U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.
IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION.

SOIL SURVEY OF HARDIN COUNTY, IOWA.

BY

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[Advance Sheets—Field Operations of the Bureau of Soils, 1920.]

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[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved, March 14, 1904.

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

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SOIL SURVEY OF HARDIN COUNTY, IOWA.

By T. H. BENTON, of the Iowa Agricultural Experiment Station, in Charge, and W. W. STRIKE, of the U. S. Department of Agriculture.

DESCRIPTION OF THE AREA.

Hardin County is situated a short distance northeast of the center of Iowa. The southern boundary of the county is about 45 miles north of Des Moines. The county is bounded on the north by Franklin County, on the east by Grundy County, on the south by Marshall and Story Counties, and on the west by Hamilton County. It comprises an area of 569 square miles, or 364,160 acres.

Hardin County is part of a vast plain over which at different times sheets of loess and glacial drift have been deposited. Slight relief has been produced by streams which have cut their channels into these unconsolidated materials, but the western four-fifths of the county has a constructional topography; that is, a topography determined by the deposition of drift and loess and not modified to any extent by subsequent erosion.

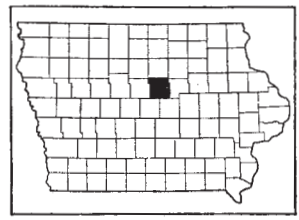

FIG. 21.—Sketch map showing location of the Hardin County area, Iowa.

The western two-thirds of the county is a part of the Wisconsin drift plain. As this region was so recently covered by drift, it is in a condition of topographic immaturity. The principal streams have cut rather deep channels, but their tributaries have not been extended over the surface far enough to afford efficient drainage. The surface is smooth and almost flat, with a lack of local drainage ways, so that large areas are wholly undrained. The flat topography and the restricted drainage are indicated on the soil map by the extensive distribution of soils which were developed under poor drainage conditions. Saucerlike depressions with no natural outlet are scattered over this region. Within these irregular flat areas are winding, low ridges and occasional knoblike hills.

This drift plain is bordered on the east by a chain of hills and ridges rising from 30 to 60 feet above the adjoining upland, and known as the Altamont moraine. This belt, which varies from 2 to 5 miles in width, enters the county in Aetna Township, extends southward past Eldora, then southwestward into Marshall County. The towns of Steamboat Rock, Eldora, and New Providence are situated on the eastern margin of this belt.

The Iowan drift plain, thinly covered by loess, occupies the northeastern part of the county. It comprises the east half of Aetna Township and the northeastern third of Clay Township. The topography is gently rolling and rather monotonous. The streams have done little cutting, but the surface is moderately well drained.

The Kansan drift, covered by a thin veneer of loess, occupies the southeastern part of the county and comprises about one-sixth of

the total area. The large streams flow through well-developed valleys and have deposited some alluvium. Their tributaries, although they have not dissected the entire surface, have penetrated the divides until the whole region is thoroughly drained.

The alluvial lands in Hardin County are well developed along all of the larger streams. They consist of first bottoms, adjacent to the stream channel, which are subject to annual overflow, and terraces or second bottoms, usually forming the part of the valley floor bordering the uplands and well above flood waters.

The first bottoms are only about 100 feet wide near the heads of streams, but gradually widen out to three-fourths mile along the lower courses. They are generally level, except for areas in the sharper bends of the streams, where a continual shifting and reworking of materials has left uneven rifts of sand and coarse gravel. Agriculturally, their chief value is for pasture.

Practically all of the terrace development is restricted to the Iowa River, South Fork of the Iowa River, and Beaver Creek. A few small isolated benches are found along Tipton, Honey, Bear, Pine, Elk, and Doud Creeks. The elevation of the terraces ranges from 928 feet at Union to 1,107 feet at Iowa Falls. They appear at three different elevations, usually 10 to 30 feet, 40 to 65 feet, and 90 to 110 feet above the river. At Iowa Falls three distinct benches appear—the first at 15 to 20 feet (south of the river), the second at 45 feet (south), and the third at 110 feet (north). Most of the terrace formations, including many of those at the highest elevation, are underlain by gravel.

The upland ranges from 1,036 feet above sea level at Whitten, in the southeast corner of the county, to a maximum of 1,225 feet on top of a morainal hill, north of the river between Alden and Iowa Falls. Alden, in the northwest corner, has an elevation of 1,170 feet; Radcliffe, near the west county line, 1,189 feet; Hubbard, in the south-central part, 1,094 feet; Ackley, in the extreme northeast corner, 1,092 feet; Owasa, 5 miles north of the center, 1,110 feet; Eldora, in the east-central part, 1,069 feet. The general slope of the surface of the plain and the general direction of flow of the main streams is southeast.

The Iowa River and its tributaries carry more than 90 per cent of the drainage waters of the county. An area of about 40 square miles in the northeast corner is drained by tributaries of the Cedar River. In the extreme southwest corner, Indian Creek, a tributary of Skunk River, carries southward the surface drainage of about 8 sections.

The course of the Iowa River is carved from 70 to 175 feet into the drift plain. From Gifford south to the county line and north from Alden, the valley shows evidence of great maturity, the winding stream flowing through a broad terraced valley three-fourths to 1½ miles wide, with a flood plain averaging three-eighths mile wide.

The channel varies from 100 to 400 feet in width. Continuous terrace benches border the flood plain, broken only by trenches cut by streams issuing from the uplands. At the Marshall County line the terrace nearly merges with the first bottom at 910 feet above sea level, but increases in height northward, being 10 feet above the flood plain at Union and 23 to 30 feet above at Gifford. In sharp contrast to this mature valley development is the more recent part

of the valley between Gifford and Alden. Here the river flows through a more or less close walled gorge, 150 to 175 feet deep, with practically no flood plain in many places. Between Secor and the northern part of Clay Township the rock-supported valley walls consist of reddish sandstone, and perpendicular exposures of 30 to 80 feet are common between Eldora and Steamboat Rock. These are underlain by a shale which carries some coal and constitutes the northern limit of the Iowa coal measures. North of section 7, at Clay Township, the bluffs recede somewhat from the river and limestone supplants the sandstone. Level terrace benches appear high above the narrow flood plain. At Iowa Falls a channel has been cut through the solid limestone, which rises 30 to 70 feet above the river bed. This was caused by ice blocking the old channel, which lies a short distance southward and almost parallel to the present course. For most of the distance between Iowa Falls and Alden the river has carved its narrow trenchlike course into the solid limestone floor of the terrace, which rock forms both walls and bed. The terrace benches here are underlain largely by gravel or limestone, the limestone being under the lower shelf.

South Fork of the Iowa River is the only tributary of any consequence entering the Iowa River from the west. In the northwest corner of the county it appears first as a prairie stream. A large dredged ditch, cut to afford drainage outlets for adjacent farms, closely follows the natural channel and extends into the edge of Buckeye Township, where the river resumes a natural course through a more rolling area. Where it crosses several morainal ridges the river has cut from 50 to 125 feet below the general upland level, and flows in a valley walled in by bluffs. Very little alluvium has been deposited, except along the last 10 miles of its course, where the river enters a broad, gravel-terraced valley, with a flood plain one-fourth to three-fourths mile wide, and comparable to the lower valley of the Iowa River. With its tributaries, Tipton and Beaver Creeks, the South Fork drains more than one-third of the county.

Beaver Creek has an old alluvial development similar to the South Fork of the Iowa River, from the point where it enters the South Fork (2½ miles northwest of Gifford) to a point about 7 miles upstream. Here the creek becomes a sluggish prairie stream, rising in the flat prairie 3 miles southwest of Alden.

Tipton Creek has its source in Hamilton County. It enters the southwest corner of Buckeye Township, has a dredged channel for about 4½ miles, where it begins to cut a sharply winding southeasterly course, and empties into South Fork in the west-central part of Pleasant Township.

Honey Creek enters the county 2 miles northwest of Radcliffe as a typical prairie stream. From Hubbard southeastward the bluffs become more pronounced, but are less rugged than those along Tipton Creek. The flood plain, narrow at the source, rapidly widens out and finally attains a width of about three-eighths mile.

Mud, Indian, and Minerva Creeks, in the southern part of the county, are essentially sluggish prairie streams. Elk, Pine, and Bear Creeks, the principal tributaries of the Iowa River from the east, show in the old high terraces along their courses evidences of being older than the parent stream. They flow in a southwesterly direction, have shallow valleys, and are bordered by narrow belts of alluvium.

The drainage system of the area may be separated into two divisions. That part east of the Altamont moraine, where the interstream areas are loess covered, has a gently rolling to rolling topography, with minor drainage ways affording drainage outlets for practically every farm. Only a few flat areas on top of the wider divides are without natural drainage.

Over the region west of the moraine, covered by the Wisconsin drift, the interstream divides are flat to gently undulating, with few intersecting streams. Adequate natural drainage here is restricted to farm lands adjacent to the immediate stream courses. Many artificial drainage ditches, particularly along the western side of the county, unite disconnected sloughs and draws and provide outlets for the tile drainage necessary here on many farms.

The only stream that has sufficient fall for water power is the Iowa River. Formerly a number of grain mills utilized the current at various points along the river. Water power is still developed at Iowa Falls, Eldora, and Union.

The water supply for stock and household purposes usually comes from drilled wells. Windmills and gas engines are used for pumping. Permanent water is obtained at 70 to 300 feet, the wells having an average depth between 125 to 175 feet. Artesian basins of small extent are scattered over the west side of the county. Flows strong enough to rise 2 or 3 feet above the flood plain are found along the South Fork of the Iowa River in Buckeye, Ellis, and Tipton Townships. These wells reach depths of 80 to 120 feet. Springs are found along all of the larger drainage ways, but particularly along Tipton Creek. The water of Siloam Springs, 1½ miles northwest of Iowa Falls, has a high content of iron and sulphur and is esteemed for its medicinal properties.

Many shallow lakes formerly existed throughout the Wisconsin drift area, but the waters have been carried away through an extensive drainage system of open ditches and only the dry beds remain. Two of the largest in the county are in section 18, Providence Township, and section 21, Grant Township. The Peat and Muck beds occur largely in such depressions.

The beautiful forested valley slopes and adjacent upland groves along the Iowa River comprise most of the native timber of the county. Scattered patches of trees are also found on the steeper hillsides along the South Fork of the Iowa River and the lower courses of all the major tributary streams. Scattered belts of black oak, post oak, willow, walnut, cottonwood, sycamore, birch, haw, dogwood, and other hardwood trees are found along the stream channels below the timbered hillslopes. The more common native trees on the upland and slopes are white oak, red oak, basswood, hickory, sugar maple, elm, wild cherry, walnut, and dogwood. Some white pine, red cedar, paper or canoe birch, large-toothed aspen, and juneberry occur. Hickory and oaks predominate.

Hardin County was organized January 15, 1851. The first settler, a native of Kentucky, came from Keokuk in 1849 and located in Union Township. Pioneers from the neighboring States to the east and south followed rapidly. Eldora, the present county seat, was established in 1853.

The population of the county, as reported by the 1920 census, is 23,337, of which nearly 90 per cent is of native birth. The southwest corner, particularly Concord Township, has been settled by Nor-

wegians, the west-central and central part of the county is occupied by people of German descent. In the section around New Providence and Union there are many Quakers. The rural population, which constitutes approximately 80 per cent of the total, has a fairly uniform distribution.

Eldora, the county seat, located in the eastern part, has a population of 3,189. Iowa Falls, in the northern part, with 3,954 inhabitants, is the largest city. Ackley, in the extreme northeast corner, is a town of 1,529. Other locally important towns and shipping points are Alden, Hubbard, Radcliffe, Union, Whitten, New Providence, Garden City, Buckeye, Sherman, Steamboat Rock, Abbott, Owasa, Robertson, Cleves, Gifford, Lawn Hill, Wilke, and Macy.

A canning factory and a flour mill are located at Ackley, and a large poultry-packing plant and 2 creameries at Iowa Falls. Stone is quarried at Alden and Iowa Falls, and ground limestone for agricultural purposes can be obtained at Alden. Seven creameries, four of them cooperative, are scattered over the county in the larger towns, with cream-buying stations in the smaller towns. Brick and tile factories are in operation at Iowa Falls and Eldora.

Hardin County is well supplied with railroads, few farms being more than 6 miles from a shipping point. The main line of the Illinois Central Railroad, between Chicago and Omaha, crosses the northern part of the county. The Minneapolis & St. Louis Railroad serves the east side of the county, giving direct connection with Minneapolis and St. Louis. One branch of the Chicago, Rock Island & Pacific Railway cuts through the northeast corner, and another entering north of Iowa Falls extends southward through the western part of the county, also giving direct connection to Minneapolis. A branch of the Chicago & North Western Railway traverses the southern part of the county, with a spur leaving Eldora Junction and extending to Eldora, Iowa Falls, and Alden. The Chicago, Rock Island & Pacific Railway shops are located at Iowa Falls.

Most of the wagon roads in the county are of earth construction, and are well graded and kept in good condition. None of the roads have hard surfacing, but many of the main highways have long graveled stretches. Further extensive improvements of graveling and grading are in progress. The Hawkeye (Primary No. 5), Jefferson (Primary No. 1), and Grant (Primary No. 58) automobile routes pass through the county. An abundance of gravel and stone is available in the county for road work.

Rural mail routes and telephone lines reach every part of the county. Fine consolidated schools have been established at Whitten, Union, New Providence, Eldora, Owasa, and Steamboat Rock. There are numerous country churches and excellent rural schools. A State industrial school for boys, with 800 acres of land, is situated 1 mile west of Eldora. Ellworth College is located at Iowa Falls.

Chicago, Minneapolis, and Omaha are the principal outside markets for livestock and agricultural products.

CLIMATE.

The climate of Hardin County is marked by a wide annual range in temperature, the winters being very cold and the summers hot. The mean temperature for summer is about 70° F. and for winter about 18° F. The highest recorded temperature is 103° F., and the

lowest, −35° F. In the absence of snow protection wheat sometimes is killed during periods of extreme cold, but snow usually covers the ground during most of the winter season. Occasionally the snowfall is so heavy as to cause the blocking of roads.

The mean annual precipitation at Iowa Falls, in the northern part of the county, is 34.55 inches; in the wettest year (1867) it was 54.66 inches, and in the driest year (1894) it was 19.52 inches. At Whitten, in the southeast corner of the county, the mean annual precipitation is 30.6 inches; in the wettest year (1902) it was 46.48 inches, and in the driest year (1910), 16.82 inches. The records at Iowa falls cover a period more than twice as long as those at Whitten. Periods of drought are infrequent and of short duration. Little damage from dry weather is suffered by crops, except on the sandier upland and terrace soils of a loose, open structure, which are naturally droughty. Destructive hailstorms sometimes occur over small areas, usually in narrow belts not more than 1 or 2 miles wide.

At Iowa Falls the average growing season extends from May 4, the average of the last killing frost in spring, to October 1, the average date of the first killing frost in fall, or a period of 150 days. At Whitten the average frost-free season extends from May 5 to October 5. The latest killing frost on record at Iowa Falls occurred on June 1, and the earliest in the fall, on September 11. The season is sufficiently long to permit the maturing of all field crops common to this region. The grazing season averages about 165 days and lasts until about the middle of November.

The following tables, giving the monthly, seasonal, and annual temperature and precipitation for Hardin County, are compiled from records of the Weather Bureau stations at Iowa Falls and Whitten

Normal monthly, seasonal, and annual temperature and precipitation at Iowa Falls.

(Elevation, 1,107 feet.)

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1894).	Total amount for the wettest year (1867).
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	21.3	58	−31	1.37	0.89	2.46
January	13.8	55	−34	1.21	.72	1.74
February	16.8	59	−29	1.64	.20	5.49
Winter	17.3	59	−34	4.22	1.81	9.69
March	30.6	84	−17	1.86	1.65	3.17
April	46.4	93	3	3.13	4.33	2.14
May	58.5	92	24	4.60	1.63	7.64
Spring	45.2	93	−17	9.59	7.61	12.95
June	67.3	98	37	5.40	2.85	17.20
July	71.9	103	40	4.19	.09	4.30
August	69.5	100	31	3.71	1.56	4.29
Summer	69.6	103	31	13.30	4.50	25.79
September	60.9	96	26	3.54	1.57	4.26
October	48.4	86	11	2.36	3.78	1.82
November	32.6	78	−1	1.54	.25	.15
Fall	47.3	96	−1	7.44	5.60	6.23
Year	44.8	103	−34	34.55	19.52	54.66

Normal monthly, seasonal, and annual temperature and precipitation at Whitten.
(Elevation, 1,036 feet.)

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1902).
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	23.0	54	−26	1.05	0.10	2.10
January	16.2	55	−35	.95	1.30	.95
February	19.3	60	−26	.84	.60	.10
Winter	19.5	60	−35	2.84	2.00	3.15
March	32.4	84	−17	1.51	T.	1.71
April	48.3	93	13	2.37	1.32	1.93
May	60.2	92	29	4.80	2.19	6.69
Spring	47.0	93	−17	8.68	3.51	10.33
June	68.9	98	34	4.44	2.43	11.52
July	73.9	103	44	3.68	1.86	8.45
August	71.2	98	33	3.58	3.39	6.98
Summer	71.3	103	33	11.70	7.68	26.95
September	63.0	98	25	3.60	3.20	3.49
October	49.8	85	11	2.46	.43	.88
November	34.6	78	0	1.32	T.	1.68
Fall	49.1	98	0	7.38	3.63	6.05
Year	46.7	103	−35	30.60	16.82	46.48

AGRICULTURE.

The first settlements in Hardin County were on the more rolling lands adjacent to the larger streams. The upland prairies were heavily covered with native grasses. Abundantly forested hillslopes furnished building material and fuel. Later, coal veins 8 inches to 4 feet thick were discovered underlying the exposed sandstone cliffs along the Iowa River, and Eldora early became the center of a thriving mining industry. Farmers drove from as far as Cedar Rapids and Independence for their fuel supply. With the entrance of railroads from the south, the better grade of coal from the southern Iowa fields displaced the local product commercially. The Eldora coal is very soft and contains much sulphur in the form of bands of iron pyrites.

Agriculture has always been the most important industry, and its development covers a period of 70 years. The raising of livestock and the growing of the staple field crops, corn, oats, wheat, and hay, have always occupied the place of first importance. Flax was grown extensively at first on new sod ground. The table below shows the acreage and production of the principal field crops, as given in the United States census reports of 1880 to 1920, inclusive.

Acreage and production of the leading field crops of Hardin County, census years 1879 to 1919, inclusive.

Year.	Corn.		Oats.		Wheat.		Hay and forage.	
	Area.	Production.	Area.	Production.	Area.	Production.	Area.	Production.
	Acres.	*Bushels.*	*Acres.*	*Bushels.*	*Acres.*	*Bushels.*	*Acres.*	*Tons.*
1879	71,067	2,742,057	19,346	687,798	29,487	346,929	25,931	36,460
1889	84,178	3,501,708	51,510	2,269,305	720	8,765	53,180	74,816
1899	108,425	4,253,890	65,308	2,600,310	13,731	245,360	46,418	63,736
1909	96,853	4,087,214	65,577	1,991,544	2,184	34,117	47,535	73,863
1919	109,685	4,193,386	80,972	2,672,326	2,238	32,534	45,720	105,132

As the census reports show, corn has been the leading crop from the earliest period. The average yields for the five census years range from 38 to 42 bushels per acre. Previously to 1890 wheat was second in importance as a cash crop, but it has been superseded by oats. The average yield of oats has ranged from 47 bushels per acre in 1879 to 30 bushels in 1909. The State census gives 40 bushels as the average yield for 1920. The yields of oats per acre vary greatly according to the season. Potatoes, barley, rye, sorghum, pop corn, and millet are important supplementary crops. Alfalfa is grown in small fields. Flax has practically disappeared as a field crop since 1899. Orcharding attained its maximum development about 1899. Apples were the principal fruit, there being in that year 46,779 apple trees in the county. Some small fruits, principally grapes, are grown in a small way.

The present system of farming in Hardin County is extensive rather than intensive, and consists of grain growing combined with stock raising. Dairying is carried on principally in conjunction with the raising of livestock.

The average yield of corn in 1920, according to the State Year Book, was 49 bushels per acre, and yields of 80 bushels were common on comparatively large fields in 1920; but the average yield for a series of years is around 40 bushels. Reid Yellow Dent, Silver King, Calico, and Western Plowman are the leading varieties, given in the order of preference. About half the seed used is pure, and the rest is of mixed strains. There seems to be a general preference for yellow corn, except in Aetna Township. Seed corn is tested for germination on many farms, especially in years following seasons of early fall frosts. Probably 60 per cent of the seed is selected in the field at husking time. A good share of the crop is used for silage. A combination of soy beans and corn is becoming popular for silage. This mixture has a very high feeding value. There are 339 silos on farms. About 70 per cent of the corn crop is fed to livestock on the farms; a small part is sold within the county to other feeders; the rest is shelled and marketed, principally in Chicago, but a small proportion goes to St. Louis and Omaha. Seventeen cooperative elevators, serving all parts of the county, handle most of the grain shipped. Canada thistle and quack grass are the most troublesome weed pests.

Oats are grown on nearly every farm and are second to corn in acreage. Richland (Iowa No. 105) and Albion (Iowa No. 103) are the early varieties preferred; Silvermine and Green Russian are the late varieties. About 60 per cent of the crop is of the early varieties, which mature 7 to 10 days earlier than the late ones. More than

half the entire oat crop is fed to work stock, except on tenant farms, where it is largely a cash crop. Smut and red rust cause much damage in some seasons. The formaldehyde treatment is an effective remedy for smut.

Hay and forage crops occupied 45,720 acres in 1919, as reported in the 1920 census. This includes 26,287 acres of tame grasses, 5,582 acres of wild grasses, 4,608 acres of silage crops, 8,628 acres of corn cut for forage, and small acreages of grain cut for hay and sorghum for forage. Timothy and clover mixed is the main hay crop, with an average yield of about 1½ tons per acre. Very little timothy alone is grown for hay and seed. Wild hay is cut in low, poorly drained draws and depressions. Practically the entire hay crop is fed on the farm. Some hay, including alfalfa, from outside the county is shipped into Iowa Falls and used in feeding stock on near-by farms.

Clover is being used more over the entire county. It is generally sown with oats as a nurse crop. In favorable seasons considerable seed is harvested, mostly in the eastern part of the county near the Iowa River. Seasonal conditions of recent years resulted in much winterkilling, which has greatly reduced the clover acreage. Medium red is grown for both seed and hay, and gives an average yield of 1½ to 2 tons of hay per acre.

Alfalfa is usually grown on small fields of 2 to 5 acres, with a maximum of 40 acres. In 1919 the total acreage was 186. Three cuttings are made annually, with a yield per season of 2½ to 4 tons per acre. Alfalfa stands are not difficult to obtain on well-drained fields which have been limed and inoculated. Acidity and poor drainage are usually the limiting factors in both alfalfa and clover stands.

Sweet clover grows luxuriantly along the roadsides. The high price of red-clover seed during the last few years has stimulated the growing of sweet clover for hay and pasture. The hay crop is cut in June, good drying weather being necessary for proper curing. In rotations it is seeded with oats, used for fall pasture, and plowed under in spring as green manure.

Soy beans are grown mainly for silage. The high protein content gives them an especial feeding value. Enough seed is harvested in the county to supply the local need. Practically all the soy beans are grown with corn, being planted by means of a special attachment on the corn planter. The Mongol and Medium Green varieties are the best for silage, and the Manchu and Ito San are best for hogging down.

Sweet corn is produced in the northeastern corner of the county, mostly in Aetna Township. It is marketed at Ackley, where there is a large canning factory. The average yield is from 6 to 7 tons per acre. The price in 1920 was $12 a ton. In the vicinity of Hubbard about 5,000 bushels of pop corn are produced annually.

Wheat has become of little importance as a field crop. Only 168 acres of spring wheat and 183 of winter wheat were reported in the 1920 State census. The average yields per acre were 14 and 22 bushels, respectively. According to local reports, winter wheat is more certain and gives a better yield than spring wheat.

Barley occupied 1,679 acres in 1919, with a production of 41,342 bushels. Occasionally barley is used to take the place of oats in the

rotation. The crop is fed to hogs. Other grain crops grown to a small extent are buckwheat, kafir, rye, and emmer. Some sorghum is grown for feed and sirup. Sudan grass is rapidly taking the place of millet. Rape is sometimes sown in corn at the last cultivation, or with oats at the time of seeding.

Pastures are mostly permanent and occupied 74,386 acres in 1920. A mixture of sweet clover and bluegrass is used mostly for seeding. Where alsike, sweet clover, or bluegrass has been sown with red clover and timothy, the land ordinarily is used for grazing for about two years before reseeding.

The production of potatoes is insufficient for local demands, and as many as 12 to 15 carloads are shipped in annually. Most of the crop is grown in the northern and eastern parts of the county, with a small surplus in the eastern part. Potatoes occupied 1,298 acres in 1919. A few sweet potatoes and melons are produced on the sandier upland and terrace soils along the river. Trucking is carried on in a small way around Eldora and Iowa Falls.

Fruit growing is not extensive, but is of local importance. Apples are the principal tree fruit. The Northwestern Greening, Jonathan, Baldwin, Oldenburg (*Duchess of Oldenburg*), Wealthy, Malinda, and Pewaukee are the most common varieties. Some cherries, plums, and pears are grown. Most of the fruit is grown on the silty soils in the southern and eastern parts of the county, where the topography is more rolling, and is particularly adapted to fruit growing. Grapes, raspberries, strawberries, gooseberries, blackberries, and currants thrive. The bulk of the fruit is used on the farm, a small surplus being sold in the neighborhood and the nearest towns.

Livestock is the chief source of income on most farms. In the northwest corner—Concord, Buckeye, and Alden Townships, and part of Sherman Township—there is a tendency to feed less and market more grain. In Providence Township many farmers buy corn for finishing feeders shipped in. As a rule more cattle are fed in Union, Hardin, Sherman, Grant, Eldora, and Providence Townships than in other parts of the county.

Hog raising and feeding is the most important livestock industry and chief source of income. According to the census there were 84,160 hogs in the county on January 1, 1920. While most of the hogs are mixed high grades, many purebred herds are found. Duroc-Jersey, Poland-China, Hampshire, Chester White, and Spotted Poland-China, in the order named, are the leading breeds. On the average farm about 12 brood sows are kept. These are bred to purebred sires. The average number of hogs per farm is 65. On tenant farms fewer hogs are fed and more grain is sold. A few stock hogs are shipped in and fed. Tankage and corn are used largely for finishing. The hogs are generally marketed through cooperative livestock shipping associations, most of them going to Chicago and a few to Mason City and Cedar Rapids.

Cattle are next in importance. The cattle are for the most part grades. Shorthorn crosses are most popular, with grades of Angus, Holstein, and Hereford breeds next in order of preference. Purebred sires are largely used, and the quality of the stock is rapidly improving. About 5 per cent of the cattle are purebred. Herds of purebreds are found mainly in the southeast corner of the county; a few others are scattered over the county. The favorite breeds are Shorthorn,

Angus, and Holstein, with some Hereford, Jersey, and Red Poll. About 300 cars of feeders are shipped into the county annually. These are brought in between September 15 and December 1, from Omaha, Sioux City, and St. Paul. They are finished mainly on corn, with some cottonseed meal and oil meal. The older cattle are fall pastured and shipped earliest, the younger being carried over. Chicago gets practically all the cattle shipped from Hardin County.

Dairying is carried on principally as a side line. From 8 to 10 milk cows, mostly grade Shorthorn and Holstein, are kept on the average farm. The cream is separated and sold to the nearest cream-buying station. Several strictly dairy farms, on which the cows are mostly Holstein, located near Eldora and Iowa Falls, supply milk for these cities. There are four cooperative and three commercial dairies in the county, and cream-buying stations are in nearly every town. A considerable amount of butter is shipped from the creamery at Iowa Falls to New York City. The State census for 1920 reports 10,596 cows and heifers kept for milk.

Sheep are raised on the rougher lands along the Iowa River and its tributaries. Oxford and Shropshire seem to be the favorite breeds. The flocks as a rule are small. Several carloads of western feeders are shipped in and finished each year. There were 6,910 sheep raised and 6,530 shipped in for feeding in 1920. The wool clipped, 28,819 pounds, was practically all marketed through the Iowa Wool Growers' Association and shipped to Chicago.

Horses on all farms in the county numbered 14,789 on January 1, 1920, and mules, 683. The average farm has about five horses, usually of light draft. Hardly enough colts are raised to keep up the supply of work stock. The Percheron is the favorite breed.

Poultry is raised on all farms. The poultry consists largely of chickens, but a few geese, ducks, turkeys, and guinea fowls also are raised. The flocks, which average about 175, are largely of mixed breeds. Iowa Falls is the largest local market. The Boston market receives most of the poultry and poultry products. Poultry on the farms (January 1, 1921) numbered 294,001 fowls, with an egg production of 947,318 dozen.

Most of the grain, hogs, and wool, and considerable cream is marketed through cooperative agencies, including 17 cooperative elevators, 13 livestock shipping associations, 4 cooperative creameries, and 1 wool growers' association.

A general adaptation of crops to certain soil types is recognized by the farmers. The heavy black Webster soils are the strongest corn soils, upon which small grains are likely to grow rank and lodge, especially in a wet season. The Clarion, Carrington, and Tama soils are adapted to general farming. The Lindley soils, occupying the rough and steep slopes along the larger streams, are best utilized for pasture. Potatoes and truck crops do best on the sandier soil types and Muck and Peat. The more rolling slopes of the Tama silt loam in the southern part of the county are adapted to orcharding. The lighter colored Clinton types are more productive for wheat, hay, and vegetables than for corn. They also are suited to fruit growing. Because of frequent overflows, the Wabash and Lamoure types are used largely as pastures.

With the exception of the Webster, Fargo, and Lamoure types, all the soils of the county range from nearly neutral to more or less

acid. Application of crushed limestone on ground intended for legumes is generally profitable, as it greatly stimulates the growth and yield. Very favorable and marked results have been obtained recently with lime on the Carrington and Tama soils, according to information of the local farm bureau. On the extremely sandy upland and terrace types, crops should be planted as early as possible to avoid drought, and efficiently mulched throughout the growing season. A 3-year rotation would probably be best here. On the lighter colored Clinton and Lindley soils, incorporation of more organic matter by turning under clover and other green-manure crops, is especially needed. Lime and acid phosphate should give beneficial results on these types. The present freight rates make raw rock rather expensive.

While a definite rotation of crops is not the usual practice, more planning of systematic rotations is being done. The use of the 4-year rotation of corn, corn, oats, and clover seems to be best suited for this region. Probably the most commonly used rotation consists of corn, corn, oats, or of corn, oats, clover. The growing of corn and oats alternately is still favored in some sections.

All farming operations are centered more or less around the production of corn. Land to be planted to corn is usually plowed in the fall. Corn planting begins around May 7, and the crop is laid by about July 1. Corn harvest begins about October 15. The preparation of the seed bed and subsequent care and cultivation are as a rule very thorough. About 5 per cent of the crop is cut for fodder and silage, the greater part being husked by hand in the field and stored in cribs. Cattle are pastured on the standing stalks. Oats usually follow corn. The field is disked before plowing if the cornstalks are not well cleaned up. The seed is sown broadcast about April 1. Clover and timothy mixed, 7 and 8 pounds per acre, respectively, is sown on from 30 to 50 per cent of the area devoted to oats and left for one or two years, usually two. Medium red clover alone is sown at the rate of about 8 pounds per acre. Clover is often turned under for green manure. Sweet clover, which is more extensively used for green manure, is usually turned under in the fall to give time for thorough decomposition of the plant fiber, so that the following crop may receive the full benefit of the added organic matter.

Most of the plowing is 5 to 8 inches deep. Tractors are used on the more level farms along the western side of the county. Five horses are used on the gang plow in heavier fields and four on the lighter soils. The use of light trucks on the farms is increasing.

Very little commercial fertilizer is used, except in an experimental way. The State Agricultural Experiment Station has a series of experimental plats on the State Industrial Farm west of Eldora.

The supply of farm labor is normally sufficient. It is drawn mainly from native whites. Monthly wages range from $35 to $60, with board and washing in addition. From $40 to $65 is paid tenant families, and they are usually furnished a house, garden, cow, chickens, and hogs to butcher. Most of the farm labor is hired for a period of nine months. During harvest the average day wage is $3. On 1,437 farms reporting, there was a total expenditure of $795,407 for labor in 1919.

The total number of farms in Hardin County, according to the United States census, was 2,129 in 1919, and the average size of farms 164.4 acres. The average size has consistently increased since 1879, when it was 128 acres. About 96 per cent of the county is included in farms, and 86 per cent of the farm land, or an average of 141.4 acres per farm, is improved.

Nearly half the farms are operated by tenants. The prevailing lease is based on a part-crop and part-cash plan, in which the tenant furnishes horses and machinery. The owner receives half the crop delivered and $8 to $10 cash per acre for pasture. At present (1920) cash rents are ordinarily $10 to $15 per acre, but in some cases of exceptional improvements as much as $25 is paid.

Farm lands vary greatly in price, selling at $175 to $400 an acre. The degree of improvement, location, topography, roads, soils, and general condition of the fields and buildings, are the factors that determine land prices.

SOILS.

Hardin County lies in the prairie region of the United States, where the topography and the abundant moisture supply have favored a heavy grass vegetation over the greater part of the area. The original constructional surface of the region, with its poorly drained areas, was unfavorable to tree growth, and the heavy grass vegetation furnished fuel for fires that also prevented encroachment of forests. As topographic changes have developed better drainage, forest growth has spread over the eroded slopes, but it has not invaded the unchanged areas.

The soils of the area, therefore, were developed under the influence of a native vegetation consisting of grasses over the relatively smooth upland, and of forest along the deeper stream valleys.

It is now believed that the characteristics of the soil in its present stage of development, with the exception of texture, have been determined to a greater extent by soil-forming processes, which have resulted in the accumulation of organic matter, and in the weathering, leaching, and oxidation near the surface, than by variations in the character of the parent material.

Upon the basis of their most widely distributed and broadest characteristics, the soils of the county may be divided into a light-colored and a dark-colored group. The area of light-colored soils is nearly coextensive with the area covered by forest when the white man first came to the region. The soil profile, developed under a native vegetation consisting of trees, has a surface layer ranging in depth from 5 to 12 inches of gray, grayish-brown or light-brown color, and with a silty texture and floury structure. This is underlain by a coarsely granular material extending to a depth of 2 or 3 feet. Below this layer the texture is lighter and the structure less compact. The soils which belong to this light-colored group are those of the Clinton, Lindley, and Fayette series.

The dark-colored soils include the soils of the upland prairie and also certain areas of alluvial soils. The dark-colored soils fall into two groups whose differentiation is based on drainage conditions of soil or subsoil, or both, during their development.

The soils of one of these groups, of which the Carrington series is representative, were developed under conditions of good surface and internal drainage. The typical profile has a surface layer of dark-brown to black color and granular structure, ranging from 5 to 15 inches in thickness. This is underlain by a brown layer, lighter in color than the surface, with a somewhat granular structure, ranging in thickness from 1 or 2 inches to 12 inches. Below this is a brown to yellowish-brown subsoil, perceptibly heavier in texture than the two upper layers, and friable and coarsely granular in structure. This lower layer extends to a depth ranging from 2 to 4 feet, and is underlain by a slightly weathered layer of the parent material not greatly differing from the unweathered rock, which in this area is either glacial drift or loess. The carbonates have as a rule been removed to a depth of several feet. This group includes the Carrington and Tama soils on the upland, and the Waukesha, Buckner, O'Neill, and Millsdale soils on the alluvial terraces.

The members of the other group of dark-colored soils mentioned, developed under conditions of poor drainage, have a black surface soil usually with a well-defined granular structure. This is underlain by a gray or mottled gray and yellow or brown subsoil, somewhat heavier as a rule than the surface soil. The details of the profile of these soils vary considerably, depending on the depth to which good drainage and oxidation have extended. In some cases both surface soil and subsoil have developed with water standing upon the surface or at least under conditions of permanent saturation. In other cases the soil has been rather well drained but the subsoil has been wet, while in still others only the deeper part of the subsoil has been subjected to wet conditions. In this group the Webster and Clyde series of the upland, the Bremer and Fargo series of the terraces, and the Lamoure and Wabash series of the flood plains, represent soils developed under very poor drainage conditions. The Clarion and Muscatine soils belong to the group having poorly drained subsoils.

The Wisconsin drift, which is the parent material for the soils of about four-fifths of the county, consists of more or less finely ground rock material mixed with gravel and bowlders. The greater part of the surface material, however, approaches a loam in texture. The unmodified drift, a yellow compact mass, is derived from limestone, sandstone, shale, and granite rocks. In this region the limestone fragments and ground limestone form so large a proportion of the material that the mass as a whole is highly calcareous. The weathering, leaching, and oxidation of this material under the conditions of drainage described above, have resulted in the formation of the Carrington, Clarion, and Webster series.

The older and more thoroughly leached Iowan and Kansan drift sheets of the eastern part of the county have produced the Clyde, Lindley, Clinton, and Fayette series.

These older drift deposits are for the most part covered by a thin mantle of loess. In the well-drained rolling areas the loess has produced the Tama series, and on the flat areas, where the subsoil drainage was less perfect, the Muscatine.

The soils have been grouped into series on the basis of similarity in color, subsoil, topography, drainage, and origin. A further separation into types in each series is made on the basis of difference in texture, determined by the relative content of sand, silt, and clay.

On this basis 25 soil types, representing 17 series, have been mapped in Hardin County. In addition Peat and Muck, a miscellaneous classification, has been mapped.

The surface soils of types of the Carrington series are dark brown, and the subsoil is light brown to yellowish brown. This series predominates in the Wisconsin glacial till area of northern Iowa. The topography varies from undulating to sharply rolling. To a depth of 3 feet the soil is characteristically noncalcareous, lime particles having been removed through long periods of weathering and leaching. The Carrington sandy loam, fine sandy loam, loam, and silt loam are mapped in Hardin County.

The surface soils of types of the Clarion series are dark brown to black, and are underlain by a yellowish-brown subsoil similar to that of the Carrington series. But at varying depths, usually 30 inches, light grayish brown or yellowish-brown, unweathered, and highly calcareous parent material is encountered. This layer distinguishes the series from the Carrington. The topography may be similar to that of the Carrington soils, but usually it is gently undulating to undulating. The series is represented here by the Clarion loam.

The Webster series is characterized by black surface soils, underlain at a depth of from 12 to 30 inches by a yellowish-brown or grayish-yellow material, highly mottled with gray and yellow. Ordinarily only the subsoil, which is highly calcareous, effervesces with hydrochloric acid. The topography is gently undulating to level, and the natural drainage is poor. Two types of this series are mapped, the loam and the silty clay loam.

The types of the Lindley series are derived from glacial till, with little or no modification from loessial deposits. The surface soils are light brown to grayish brown, sometimes faint reddish brown, and the subsoil is light brown or yellow, with some gray and yellow mottlings. The topography is rolling to almost precipitous, and most of the land is subject to continued destructive erosion. Granite bowlders of various sizes and fragments and outcrops of limestone and sandstone are found in the weathered drift material. The Lindley very fine sandy loam, and the Lindley loam with a steep phase, are mapped.

The types of the Clyde series have black surface soils underlain by a grayish-brown or drab subsoil mottled with gray. They have been formed under restricted drainage conditions in small depressions and sloughs on the upland. In places the lower subsoil effervesces slightly, but it is typically not calcareous within the 3-foot zone. This series is most common in the Iowan drift region of northeastern Iowa, and is represented in this county by the silty clay loam.

The types of the Tama, Muscatine, Clinton, and Fayette series are upland soils wholly or partly of loessial origin.

The types of the Tama series have dark-brown to very dark brown surface soils, and a yellowish-brown to brownish-yellow subsoil, smooth and friable in structure and free from grit and coarse material. Through weathering and leaching the calcareous material originally present has been removed to below the 3-foot section. The topography is gently to strongly rolling. The Tama silt loam is the only soil of this series in Hardin County.

The surface soils of types included in the Muscatine series are dark brown to black. The subsoil is yellowish brown, heavy, and strongly mottled with gray and yellow. Rusty-brown iron concretions are present in the lower depths. The silt loam type is mapped in Hardin County. It occupies the flat tops of the interstream loessial areas and has poor natural drainage. Neither soil nor subsoil is highly calcareous.

In types of the Clinton series the surface soils are prevailingly grayish brown or light brown, and the subsoil is compact and has a yellow or yellowish-brown color with pronounced gray and pale-yellowish mottlings. The topography is rolling to broken, and the silty character of the material makes it erode easily. The soils have developed under forest conditions. The Clinton silt loam is mapped in the present survey.

The types included in the Fayette series have light-brown to grayish-brown surface soils, underlain by a friable yellowish-brown subsoil, faintly mottled with gray in the lower depths. The series differs from the Clinton in having a flat topography, fewer gray mottlings, and less compaction in the subsoil. It is represented in the present survey by the Fayette silt loam.

The alluvial soils include types on the second bottoms or terraces and on the first bottoms or present flood plains. The types of the Waukesha, Bremer, Fargo, Millsdale, Buckner, and O'Neill series have been developed on the terraces well above overflow, and those of the Wabash and Lamoure series in the existing flood plains.

The Waukesha series consists of types with dark-brown to black surface soils and a light-brown to yellowish-brown subsoil. These soils are composed of water-assorted loessial and glacial materials, occupying level to gently undulating benches along the streams. The soils are well drained and not highly calcareous. The silt loam is mapped in this county.

The surface soils of types of the Bremer series are black, and the subsoil is dark gray, grayish brown, or black. Mottlings of gray or yellowish brown may be present in places. The subsoil is usually heavy and tenacious. The series occupies flat or poorly drained depressions, having been formed under conditions of restricted drainage. It is represented here by the silty clay loam type.

The Fargo series consists of types with black surface soils and a dark-gray or mottled subsoil. These types occur in depressions or on poorly drained terraces and are developed on sedimentary material by weathering under conditions of restricted drainage. The lower subsoil is always highly calcareous and in this respect differs from the Bremer subsoil. The Fargo silty clay loam is mapped.

The types of the Millsdale series are level to gently undulating and occupy the lower terrace benches. The surface soils are dark brown in color and are underlain at a depth of about 8 to 15 inches by a yellowish-brown to dark-brown subsoil containing considerable sand and coarser material. This series is characterized by the presence of a limestone floor, lying in most places from 18 to 30 inches below the surface. In a few places small outcrops rise a few inches above the valley floor. The series is represented by one type, the loam.

The types of the Buckner series have a brown to light-brown surface soil, and a lighter colored subsoil, with a texture similar to or

lighter than the soil. The surface and internal drainage is good, but the soils of this series are not droughty. Two types, the fine sandy loam and the loam, are mapped.

The types of the O'Neill series differ from the Buckner soil only in having a gravel substratum within the 3-foot section. This generally occurs in this county at depths of 9 to 18 inches. The surface is flat, but the loose structure of the materials gives good drainage. In periods of excessive heat and dry weather, crops on types of this series are affected by drought. The O'Neill loam is mapped in this county.

The types of the Wabash series occupy the first bottoms immediately adjacent to the stream channel, which are subject to annual overflow. The surface soils are dark brown to black, and are underlain by a brown, gray, or black subsoil as heavy as or heavier than the surface layer. The substratum in most places is lighter in color and much heavier than the surface soils. The loam, silt loam, and silty clay loam types occur in Hardin County.

The types of the Lamoure series differ from the Wabash soils in being calcareous, normally in both soil and subsoil. The subsoil is dull gray to yellowish gray. The natural drainage is poor. The Lamoure silty clay loam is the only type of this series to be developed in Hardin County.

Peat and Muck is a miscellaneous classification of soil composed largely of cumulose material in various stages of decomposition.

The distribution of the soils of Hardin County is shown on the soil map accompanying this report. The names and the actual and relative extent of the soils are given in the table below.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Carrington loam	125,632	35.2	Carrington fine sandy loam	3,136	0.9
Steep phase	2,624		Wabash silt loam	3,008	.8
Clarion loam	70,912	19.5	Buckner loam	2,304	.6
Tama silt loam	47,872	13.2	Waukesha silt loam	2,240	.6
Webster silty clay loam	36,608	10.0	Carrington sandy loam	1,856	.5
Wabash loam	11,904	3.3	Millsdale loam	1,856	.5
Webster loam	11,392	3.1	Fayette silt loam	1,536	.4
O'Neill loam	7,872	2.2	Wabash silty clay loam	1,472	.4
Lamoure silty clay loam	5,184	1.4	Peat and Muck	1,472	.4
Carrington silt loam	5,120	1.4	Muscatine silt loam	1,344	.4
Lindley loam	2,880	1.3	Fargo silty clay loam	960	.3
Steep phase	1,984		Buckner fine sandy loam	832	.2
Clinton silt loam	4,224	1.2	Bremer silty clay loam	704	.2
Lindley very fine sandy loam	3,968	1.2			
Clyde silty clay loam	3,264	.9	Total	364,160	

CARRINGTON SANDY LOAM.

The surface soil of the Carrington sandy loam is a brown to dark-brown sandy loam. At about 10 inches this passes rather abruptly into the subsoil, which is a yellowish-brown sandy loam containing a relatively high proportion of clay and silt. The substratum, that is, the layer below the 3-foot section, is a pale-yellow incoherent sandy loam or sandy clay loam, relatively high in silt, and usually high in lime. In places this layer is reached within the 3-foot profile especially along the steeper eroded slopes and on narrow hill crests.

This type shows rather wide variations in texture and in organic matter content. On the more gentle slopes of the smooth rounded

hills the soil is more loamy and contains more organic matter and less coarse sand, gravel, and small granite and sandstone fragments than on the higher lying parts or on the crests of ridges.

A gravelly variation of this type has been indicated on the soil map by gravel symbols. It occupies morainic mounds and ridges or kames scattered over the southwestern part of the county, but mainly in Grant Township. The soil over the greater part of these areas is not markedly different from the typical Carrington sandy loam, but along the crests of the ridges are exposures of coarse gravelly loam including bowlders of various sizes. These pockets of gravel and bowlders extend back into the hills and ridges and often make up a large part of their bulk. The glacial débris in such moraines consists of fragments of a great variety of rocks, including limestone, sandstone, granite, gneiss, greenstone, quartz, and feldspar. This very stony and gravelly land has little value for farming, on account of its leachy, droughty nature. Where a sandy loam soil covers the coarser material, it is farmed to some extent, but the yields are lower than on the typical soil.

The drainage of the Carrington sandy loam is good, as the rather loose open structure would indicate, but the moisture-holding capacity is low, and in droughty weather yields are likely to be reduced materially.

This type occurs mostly in the northwestern and southern parts of the county, in small disconnected bodies, containing in most areas from 20 to about 80 acres. It occupies the higher hills within or adjacent to areas of the Carrington loam. There is little waste land in this type, except the gravelly areas described above. Most of the soil is farmed with the Carrington loam. On some of the hilly areas adjacent to the bottoms of the Iowa River, permanent pastures of native bluegrass are dotted with scattered clumps of hardwood trees and hazel thickets.

All the staple farm crops can be grown on this type, and the yields are comparable to those on the Carrington loam in favorable seasons.

As a rule this type forms only a small part of individual farms, but it would sell alone for $175 to $275 an acre.

An additional supply of organic matter is essential for maintaining the productivity of this type. More green-manure crops should be grown and turned under. Lime would be very beneficial to clover crops.

CARRINGTON FINE SANDY LOAM.

The Carrington fine sandy loam consists of a dark-brown, uniform, fine sandy loam to a depth of about 10 inches, where it passes into a lighter yellowish brown fine sandy loam, which contains yellowish and grayish mottlings in places. Considerable moderately coarse sand is present throughout the profile, and very small water-smoothed pebbles occur here and there. No calcareous material is encountered, except at great depths. The surface soil has a grayish to light-grayish appearance when dry.

The Carrington fine sandy loam is most extensive south of Eldoro on the slopes and ridges abutting the wide terrace on the east side of the South Fork of the Iowa River, and on the east bank of the Iowa River, extending in disconnected strips from Secor to the Marshall County line. Other sizable areas occur 3 miles north of Alden and 2½ miles southwest of Union along Honey Creek.

It is noticeable that this type characteristically occupies the slopes and immediate upland on the east side of stream courses, adjacent to the loessial soils. In dry weather on the lighter textured and exposed areas high winds frequently cause considerable shifting and drifting of soil. This condition is notable along the lower course of the Iowa River where small patches are texturally close to a loamy fine sand to fine sand.

Most of this type is in cultivation to ordinary field crops. A few hillslopes have scattered patches of hardwood trees and hazel brush, with oak and hickory trees predominating. In many places the sandy subsoil apparently has a good moisture-holding capacity, but the soil on the whole is inclined to be droughty. Seasonal conditions largely determine the crop yields; consequently they are very variable. The average yields are below those on the Tama silt loam on the adjoining upland, and only in rather wet seasons will yields equal those on the Tama soil.

The selling price of this type ranges from $175 to $275 an acre. This soil is usually sold in farms with the Tama silt loam.

Conservation of moisture and addition of organic matter are the most important factors in handling this soil. Careful soil mulching, growing more clover, preferably with rye for a nurse crop, and the application of lime will go far to insure maximum crop yields. Permanent pastures of bluegrass and alsike clover would be profitable on the steeper slopes. This soil is especially adapted to melons and truck crops, which are being grown to a very small extent at present.

CARRINGTON LOAM.

The surface soil of the Carrington loam ranges from brown or dark brown to black in color, and from 8 to 15 inches in depth, averaging about 14 inches. This soil has a moderately high content of organic matter, is mellow and friable, and contains varying quantities of coarse sand particles and some gravel. The subsoil is a yellowish-brown silty clay to clay loam, which becomes heavier, lighter in color, and more gritty with depth. Rusty-brown iron stains are numerous in the lower subsoil. The unmodified glacial till, pale-yellow to mottled yellowish gray silty clay to clay, is encountered at depths of 3½ to 5 feet below the surface. It consists of ground-up limestone and sandstone, with fragments of shale, limestone, and granite, and is high in lime. Within the 3-foot section, however, weathering, leaching, and oxidation have removed a large part of the originally calcareous materials and an acid condition exists to a greater or less degree.

While the texture of the drift is fairly uniform, there is a considerable variation within certain limits. A sandier coarser surface layer, lighter in color, and varying from 5 to 12 inches in thickness, is generally found on the steeper slopes near the streams and on the rounded morainic hills, ridges, and kames. The subsoil is more gritty than in the typical areas. Pockets of yellowish-brown gravelly sand, practically free from clay or silt, occur on the steeper slopes in the morainic areas, and small granite and quartzite bowlders are common. Similar bowlders, originally scattered over much of the upland, have been removed from cultivated fields.

In the northeastern part of the county, in Aetna and Clay Townships, where the Wisconsin drift merges into the Iowan drift with its

thin loess covering, the textural change to silt loam is very gradual and rather indefinite. Loessial silt has here been incorporated with the drift at the surface, giving rise to the Carrington silt loam. The soil boundaries between this type and the Carrington loam at this point are necessarily rather arbitrary, and the Carrington loam here has a relatively high content of silt in the surface layer.

Many small draws and depressions filled with a black silty clay loam occur throughout this type, particularly in the morainic region. These are too small to map separately, and have been included with the Carrington loam because of their small extent and close association with the latter soil. Another variation occurring within this type are small spots of yellowish-brown clay (locally called gumbo spots) exposed on some of the steeper slopes. These require special tilling and careful handling.

In general the shallow and lighter textured surface soil with looser subsoil is developed in the more hilly morainic situations and on steeper hill slopes, and the heavier surface soil with more compact and less gravelly subsoil on the gentle slopes and more level areas.

The Carrington loam is extensively developed throughout Hardin County, except along the eastern side, where a thin loessial mantle covers the drift. The surface relief on this type is about 175 feet. The internal and surface drainage is good, and the soil has excellent moisture-holding capacity. Small spots on the more abrupt slopes, where the subsoil is more sandy or gravelly, may be rather droughty in prolonged dry periods.

This type is one of the most important in the county, and occupies about 35 per cent of the entire area. Approximately 90 per cent of it is under cultivation, and the rest is occupied by farm homes and buildings and pastures. There is practically no waste land. The few scattered patches of trees on this type are restricted to the rougher areas adjacent to the stream courses and to groves planted around the farmsteads. Most of the type originally supported a luxuriant growth of prairie grasses.

Corn is the principal grain crop, with an average yield of about 45 bushels per acre. It is largely fed to hogs and beef cattle. The oat crop is second in importance to corn, and ordinarily averages 40 to 45 bushels per acre, although yields of 65 to 70 bushels are not unusual in favorable seasons. Most of the wheat in the county is grown on this type, particularly in the northeastern part of the county. The average yield is about 18 to 20 bushels. Timothy and clover are the principal hay crops, with an average yield of 1¼ to 1½ tons per acre. Some barley is grown for hog feeding. Potatoes do well, averaging about 100 bushels per acre. They are grown mainly in the northern part of the county. Sweet corn is grown commercially in the northeast corner of the county and marketed at a canning factory in Ackley. The average yield is about 6 tons per acre. Alfalfa, sweet clover, and soy beans are minor crops but are increasing in popularity. Orchards are confined to small farm plantings. Dairying is carried on in a small way near the larger towns, the cream being sold at the local cream-buying stations.

Practically no commercial fertilizers are used on this type. Some lime (crushed rock) has been applied on farms experimentally with beneficial results. Barnyard manure is applied in the spring on corn

ground. Pastures and clover sod are also given a top dressing of manure.

The Carrington loam, being mellow, friable, and naturally productive, is easily cultivated and handled by ordinary farm methods. It warms up earlier in the spring than the more compact and lower lying Clarion and Webster soils, with which it is closely associated.

The value of crop rotation is recognized and practiced to a large extent, but the rotations vary considerably. The general practice is corn, corn, oats, corn, oats, and clover. Fall plowing is practiced as much as possible. Oats are sown broadcast on corn ground which has been disked.

Farms on the Carrington loam have a variable market value, depending largely on improvements, nearness to markets, and general condition of the farm land. The selling price is from $225 to $350 an acre, and a few very highly improved farms in choice situations bring over $400 an acre.

The addition of organic matter would be beneficial over most of this type for increasing yields and improving the tilth of the soil. For this purpose more legumes should be grown and turned under. A 4-year rotation of corn, corn, oats, and clover is recommended. Failures of alfalfa have been due largely to lack of inoculation and liming. As most of the soil of this type is acid, applications of crushed limestone should be profitable.

Carrington loam, steep phase.—The Carrington loam, steep phase, occurs only on the steep eroded slopes adjacent to the larger streams. The surface covering is generally a thin layer of brown to dark-brown friable loam, 3 to 10 inches deep. The subsoil is a yellowish-brown or pale-yellow gritty silty clay to clay loam. Coarse sand, glacial pebbles, and small bowlders are scattered throughout both surface soil and subsoil. In many places on the more precipitous hillsides the surface soil has been removed by erosion.

This phase occurs in narrow strips along Tipton and Honey Creeks, the upper course of the Iowa River, and in disconnected patches along the South Fork of Iowa River. Along the bluffs of the Iowa River near Iowa Falls, limestone outcrops, which in places form perpendicular walls, are included with this type, as they are covered in many places with a taluslike veneer of soil from 1 foot to 4 feet thick. Occasional borings here and along other streams, where erosion has carried away the surface covering, indicate that the subsoil is highly calcareous. The substratum, however, to a depth of 3 feet is not usually high in lime. Because this phase is not important agriculturally, the calcareous areas were not separated.

This phase has little value for agriculture and practically none of it is under cultivation, except very short taluslike accumulations of soil material adjacent to the tillable alluvial soils along the stream courses. It is largely forested with hickory, elm, basswood, oak, maple, and other hardwood trees. Its chief value is for pasture, as native bluegrass covers the slopes where erosion is not at present active. Many short tributary streams from the upland plain have cut gullies and ravines down the steep embankments and hillsides.

This phase is sold in conjunction with other soil types, and constitutes only a small fraction of the area of the farms in which it occurs.

CARRINGTON SILT LOAM.

The Carrington silt loam, to a depth of 14 inches, is a dark-brown to black, friable, mellow silt loam, faintly mottled with gray and brown. Below this appears a semiplastic yellowish-brown silty clay loam to clay loam, highly mottled with yellow and gray, which becomes heavier with depth. Fine and coarse sand particles, small fragments of white quartz rock, and some small gravel are present in the subsoil, increasing in quantity with depth.

The surface layer is composed principally of loessial silt with some incorporated fine drift material, and has a high content of organic matter.

The larger developments of this type occur in Aetna and Clay Townships, occupying the gently undulating upland between the thin loess-covered Iowa drift and the Altamont moraine in the Wisconsin drift. It represents the transition between the Tama silt loam, of loessial origin, and the Carrington loam, which is the dominant soil of the Wisconsin drift area. The boundary line between this type and the Carrington loam is arbitrary in many places, as the silt loam merges very gradually with the loam. Narrow disconnected strips occur on slopes adjacent to stream channels cut through the loessial region, which is restricted to the east side of the county. Here the underlying drift has been more or less exposed by erosion and mixed with the loessial silt. Drainage is good, and even excessive on the steeper slopes.

All of this type is under tillage and is farmed with the Tama silt loam, with which it is closely associated. Crop yields are about the same as on the latter soil. The methods of handling and improving the Tama silt loam are applicable to the Carrington silt loam.

The selling price and the rental value of this land are about the same as for the Carrington loam.

CLARION LOAM.

The surface soil of the Clarion loam is a dark-brown to black friable loam, with a high content of organic matter, about 12 inches deep. The subsoil is a yellowish-brown silty clay to clay loam, which is very similar to the subsoil of the Carrington loam. A lower subsoil layer, appearing at a depth of 24 to 30 inches, consists of light yellowish brown or grayish-yellow silty clay to sandy clay loam, mottled with gray. This layer is high in lime, containing streaks and nodules of calcareous material. Occasional iron stains are present. Coarse materials, including fine and coarse sand, small rock fragments, gravel, and occasional small granite and quartzite bowlders, are found throughout the soil section, but are usually most abundant in the lower subsoil. These coarse materials, however, form only a very small proportion of the entire soil mass.

The arable soil layer varies in texture from a heavy loam on the long gentle slopes to a coarse gritty loam on small knolls commonly found scattered over this type. Many of these knolls contain pockets of sand and gravel.

The typical Clarion loam represents a gradation between the Carrington loam and Webster loam. The surface soil and the subsoil to a depth of 24 to 30 inches closely resemble the corresponding sections of the Carrington loam, except that the Clarion loam is

nearer black than dark brown at the surface. The subsoil below 30 inches is like the calcareous subsoil of the Webster series.

The Clarion loam occurs on slopes scattered over the west half of the county, on slopes bordering flat areas of the Carrington loam, and in the undulating areas on the nearly level divides between the principal drainage lines, where short tributaries lose themselves in disconnected swales and sloughs within this type. The largest developments occur near Garden City and Radcliffe and in the northwest corner of the county.

In a considerable area lying south of Alden the type resembles the Webster loam topographically and structurally. Here the surface soil is black and the intermediate yellowish-brown noncalcareous layer is very thin.

The Clarion loam is all under cultivation and is one of the most productive soils in the county. The only tree growth consists of windbreaks planted about the farmsteads. Originally prairie grasses covered the entire type.

Corn, oats, and hay are the main crops. Some pop corn is grown commercially near Hubbard. Corn averages about 45 bushels per acre, with yields of 65 to 75 bushels in favorable seasons. Oats yield 45 to 50 bushels per acre, and timothy and clover about 1½ tons. Small patches of alfalfa yield at the rate of 3 to 3½ tons for the season, or about 1 ton per cutting. While many cattle and hogs are fed on farms composed of this type, more of the grain is sold than on the Carrington loam.

The Clarion loam has a large reserve of plant-food materials and excellent moisture-holding capacity. It is handled according to the methods prevailing over the county. Tile drainage is essential to insure maximum crop production, for in moist seasons the slow runoff and percolation tend to interfere with cultivation. No chemical fertilizers are used on this type.

Land of the Clarion loam type sells for $250 to $375 an acre, and especially improved farms situated close to town have sold for $400 to $450 an acre. The average cash rental is about $15 an acre.

Deeper plowing, efficient tile drainage, and more legumes to maintain the supply of organic matter, are needed on this type. Application of crushed limestone would improve the tilth and correct the somewhat acid condition of the surface soil.

WEBSTER LOAM.

The surface soil of the Webster loam consists of two layers, an upper one of black, heavy loam, 12 to 16 inches thick, and a lower one of dark-brown to black silty clay loam, 2 to 4 inches thick. The subsoil is a grayish-brown or yellowish-brown silty clay loam, strongly mottled with gray and some yellowish brown. It is highly calcareous and contains many lime nodules. Coarse sand and gravel particles are present throughout the soil profile, increasing in quantity with depth.

This type has been developed under conditions of restricted drainage which has favored the accumulation of large qantities of organic matter in the surface soil.

Small bodies and narrow strips of silty clay loam, too small to be shown separately, occur within this type. Other irregularities con-

sist of sparsely scattered moundlike swells, from 4 to 15 feet in diameter, in which there occurs a coarse loam to gravelly loam surface soil underlain by a coarse gritty clayey subsoil, giving way in places to a coarse grayish clayey sand at depths of 30 to 36 inches.

The largest and most typical areas of Webster loam occur 2 miles northwest of Buckeye and in the northwest corner of the county in Alden Township. Smaller disconnected bodies are scattered over the entire Wisconsin drift region of the county, generally adjacent to the lower lying areas of Webster silty clay loam.

There is very little run-off and the natural drainage is poor, but enough tile drains have been installed to afford adequate drainage. The tiles are laid 4 to 6 rods apart. To insure efficient drainage in rainy seasons the tile should be not more than 4 rods apart.

The Webster loam is practically all used for cultivated crops, only a few small areas being in native prairie grass. There is no waste land on this type.

Corn, oats, and hay are the leading crops. The crop adaptation of this soil is about the same as that of the Webster silty clay loam, except that prolonged wet periods do not affect this type as seriously as the heavier silty clay loam type. The underground water level is very close to the surface in the lower lying areas in the western part of the county, and occasionally flowing wells are obtained on this and the silty clay loam type.

Land values on the Webster loam range from $275 to $325 an acre, depending on improvements, location, and drainage.

Deep fall plowing is essential on this type, as it allows earlier cultivation in the spring and gives a more mellow seed bed. Although this soil is naturally productive, to maintain it in this state will require the application of more barnyard manure and growing legumes in systematic rotation.

WEBSTER SILTY CLAY LOAM.

The surface soil of the Webster silty clay loam consists of a black, sticky, silty clay loam to clay loam, which grades into a very dark brown to black clay loam at about 8 to 12 inches. The subsoil below 22 or 24 inches is a light yellowish brown or grayish-yellow clay loam to silty clay, with many gray and yellow mottlings and occasional rusty-brown iron stains. The subsoil contains much lime and has a pale yellowish gray color when dry. Fragments of granite, quartz, sandstone, limestone, and some gravel are present in small proportions throughout the soil section, but in greater abundance in the lower depths. The surface soil and subsoil as a rule do not effervesce with hydrochloric acid, but the lower subsoil, which has been modified only to a very small extent by leaching or oxidation, always does. The surface soil is very rich in organic matter. In some places the dark-brown to black intermediate layer, owing to the presence of a larger content of organic matter accumulated under extremely poor drainage conditions, extends to a depth of 3 feet.

The Webster silty clay loam occurs in all parts of the county except in the loess-covered area in the extreme eastern part. It is developed in narrow sloughlike strips and larger flat depressions on the broad intersteam areas, which were formerly ponded most of the year. It usually lies from 2 to 6 feet below the surrounding

upland soils. Originally a heavy growth of slough and water grasses flourished under the extremely moist conditions, and the accumulation of plant remains was large, giving the soil its deep black color and high content of organic matter.

Included within this type are small areas of Peat and Muck which were too small to map separately. Other variations consist of numerous alkali spots occurring in narrow strips along the margins of Peat and Muck beds and around formerly ponded areas recently drained.

The drainage is naturally poor, but has been improved over a greater part of the type by open ditches and tile drains. Large open ditches, 6 to 10 feet deep, cut through and connect the intermittent sloughs and depressions and furnish outlets for the tile laterals.

Few individual farms are situated entirely on this type, but a large proportion of the farms in the Wisconsin drift area include small areas of it. Formerly these areas were too wet for cultivation, but most of them are now efficiently drained. The few undrained areas are used as pasture and hay land. This soil is one of the strongest and most durable in the county and is particularly adapted to corn, where well drained, because of its high fertility and moisture-holding capacity.

The principal crops are corn, oats, and hay. Corn yields range from 35 to 70 bushels per acre. Oats give a larger yield of both straw and grain than on the better drained upland types, but in moist seasons the crop is likely to lodge, because of excessive stem growth. The ordinary production of oats is from 30 to 60 bushels per acre. Hay yields from 1 to 2 tons.

This land should not be plowed and cultivated when it is wet, as it is likely to clod and bake. In extremely dry weather even careful mulching will not prevent some surface cracking.

Barnyard manure is applied occasionally, but no commercial fertilizers are used. Early-maturing varieties of oats and corn are preferred on this type. The soil warms up slower in spring, and the early oats escape the warmer weather at filling time. Corn in these low poorly drained pockets is subject to earlier damage by frosts.

Drained areas of this type, if sold alone, would bring from $200 to $300 an acre; the undrained areas sell for $25 to $75 less.

Efficient drainage is the important factor in obtaining maximum crop production on this type. As on all heavy soils, deeper plowing, and the incorporation of crop residues, green crops, and barnyard manure will improve the physical condition of the soil as well as stimulate increased crop production. Alkali spots should receive heavy applications of barnyard manure after being thoroughly tiled.

LINDLEY VERY FINE SANDY LOAM.

The surface soil of the Lindley very fine sandy loam consists of 18 inches of friable and almost floury grayish-brown very fine sandy loam, faintly mottled with gray and yellow. The subsoil, from 18 to 36 inches, is a brown silty clay loam to clay loam, marked with pronounced yellowish and gray mottlings. Fine angular particles of rock and occasional fine gravel are distributed sparingly throughout the subsoil layer, which is very compact and has a tendency toward the characteristic cube structure of the Clinton soils.

There is considerable variation in the texture of the surface soil of this type, but in all areas there is a high proportion of silt. Small spots of silt loam, whitish gray in color and floury in texture, are found here and there, mostly in slight depressions. There are also areas of small size that contain some coarse sand. small rock fragments, and gravel.

This type is not very extensive. Nearly all of it occurs along the Iowa River beginning just north of Steamboat Rock and extending to Eagle City. A few smaller areas lie along the lower course of Honey Creek and the South Fork of the Iowa River.

The Lindley very fine sandy loam occupies the undulating to rolling uplands beginning at the edge of the steep hillsides and precipitous limestone escarpments along the Iowa River. The type extends back from the bluffs one-eighth mile to 1½ miles, and merges with the Carrington loam. It occupies the same relative position as the Clinton soils in the loess-covered part of the county. Many short streams have cut gullies from 5 to 50 feet deep in this soil.

Formerly this belt was heavily forested, but the original trees have been largely removed and the remaining cover is mostly second growth and thinly scattered. Probably one-third the type has been completely cleared and is in cultivation. The fields are mostly small and irregular.

The drainage in general is good, and is excessive on the more rolling parts. The soil erodes easily, and small gullies once started rapidly deepen.

This type is adapted to the general farm crops, but less corn and more hay and small grain are grown. Crop yields are about the same as on the Clinton silt loam. As the color indicates, this type is low in organic matter, and this deficiency should be made up by growing more legumes and turning under occasional crops. Lime and inoculation should insure a catch of clover or alfalfa under normal seasonal conditions.

Only a few farms are entirely on this type. The land has a value of $150 to $225 an acre, according to improvements, acreage cleared, and location.

An area of Lindley loam of coarse texture, lying 1½ miles southwest of Abbott in section 5, Clay Township, has been included with this type because of its small extent. Other included areas of coarser soil, too small to show on the map, contain more coarse sand, fine rock fragments, and small glacial gravel in the soil section. The surface soil is a grayish-brown to yellowish-gray loam, relatively high in the coarser grades of sand, and the subsoil is a gritty yellowish-brown silty clay loam to clay loam mottled with gray and yellow.

LINDLEY LOAM.

The surface soil of the Lindley loam consists of a grayish-brown or brown loam to a depth of about 8 inches. The immediate surface is light grayish brown or gray when dry. The subsoil is a yellowish-brown or reddish-brown clay or silty clay loam. On the slopes along the Iowa River from Steamboat Rock to Eldora the subsoil is in most places reddish brown, while from Eldora southward to the county line it is light yellowish brown, conspicuously mottled with yellow and gray, and contains a larger proportion of fragmentary

limestone, chert, quartzite, and sandstone. A deep talus covering obscures the underlying sandstone and limestone rock over most of the type, but perpendicular walls and ledges are exposed in places.

The Lindley loam occupies the steep slopes between the high upland plain and the alluvial soils along the stream courses. With the exception of a few narrow strips along Honey Creek, this type is confined to the steep slopes of the Iowa River, extending short distances up the ravinelike walls of the many short tributary drainage ways.

This type occurs only in the loessial region and lies adjacent to and lower than the light-colored Clinton silt loam. On the upper slopes considerable silt has been received by wash from the upland soils, and the material of the first 3 or 4 inches differs from the Clinton silt loam. On the steeper slopes, where the soil has been removed by erosion, there are many exposures of yellowish or reddish gritty clay loam. Occasional spots of very fine sandy loam and fine sandy loam are also included. Numerous irregular fragments of sandstone, limestone, quartzite, and granite characteristically are found on the surface and throughout the soil, and bowlders of moderate size are found here and there.

Owing to its position on the steeper slopes, the soil is excessively drained. The run-off is rapid and erosion active. Gullies once started rapidly become deep trenches. At one time a dense growth of hickory, white oak, elm, ash, post oak, and other hardwood trees and shrubs occupied the hillsides, but indiscriminate cutting has reduced this forest to a thin and patchy cover.

On account of its unfavorable topography, probably not more than 5 per cent of the Lindley loam is under cultivation to field crops. The cultivated part is always the lower taluslike accumulation at the foot of the steep slopes next to the bottom lands. The type is utilized as pastures, largely for sheep. A natural covering of bluegrass tends to check erosion.

This land, which occurs in narrow strips, is sold only with other soil types.

The Lindley loam is without doubt better adapted in its present condition to grazing than to any other use, and is particularly desirable for sheep. Systematic reforestation, while slow in accomplishment, with little immediate cash return, would probably be the most profitable way of using a large part of this land.

Lindley loam, steep phase.—The Lindley loam, steep phase, occupies the steep slopes forming the V-shaped valley walls along the Iowa River. It lies below the Lindley very fine sandy loam on the upland, which extends to the edge of the slopes. The surface soil, which is a grayish or yellowish-brown loam, 4 to 8 inches deep, overlies a subsoil of gritty, compact, yellowish-brown clay loam. A few perpendicular limestone ledges are exposed at the lower ends of the deep valleys of tributary streams where they enter the main valley. This phase extends well up toward the heads of these tributary streams, occurring wherever there are eroded slopes.

The Lindley loam, steep phase, is all underlain by limestone or sandstone, which is hidden by a covering of drift talus. The slopes in which it occurs range from steep to precipitous, rising from 100 to 175 feet above the river channel and its narrow strip of alluvium. The run-off is so rapid that on unprotected slopes erosion is severe.

This is held in check, however, by tree growth and grasses. Most of these slopes are covered with a dense forest consisting of soft maple, red oak, white oak, prickly ash, white ash, basswood, elm, black maple, red cedar, white pine, white birch, hackberry, and cherry birch. It is said that the cherry birch is found nowhere else in the State.

This soil is too steep for profitable agriculture. It affords only meager pasture for short periods, as the rapid run-off from summer rains tends to loosen and wash out the grass roots and prolonged dry periods cause the burning out of the grasses. The purchase of these magnificently forested hillsides for a State park is at present under consideration. With the present rapid cutting of the trees, the forest will soon be reduced to scrubby trees and underbrush and the land will have value only for sheep pasture.

CLYDE SILTY CLAY LOAM.

The surface soil of the Clyde silty clay loam consists of 14 inches, more or less, of black silty clay loam, the lower part of which grades into a stiff, plastic, less densely black heavy silty clay or clay loam. The subsoil is a grayish-brown or drab clay loam, mottled in varying degrees with yellow, gray, or brown. The entire soil section is in most places free from grit and coarse material, but may contain small quantities in a few spots. A few small granite bowlders are strewn over the surface. Very small patches of shallow Muck are common in parts of the type. The entire soil layer is normally noncalcareous, but in places the extreme lower subsoil may give a slight alkaline reaction.

This type is confined to the northeast corner of the county and to a few small areas along the southern border, south of New Providence. It occurs at the heads of small drainage ways or along the approaching gentle slopes, extending well up the slopes toward the crest of the upland divides. It is typically developed in the gently undulating Iowan drift region between Abbott and Ackley, and is closely associated with the shallow, higher lying, upland loessial soils.

The drainage is naturally poor, and although the gentle slope of the surface toward the draws below makes drainage comparatively easy, the subsoil is so compact that the tile laterals must be laid at frequent intervals to insure complete removal of excess moisture.

The Clyde silty clay loam is naturally a strong, productive soil. Where adequately drained it produces excellent crops, especially of corn. There is no forest on this type. Probably about 60 per cent of the land has been tiled and planted to field crops. The undrained areas afford excellent pasturage.

Land values are about the same as on the Webster silty clay loam, with similar drainage and improvements.

Efficient drainage and, notwithstanding the natural high content of organic matter in this soil, the systematic application of manure or the plowing under of green-manure crops are important means of maintaining the productiveness of the type.

TAMA SILT LOAM.

The surface soil of the Tama silt loam is a friable, mellow, dark-brown silt loam, with a depth of 10 to 15 inches. Below this is a

layer of light-brown to yellowish-brown silty clay loam, and below 18 inches a layer of yellowish-brown, friable but compact clay loam, mottled faintly with gray. Neither soil nor subsoil is highly calcareous.

The Tama silt loam is found only in the eastern part of the county, the belt of its occurrence extending from Franklin County on the north to Marshall County on the south. It is derived from loess, which is very easily distinguished from the underlying drift, appearing at various depths. From a point 4½ miles northeast of Eldora to the southern county line, this loessial deposit is from 6 to 25 feet thick, and is underlain by the Kansan drift. North of this point and extending to the county line at Ackley, the loessial covering is very thin, ranging from 30 to 60 inches, and rests on the Iowan drift. Here the subsoil at depths of 28 to 34 inches contains considerable very fine sand and in places small quantities of coarse sand and fine gravel. These underlying drift sheets separate the Tama silt loam into two distinct topographic divisions. The northern part over the Iowan drift is characterized by gently rounded undulating hills with long slopes descending to shallow and almost sloughlike drainage lines whose cutting has not been more than 25 to 50 feet below the original surface of the plain. In sharp contrast is the region to the south, where large streams flow through well-developed valleys with steeper V-shaped walls, and their many tributary streams have dissected the upland divides. Here the surface inequalities range from 100 to 175 feet. The surface and internal drainage over the entire type are good, and on the steepest slopes excessive.

The Tama silt loam is normally well supplied with organic matter and other plant-food elements. The soil is mellow, easy to work, and has excellent moisture-holding capacity. Where the crops are properly cultivated and mulched, drought has little effect. Timber is found on the hillsides along the larger stream courses, but the uplands were formerly covered with native prairie grasses.

This type is all in cultivation, except the steeper slopes, which are in cultivated grasses or support a sparse growth of trees, shrubs, and native bluegrass and are used for pasture. There is no waste land.

All of the staple crops are grown on this type. Corn ranks first in importance. The crop does well, the normal average yield being from 45 to 50 bushels per acre. Most of the corn produced is fed to cattle and hogs. Oats yield from 40 to 70 bushels per acre. The earlier varieties are preferred. The greater part of this crop is sold; the rest is fed to hogs and work stock. Clover and timothy constitute the principal hay crop, with yields of 1½ to 2½ tons per acre. Clover alone is becoming more popular. The many former failures to obtain satisfactory stands were probably caused principally by adverse seasonal conditions, acidity of the soil, and lack of inoculation. Considerable clover seed is harvested in favorable seasons. Small acreages of wheat, rye, soy beans, and millet are grown. Alfalfa does well where properly handled. Small fruits, potatoes, and truck crops are grown, but chiefly for home use. Many excellent farm orchards are found, particularly around Union and New Providence. The orchards consist almost exclusively of different varieties of apples, but include a few plum, cherry, and pear trees.

A 4-year rotation of corn, corn, oats, and clover is gradually coming into use, and is well adapted to this soil type. For the most part no definite rotation is used. Corn is grown more continuously on tenant farms. Clovers ordinarily do well, but alfalfa is successful only where the soil has been inoculated and limed. A more or less acid condition exists over the entire type, and the use of limestone has proved very beneficial to leguminous crops. Commercial fertilizers are not used.

The value of land varies according to the improvements, location, and general condition of the farm. The selling prices range from $275 to $375, and some especially well improved land brought $400 to $450 an acre in 1920. The cash rental is ordinarily $12 to $15 an acre, with a maximum of $25 in 1920.

More clover and other legumes should be grown, as the available barnyard manure is insufficient to maintain the supply of organic matter. Applications of lime have been made only in an experimental way. The results should encourage the more general use of limestone.

MUSCATINE SILT LOAM.

The Muscatine silt loam consists of 10 inches of a heavy, black, friable silt loam, which passes into a dark-brown to black stiff clay loam, showing slight gray mottlings when dry. The lower subsoil, below 20 inches, is a grayish-brown or yellowish-brown impervious silty clay to clay, strongly mottled with gray and yellow. Occasional iron stains and concretions are present in the lower part of the 3-foot section. The surface soil is especially high in organic matter, as its intense black color would indicate.

The Muscatine silt loam occurs only in the extreme eastern part of the county between Pine Creek on the north and Whitten on the south. It occupies the highest points on the upland divides, where the surface is level or flat and not dissected by drainage ways. The areas are small and irregular in shape, and are enclosed by the undulating areas of Tama silt loam. Closely spaced tile drains are necessary to insure removal of water after heavy rains, for the heavy impervious subsoil greatly retards the downward and lateral movement of water and the natural run-off in these flats is very sluggish.

The Muscatine silt loam covers no large area, but is important, as it is one of most productive soils in the county. It is all under cultivation, and is an exceptionally strong corn soil. Oats, corn, and timothy and clover are almost the only crops. Corn yields slightly more than on the associated Tama soils; the yields of other crops on the two types are about the same.

This land is sold with the Tama silt loam and brings as much as the better areas of that type.

CLINTON SILT LOAM.

The surface soil of the Clinton silt loam is a grayish-brown or light yellowish brown flourlike silt loam, with a depth of 10 to 15 inches. The subsoil is a compact, tenacious, light yellowish brown silty clay to clay loam. In both surface and subsoil there is a slight gray mottling, which increases with depth. The surface soil as a rule has a relatively high content of very fine sand. When wet, the surface soil has a brownish appearance and the subsoil becomes very tenacious and adhesive.

The Clinton silt loam occurs along the Iowa River south from Steamboat Rock to the county line. It lies in irregularly shaped bodies, usually in long, narrow strips between the Tama silt loam or Fayette silt loam of the upland and the Lindley loam on the steep slopes forming the valley walls. It is also developed along most of the larger tributary streams, in very narrow disconnected strips on the tops of the ridges, but as a rule extends only short distances back from the mouth of these branches.

The surface is rolling and broken by short, deeply cut gullies. The drainage is good to excessive. The land is subject to destructive erosion, the wash rapidly forming small ditches which in turn speedily develop into deep gullies. Originally a dense forest of hickory, elm, ash, oak, and other hardwoods covered the entire type, but most of it has been removed up to the edge of the erosions.

About two-thirds of this type is under cultivation, the rest being in woods pasture. The largest cultivated area and continuous body is 2 miles east of Eldora, along Pine Creek. It is particularly adapted to wheat, rye, oats, and hay crops. Where this soil has been manured and given thorough cultivation, corn yields 25 to 50 bushels per acre, and other crops yield about the same as on the black upland soils. Cattle and sheep are raised to a considerable extent. Tree and small fruits thrive and are of superior quality and flavor.

Several small bodies of Clinton very fine sandy loam are included with the Clinton silt loam because of their small area. The included soil is identical with the silt loam, except in texture, which is predominantly a very fine sandy loam. It occurs on the steeper slopes on the west side of the Iowa River in sections 22 and 28, Eldora Township, and on the east side of the river in sections 10, 15, 23, and 26, Union Township. These areas are almost entirely in forest and are used for pasture.

Land of the Clinton silt loam sells for $175 to $275 an acre, the price varying with the location and improvements.

Barnyard manure and leguminous crops should be used to build up the humus supply. The soil is decidedly acid, and limestone should give immediate and profitable returns on clover land.

FAYETTE SILT LOAM.

The surface soil of the Fayette silt loam consists of 12 to 15 inches of grayish-brown, smooth silt loam. The subsoil is a rather compact but friable, yellowish-brown, heavy silt loam or silty clay loam. In places it has a slightly grayish cast, as in the Clinton subsoil, and iron stains are numerous below 30 inches. The surface soil is usually very high in silt, but in some small bodies the content of very fine sand is relatively high.

The Fayette silt loam occurs only east of the Iowa River, just across from Eldora. It occupies the flat tops of the high upland plain between the Tama silt loam and the narrow strips of Clinton silt loam, being a sort of intermediate type. Both run-off and internal drainage are rather slow, because of the flat surface and compact subsoil.

The Fayette silt loam is all in cultivation, the forest which once flourished on this type having been entirely removed. All the common field crops are grown. The crop yields average slightly less than on the Tama silt loam.

Land values range from $225 to $350 an acre, depending on the state of improvement and the location of the farms.

This soil is somewhat deficient in organic matter, and increasing and maintaining the supply is most important. More clover or other legumes should be grown. Alfalfa should do well on this type where inoculated and limed. Heavier applications of barnyard manure will materially increase crop yields, and the use of limestone to correct the acidity of the soil should give beneficial results.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Fayette silt loam:

Mechanical analyses of Fayette silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
334325...	Soil, 0–14 inches.....	0.3	1.2	0.6	1.9	10.6	68.8	16.8
334326...	Subsoil, 14–36 inches.	.1	.4	.3	2.2	13.0	64.0	20.0

WAUKESHA SILT LOAM.

The Waukesha silt loam consists of 20 inches of dark-brown, heavy, friable silt loam, passing into a brown silty clay to clay loam subsoil. Faint gray mottlings are present in both soil and subsoil, becoming more pronounced in the lower part of the 3-foot section, but these are not due to poor drainage. The soil and subsoil are typically free from coarse materials, except along the margins abutting the upland slopes where some coarse sand and gravel has been washed down and mixed with the original silty alluvium forming the typical soil. Also along the edges of the benches adjoining the first bottoms, or where small streams from the uplands have cut through or spread out fanlike over the Waukesha areas, considerable coarse and fine sand and small fragments of rock and gravel are present.

An untypical area in section 34, Clay Township, has been included with this type because of its small size. Here the surface soil to a depth 15 to 18 inches is a grayish-brown silt loam, and the subsoil a very heavy and tenacious yellowish-brown silty clay to clay loam. This area would have been mapped as Jackson silt loam if it had been of sufficient size.

Areas of Waukesha loam have also been included with this type on account of their small size. The soil in these is a dark-brown loam and the subsoil varies from a loam to a stiff silty clay. The only area of importance lies north of Alden on the west side of the Iowa River.

The Waukesha silt loam occurs in disconnected bodies and strips on the second bottoms along the Iowa River from Eagle City south. A small area is situated on Middle Fork, south of Cleaves, and another on Doud Creek in the extreme southeastern corner. The total area of the type is small, but all of it is under cultivation. It is developed on the lower parts of terraces, lying 5 to 15 feet above the first bottoms.

The soil is highly fertile, of excellent physical structure, and is affected very little by seasonal extremes. The average crop yields are comparable to those on the Tama silt loam.

BREMER SILTY CLAY LOAM.

The surface soil of the Bremer silty clay loam consists of 8 inches of black silty clay to clay loam, faintly mottled with gray when dry. The subsoil from 8 to 18 inches is a dark-brown to black clay loam to clay, somewhat mottled with gray, and the lower subsoil is a yellowish-brown clay loam to clay with numerous yellow and gray mottlings. Iron stains are numerous below 24 inches. The entire subsoil is very heavy and tenacious. Some fine sand has been carried onto the top soil by surface wash.

This type is confined to the draws and depressions on the terraces along the Iowa River in the vicinity of Union. The drainage is poor, and tiling is necessary to make cultivation possible. With the exception of a small narrow strip south of Union and a draw along the west side of section 36, Union Township, all the type is in cultivation to common field crops or cultivated grasses. Formerly these areas were too wet for cultivation and of value only as pasture and for wild hay.

The Bremer silty clay loam lies above ordinary overflow, but at intervals of several years the highest flood waters may back up through the lower draws and partly inundate the surface for a period of not more than 24 or 36 hours.

This type is naturally high in organic matter and productive when well drained. The soil should be handled and cropped in about the same way as the Fargo silty clay loam.

FARGO SILTY CLAY LOAM.

The Fargo silty clay loam is a sticky dark-brown to black silty clay loam to clay loam, passing at 8 to 10 inches into a black tenacious clay loam to clay, and then, below 18 to 22 inches, into a grayish-brown clay loam to clay mottled with gray. Faint yellowish-brown mottlings and rusty-brown iron nodules are present in places in the lower subsoil. Small angular fragments of granite, quartzite, and other rocks, mica particles, and water-rounded pebbles occur, being concentrated somewhat in the upper part of the surface soil and below a depth of 28 or 30 inches. The lower subsoil is nearly everywhere calcareous and contains small lime nodules and concretions.

The Fargo silty clay loam is developed along the Iowa River, the South Fork of Iowa River, Tipton Creek, and Beaver Creek. It occupies the lower sags and depressions, lying at the foot of the upland slopes where they meet the terrace floor. The individual areas are small and narrow, usually less than one-fourth mile wide and one-fourth to three-fourths mile long. Their areas range from 10 to 150 acres.

The natural drainage is poor, owing to the position of the type and the heavy texture of both soil and subsoil. The surface is flat with a gentle slope to the center of the depression, where water stands for some time if the area has not been drained artificially. In a few places seepage water collects in these low parts, forming wet spots in which peaty or mucky areas have developed.

The greater part of the type has been tiled. Undrained parts are used for pasture.

This type is inherently fertile, and where the fields are adequately tiled the average yields equal those on the Webster silty clay loam

of the uplands. The soil must be handled within a narrow range of moisture conditions. If the soil is not stirred soon after rains, large cracks form and injure the roots of the corn and other crops, but stirring the soil when too wet greatly impairs its physical condition.

The Fargo silty clay loam is almost identical in its soil profile with the Webster silty clay loam on the uplands, differing only in its terrace position and its derivation from alluvial deposits. Suggestions for improving the Webster silty clay loam type apply equally well to this type.

MILLSDALE LOAM.

The Millsdale loam consists of a dark-brown to black, mellow, friable loam, 14 to 16 inches deep, underlain by a brown silty clay to clay loam subsoil, mottled with yellowish brown. Underlying these soil layers, at depths varying from 20 to 34 inches, is a base of stratified limestone, small outcrops of which appear in places.

This type is developed only along the Iowa River between Alden and Steamboat Rock. It occupies a terrace position from 5 to 20 feet above the river and above overflow. The surface is nearly flat with a gentle slope toward the main stream, and an abrupt drop to the first bottom or flood plain.

In sections 6 and 7, Clay Township, an area included with this type lies about 50 feet above the river. Here the surface soil is grayish or light brown, and contains a higher proportion of silt. The edge of the bench floor at the bottom land, instead of being perpendicular, is a steep talus-covered slope, and the underlying limestone is covered 4 to 5 feet deep. The slope is all in forest, and organic matter derived from the decay of leaves and grasses has changed the color of the immediate surface to a very dark brown.

With the exception of the high-terrace area just described, the Millsdale loam is all in cultivation. The soil is relatively high in organic matter and produces crop yields comparable to those on the better upland soils. The soil is very retentive of moisture, and there is apparently no tendency toward droughtiness from the underlying limestone floor, except in a few places where the soil is very shallow near the few outcrops.

Land values are variable, depending largely on nearness to town and the character of the improvements. Most of the type is included in farms with other soils. The average selling price ranges from $175 to $275 an acre.

The results of mechanical analyses of samples of the soil and subsoil of the Millsdale loam are given in the table below:

Mechanical analyses of Millsdale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
334341	Soil, 0–16 inches	2.6	8.8	7.2	24.0	13.3	32.5	11.6
334342	Subsoil, 16–20 inches.	1.1	5.1	4.7	22.6	16.7	36.0	13.8

BUCKNER FINE SANDY LOAM.

The surface soil of the Buckner fine sandy loam consists of a light-brown fine sandy loam, 18 or 20 inches deep, which has a grayish appearance in the field when dry. The subsoil below 20 inches is a yellowish-brown fine sandy loam mottled with brown and yellow. Coarse particles of sand and small gravel are found scattered through the soil and subsoil, but comprise only a small percentage of the material.

Only three small areas of this type occur in the county. The largest lies 3 miles west of Eagle City. The other areas are located north of Eldora and south of Steamboat Rock.

The surface is rather uneven, with shallow ridges and mounds, formed by the shifting of the surface soils by wind. High winds cause considerable drifting and moving of the surface soils where the fields are bare. This would probably cause injury to corn in the early stages of growth. As with all open sandy soils, the drainage is good, and is excessive in dry periods. Seasonal variations largely control the crop yield.

The greatest need of this type is organic matter, which can be supplied by growing and plowing under green-manure crops. This will increase the moisture-holding capacity of the soil, check the tendency to drift, and thus increase productiveness.

BUCKNER LOAM.

The surface soil of the Buckner loam is a moderately brown to dark-brown loam, 18 to 20 inches deep. The subsoil is a yellowish-brown sandy loam or fine sandy loam mottled with brown or yellow. Small quantities of coarse sand and small waterworn gravel are incorporated in both soil layers, being more concentrated in the lower subsoil. Pockets of coarse sand and gravel are encountered here and there within the 3-foot section.

This type occurs along the entire course of the Iowa River and along Beaver Creek. The most extensive developments are near Eagle City and Union. The benches are flat, with a gentle slope toward the main stream channel. The drainage is adequate, except in occasional low pockets. Between Steamboat Rock and Iowa Falls, the type occupies high tables 25 to 50 feet above the first bottoms, but ordinarily it is only 10 to 15 feet above overflows.

Practically all of the Buckner loam is under cultivation, and all the staple crops are grown. Ordinarily the yields compare favorably with those on the upland soils, but in periods of prolonged drought or irregular rainfall the yields are lower. The type is earlier than the heavier upland soil. Land values are about the same as on the O'Neill loam.

The general need of this type is to maintain and increase the organic content by the use of more green-manure crops.

O'NEILL LOAM.

The O'Neill loam varies considerably in texture and in depth of the surface layer. The average depth is about 10 inches, and the texture is a loose friable loam to almost a sandy loam. The upper subsoil is a yellowish-brown coarse sandy loam somewhat mottled

with yellow and brown which grades at a depth of 18 or 20 inches into a layer of yellowish-brown gravelly loam 4 to 10 inches thick. These soil layers rest on a stratified deposit of coarse water-worked gravel, varying in thickness from 5 to 25 feet, overlying bowlder clay. There is more or less small gravel in both the surface and subsurface layers, and more in the subsoil. Narrow, broken strips of fine sandy loam and sandy loam, ranging in width from 10 to 40 feet and lying slightly higher than the surrounding terrace floor, are included with the type as mapped. They occur principally on the wide benches northeast of Gifford and southeast of Union.

The O'Neill loam is developed extensively along the entire course of the Iowa River, the South Fork of Iowa River, and Beaver Creek, occupying a terrace position well above overflow. Small isolated areas are found along Elk, Tipton, and Honey Creeks. The area of this type is nearly equal to the combined area of the six other terrace types mapped in the county.

The surface is comparatively level, with a few slight elevations and occasional depressions adjacent to the upland. A few shallow stream channels have been formed by short drainage ways crossing the terraces from the upland to the main stream channel. Most of the terraces are from 8 to 25 feet above the first bottoms, but between Steamboat Rock and Iowa Falls they attain an elevation of 30 to 50 feet. Normally the terrace slopes toward the river, being 4 to 8 feet higher at the base of the upland than on the side nearer the streams. The run-off and underdrainage are free, and this with the loose structure of the soil causes droughty conditions in periods of light rainfall.

The underlying gravel is of exceptionally fine quality, and large pits are being worked commercially in different parts of the county. The type is practically all in cultivation. Corn, oats, and hay are the leading crops. Some rye is produced in small fields, and potatoes and melons are grown to a small extent. Corn occupies the largest acreage. It yields from 25 to 50 bushels per acre, depending on the distribution of rainfall and on the crop last occupying the field. After a green-manure crop, the yield, with normal seasonal conditions, is appreciably increased.

This soil has the usual wide range in selling price, depending on location and improvements. Much of it is included in farms with other types. The price ordinarily ranges between $175 and $250 an acre, but in the vicinity of towns it may be higher.

The organic matter content of the O'Neill loam is lower than of most of the upland soils, mainly because of the open structure of the soil and subsoil. Large applications of barnyard manure and the frequent turning under of green manure are needed to supply the deficiency and prevent further depletion. Shallow plowing or disking and maintaining a good mulch will aid in conserving the moisture. The use of heavy rollers or subsurface packers might be profitable on the lighter variations of the type. The soil and subsoil are both strongly acid, and crushed limestone or burnt lime should be used, especially when clover is to be grown.

WABASH LOAM.

The Wabash loam is a first-bottom soil subject to frequent overflow during periods of heavy continuous rains. It consists typically of 12

to 15 inches of dark-brown, mellow, friable loam which grades into a dark-brown friable silty clay loam. As in all alluvial soils subject to annual floods and reworking, the texture varies considerably, even within short distances. Scattered deposits of fine sand and coarser gravelly materials are common over the whole type, particularly along the lower course of the South Fork of Iowa River and a small creek just south of Steamboat Rock. The textural variations in these sandier beds range from a coarse sandy loam to almost a pure fine sand. These deposits most frequently lie in the sharp oxbow bends of the streams. Another variation occurs along the Iowa River from a point one-half mile northwest of Alden to Eagle City. Here the alluvium is deposited over a solid limestone floor, and is only 24 to 36 inches deep. Limestone fragments are present in the lower 2 or 3 inches of the subsoil next to the bedrock. Here the soil contains considerable lime; elsewhere it does not effervesce when tested with hydrochloric acid.

In general, the rather open structure of the subsoil insures good drainage between overflows.

Native forest trees, chiefly ash, cottonwood, willow, black walnut, post oak, and red haw, are thinly scattered in clumps and individually over the flood plains, principally near the stream banks. A native blue-grass sod covers most of the type, and on account of the frequent overflows and the uncertainty of crops the chief value of this land at present is for pasture.

WABASH SILT LOAM.

The surface soil of the Wabash silt loam consists of 12 to 16 inches of very dark brown or black, heavy, friable silt loam. The subsoil is a heavy, compact, yellowish-brown or dark-brown silty clay loam. The surface soil is very high in organic matter and the black color indicative of this high content in places extends to a depth of 20 or 24 inches. The extreme lower subsoil is of a mottled light yellowish brown. In a few places the surface soil is heavier than typical, approximating a light silty clay loam. Very little coarse material is found in either soil or subsoil, silt and clay being the principal constituents.

The Wabash silt loam occupies the narrow first bottoms along all the smaller streams in the southeastern part of the county, which have cut deeply into the loessial upland plain. Toward the heads of these small streams the soil is in part colluvial. Along the Iowa River and its larger tributaries the type occurs mainly in narrow broken strips at the extreme outer edge of the flood plain. Here it is closely associated with soils of loam texture, and the soil boundaries are in places rather arbitrary.

The surface is flat with a slight incline toward the stream channel. The drainage between overflows is generally good. An area of considerable size lying one-half mile northeast of Gifford is subject to only partial overflow at intervals of several years.

Very little forest growth is found on this type. The areas along the larger streams are mostly in cultivation; those along the smaller streams in the loessial region, consisting of narrow strips, are used mainly for pasture. Corn is the principal crop, with some hay and oats. Corn produces 25 to 60 bushels per acre and hay yields from

1 to 2 tons. The success depends upon the time and severity of floods. Very little manure is used, the natural fertility of the soil making it unnecessary to apply artificial fertilizers.

In practically all cases this type is sold with associated soil types. Separately its value would range from $100 to $250 an acre.

The main problem on this type is adequate drainage and protection from overflow. Most of the type is better suited for pasture than for cropping.

WABASH SILTY CLAY LOAM.

The Wabash silty clay loam is a dark-brown to black, heavy, sticky silty clay loam, 18 inches deep, passing below into a dark-brown tenacious silty clay mottled with dull brown or gray. The transition from surface soil to subsoil is gradual, and in places the solid dark-brown or black color extends throughout the 3-foot section. More or less coarse sand and gravel has been mixed with this soil, principally with the surface material, during the periodic overflows, and small patches of gravelly or sandy clay have been deposited over the surface. A high organic content is characteristic of the surface layer, as indicated by the color. There is no lime in the soil or subsoil; in this respect the type differs from the Lamoure silty clay loam. Areas of Lamoure silty clay loam too small to map separately have been included.

The Wabash silty clay loam is developed along all the larger streams, generally in short disconnected belts lying slightly lower than the rest of the flood plain, and as a rule away from the stream courses at the foot of the adjoining upland or terrace slopes. The only extensive development of this type is northeast of Lawn Hill, along the South Fork of the Iowa River, where a strip nearly 3 miles long, containing more than 400 acres, is mapped.

The surface of the type is flat to depressed and naturally poorly drained. Where not artificially drained, water stands for considerable periods after the floods have subsided. Small patches of Muck occur in the larger bodies.

This type is used largely for pasture. Only small fields have been reclaimed and planted to crops. Corn is the principal crop. Timothy does well. Native grasses make a luxuriant growth and are cut for hay, yielding from 1 to 2 tons per acre.

The Wabash silty clay loam usually comprises only a small part of a farm. Its value if sold alone would range from $100 to $200 an acre, depending on the frequency of overflow and present drainage conditions.

LAMOURE SILTY CLAY LOAM.

The surface soil of the Lamoure silty clay loam is a black silty clay to clay loam 10 inches deep. This is underlain by a dull grayish brown plastic clay loam to silty clay loam highly mottled with gray and yellowish brown. Reddish-brown iron stains are numerous in the lower depths of the subsoil. As in all first-bottom types, varying quantities of sand and gravel are incorporated in the soil, but in this type they constitute only a small proportion of the total soil mass. The subsoil is characteristically calcareous, and in places the surface soil also contains enough lime to effervesce with acid. Lime nodules are common between depths of 10 and 36 inches, having their greatest concentration in the lower part of the subsoil. A few

small areas of Wabash silt loam and Lamoure loam, which could not be separated because of their small size, are included with the silty clay loam.

The Lamoure silty clay loam occurs along the smaller streams in all parts of the county except the southeastern quarter. It also forms the first bottoms along the headwaters of the larger tributaries of the Iowa River. The most extensive development is along the drainage ways in the western and northeastern parts where the channels are cut only from 1 foot to 4 feet below the level of the flood plains, and the streams are sluggish and intermittent. Colluvial material is abundant in many places along these narrow drainage lines. The heavy impervious nature of both surface soil and subsoil results in poor natural drainage.

This type is strong and durable, and will produce high yields where properly drained and cultivated. At present only small acreages are in cultivation, and these are mainly in corn. Some wild hay is cut, but most of the type is used for pasture.

The Lamoure silty clay loam is similar to the Wabash silty clay loam and has about the same value. The chief difference between the two types is the presence of lime in the Lamoure soil and its absence in the Wabash.

PEAT AND MUCK.

Peat is composed of loose, fibrous, semidecomposed vegetable matter, of dark-brown color and varying in depth from 6 inches to 4 feet. The immediate surface in which less disintegration has taken place has a light-brown or reddish-brown fluffy appearance when dry. The underlying subsoil is a sticky, impervious, drab or grayish-brown silty clay to clay with gray and faint yellowish-brown mottlings, and commonly highly calcareous.

The difference between Muck and Peat lies in the stage of decomposition of the vegetable matter and the proportion of mineral matter present. The original coarse plant and root fibers present in the Peat, after drainage, cultivation, and the consequent oxidation and decay become a more compact finely divided soil. More mineral soil material washed in from the surrounding higher land is added, and finally a soil produced that is classed as Muck. On account of the small area covered by Muck, it is not shown separately on the soil map but is included with the undifferentiated Peat and Muck.

The development of Peat and Muck occurs in shallow undrained basins, ponds, or lakes, in which rushes, sedges, and aquatic plants have flourished, and their remains accumulated. Peat and Muck areas, which range in size from 1 to 150 acres, are scattered through the Wisconsin drift region. Many of the smaller bodies could not be shown on the map.

Along the edges of the beds the surface soil is shallow and mucky, containing considerable silt and clay washed in from the surrounding glacial soils. Toward the center of the beds the material becomes coarser and the deposit increases in depth, in places to 3½ or 4 feet, but ordinarily not exceeding a depth of 25 to 30 inches.

More than 60 per cent of the Peat and nearly all the Muck has been drained and placed in cultivation or seeded to grass. The uncultivated part is in native grasses and is used for pasture. Corn,

the principal crop, yields from 20 to 50 bushels per acre, depending on seasonal conditions. It does best where the soil is compact and not too fibrous. Small grains are inclined to lodge before ripening. Potatoes are successfully grown on a very small acreage. In adjoining counties sugar beets give large yields on this soil, but the special labor required and the difficulty of marketing would probably make production unprofitable in Hardin County at the present time.

This land is nearly always sold with associated types. It would probably bring $125 to $225 an acre if sold alone, the price depending on drainage and stage of decomposition.

The most important factor in reclamation is drainage. Deep plowing will hasten the decomposition by increasing the depth of weathering and oxidation. Pasturing heavily after seeding to alsike clover and timothy has given the best results, as the tramping of cattle tends to compact the soil and cause more rapid disintegration.

SUMMARY.

Hardin County is situated a short distance northeast of the center of Iowa. Its area comprises 569 square miles, or 364,160 acres.

The surface is a broad plain, which lies from 910 feet to 1,225 feet above sea level, giving a maximum relief of 315 feet. The slope and general direction of the drainage lines is to the southeast.

There are three distinct soil provinces. The western two-thirds of the county is part of the Wisconsin glacial drift plain; the northeast corner is in the older Iowan drift region; and the central-eastern and southeastern part is covered with a deposit of loess 4 to 20 feet thick, overlying the Kansan drift, and belongs to the southern Iowa loessial province.

The Wisconsin drift area as a whole has poor drainage. In the eastern third of the county, or loess-covered section, the drainage is fair to good in general and excessive on some of the steep slopes.

In 1920 the population of the county was 23,337. The rural population is approximately 80 per cent of the total and is well distributed over the county. Eldora, the county seat, has a population of 3,189. Iowa Falls, the largest town, has 3,954 inhabitants.

Railroad facilities are excellent, providing direct connection with Chicago, Minneapolis, Omaha, Des Moines, and Sioux City. The wagon roads are well graded and kept in good condition. Excellent rural schools, six in consolidated districts, provide educational advantages for all parts of the county.

The mean annual temperature at Iowa Falls is 44.8° F. and at Whitten 46.7° F. The mean annual precipitation at Iowa Falls is 34.55 inches, and at Whitten, 30.6 inches. The rainfall is well distributed over the growing season, which covers a period of 149 days.

Agriculture is the main industry in Hardin County. The present system of farming consists of the production of grain combined with the feeding of livestock. Corn, oats, and timothy and clover hay are the leading crops. Hog raising is the most important livestock industry. Barnyard manure is practically the only fertilizer used.

The total number of farms is 2,129, of which 1,067 are operated by owners and managers. The average size of farms is 164.4 acres. The selling price of farm lands ranges from $175 to $400 an acre (1920).

The soils are prevailingly loams in texture in the drift area and silt loams in the loessial region. They are mostly dark brown to black in color and contain a high percentage of organic matter.

The Carrington soils predominate on the uplands, and their topography is undulating to steeply rolling. The Clarion, Webster, and Clyde soils belong to the dark-colored drift soils, the two latter being poorly drained. The Lindley soils are light colored, are of drift derivation, and were formerly forested. The Peat and Muck areas are developed throughout the Wisconsin drift in what were formerly sloughs, ponds, and shallow lakes.

The loessial upland soils in the eastern third of the county are represented by dark-colored soils of the Tama and Muscatine series. The Tama silt loam is rolling, well drained, and third in extent in the county. The Muscatine silt loam lies on the flat tops of the interstream divides, surrounded by the Tama soils, and has poor natural drainage. The Fayette and Clinton soils were formerly forested, are light colored, and low in organic matter. Forage crops, small grains, tree fruits, and small fruits do well on these soils.

Of the terrace types, the Bremer and Fargo soils have been developed under poor drainage conditions. They are black, heavy, and high in organic matter. The Millsdale and Waukesha soils have dark-colored surface soils, with lighter colored and heavier subsoils. They are normally well drained. The Millsdale loam is underlain by limestone. The soils of the Buckner and O'Neill series are brown to dark brown in color, with subsoils of a somewhat open and porous nature, usually light brown to brown in color. The O'Neill loam is distinguished from the Buckner by an underlying stratum of gravel within the 3-foot section.

All the staple farm crops are grown on all the upland and terrace types.

The first bottoms or overflow lands are represented by the Wabash and Lamoure series. Both are dark brown to black in color. The Lamoure soils differ from the Wabash in being highly calcareous. The bottom land types are used principally for pasture.

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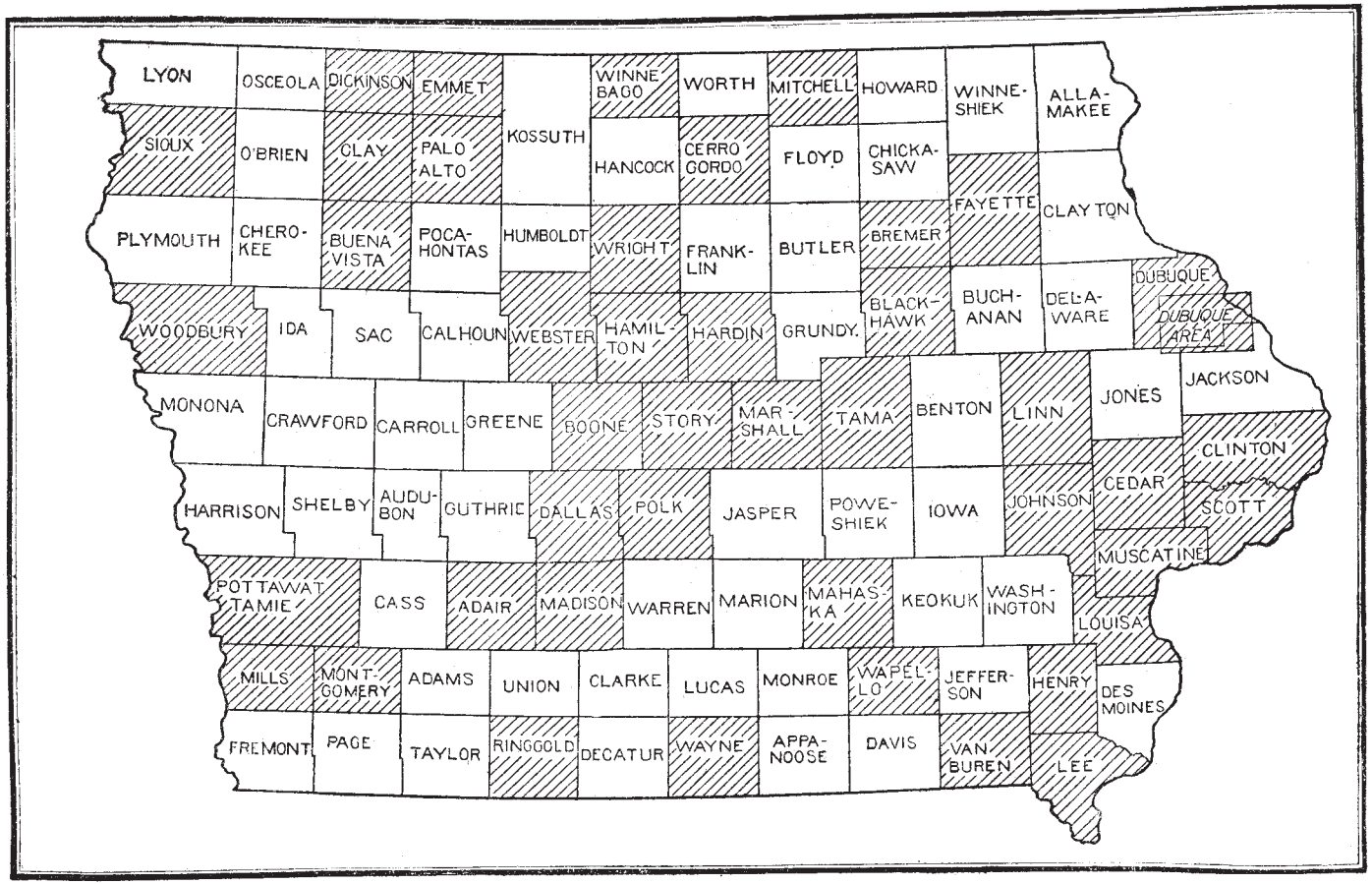

Areas surveyed in Iowa, shown by shading.

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If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed

complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).