues to a depth of 30 or more inches. Below this layer the material consists of dark-gray heavy silt loam or silty clay, mottled with brown or bluish gray and rust brown.

Very little of this soil is under cultivation. Its principal use is for permanent pasture. Where not too wet it supports a luxuriant growth of bluegrass and white clover, and in the wetter areas redtop is common, but in the more or less permanently wet areas coarse water-loving grasses predominate. Most of the areas under cultivation must be artificially drained. On the cultivated areas corn is the principal crop, and yields are approximately the same as on Genesee silt loam.

Wabash silty clay.—Wabash silty clay occupies the greater part of the flood plains of the Mississippi River from a point about 2 miles north of the outlet of the Maquoketa River southward to the Clinton County line. This is a dark-colored soil developed under forest vegetation on poorly drained bottom land. Internal drainage is very slow, but in places, when the rivers are low, surface drainage ranges from fair to good.

The surface soil is very granular nearly black silty clay to a depth of about 4 inches. The subsoil is very compact in place. In old ditch banks where the subsoil has been exposed for some time, it breaks into a very sharply angular small-nut structure, but in new exposures no structure development is apparent, and, as the cleavage lines are not sufficiently well established to be observed, the material comes out in a sticky plastic mass. The texture continues a silty clay with no noticeable change, but in the subsoil the dark or black color gradually fades out with depth, and the mass color becomes a muddy dark gray with mottlings of brown and bluish gray. The lower part of the subsoil is very sticky and plastic and is rather impervious to moisture.

This soil occupies a total of 17.4 square miles, of which less than 10 percent is under cultivation and the rest is forested and used for pasture. In places the forest growth is very dense and very little pasture grass is produced; in other places the stand of trees is more or less open, and some bluegrass, redtop, and white clover grow, but the grasses are more commonly of the tall coarse varieties. In the wet marshy places tall coarse sawgrass and bluejoint predominate. The value of this land for pasture is further reduced by the dense growth of willows and other underbrush. The crops commonly grown on the cultivated areas are corn, oats, barley, and wheat, and some areas are cleared and used for the production of wild grasses for hay. The forest growth consists of boxelder, elm, ash, soft maple, willow, cottonwood, basswood, poplar, and in places red, black, bur,

and white oaks predominate. The underbrush consists of young trees of all the varieties mentioned, especially willow, maple, and box-elder, together with grapevines, poison-ivy, Virginia creeper, and greenbrier.

A variation of Wabash silty clay occurs mainly at the junction of the flood plains of the Maquoketa and Mississippi Rivers, and a few small areas of such soil are about 4 miles north of Sabula. Owing to a thin covering of recent alluvium, the surface soil to plow depth is more friable and the color is somewhat grayer than in the typical soil. Approximately 2 square miles of Wabash silty clay as mapped are of this better drained variation, and most of it is under cultivation. It is seldom overflowed except during very high floods, as the Maquoketa River has been straightened and the channel is enclosed by dikes on both sides. Corn is the principal crop and yields are good, but this soil is not so well adapted to corn as is Genesee silt loam or Wabash silt loam. Wheat, barley, and oats are important crops on this soil. Clover and timothy are the most important hay crops, but some alfalfa is grown on the higher lying areas.

Alluvial soils, undifferentiated.—This group includes soils of the narrow bottoms along the creeks and other drains, most of which are bordered by rough stony land. Although Genesee silt loam is the principal soil of these bottoms, areas of other soils are intermixed with areas of that soil. The depth of soil material ranges from a few inches over the rock-strewn bottoms to several feet in other places. In many places the surface is badly cut by the rapidly flowing waters whenever the stream gets out of its regular channel. In some places the stream channel is barely wide enough to carry the ordinary flow, and after a heavy shower or during a prolonged downpour of rain the stream rises over the entire width of the bottom land, but the flow of water is so swift that within a few hours after the storm has passed all the excess water has run off and the stream recedes into a single channel. Indications are that Wabash silt loam had developed on many of these narrow bottoms within the deep gorges, but after the surrounding uplands came under cultivation sediments were washed in from Clinton silt loam areas and spread over the bottoms to form the parent material of the present soils. The predominating color is gray or grayish brown, but both Wabash silt loam and Ray silt loam profiles are noticeable within these areas.

A total area of 29.4 square miles of these soils is mapped, but only a small part of the area has been brought under cultivation, and here and there small selected patches are planted to corn. These soils are distributed throughout all parts of the county, some of the larger areas being in the valleys of upper Tete des Morts Creek, upper Mill Creek, Bear Creek, and Brush Creek. In the valley of Brush Creek small areas of typical Ray, Wabash, and Genesee silt loams could be separated on a larger scale map.

Riverwash.—Riverwash includes a few small areas, principally of sand, along the main channel of the Mississippi River. These areas lie very little above the level of the river and are subject to change with each rise of the stream. This land is entirely nonagricultural. A few small bodies are mapped between the mouth of the Maquoketa River and Sabula.

PRODUCTIVITY RATINGS

In table 5 the soils of Jackson County are given comparative ratings according to their capacity to produce the more important crops of the Corn Belt. They are listed in the approximate order of their general productivity under current farming practices.

TABLE 5.—*Productivity ratings of soils of Jackson County, Iowa*

Soil (type, phase, and land type) [1]	Crop productivity index [2] for—						General productivity grade [4]	Land classification [5]
	Corn	Oats	Clover and timothy hay	Alfalfa		Pasture [3]		
				With lime	Without lime			
Muscatine silt loam, drained	120	95	100	100	------	140	1	Excellent cropland.
Tama silt loam	120	95	100	100	[6] 75	140		
Genesee silt loam [7]	130	80	100	------	90	150		
Wabash silt loam [7]	130	70	100	------	------	150		
Bremer silt loam, drained	120	85	90	85	------	140		
Ray silt loam, drained	120	70	90	80	------	140		
Muscatine silt loam, slope phase	100	90	100	95	------	140		
Muscatine silt loam, undrained	90	80	80	80	------	140	2	Good cropland.
Jackson silt loam	90	80	80	80	------	100		
Clinton silt loam	85	80	80	80	------	95		
Carrington loam	85	80	70	70	------	90		
Jackson fine sandy loam	80	70	70	70	------	90	3	
Judson silt loam	75	70	70	65	50	85		
Tama fine sandy loam	70	70	70	70	------	75	4	Fair cropland.
Chariton silt loam	75	65	60	50	------	90		
Bremer silt loam, undrained	55	50	50	45	------	120	5	
Clinton fine sandy loam [8]	50	50	65	65	------	80		
Clinton silt loam, slope phase [8]	50	50	60	65	------	75		
Lindley sandy loam	50	55	60	60	------	60		
Wabash silty clay [7]	50	40	80	------	------	100		
Cass loam [7]	50	40	50	------	50	85		
Clinton silt loam, shallow phase	40	40	50	50	[6] 50	70	6	Fair to poor cropland.
Gasconade loam [9]	40	40	40	40	35	50		
Lindley loam	25	25	30	40	------	50	7	
Sparta sand	30	25	30	30	------	30		
Wabash silt loam, poorly drained areas	------	------	------	------	------	130	8	Grazing land.
Genesee silt loam, poorly drained areas.	------	------	------	------	------	130		
Ray silt loam, undrained	------	------	------	------	------	120		
Wabash silty clay, poorly drained areas.	------	------	------	------	------	95		
Alluvial soils, undifferentiated	------	------	------	------	------	70	9	
Cass loam, poorly drained areas	------	------	------	------	------	60		
Rough stony land	------	------	------	------	------	20	10	
Riverwash	------	------	------	------	------	------		

[1] The soils are listed in the approximate order of their general productivity under the average current practices, the most productive first.

[2] The soils of Jackson County are given indexes that indicate the approximate average production of each crop in percent of the standard of reference. The standard represents the approximate average yield obtained without the use of amendments on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown.

[3] These ratings are only estimates, as data are limited.

[4] This classification indicates the comparative general productivity of the soils under average current practices. Refer to text for further explanation.

[5] This is a general grouping or classification to indicate the physical suitability of the soils for farming or grazing uses. In the actual delineation of land classes on a map, other considerations, such as pattern of distribution of soil types, are important.

[6] This index applies to a few small areas in preglacial valleys where the soil is not acid.

[7] Indexes apply to the naturally better drained or artificially protected areas. Poorly drained areas are used largely for pasture.

[8] Indexes for crops apply to less sloping and smoother areas. Steeper areas are used for pasture.

[9] Indexes for crops apply to small areas of deeper soil. Most of the total area is used for pasture and timber.

The ratings compare the productivity of each soil for each crop to a standard of 100. This standard index represents the approximate average acre yield of the crop obtained without amendments on the more extensive and better soils of the regions of the United States in which the crop is principally grown. An index of 25, for example, indicates that the soil is one-fourth as productive as are those with the standard index. Soils given special treatment or amendments, such as lime or commercial fertilizers, or unusually productive soils of small extent may have indexes above 100 for some crops.

The standard index of 100 is set up to represent a particular acre yield for each crop, and the following tabulation sets forth some of the yields that have been established as standards of 100. These yields are meant to represent long-time average yields of crops of satisfactory quality on the better soils of the United States without the use of amendments. In Jackson County the application of some barnyard manure and the occasional growing of legumes are considered to be part of the general current practice among farmers.

Crop:		
Corn	bushels	50
Oats	do	50
Clover and timothy	tons	2
Alfalfa	do	4
Pasture	cow-acre-days [1]	100

[1] Cow-acre-days is a term used to express the carrying capacity of pasture land. As used here it is the product of the number of animal units carried per acre multiplied by the number of days the animals are grazed without injury to the pasture. For example, the soil type able to support 1 animal unit per acre for 360 days of the year rates 360, whereas another soil able to support 1 animal unit per 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days the rating is 25.

The principal factors determining the productivity of land are climate, soil (including a long list of physical, chemical, and biological characteristics), slope, drainage, and management (including the use of amendments). The combined effects of all these factors must be considered, therefore, in setting up productivity ratings for soil types. An attempt is made to evaluate the combined influence of these factors under current practices. Crop yields themselves over a long period of time furnish the best available summation of the combined effects of the factors of production. Such yields have been used as a basis for the establishment of the crop productivity indexes wherever data are available. The acre yield of crops from figures compiled by the State assessors, the United States census, and outlying cooperative fields of the Iowa Agricultural Experiment Station have been used as guides in the establishment of productivity ratings. The acre yields of crops compiled by the assessors and those given in the census are reported by townships and counties and therefore do not give the actual yields by soil types. Some interpretation of these data is therefore necessary; consequently, all ratings are based partly on inductive estimates rather than on actual crop yields. Some ratings are based entirely on estimates because of lack of definite information regarding crop yields. It is thought, however, that the ratings do give a fairly accurate picture of the relative productivity of the different soils in the county.

Natural drainage is not a limiting factor in crop production on many of the soils in Jackson County. Drainage is restricted and, in places,

poor in the flood plains of the streams, especially in bodies of the Wabash, Ray, Genesee, and Judson soils. Separate productivity ratings to represent extreme conditions of drainage are given for these soil types. Improvement of the natural drainage by artificial means is necessary in the flat areas of Muscatine silt loam and also on some of the terraces occupied by Bremer silt loam. Productivity ratings are also given for the artificially drained and the undrained conditions of these two soils.

The soils are listed in table 5 in the approximate order of their general productivity under current practices, and productivity grade numbers are assigned in the column "General productivity grade." The general productivity grade is based on the weighted average of the indexes for the various crops using the approximate acreage grown and the relative value of the different crops as the basis for the determination of weights.[6] If the weighted average falls between 90 and 100 the soil type is assigned a grade of 1, if it falls between 80 and 90 it is assigned a grade of 2, and so on. As it is difficult to evaluate mathematically either the exact significance of a crop in local agriculture or the importance and suitability of certain soils for particular crops, the weightings set up were used only as guides in determining the general productivity grade. Certain modifications based on personal judgment are allowed in the general ratings of the soils.

The column "Land classification" summarizes in a simple way the productivity and use-capabilities of the various soils by placing them in a few groups on the basis of their relative suitability for farming and grazing.

Productivity tables do not present the relative roles of soil types in the agriculture of the county, but rather indicate the productive capacity of each individual soil type. The total agricultural production for any given crop from one soil type depends on the extent and geographic distribution of that soil as much as on its actual productivity. The quantity of corn grown on Muscatine silt loam, for instance, depends on the acreage grown on the soil type as well as on the yield per acre.

Economic considerations play no part in determining the productivity indexes. The indexes, therefore, cannot be interpreted into land values except in a very general way. The value of land depends on distance from market, relative prices of farm products, and a number of other factors, in addition to the productivity of the soil.

LAND USES AND AGRICULTURAL METHODS

The soils of Jackson County have developed mainly from loess or from alluvium derived from the loess; therefore, a silt loam texture predominates in all the soil types and phases on the uplands, the terraces, and the flood plains. In a section where general farming together with livestock raising or dairying is practiced so universally

[6] The weights in percentage given each crop index to arrive at the general productivity grade are as follows:

Corn	40
Oats	15
Clover and timothy hay	20
Alfalfa	10
Pasture	15

as in this county, the different uses to which the soils are placed do not conform so strictly to type or to the soils of light or dark colors as in sections where specializing in certain products is practiced. For general farming the position of the soil in respect to relief is frequently more important in deciding what crops to plant than the color or texture of the soil. The dark-colored soils, however, such as Tama silt loam, Muscatine silt loam, and Bremer silt loam, are more productive and will produce more roughage, straw, and especially more corn, than the light-colored soils. The dark-colored soils may also be more productive in quantity of grain, but the quality of the grain, and also the quality of clover, alfalfa, and timothy seed, is commonly superior on the light-colored soils. In localities where considerable sorghum is produced for sirup, many growers prefer the light-colored soils because they claim the color of the sirup is lighter and the flavor more mild.

The soils have developed in a humid climate and are, therefore, leached of all the more soluble salts. Both the light-colored and the dark-colored soils on the uplands and terraces are acid in reaction and require liming to prepare them for the production of alfalfa or sweetclover. In exceptional areas in the preglacial valleys the soil covering the limestone is very thin and the soil acids have become neutralized by the direct mixing of the limy material, and in spots on the bottoms the vegetation brings up sufficient lime to keep the soil neutral. Such areas are few and not generally continuous over one field, so it is advisable when selecting a soil sample in such areas for an acidity test that the farmer avoid any known shallow spots, as such samples may indicate no lime requirement for alfalfa, whereas most of the field may require liming to grow the crop successfully.

Bremer silt loam, Chariton silt loam, and Muscatine silt loam may prove disappointing hosts for alfalfa unless the internal drainage has been artificially improved. Alfalfa prefers a soil with a well-drained and well-aerated subsoil, and the mottlings in the above-named soils indicate slow internal drainage and poor aeration. Improving the internal drainage by tiling or deep open ditches does not remove the mottlings but removes the cause and therefore eliminates the objectionable features that the mottlings indicate.

The rough stony lands and the poorly drained bottom lands on the Mississippi flood plains are used for the production of timber. These soils, especially rough stony land, should be kept in forest, in order to supply firewood and certain grades of hardwoods for the market, as well as rough lumber for local use.

One of the most important feed crops successfully introduced in the last few years is alfalfa. According to the United States census, 4 acres were reported in alfalfa in 1899, 37 acres in 1909, 221 acres in 1919, 3,377 acres in 1929, and 14,120 acres in 1934. The use of hybrid seed in corn production has received attention from many farmers in the last few years.

DRAINAGE

All the upland soils have good to excessive external drainage and good internal drainage, except Sparta sand, where internal drainage is excessive, and Muscatine silt loam, where it is slow. On the

terraces, Jackson silt loam and Jackson fine sandy loam have good external as well as good internal drainage, and most of Chariton silt loam has fair to good external drainage but very slow external drainage. Bremer silt loam has developed under poor external drainage as well as poor internal drainage. On the first bottoms all soils are subject to more or less flooding, but the surface run-off in most places is sufficiently good to remove most of the water within a very short time after the streams have receded into their channels; but with the exception of Genesee silt loam, which has a loose open structure and therefore good internal drainage, most of the bottom lands are poorly drained unless improved by artificial means.

In the uplands, only Muscatine silt loam has required artificial drainage to any great extent. In that soil it has been necessary in places to tile drain the flatter tablelands or the long very gently sloping heads of drainageways, in order to make tillage possible during wet years, because movement of the water by natural seepage is slow. In a few places tile drainage has been advantageous in areas of Clinton silt loam and Tama silt loam in order to combine two or more small areas into larger areas for tillage purposes. In the preglacial valleys it has been necessary to drain all the flatter areas and small depressions before they can be placed in cultivation. In most places this drainage has been accomplished by tiling, except the main or center drain in the larger areas, which is most commonly an open ditch of sufficient size to take care of the excess water.

In the lower part of the Maquoketa River Valley, beginning a few miles below Sprague ville, the river channel has been straightened by dredging to reclaim much of the wide bottoms for tillage. In addition, part of the bottom lands at the junction of the Maquoketa River with the Mississippi River has been protected from high water from either river by a system of dikes that enclose the protected areas.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of environment acting upon the soil materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent soil material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the relief, or lay of the land, which determines the local or internal climate of the soil, its drainage, moisture content, aeration, and susceptibility to erosion; (4) the biologic forces acting upon the soil material, that is, the plants and animals living upon and in it; and (5) the length of time the climatic and biologic forces have acted on the soil material.

The surface of more than four-fifths of the county is that of a deeply dissected plain. The divides are small gently undulating to gently sloping plateaus and moderately wide gently rounded to narrow strongly rounded ridge tops. The drainageways are deep V-shaped gullies, narrow gorgelike ravines, and small streams with narrow to wide flood plains bordered by limestone bluffs or abrupt slopes. The elevations above sea level range from 576 to 1,190 feet, and the differ-

ences in the relative elevation of the divides and the bottoms of the valleys range from about 200 to nearly 500 feet.

The bedrock formation most widely exposed is Niagara dolomitic limestone. This rock is covered with a thick mantle of unconsolidated material ranging from more than 45 feet in places in the central and western parts of the county to 20 feet or less in the northeastern part and on the eastern rim. The loess, which forms the greater part of the unconsolidated rock and is the most important soil material, is highly calcareous and has the texture of light silty clay or heavy silt loam. It contains from 62 to 66 percent of silt (0.05 to 0.005 mm.) and 28 to 33 percent of clay (0.005 to 0 mm.)

The remaining one-fifth of the area is included largely in the two fairly large preglacial valleys in the southern part of the county. The relief in the valleys is undulating or gently rolling, with a few small nearly flat depressions. Both external and internal drainage range from good to very slow. The general elevation of the preglacial valleys ranges from 350 to nearly 500 feet lower than the higher uplands in other parts of the county. The unconsolidated soil mantle in the preglacial valleys consists mainly of a light silty clay or heavy silt loam material somewhat similar to the loess on the higher uplands, except that in places it contains an admixture of glacial drift in the form of granitic gravel, lenses of assorted medium to fine sand, and a few boulders in places where the covering is very thin over the limestone formation. The lenses of assorted fine sands continue into the more deeply silt-covered areas and occur as more or less sandy layers in the leached C_1 and the unleached C_2 horizons of Tama silt loam areas in the southeastern part of the county.

A small proportion of the upland soils is derived from material more or less influenced by glacial drift. The most typical glacial material occupies a small tongue of land extending from the west into the northwestern part of Butler Township. The material is predominantly Iowan glacial drift, but it is so modified in places by chert fragments from the local limestone formation and in other places by irregular layers of silt loam derived from the loess that the material lacks sufficient uniformity to develop a profile typical of any soil.

The larger areas of soils in this county have developed under the influence of a deciduous forest vegetation, but smaller areas have developed under the influence of grass vegetation. The zonal soils of the area belong to two of the great soil groups—the Gray-Brown Podzolic soils and the Prairie soils. In the soils of both groups in this area the soluble salts have been leached from the A, B, and C_1 horizons, but the C_2 horizon is highly calcareous. The depth to the C_2 horizon ranges from 8 to 12 feet below the surface, but in the southeastern part of the county and in the preglacial valleys carbonates are reached in places at a depth no greater than 70 inches in both Clinton silt loam and Tama silt loam. In a few places on the divides in the central and western parts of the county the reaction of Clinton silt loam is acid to a depth of more than 12 feet below the surface. The only soils that have normal zonal profiles have developed from loess or from material derived predominantly from

loess and occupy positions that have undulating to gently rolling or gently sloping relief, where external and internal drainage are neither excessive nor deficient. The Gray-Brown Podzolic soils have developed under a deciduous forest vegetation that consisted of bur, white, red, and black oaks, shellbark and black hickories, ash, and ironwood; but stands of basswood, cottonwood, hard and soft maples, and boxelder grew in scattered to solid stands in places.

The main characteristics of the normal soil profile are the light-colored surface soil over a brown or yellowish-brown subsoil with a texture considerably heavier than that of the surface soil and slightly heavier than the texture of the parent material. The Clinton, Jackson, and Lindley soils belong to the Gray-Brown Podzolic group, but only Clinton silt loam and Jackson silt loam have a well-developed normal zonal profile. Clinton silt loam [7] is the most typical. It occupies the small plateaus and the more gently rounded ridge tops on the divides and the more gentle slopes in other places. It has good external drainage and good internal drainage and aeration. Under virgin conditions the A_0 horizon consists of leafmold in a more or less decomposed state, and the A_1 horizon is a 1- or 2-inch layer of the surface soil containing enough organic matter to give it a dark brownish-gray color.

Following is a description of a profile of Clinton silt loam, as observed in the southeastern part of the county. Carbonates are present at a depth of 70 inches.

0 to 7 inches, gray or ash-gray loose practically structureless silt loam, which crumbles to a loose finely granular or crumb structure when lightly crushed.

7 to 10 inches, light grayish-brown very friable silt loam, which breaks to a somewhat flaky structure if carefully loosened but when lightly crushed breaks to a fine-crumb structure.

10 to 14 inches, dark grayish-yellow or yellowish-brown smooth silt loam, somewhat more uniform in color than the material in the layer above. There is not much change in color when the material is crushed to a loose floury mass. Near the lower limit, faint cleavage lines appear with faint gray streaks along the cleavage lines.

14 to 32 inches, dark-brown stiff silty clay, which breaks to a medium- or coarse-nut structure along well-defined cleavage lines well coated with dark-brown colloidal clay. When the fragments dry they become very hard, but they are somewhat plastic when moderately moist. The fragments are sharply angular and slightly larger than in some samples. The cleavage lines appear gray because of a thin coating or layer of whitish-gray floury very fine sand or silt particles. This material occurs between the fragments and is not a part of the colloidal coating.

32 to 42 inches, mottled gray, yellow, and brown silty clay, which breaks to a sharply angular medium- to coarse-nut structure along well-defined but thinly coated cleavage lines.

42 to 50 inches, faintly mottled brown, gray, and yellow silt loam, which breaks into flaky crumbs when lightly crushed. The differences in color may be described as faint shadings of brown, gray, and yellow rather than mottlings.

50 to 70 inches, loose very friable silt loam faintly streaked with shades of yellow and brown and somewhat streaked with gray in places. This layer breaks more or less along horizontal planes as if slightly stratified and when crushed breaks into flaky crumbs.

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[7] Chemical analyses of this soil are given in the following publication: MIDDLETON, H. E., SLATER, C. S., and BYERS, H. G. THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE SOILS FROM THE EROSION EXPERIMENT STATIONS—SECOND REPORT. U. S. Dept. Agr. Tech. Bul. 430, 63 pp., illus. 1934.

70 to 90 inches, smooth very friable grayish-yellow silt loam, which crushes easily to a floury mass, but when carefully removed comes out in fairly thin layers. The material in this layer is highly calcareous.

The soils of the Prairie group developed under a grass vegetation, and most of them were in open grasslands when the first settlers arrived, but in places some trees had encroached upon them, and thin stands of bur oak and other trees, with hazel brush in the intervening spaces, covered parts of them. Tama silt loam, Tama fine sandy loam, and Carrington loam [8] belong to the group of Prairie soils. Tama silt loam is the most nearly normal in profile development. As mapped in Otter Creek and Prairie Springs Townships, this soil differs from Tama silt loam as mapped in the southern part, where in many places the C_1 and C_2 horizons contain lenses of fine sand or medium sand. Following is a description of a profile of Tama silt loam as observed in the preglacial valleys in the southern part of the county.

0 to 6 inches, dark grayish-brown friable and finely granular silt loam. When the soil is wet it appears black, but when dry it becomes dark gray.

6 to 17 inches, dark brownish-gray very granular silt loam. A cut surface appears dark grayish brown. The granules are small and loosely formed, with a gray dustlike coating that gives the loosened mass a gray color, whereas the crushed mass or the cut surface is brown.

17 to 20 inches, dark grayish-brown heavy silt loam grading into the dark yellowish-brown subsoil.

20 to 33 inches, dark yellowish-brown friable heavy silt loam slightly mottled with shades of brown and yellow. The structure is made up of subangular or angular granules, and the material is very porous and pervious to roots.

33 to 44 inches, dark yellowish-brown silty clay loam, which breaks into angular fragments along well-defined cleavage lines. The fragments are thinly coated with brown colloidal material. The color of a broken surface is slightly mottled or shaded with dark yellow and brown, but a cut surface is much brighter and more uniform in color.

44 to 53 inches, mottled yellow and brown heavy fine sandy loam spotted with rust brown. The sand and clay are intermixed but appear to have been laid down in layers.

53 to 74 inches, light yellowish-brown light silty clay containing some very fine sand. The color is mottled with rust brown and faint streaks of reddish brown. No effervescence with acid was observed at a depth of 8 feet.

Most of the soil types and phases, as well as most of the area of miscellaneous soil materials, are intrazonal soils. Some of the types and phases, such as Clinton silt loam, shallow phase, and rough stony land, lack the normal zonal profile development because of excessive drainage and erosion; some, as Bremer silt loam, because they lack good surface drainage and have slow internal drainage; some, as Muscatine silt loam on the wider divides and Chariton silt loam on the terraces, because of slow internal drainage; some, as Sparta sand, because of the extremely sandy material from which they are derived; and some, as Genesee silt loam and Ray silt loam, because they consist of recently deposited alluval material, which has undergone little development.

Table 6 gives the results of mechanical analyses and pH determinations of five soil profiles.

[8] Chemical analyses of this soil are given in the following publication: BYERS, HORACE G., ALEXANDER, LYLE T., and HOLMES, R. S. THE COMPOSITION AND CONSTITUTION OF THE COLLOIDS OF CERTAIN OF THE GREAT GROUPS OF SOILS. U. S. Dept. Agr. Tech. Bul. 484, 39 pp. 1935.

TABLE 6.—*Mechanical analyses*[1] *and pH determination of 5 soil profiles in Jackson County, Iowa*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay	Colloid[2]	Mineral[3] matter	Organic[4] matter	pH
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	
Clinton silt loam:												
339137	0- 7	0.0	0.2	0.2	0.6	4.0	77.4	17.5	12.0	0.3	1.6	5.7
339138	7-14	.0	.1	.2	.3	4.4	67.3	27.7	21.4	.1	.3	5.5
339139	14-24	.0	.0	.1	.3	3.6	64.0	32.1	26.9	.3	.2	4.9
339140	24-38	.0	.1	.1	.3	4.4	61.2	33.8	30.1	.3	.1	5.2
339141	38-54	.0	.0	.1	.3	5.5	62.5	31.6	27.0	.0	.2	5.3
339142	54-90+	.0	.2	.1	.3	3.8	66.2	29.5	25.4	.0	.0	5.7
Tama silt loam:												
339101	0- 6	.0	.2	1.1	2.5	2.8	64.8	28.6	24.7	.5	3.3	5.4
339102	6-17	.0	.2	1.4	2.6	2.8	63.6	29.5	24.9	.4	2.2	5.1
339103	17-20	.0	.4	2.9	5.7	2.6	60.9	27.5	23.2	.2	1.2	5.0
339104	20-33	.0	.8	5.4	9.7	3.2	53.5	27.4	23.2	.2	.5	5.3
339105	33-44	.0	1.0	8.1	15.8	4.8	46.5	23.8	21.0	.1	.1	5.4
339106	44-53	.0	1.0	12.0	31.6	4.7	33.1	17.5	15.0	.1	.0	5.7
339107	53-74+	.0	.3	1.6	5.8	6.2	60.7	25.4	21.6	.1	.0	5.7
Bremer silt loam:												
339108	0- 7	.0	.2	.3	.5	2.1	66.3	30.5	24.7	.4	5.5	5.8
339109	7-15	.0	.3	.4	.6	2.1	65.6	30.9	24.3	.4	3.4	5.2
339110	15-23	.1	.3	.4	.6	2.3	68.1	28.3	23.3	.3	.9	5.2
339111	23-36+	.0	.3	.2	.5	3.1	62.2	33.8	30.3	.2	.2	5.1
Muscatine silt loam:												
339153	0- 8	.1	.8	.4	.5	2.0	66.2	29.9	23.4	.5	3.9	4.8
339154	8-21	.1	.5	.4	.5	2.6	64.1	31.9	25.4	.4	4.9	5.0
339155	21-27	.0	.4	.3	.5	2.8	63.6	32.4	26.1	.4	2.6	4.8
339156	27-37	.0	.2	.3	.6	4.3	61.2	33.4	29.1	.2	.6	5.2
339157	37-50	.0	.0	.1	.3	3.2	65.8	30.6	25.8	.2	.2	5.4
339158	50-72+	.0	.1	.2	.5	4.6	63.6	30.9	27.6	.2	.0	5.2
Sparta sand:												
339130	0- 9	.1	13.4	50.5	28.4	.7	3.2	3.8	3.4	.1	1.0	6.2
333131	9-36	.1	11.4	51.2	30.9	.5	2.1	3.9	2.7	.1	.4	5.8
339132	36-60+	.0	7.5	48.9	39.4	.7	1.4	2.0	1.8	.1	.1	6.0

[1] Analyses based on organic-free oven-dry sample.
[2] Colloid 0.002—0 mm. (included in clay).
[3] Dissolved by H_2O_2.
[4] Determined by decomposition with H_2O_2.

SUMMARY

Jackson County is in the extreme eastern part of Iowa, about midway between the southern and northern boundaries of the State. The elevation ranges from 576 to 1,190 feet above sea level. The drainage system is dendritic in form and branches out from the Mississippi River. More than three-fourths of the county is drained by the Maquoketa River and its tributaries, and that river and most of the large creeks and intermittent streams have cut their channels to base level in respect to the Mississippi River. Many of the streams have built up comparatively wide flood plains. The streams have cut the surface into a series of deep gorgelike valleys separated by comparatively small plateaus and narrow ridges. The valley walls consist of limestone bluffs or abrupt slopes that extend from the flood plains, or the narrow valley bottoms, to the top of the limestone formation and continue in more gentle slopes to the top of the divides. The tillable lands occupy the small plateaus, the ridge tops, the slopes above the limestone outcrops, the preglacial valleys, and the first and second bottoms. Rough stony land borders the stream valleys and occupies the area between the base of the slopes and the top of the rock outcrops. Most of the tillable lands are in cultivation or in improved pastures and hay lands.

The first settlement was made near Bellevue in the fall of 1833, and in the spring of 1834 land was prepared for growing the first crops.

The crops produced by the early settlers were those that would provide the necessary food supplies and feed for the domestic animals. Wheat became the main cash crop and remained the most important cash crop until the seventies, when it was displaced by corn as the most important field crop and by cattle and hogs as the most important sources of income. A few water-power gristmills and sawmills were built, but the industry of the county was primarily agricultural. The first means of transportation for surplus products to outside markets was by steamboats, which plied the Mississippi River from early spring until late fall. The first railroad was completed in 1872, and with its coming agriculture changed from the growing of cash crops tc the raising of cattle and hogs.

All the small villages that form the more important trading centers, except Andrew and Lamotte, are in the preglacial valleys in the southern part of the county or on the Mississippi River. The present farm program centers around the production of beef cattle, dairying, and hog raising. No important cash crop is included, but the farmers' attention is directed toward the production of such feed concentrates and roughage crops as can be grown most economically to raise and fatten the beef cattle and hogs or to produce the dairy products. The principal crops, according to acreage, are hay, corn, and oats; but according to value corn ranks first. As cash-income producers beef cattle are first, hogs second, and dairy products third. The income from poultry and eggs is also very important.

The soils are classed in 15 series and include 20 soil types and 3 soil phases, in addition to 3 miscellaneous land classifications. The soils are predominantly tillable. Clinton silt loam, together with its 2 phases, occupies more than one-half of the area of the county, and the next most important upland soil is Tama silt loam. On the terraces, Jackson silt loam and Bremer silt loam are the most important soils for crop production. One of the most important soils for the production of corn is Genesee silt loam, a first-bottom soil derived from recently deposited alluvial material. Rough stony land, the narrow mixed bottom lands, and the wide flat bottom lands along the Mississippi River are used for growing timber and for permanent pastures.

The soils are placed in two main groups—those used for growing cultivated crops and those used mainly for forest and pasture. The group of tillable soils is further divided into two subgroups according to their light-colored or dark-colored surface soils. In agricultural importance, Clinton silt loam and its phases rank first because of their large total area, but Tama silt loam is perhaps the most desirable for general farming, both because of its more gentle relief and because it is inherently more productive. Muscatine silt loam also is a desirable crop soil, but it has a narrower range of moisture conditions under which it can be tilled without puddling or becoming cloddy than either the Clinton or the Tama soils.

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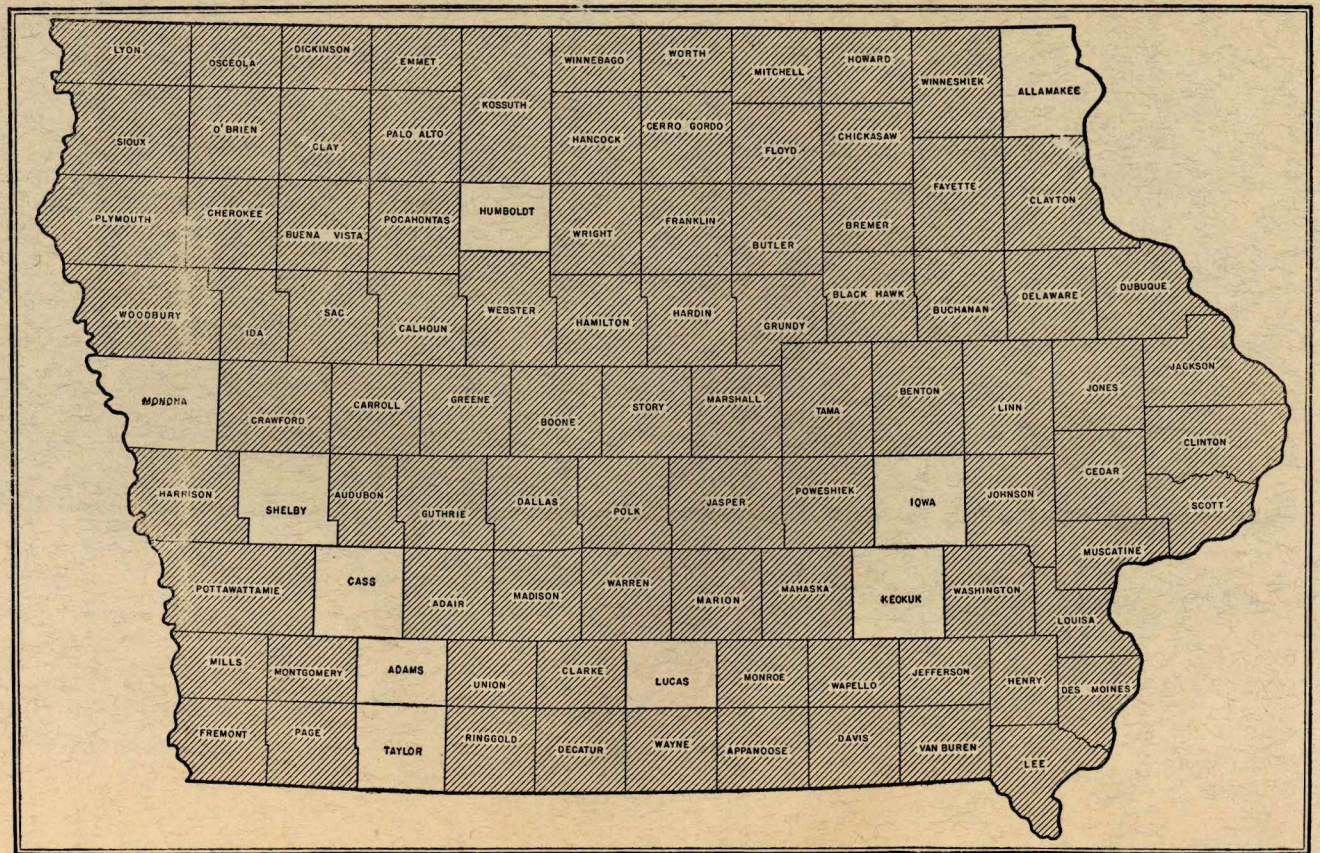

Areas surveyed in Iowa shown by shading.