

SOIL SURVEY OF WINNESHIEK COUNTY, IOWA

By T. H. BENTON, of the Iowa Agricultural Experiment Station, in Charge,
and N. J. RUSSELL, of the U. S. Department of Agriculture

DESCRIPTION OF THE AREA

Winneshiek County is located in the northeastern part of Iowa. Its northern boundary is the State line between Iowa and Minnesota, and it is separated by only one county from the eastern boundary of the State, the Mississippi River. The area is almost rectangular in shape and is composed of 20 congressional townships; 4 tiers of townships east and west and 5 north and south. It comprises a total area of 686 square miles, or 439,040 acres.

Winneshiek County lies within an area formerly consisting of a broad, smooth, but not entirely level plain, which has been dissected by a widely ramifying system of drainage ways.

The topography at present is the product of a number of cycles of erosion, in addition to the one now in progress. The work of the former cycles was largely obliterated after the work of each had been interrupted, the obliteration being effected by the partial filling of the valleys produced during each cycle, resulting in the filling of the small ravines and narrow valleys, but leaving the larger, broader, deeper valleys as broad belts of lowland and the former watershed ridges as low, ironed-out ridges. When the existing streams began their work, therefore, they began on this slightly uneven surface, into which they have cut the existing valleys and ravines. So far as the main features of the topography of the region are concerned, especially the details of hill and valley, they are the product of the streams now in existence, permanent and intermittent.

The drainage ways have invaded practically all parts of the county, but the watershed ridges are broad, undulating to rolling uplands, while the hilly lands are confined to relatively narrow belts lying along both sides of the valleys of the larger streams.

Along all the larger streams there are belts of alluvium or "bottom land," but these consist of comparatively narrow strips. Along the Upper Iowa River, from the northwestern corner of the county to Decorah, narrow flood plains have been built up in the bends where the streams recede from the rock walls. (Pl. XXXVI, fig. 1.) Such bottoms are less widely developed below Freeport and on Turkey River and a few other streams. These alluvial flats for the

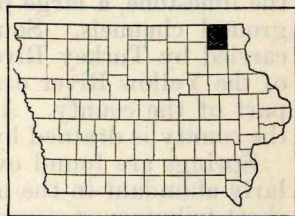


FIG. 45.—Sketch map showing location of the Winneshiek County area, Iowa

most part stand only a few feet above the level of the streams and are subject to flooding at frequent intervals. Below Decorah terrace remnants which are considerably eroded occur 30 to 50 feet above the present flood plain. On both sides of Turkey River well-marked and uneroded terraces stand 20 to 30 feet above the first bottoms.

The maximum relief of Winneshiek County is 600 feet. The lowest point, 760 feet above sea level, is on the Upper Iowa River on the east county line; the highest point, 1,360 feet above sea level, is a short distance west of Hesper. Other elevations in the county are: Castalia, 1,245 feet; Ossian, 1,269 feet; Ridgeway, 1,209 feet; and Decorah, in the valley of the Upper Iowa River, 875 feet above sea level.

The drainage of the county is collected in two principal drainage basins and in two others which cover only small areas. The two large basins are separated by the ridge passing through Ridgeway, Calmar, and Ossian. The part of the county lying north and east of the ridge is drained by the Upper Iowa River. Most of the tributary streams are intermittent. Where the water can penetrate the limestone, a large part of the local drainage is carried in underground channels. Southwest of the high divide the drainage is carried by Turkey River to the Mississippi River. The tributaries of the Yellow River drain about 35 square miles in the southeastern part of the county. A narrow strip along the northern border of the county is drained by Root River.

Springs are found over nearly the entire county, but are particularly abundant in the northeastern two-thirds of the county. Many short tributary streams in the northeastern and eastern parts of the county, coursing over rocky limestone beds, are supplied with a continuous flow of cold water from these springs and have been stocked with rainbow and speckled trout. The most important springs occur at the base of the Galena limestone, 50 to 100 feet below the surface, where the impervious Decorah shales underlying the Galena limestone stop the downward passage of the water. Dunning Springs, opposite Decorah, and Coldwater Springs, a few miles northwest of Bluffton, are among the largest in the county. An ice cave is found in the bluffs of the Upper Iowa River opposite Decorah.

Two large electric-power plants, located on the Upper Iowa River 7 and 10 miles, respectively, northeast of Decorah, furnish power locally. Excellent water-power sites are also found at Spillville and Fort Atkinson on the Turkey River. The water supply for stock and household purposes comes largely from drilled wells.

There are three distinct forest areas. These occupy the valley slopes and the adjacent uplands along the Upper Iowa, the Turkey, and the Yellow Rivers, extending back up their tributaries. Originally about one-fourth of the county was forested, but only a small proportion of this growth remains. The heaviest tree growth is on the steep, rough sections unsuited for farming. The oaks, hickory, elm, basswood, ash, box elder, cottonwood, butternut, walnut, white pine, red cedar, and canoe birch are the more common native trees.

The permanent settlement of the county began in 1848. Prior to this the Winnebago Indians occupied the region. In 1840 the Government built a fort on the Turkey River at Fort Atkinson. The county was permanently organized in 1851.

The population of the county was given in the Federal census of 1920 as 22,091. Most of the inhabitants are native born. The north-eastern two-thirds of the county is largely occupied by descendants of people from the Scandinavian countries, particularly from Norway and Sweden. There are also many inhabitants of German descent, especially in the southern and the southwestern parts of the county. The rural population is uniformly distributed and constitutes 81.7 per cent of the total, with a density of 26.3 persons to the square mile.

Decorah, the largest town and county seat, is located within 2 miles of the center of the county and has a population of 4,039. The cooperative association in Decorah does a very heavy cooperative shipping business. Calmar, in the south-central part of the county, is second in importance with a population of 1,039. Ossian has a population of 853; Burroak, 600; Ridgeway, 349; Fort Atkinson, 315; Spillville, 315; and Castalia, 272. Hesper, Freeport, Conover, Frankville, Festina, Jackson Junction, and Bluffton are towns of less than 200 inhabitants.

Creameries are located at Ridgeway, Canoe, Festina, Decorah, Calmar, Burroak, Highlandville, Fort Atkinson, Ossian, and Nordness. Limestone quarries are located at Decorah and Hesper. Other industries at Decorah are a wagon and carriage factory, scale works, drug factory, flour and feed mill, and a Norwegian publishing house. The Chicago, Milwaukee & St. Paul Railway shops and roundhouse, a door factory, and a wagon factory are located at Calmar.

Winneshiek County is fairly well supplied with railroads, no place being over 15 miles from a shipping point. Branches of the Chicago, Milwaukee & St. Paul Railway serve the southern and western sides of the county. A spur line runs north from Conover to Decorah. These lines give direct connections with the Chicago, Milwaukee, St. Paul, and Mason City markets. The Decorah and Cedar Rapids branch of the Chicago, Rock Island & Pacific Railway enters the southeast corner of the county and extends northward through Castalia, Ossian, Nordness, and Decorah.

The wagon roads in the county are all of earth construction. The roads follow the land lines in the less rolling prairie sections. Where the terrain becomes rolling to steep they follow the bottoms of the ravines, the tops of ridges, and the gentler slopes. Three State primary roads pass through the county. Rural mail routes serve all parts of the county. Practically all farms have telephones.

An excellent public-school system is developed in the county and schools are easily available in all rural sections. Farm buildings and farmhouses are commodious, substantial, and mostly of wood construction.

The principal markets are Chicago, Austin, Minneapolis, Cedar Rapids, and Mason City. Butter and eggs are marketed largely in the East.

CLIMATE

The climate of Winneshiek County shows a wide variation in temperature, but is suitable for growing all the staple crops of this region.

The mean annual precipitation is 32.53 inches. Rainfall is usually well distributed over the growing season. The mean rainfall for the spring and summer is 20.4 inches. May and June are normally the wettest months. The wettest season was in 1902 with a precipitation of 43.22 inches; the driest season was in 1910 with 18.51 inches. Droughts are infrequent, of short duration, and usually attended by little damage. Probably more damage has been caused by excessive rainfall than by droughts. Snow usually covers the ground most of the winter season and frequently causes blocking of the country roads. Primary roads are kept open all winter. Occasionally damage is done by hail, but is restricted to short and narrow strips from one-half mile to 1½ miles wide.

The highest temperature recorded for the county is 108° F., and the lowest is -37°, these temperatures occurring in July and January, respectively. The mean annual temperature is 45.7°.

The prevailing winds are from the northwest in winter and from the south and southwest in summer. Planted windbreaks are commonly found on farmsteads in the more open prairies.

The average growing season covers a period of 140 days. The latest killing frost recorded in spring occurred June 8, and the earliest in fall on August 30. However, the average date of the last frost in spring is May 10 and the average date for the first in the fall is September 28.

The normal monthly, seasonal, and annual temperature and precipitation for Winneshiek County are given in the following table, compiled from the records of the Weather Bureau station at Decorah:

Normal monthly, seasonal, and annual temperature and precipitation at Decorah

[Elevation, 875 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.....	22.2	55	-29	1.34	0.63	3.00
January.....	13.9	50	-37	1.22	1.85	1.20
February.....	17.6	52	-31	1.03	.91	1.35
Winter.....	17.9	55	-37	3.59	3.39	5.55
March.....	30.2	83	-15	1.80	.05	1.77
April.....	46.9	93	6	2.44	2.56	1.27
May.....	60.0	97	23	4.61	3.82	11.63
Spring.....	45.7	97	-15	8.85	6.43	14.67
June.....	68.5	105	35	4.24	.05	5.35
July.....	73.4	108	42	3.95	.73	8.43
August.....	71.2	100	32	3.36	4.08	1.78
Summer.....	71.0	108	32	11.55	4.86	15.56
September.....	62.2	94	29	3.94	2.72	3.86
October.....	49.1	84	16	2.77	.85	1.51
November.....	33.7	73	-7	1.83	.26	2.07
Fall.....	48.3	94	-7	8.54	3.83	7.44
Year.....	45.7	108	-37	32.53	18.51	43.22

AGRICULTURE

The first permanent settlement began in 1848, following the removal of the Winnebago Indians. The more level prairies were then covered with native grasses, and the more rolling lands, including the stream slopes and rolling hills, were heavily wooded. The original forest probably covered about one-fourth of the entire county. The forested sections were occupied first, since they afforded protection from the severe winters and furnished fuel. There were many deer and wolves and much wild game. Progress was very slow at first because of poor roads and lack of transportation facilities. Small acreages were cleared and crops raised for sustenance. Wheat, flax, and corn were the principal crops at first.

Agriculture has always been the chief industry of this county. Dairying early became important. The wheat acreage in the early days was equal to that of nearly all other crops combined.

The acreage and production of the principal field crops, as given in the table below, compiled from the United States census reports for 1880 to 1925, inclusive, show the development and trend of the chief agricultural crops of the county.

Acreage and production of leading field crops in 1879, 1889, 1899, 1909, 1919, and 1924

Year	Corn		Wheat		Oats		Hay		Coarse forage	
	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
	<i>Acres</i>	<i>Bushels</i>	<i>Acres</i>	<i>Bushels</i>	<i>Acres</i>	<i>Bushels</i>	<i>Acres</i>	<i>Tons</i>	<i>Acres</i>	<i>Tons</i>
1879.....	42,641	1,790,061	117,753	1,036,113	29,548	1,107,294	39,194	58,716	-----	-----
1889.....	67,450	2,473,179	6,322	87,871	64,499	2,555,437	63,092	96,045	-----	-----
1899.....	80,928	3,151,750	10,553	155,560	76,849	2,658,740	56,985	90,141	1,381	3,043
1909.....	74,995	2,801,871	4,412	74,976	64,381	1,770,510	66,244	107,467	2,285	5,828
1919.....	70,332	3,192,631	13,837	141,782	68,777	2,212,473	59,788	102,540	14,785	32,286
1924 ¹	46,289	1,019,882	-----	-----	77,522	2,843,188	65,446	88,099	-----	-----

¹ Preliminary announcement of the 1925 farm census, subject to correction. Wheat and forage crops were not included in this announcement.

Wheat was early the leading crop. In 1879 the acreage was nearly as large as that of all other crops grown and about three times that of corn. The corn crop was second in acreage and hay crops third. Barley and flax were raised to some extent. Shortly after the advent of railroads many creameries and cheese factories were built, and dairying became important. In 1889 wheat became a minor crop, with corn taking first place. Oats and hay crops were within 5 per cent of the corn acreage. Since that time corn has held only a slightly greater acreage over oats. Hay and forage crops have about doubled in acreage since 1879. Orchards increased from 9,261 trees in 1879 to 45,321 in 1919. Apples constitute 92 per cent of the fruit trees.

The predominant system of farming at the present time is of a combined type, including grain growing and stock raising, supplemented by dairying. Corn, oats, and timothy and clover are the leading crops grown. Wheat and barley are secondary crops. Small acreages of rye, buckwheat, and flax are also grown.

Corn is the leading field crop. The average yield for a series of years is about 45 bushels per acre. This county ranks with the highest in the State for average yield, owing largely to the prevalent three-year rotation and extensive growing of clover. Corn is grown on all soil types. Reid Yellow Dent, Silver King, Minnesota No. 13, Iowa Silvermine, and Calico are the principal varieties, in order of their preference. The Silver King corn was originated near Fort Atkinson by a Mr. Goddard. Corn is planted from May 5 to June 1, depending on the season. Most of the corn is cut, shocked, and then hauled and fed to dairy and beef cattle. Practically all the corn is fed on farms. In some years considerable corn is shipped in for feeding. Probably 10 per cent, mostly yellow corn, is used for filling silos. There are 472 silos in the county.

Oats generally occupy only a slightly smaller acreage than corn. The average annual yield is from 32 to 35 bushels. In particularly favorable seasons 60 to 70 bushels are obtained on some fields. About 25 per cent of the oat crop is sold for cash, through local elevators, which are operated mostly by cooperative or farmer-owned stock companies. The remainder is fed on the farms. About one half is early and the other half is late oats. Sowing is usually from April 5 to 25. The seed is broadcasted on stubble land, disked, and dragged. A considerable part is drilled in. Harvest varies with the season, from the 1st to the latter part of July. Although the late oats have an advantage in production and straw, the early oats are less affected by rust. Smut and red and black rust cause some trouble at times. During a barberry eradication campaign conducted recently by the Iowa State College, over 2,500 bushes were removed. Early oat varieties raised are Albion (Iowa No. 103), Richland (Iowa No. 105), Early Champion, Green Russian, and Iowar, named in order of popularity. Late varieties are Silvermine and Goldmine, a local variety resembling Iowa No. 103. In some sections Swedish Select is raised, and Iogren is grown on a few farms. Chicago and Minneapolis are the principal markets for oats.

Timothy and clover mixed is the chief hay crop. The acreage as reported in the 1920 census was 40,406 acres, or three-fourths of the acreage of all tame hay grown. The average yield is about 1½ tons per acre. Some difficulty is caused by winterkilling. This is especially true on acid soils where there is not the necessary root development. Where clover kills out, the timothy is usually cut for seed. Not much clover is sown alone. It has been found that clover alone does not hold the soil so well as clover and timothy mixed. Where timothy and clover remain on the land the third year there is very little clover in the crop. The sod is usually plowed under the second year. Clover alone, mostly medium red, was reported on 1,382 acres in 1919. Occasional fields of mammoth red are grown, yielding 2 tons per acre. Some alsike and occasionally small acreages of Hubam and sweet clover are found.

Timothy alone is reported for 1919 on 11,451 acres. The average yield is about 1½ tons per acre. Most of it is plowed under the second year. Some farmers pasture it the second and third years. The timothy is cut for both seed and hay. According to the 1921 Iowa Year Book¹ about one-half is cut for seed, averaging 4 bushels

¹ Iowa Year Book of Agriculture, 1921.

of seed per acre. The hay is fed to work stock and cattle. Some hay and straw is shipped to Mason City.

Soy beans are grown in a small way; mostly they are planted with corn and used for hogging down or silage. A few are raised in gardens for seed. Black Eyebrow and Manchu are the varieties grown. Wild hay is cut from the poorly drained Clyde soils in the southwest part of the county. In 1919 there were 4,012 acres of silage crops and 14,785 acres of coarse forage crops.

Alfalfa has been grown in an experimental way, in small fields of 1 to 10 acres, within the last few years. It can be successfully grown where the land is well limed and well inoculated. Three cuttings are obtained, with a yield of 3 to 3½ tons per acre.

Wheat, at one time the most important crop, is now a minor crop. It was grown on 13,837 acres in 1919. Winter wheat is most extensively sown and yields slightly higher than spring wheat. Winter wheat averages 15 to 18 bushels per acre and spring wheat 12 to 16 bushels. In favorable seasons 30 to 35 bushels may be obtained. In the southeast corner of the county and around Spillville and Calmar spring wheat is most commonly grown. It is hauled to Spillville to be ground for farm use. Part of the winter wheat is used locally, but most of it is sold through local elevators.

Barley was raised on 8,846 acres in 1919. Yields generally average about 18 to 20 bushels per acre. Barley is often used as a substitute for oats in the rotation. It is fed largely to hogs. Flax was grown on 555 acres in 1919. It generally produces an average of 7 to 10 bushels of flaxseed per acre. Other crops raised on small acreages are buckwheat, millet, rye, sorgo (sweet sorghum), rape, and pop corn.

Potatoes are raised for home use, and a small quantity is sold locally. The loams and more sandy soils in the southwestern part of the county are better adapted for potatoes than the heavier-textured soils. The average yield is from 75 to 100 bushels per acre.

Trucking is carried on in a small way around the larger towns for the local markets. The largest fields of vegetables and melons are around Freeport and near Decorah on the sandier terrace and bottom soils. Sweet corn is raised in small acreages, the largest production being in the southeastern part of the county.

Pastures are largely of native blue grass, which grows luxuriantly everywhere. Alsike clover, sweet clover, red clover, and timothy are often used in various mixtures for pasture. The estimated number of acres in pasture is 152,900, according to the Iowa Year Book of 1921. The most troublesome weed pests are quack grass, foxtail, and morning-glory. Cocklebur, Russian thistle, and small patches of Canada thistle are also found.

Fruit growing is well developed. Apples are the principal tree fruit. The census of 1920 reported 41,498 trees of bearing age in the county. They are well scattered over the county. Northwestern Greening, Whitney, Snow, Malinda, and Wealthy are the main varieties. Some Ben Davis and a few Delicious are grown. Quite a few plums, some cherries, compass cherries (a cross between a cherry and a plum), and a few pears are the other tree fruits. Farm orchards vary in size from 20 to 80 trees. A few commercial orchards occupy 5 to 12 acres. The orchards on the more rolling

loessial soils appear to be the most successful. Considerable fruit is shipped in each year for the local markets. Small quantities of strawberries, blackberries, raspberries, gooseberries, grapes, and currants are raised, but not in sufficient quantities for local consumption.

On most farms livestock is the chief source of income. The territory northeast of the Cresco-Calmar-Ossian ridge is the leading dairy section. The raising of hogs and beef cattle is practiced over the entire county.

Hog raising is the most important livestock industry in the county. There were 129,079 hogs on farms January 1, 1922, according to the State Year Book. Most of the hogs are mixed grades. The Poland-China type predominates, with Duroc second. A few Chester Whites, Spotted Poland-Chinas, and Hampshires are scattered over the county. From 8 to 15 brood sows are kept on the average farm and from 50 to 125 pigs are raised. Purebred boars are common, but there are only a few purebred herds. Most pigs are farrowed early in the spring. Several carloads of stock hogs are shipped in and fed annually. About two-thirds of the hogs are shipped cooperatively. Decorah has the largest cooperative shipping business in the State, 15 to 20 carloads being shipped every Saturday during the marketing season. They are marketed at Chicago, Austin, and Cedar Rapids.

Cattle not kept for dairy purposes were reported as 41,622 on January 1, 1922, according to the Iowa Year Book. Most of these are good Shorthorn grades. Some Angus and Herefords are raised. There are a number of purebred herds in the county, mostly Shorthorns, with a few Hereford and Angus. Some years feeders are shipped in for finishing. Because of the extensive pasture lands, much young stock is raised. Corn, with timothy and clover hay, is largely used in finishing. Cattle are largely marketed through farmer-owned shipping or cooperative shipping associations. Most of the cattle are shipped to Chicago and St. Paul, and a few to Mason City, Austin, and Cedar Rapids.

Dairying is an important industry. The State Year Book reported 27,208 cattle kept for dairy purposes on January 1, 1922. Good grade milking Shorthorns are the predominating type. Holsteins, Herefords, and a few Guernseys are scattered over the county. Purebred sires are commonly used. Dairy products are sold to local creameries, and local cream-buying stations are accessible to all communities. Butter is manufactured and shipped to eastern markets. The value of dairy products for 1919 was reported by the census as \$1,685,992.

Sheep raising is carried on principally on the rougher lands. The total number of sheep in the county on January 1, 1922, according to the Year Book, was 7,288. They are mostly Shropshire grades, with some Cotswold. A few range feeders are shipped in each year. The wool clip in 1921 was 53,625 pounds. It is sold to traveling buyers of the county cooperative wool association. Considerable trouble is experienced with wolves in the northeastern corner of the county. Goats are raised in the rougher areas to clean up cut-over lands, and several hundred are marketed each year.

Horses are raised principally for work stock. There were 14,262 head reported in the county in 1922. The Percheron breed pre-

dominates, with Belgians second, and some Shires and Clydes. Most of the farm work is done with horses, only 159 tractors being reported on farms. These are found largely in the southern and western parts of the county on the less rolling lands.

Poultry raising is an important source of revenue on the farm. The flocks are largely mixed, but more attention is being given to the pure strains. The average flock is from 100 to 150 fowls. Barred Rocks, Rhode Island Reds, Buff Orpingtons, and Leghorns are preferred in the order named. The State census reported 343,894 fowls on farms on January 1, 1922 and an output of 1,434,833 dozen eggs. Ducks, geese, and turkeys are raised in considerable numbers. There were 1,573 swarms of bees in the county on January 1, 1922.

Crop rotation is practiced on most farms. Because of the prevailing hilly topography, a three-year rotation (corn, oats, and clover and timothy mixed), is commonly used. Barley is sometimes substituted for oats. This rotation is particularly adapted for conditions here as it tends to prevent erosion and also builds up the soil. A four-year rotation is used on some of the less rolling farms, particularly in the southwestern and western parts of the county. In very hilly sections the land is left in pasture for longer periods, three to five years. Except for rotation adaptation, there is little variation in farming practices on different soils.

Modern farm implements are used on all farms. Farm buildings are commodious and kept in good shape. About 600 farm homes have furnace heat and about 400 have electric light.

Crop insects causing the most trouble are the wireworm, cutworm, and white grub. The latter in some seasons is particularly bad, because of the extensive pasture lands. Corn must often be replanted on account of grubs. Gophers do considerable damage.

Commercial fertilizers are not used to any extent. Liming the soils has been tried in a small way and has produced marked results on the clover crop. Barnyard manure is the only fertilizer used to any extent. Occasionally a clover sod is turned under. Manure is usually hauled out on sleds in the winter and scattered in the spring. It goes largely on timothy and pasture sod.

Farm labor is done largely by the farmer and his family. Hired help is used eight to nine months of the year. A few farmers employ hands the year round. Extra laborers for haying, harvesting, and corn shucking are employed by the day.

In Winneshiek County, according to the Federal census, 74.3 per cent of the farms was operated by owners in 1920, 24.8 per cent by tenants, and 0.9 per cent by managers. The average size of the farms was 147 acres, the total number was 2,915, and approximately 97.6 per cent of the area of the county was in farms.

Farm rentals are mostly on the share basis, the owner receiving one-half the corn and two-fifths the oats, with a cash rental for pasture and hay land. The stock-share system is becoming more popular. Under this plan the owner furnishes one-half the stock and the tenant the implements and the horses. Very little land is rented for cash.

Farm lands vary greatly in selling price over the county. Improvements, location, railway transportation, roads, and the condition of

the soil and farm determine the value. The lands range from the rough, steep, stony land fit only for pasture to the fertile soils of the black gently rolling prairies. At the time the survey was made (1922) the prices ranged from \$30 to \$250 an acre, and especially well improved farms in choice locations brought as high as \$300 an acre.

SOILS²

The soils of Winneshiek County have been differentiated in this report into a number of series and types on the basis of their most obvious physical characteristics and their chemical constituents so far as these could be ascertained in the field. The characteristics of the soils of any region are controlled (1) by the character of the material from which they were derived and (2) by the processes of soil formation, including all those physical and chemical forces to which the soils have been subjected during their development. The nature of the soil-forming processes and the rapidity with which they have acted are determined to a large degree by climatic conditions. The soils of this region, with the exception of immature soils derived from materials recently exposed to weathering, owe their principal characteristics to the soil-forming processes rather than to the composition of the parent material.

On the basis of their most striking and widely distributed characteristics the soils of this county may be differentiated into dark-colored and light-colored soils. These two groups are nearly everywhere coextensive with two kinds of topography, with their corresponding native vegetation. The dark-colored soils have been developed on the smoothly rolling prairies. They also include alluvial soils which owe their dark color to organic matter washed down from the upland and redeposited by the streams. The light-colored soils are confined to those areas which have been dissected or lowered by streams and on which a forest growth has established itself.

The dark-colored soils of the flat or gently rolling prairies owe their color largely to the influence of a grass vegetation. This color is imparted to the soil by a finely divided organic matter derived from the decay of grass roots and intimately mixed with the mineral constituents of the soil. A smooth topography and certain climatic conditions with respect to both temperature and moisture are the principal factors which operated to keep this a treeless region, to favor the growth of grasses, and to provide the proper conditions under which the organic matter supplied by the grass vegetation could be preserved in the upper part of the soil.

As the smooth surface of the original plain has been attacked by erosion, areas of more rolling or broken topography have been produced, and these have gradually widened outward from the stream courses. Better surface and subsoil drainage on these eroded areas has been more favorable to tree growth. When the region was first settled by the white man the forests, following the eroded areas,

² Winneshiek County adjoins Fayette County on the south. In certain small areas the soils of these two counties do not seem to agree. These apparent discrepancies are due to changes in correlation resulting from a fuller knowledge of the soils of the State, as where the Thurston sandy loam in Fayette County is changed to Dickinson sandy loam in Winneshiek County and the Carrington fine sandy loam to Cass fine sandy loam. The Plainfield loam of Fayette County has not been extended into this county on account of its very small area, but is combined with the Plainfield fine sandy loam.

were fast encroaching upon the prairies. Upon these eroded stream slopes, where forests have been established for the greatest length of time, the light-colored soils are developed.

In both of these groups of soils the agencies of weathering and soil formation have resulted in the concentration of clay in the subsoil and the removal of lime and other carbonates to depths of several feet.

The soils developed under a native vegetation consisting of trees have 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 coarsely granular, heavier material extending to depths of 2 to 3 feet. Below this the texture is lighter and the structure is less compact. The soils which belong to this group are those of the Clinton, Fayette, Lindley, Dubuque, and Boone series on the upland, the Jackson and Plainfield on the higher terraces, and the Genesee on the first bottoms.

The dark-colored soils of the area may be subdivided into two groups or subclasses, whose differentiation is based on the effect of drainage conditions in the 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 soil and subsoil drainage. The typical profile has a surface layer of dark-brown or dark grayish-brown color and a friable finely granular structure. This is underlain by a brown granular horizon slightly heavier in texture than the surface layer. At depths of 18 to 24 inches this material is underlain by a brown or yellowish-brown horizon, usually heavier in texture than the upper layers. At 30 inches a material is encountered which is usually lighter in color and more friable than that immediately above it. This is the slightly weathered parent material from which the upper horizons have been developed by weathering.

This group includes the Carrington, Tama, and Dickinson series on the upland, and the Waukesha, Judson, and Buckner series on the higher terraces. The O'Neill and Millsdale series on the terraces belong to this general group, as they are similar in their upper two horizons. The O'Neill soils, however, are underlain at about 20 inches by sand and gravel, and the Millsdale soils rest at shallow depths upon bedrock, usually limestone.

The members of the other group of dark-colored soils were developed under conditions of restricted drainage. They are underlain by mottled gray, yellow, and brown subsoils somewhat heavier as a rule than the surface soils. The details of the profiles of these soils vary considerably, depending on the depth to which good drainage and oxidation have extended. In this group may be placed the Clyde series on the flat and depressed upland areas, the Bremer on the higher terraces, and the Cass and Wabash soils of the flood plains.

The principal characteristics of these groups have been determined to a greater extent by the soil-forming processes, such as the accumulation of organic matter and the weathering, leaching, and oxidation of the material near the surface, than by original differences in the character of the parent material. In the differentiation of the soils

into series, however, account has been taken of the composition, source, and processes of accumulation of the material from which the soils have been developed.

The silty material known as loess, so widely distributed over the eastern two-thirds of the county, was the parent material of the most extensive upland soils. In its unweathered condition the loess was a light-colored, finely divided, floury material, supposed by most geologists to have been deposited in its present position by wind. Under prairie conditions the loess was converted by the processes already mentioned into the dark-colored Tama soils. In forested areas different processes of weathering developed the Fayette and Clinton soils.

The glacial drift, as spread over the region by the ice sheets, was composed of more or less finely ground rock mixed with gravel and bowlders. The unmodified drift of this area was a yellow or gray mass composed of debris from limestone, sandstone, shale, and igneous rocks. The proportion of limestone was relatively small, so that the drift in this county is not highly calcareous. The weathering, leaching, oxidation, and the accumulation of organic matter under prairie conditions has produced over the drift the well-drained Carrington and Dickinson soils and the poorly drained Clyde soils. On the wooded slopes the Lindley soils have been developed.

On the exposure of the indurated rocks of the region both light-colored and dark-colored soils have been developed. The Boone and the Dubuque series are light-colored soils derived from sandstone. The Dodgeville series consists of dark-colored soils developed over limestone.

The soils of the area have been grouped into soil series on the basis of similarities in the color of the surface soil and in the color, structure, lime content, and other characteristics of the various horizons in the soil profile, as well as the thickness and arrangement of these horizons. A division of the series into soil types is made on the basis of differences in the texture of the surface soil, as determined by the relative content of sand, silt, and clay.

In Winneshiek County 31 soil types, representing 21 soil series, and in addition 2 miscellaneous soils, Muck and Rough stony land, have been mapped. Their distribution is shown on the accompanying soil map and their extent is given in the table below.

Areas of different soils

Soil	Acres	Per cent	Soil	Acres	Per cent
Tama silt loam.....	135, 872	30. 9	Cass fine sandy loam.....	1, 856	0. 4
Fayette silt loam.....	112, 192	25. 6	Waukesha silt loam.....	1, 792	. 4
Carrington loam.....	53, 056	12. 1	Buckner loam.....	1, 792	. 4
Rough stony land.....	24, 704	5. 6	O'Neill sandy loam.....	1, 728	. 4
Wabash silt loam.....	23, 488	5. 3	Boone fine sandy loam.....	1, 344	. 3
Dodgeville silt loam.....	16, 128	3. 7	Buckner sandy loam.....	1, 344	. 3
Carrington silt loam.....	15, 360	3. 5	Fayette fine sand.....	704	. 2
Clyde silty clay loam.....	12, 992	3. 0	Dubuque silt loam.....	640	. 1
Lindley loam.....	4, 096	} 1. 0	Millsdale loam.....	640	. 1
Shallow phase.....	576		Jackson silt loam.....	640	. 1
Cass loam.....	4, 416	1. 0	Muck.....	512	. 1
Wabash loam.....	3, 840	. 9	O'Neill fine sandy loam.....	448	. 1
Clinton silt loam.....	3, 584	. 8	Judson silt loam.....	384	. 1
Wabash silty clay loam.....	3, 520	. 8	Genesee silt loam.....	384	. 1
Carrington fine sandy loam.....	3, 328	. 8	Plainfield fine sandy loam.....	192	. 1
Dickinson sandy loam.....	3, 200	. 7	Bremer silty clay loam.....	64	. 1
Millsdale silt loam.....	2, 176	. 5			
O'Neill loam.....	2, 048	. 5	Total.....	439, 040	-----

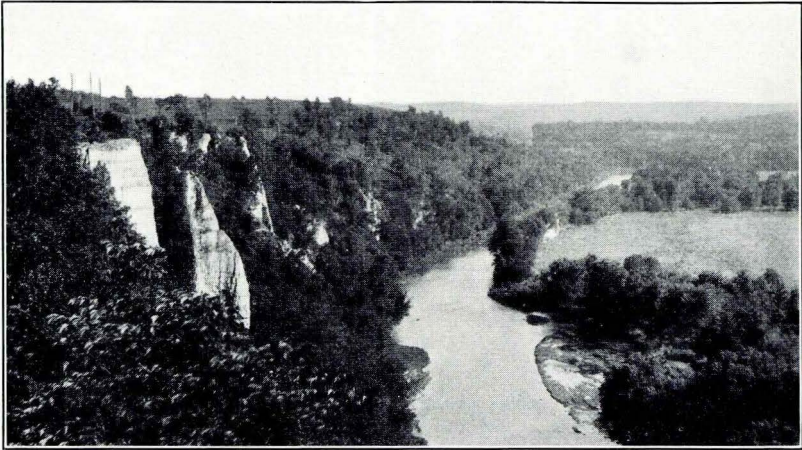


FIG. 1.—THE UPPER IOWA RIVER NORTH OF BLUFFTON

The creeks and rivers in the northern and eastern parts of the county have carved channels 200 to 400 feet deep in the limestone

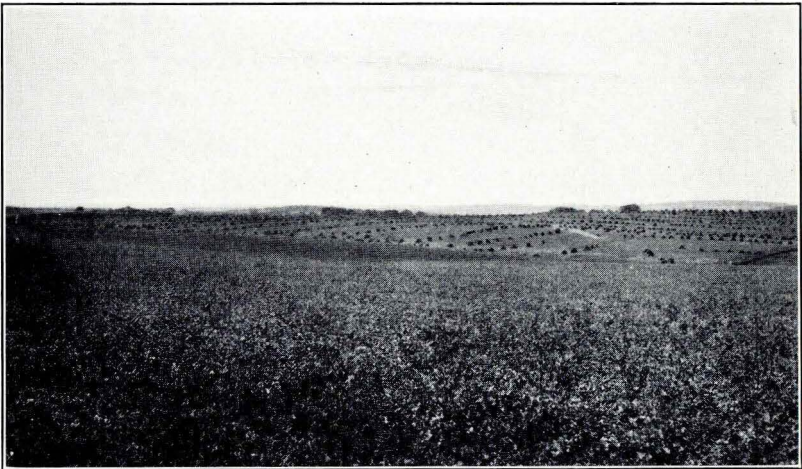


FIG. 2.—CLOVER AND OATS ON THE TAMA SILT LOAM NORTHEAST OF LOCUST

TAMA SILT LOAM

The Tama silt loam is a dark-brown, friable, smooth silt loam to a depth of 12 to 18 inches, where it grades into a dark-brown to brown silty clay loam, which passes abruptly at about 20 to 22 inches into a compact, friable, yellowish-brown silty clay loam to clay loam. The depth of the surface soil varies considerably. The more level or gently undulating divides or ridge tops show coloring from organic matter to a depth of 14 to 18 inches; on the hill slopes the surface soil varies from 4 to 10 inches in depth, with many patchy exposures of the light yellowish-brown subsoil. Locally in the flatter areas there are faint grayish mottlings in the lower subsoil below 30 inches and occasional iron stains. There is no grit in either soil layer, and the type contains no lime carbonate.

The Tama silt loam, a loessial soil overlying the old eroded Kansan drift, is developed in the northeastern and eastern two-thirds of the county. A line drawn from the center of Fremont Township on the western county line to Conover, and then straight south to the Fayette County line, roughly divides the loessial area from the younger Iowan drift. The drift dips into the southwest corner of Bluffton Township, the south and west sides of Madison Township, and barely touches the northwest corner of Springfield Township.

The Tama silt loam occupies the tops of the divides and the more gentle slopes over the entire loessial area. In Orleans and Madison Townships and the southwest corner of Bluffton Township the dark loessial covering is very thin, and in many places the Carrington soils are developed on the ridge points or hillsides. Iowan drift boulders are found on slopes at some distance from the Iowan drift border, probably having been carried by floating masses of Iowan ice during the glacial period. Near the boundary separating the drift and loess regions but within the loessial area are many prominent residual ridges, and flat upland residual benches adjacent to small streams. Where the topography becomes rolling to hilly along the Upper Iowa River, the Yellow River, and adjoining the more deeply cut drainage ways, a lighter-colored yellowish or grayish-brown loess soil, the Fayette silt loam, is developed. The boundaries between these two types are necessarily arbitrary, because of the gradual change of color from dark to light. The Tama silt loam differs from the Fayette silt loam principally in color, having more organic matter in the surface soil. The subsoil of the Tama may be slightly more compact.

The topography varies from almost flat to rolling. Along the east side of Hesper Township and in Highland Township there are a number of flat areas from 1 to 5 square miles in extent, along the outer edge of which a definite wall 30 to 100 feet high extends in semicircular fashion, the flat Tama area presenting the appearance of the bottom of a huge bowl. These flats are little dissected by drainage ways, usually only one stream cutting through or near the center and carrying the run-off. Over the remainder of the county the Tama soil ranges in topography from gently undulating on the wider interstream areas to rolling along drainage channels. Where the slopes are steep the surface wash has locally exposed the lighter

subsoil or underlying limestone. The highest elevations in the county are on this type, the highest point being west of Hesper, 1,360 feet above sea level.

The drainage in both soil and subsoil is good, except in a few of the flatter areas on the wide divides.

This type has a high humus content and excellent moisture-holding power. Where seed beds are carefully prepared and crops well cultivated drought does not seriously affect crops. Originally a luxuriant growth of native prairie grass covered this type. There was very little forest, except along the stream courses.

The Tama silt loam is one of the most important soil types in the county. About 95 per cent of it is improved, there being practically no waste land. Only a small part is used for pasture, since the rougher lands and stream bottoms associated with this type furnish sufficient pasture. Nearly one-half of the Tama silt loam is used for corn production. Oats, clover, clover and timothy, and a little wheat and barley constitute most of the other crops grown. (Pl. XXXVI, fig. 2.) The corn is ordinarily fed on the farm. The raising of dairy and beef cattle and hogs is the important livestock industry. Corn yields generally range from 30 to 60 bushels per acre. Yields of 75 to 80 bushels are often obtained on small acreages. Dairying is extensively developed. Some sheep and a few horses are raised. The acreage of oats is nearly that of corn and the yields range from 30 to 65 bushels per acre, averaging about 35 to 40 bushels. Timothy and clover yield about 1½ tons per acre. Considerable timothy seed is harvested. Small acreages of winter and spring wheat are grown. Alfalfa is grown in a few fields of 2 to 8 acres. Some barley is grown in place of oats in the rotation. Potatoes and small fruits are raised in small quantities and do well.

The soil is friable, mellow, and can be cultivated under a comparatively wide range of moisture conditions. Plowing, cultivation, and preparation of seed beds are usually well done. Although no fixed rotation is followed, the value of rotating crops is recognized and some rotation is usually practiced. Corn, corn, oats, clover, and timothy constitute a common rotation, generally covering a five-year period. A three-year system of corn, oats, and clover is also used. On tenant farms more corn is grown as a rule. Barnyard manure is commonly applied to pasture land, timothy sod, or oat stubble before plowing for corn.

Farms on this type are usually well improved. Land values have the usual wide range in selling price, governed by extent of improvements, location, distance from market, and condition of the soil.

Because of the extensive dairying, more manure is available than on the average farm, but not enough to keep up fertility to a maximum. At present hardly enough legumes are grown to supply this deficiency. More clover and alfalfa could be profitably grown. Where corn is used for hogging down, soy beans could be sown with the corn. Deeper plowing would improve the tilth of the soil and help eliminate wireworms, cutworms, and white grubs found in pasture and sod.

FAYETTE FINE SAND

The surface soil of the Fayette fine sand is a yellowish-brown uniformly fine sand. At 15 inches this passes into a slightly lighter

yellowish-brown fine sand, which in places may contain a few small pebbles and fine bits of quartz rock. Both soil and subsoil are uniform in color and texture and are not calcareous within 36 inches of the surface.

The Fayette fine sand is of little importance agriculturally because of its small extent. It occurs in small areas on the east bluffs southwest and northeast of Freeport, where it occupies a rather steep slope below a ledge of rough broken limestone outcrop which skirts the upper bluff line. Another area is in section 30 of Canoe Township. The drainage is thorough. The type is apparently derived from sand blown from the adjacent bottoms of the Upper Iowa River and laid down in its present position by the wind.

Most of this type is uncultivated or in grasses used exclusively for pasture. A few melons are grown on the lower talus slopes south of Freeport.

FAYETTE SILT LOAM

The surface soil of the Fayette silt loam is a grayish-brown or yellowish-brown smooth silt loam to a depth of 8 inches. Below this the texture becomes slightly heavier and the color slightly lighter to a depth of 20 inches, where the subsoil becomes a yellowish-brown, friable, light silty clay loam to clay loam, which is very crumbly and friable when dry. The soil and subsoil are of loessial origin and not calcareous.

The Fayette silt loam is widely developed in Winneshiek County. It occurs on the slopes and bluffs all along the Upper Iowa River and extending back along its tributaries. Large areas are developed along Canoe Creek. Smaller areas are found on the steeper slopes and ridges in the hilly areas along all the deeper valleys in the loessial area.

This type normally occupies the slopes and narrow ridge tops in steeply rolling, hilly, or broken country. (Pl. XXXVII, fig. 1.) Limestone outcrops are common throughout the type and range from precipitous to perpendicular exposures, 5 to 50 feet in height, along the deeper stream valleys. Originally practically all of the type was covered with a forest growth of elm, basswood, oak, cedar, birch, scraggy pine, hickory, and other hardwood trees. Only a scattered scrub-timber growth remains over most of the area.

A variation in both soil and topography occurs in Hesper and Highland Townships, where the type occupies flat interstream divides. Numerous limestone sinks are found over these areas, particularly in sections 21 and 28 of Hesper Township. These are from 10 to 30 feet across and 6 to 16 feet deep. Unlike the usual hilly region, these areas lie flat, having no natural run-off. The surface soil has a more ashen or grayish color than the typical developments, being a whitish gray when dry, the surface soil resembling the Marion soils of southeastern Iowa. The subsoil also differs in having a faint to pronounced grayish-brown mottling below 20 inches.

The areas of Fayette silt loam vary considerably in depth and color. The lower slopes of the forested areas and the more gentle ridge tops have a brown to almost dark-brown surface layer of 3 or 4 inches, owing to organic matter, leaf mold, and sod. This becomes incorporated with the soil proper in cultivation and assumes the typical lighter color. On the steeper slopes, where erosion is more

active, there are many patches of yellowish-brown clay loam to silty clay, the texture becoming heavier with the depth of erosion.

The drainage over this type is thorough and becomes excessive on the steeper slopes. The run-off is carried by many tributaries, which thoroughly dissect the topography. The valleys are deeply cut, V-shaped, with long and rather steep slopes. Limestone outcrops commonly fringe the tops of the slopes, or occur at the base, forming precipitous bluffs.

The typical soil is loose, friable, and easy to cultivate, except on eroded areas, where it is difficult to handle. Care must be exercised in plowing, cultivating, and cropping. Corn is generally grown only once in three years. Clover and mixed clover and timothy are grown for two years. Oats are commonly used as a nurse crop. Much of the steeper land is left in permanent pasture, and for that reason more beef and dairy cattle are raised on this type. No commercial fertilizer is used.

About 75 per cent of the type is in cultivation. Corn yields 30 to 50 bushels per acre, oats from 30 to 45 bushels, clover and timothy from 1 to 2½ tons per acre. Some barley is grown, yielding 20 to 35 bushels per acre. There are a number of small orchards, mostly of apple trees. Both tree and bush fruits do well.

The land values have a wide range, depending on such factors as location and the acreage of tillable and pasture lands.

The soil needs more organic matter. Turning under more green-manure crops and careful plowing and cultivation of the steeper slopes will help build up the soil and check erosion. Areas subject to erosion should be kept in grass as much as possible, and the steeper parts permanently.

CLINTON SILT LOAM

The Clinton silt loam differs from the Fayette silt loam principally in the subsoil. In the Clinton silt loam the subsoil is heavy, tenacious, and plastic, while in the Fayette silt loam it is lighter in texture and friable. The surface soil of the Clinton silt loam to a depth of 10 inches is a grayish-brown or yellowish-brown, smooth silt loam. This is underlain by a grayish-brown heavy silt loam to silty clay loam which changes at 20 inches to a yellowish-brown tenacious clay loam to clay. Faint gray mottlings and iron stains occur locally at depths near 36 inches.

This type occupies approximately 3,000 acres. It occurs in the southeast corner of the county in Bloomfield Township, extending slightly over the line into Frankville Township.

The topography is similar to that of the Fayette silt loam, being rolling to hilly and broken by short gullies. The land was originally forested with oaks, hickory, basswood, elm, and ash. Most of the timber has been removed and the type is largely in cultivation. The steeper eroded areas are used for pasture.

Handling of the soil, systems of cropping, and crop yields are similar to those on the Fayette silt loam. The need of this type is careful plowing and cultivation to prevent erosion and the incorporation of more green-manure crops to increase yields.

CARRINGTON FINE SANDY LOAM

The Carrington fine sandy loam to a depth of 14 inches is a dark grayish-brown or dark-brown, friable fine sandy loam. The subsoil from 14 to 30 inches is a brown to dark-brown fine sandy loam, just a shade lighter in color than the surface soil. This is underlain by a yellowish-brown gritty silty clay loam. There is textural variation in the surface soil in some areas. In section 26 of Fremont Township the texture ranges from loam to fine sandy loam, being spotted and containing more silt and coarse sand than the typical developments. Another area in section 34 of Lincoln Township is heavier in texture in both soil and subsoil, contains much coarse material, and is lighter in color than typical.

This type is developed mainly in small areas, ranging in size from 10 to 300 acres. These are scattered widely over the Iowan drift region. Most of them lie on the west side of Turkey River within 3 miles of the stream. They occupy the ridges or gentle hill slopes. Many small patches are included with the Carrington loam, being too small to show separately on a map of the scale used in this survey.

The Carrington fine sandy loam is practically all under cultivation. It is cropped about like the Carrington loam, with which it is closely associated. Ordinarily the yields are slightly lower than on the Carrington loam, but in seasons of abundant rainfall they are about the same. The soil is loose and easy to cultivate under a wide range of moisture conditions.

The greatest need of this soil is organic matter to increase the moisture-holding capacity and furnish plant food. This can be supplied by growing and plowing under green-manure crops.

CARRINGTON LOAM

The surface soil of the Carrington loam is a mellow dark grayish-brown loam, containing much fine sand, which extends to a depth of 14 inches, where it passes into the subsoil of brown to yellowish-brown silty clay loam. At 20 inches this in turn changes to a lighter yellowish-brown silty clay to clay loam. The entire soil profile contains considerable fine sand and some coarse sand and gravel.

The texture varies locally, ranging from a loam to nearly a sandy loam, the latter condition being common where the type adjoins the poorly drained and depressed bodies of Clyde silty clay loam, interspersed thickly through the drift area. Small granite and quartzite bowlders are present in places. Originally they were widely scattered over the drift area, but most of them have been removed from the cultivated fields. Pockets of yellowish-brown gravelly sand or sandy gravel are found on slopes and shoulders of some hills. The substratum 4 or 5 feet below the surface is a yellowish-brown heterogeneous mixture of ground-up lime and sandstone, with fragments of shale, limestone, and granite, and is highly calcareous. An acid condition exists, however, to a greater or less degree to a depth of 3 feet, the original calcareous materials having been removed by weathering and leaching.

The Carrington loam is the predominating upland glacial-drift soil and is developed only on the western side of the county. The

boundary of the Iowan drift extends roughly from the exit of Turkey River on the southern county line, north along the river to Fort Atkinson, then northward to Conover and northeastward to the southwest corner of Decorah Township, then generally north-westward toward Kendallville. This type is most extensively developed west of the Turkey River, and south of Walnut Creek in Madison and Lincoln Townships. Small isolated areas occur 1 mile northwest of Festina, $1\frac{1}{2}$ miles east of Fort Atkinson, and one-half mile southwest of Conover.

The surface of the type is characterized by gently rounded undulating hills with long slopes descending to shallow and almost sloughlike drainage lines, which are not more than 10 to 60 feet below the original surface of the plain. (Pl. XXXVII, fig. 2.) The natural drainage of the Carrington loam is good.

Originally the type supported a luxuriant growth of prairie grass. Most of it is now in cultivation, there being practically no waste land. Along the stream courses in a few of the rougher areas a scattered timber growth covers the slopes. A few groves, mostly of trees planted for windbreaks, are found around farmsteads.

Corn is the principal crop. It is largely fed to hogs and beef cattle. The yield ranges from 30 to 65 bushels per acre, with an average of about 37 bushels. About 25 per cent of the oats is sold, the remainder being fed. Wheat is not an important crop. Timothy and clover are the principal hay crops and yield from 1 to 2 tons per acre. Potatoes do fairly well and yield around 100 bushels per acre. Alfalfa and soy beans are grown on small acreages, which could be profitably extended. A few orchards, principally small farm plantings, are found. Dairying is carried on, but is less important than formerly.

Systematic crop rotation is practiced to a limited extent. A four-year rotation of corn, corn, oats, and clover is used most commonly. Fall plowing is practiced as much as possible. Oats are sown broadcast on disked corn land. Barnyard manure is applied as a top-dressing to pastures and clover sod. Practically no commercial fertilizer is used. Lime has been used on a few farms with excellent results.

The selling price of the Carrington loam is variable, depending largely on improvements, condition of the land, and distance from shipping points.

Over most of this type the incorporation of additional organic matter would be beneficial. The growing of more legumes should be practiced systematically. Alfalfa could be successfully grown with proper inoculation and liming. This type is acid, both in the soil and subsoil, and limestone applications would be beneficial.

CARRINGTON SILT LOAM

The Carrington silt loam to a depth of 12 inches is a dark-brown mellow silt loam containing considerable fine sand. The subsoil is a brown to yellowish-brown silty clay loam to a depth of 24 inches, where it changes to a yellowish-brown silty clay to clay loam. Some faint yellowish brown mottlings are found below 30 inches. The

subsoil contains considerable fine sand and some gravel, the content of grit increasing with depth.

The Carrington silt loam is not extensive. The parent material was a mixture of loessial and drift material, found where the loess is very thin over the drift. The loess predominates in the surface soil and the sandier, gritty drift material in the subsoil. The largest areas of this type are in Lincoln, Bluffton, and Orleans Townships, and in scattered bodies north and east of the Turkey River between the Turkey and Upper Iowa Rivers. A few small scattered areas lie about a mile west of Turkey River. In the areas north of Walnut Creek the soil is derived from a deeper loess and is siltier, but normally contains more sand and grit along the stream slopes. Where developed largely on loessial material, it grades into the Tama silt loam and the soil boundaries between these types are necessarily arbitrary. The surface soil is moderately high in organic matter. Drainage is good.

Most of the Carrington silt loam is under cultivation to field crops. Some scattered timber is found, largely on the steeper slopes adjacent to and near stream courses. The soil is easy to cultivate. The yields compare favorably with those on the Tama silt loam. The methods of handling and improving the Tama silt loam are applicable to the Carrington silt loam.

CLYDE SILTY CLAY LOAM

The Clyde silty clay loam is a black, heavy, plastic silty clay loam or clay loam to a depth of 6 inches. From 6 to 20 inches the soil is a dark-brown to black clay or clay loam, adobelike when dry. The lower subsoil from 20 to 36 inches is an olive-gray or grayish-brown, plastic silty clay or clay, mottled somewhat with brown, yellowish-brown, and gray, and with occasional rusty brown iron stains. In places the surface soil contains fine quartz particles washed in from the surrounding higher drift areas, in some places to such an extent that the surface soil at the outer edge adjacent to the Carrington loam is a heavy coarse loam to a depth of 2 or 3 inches. Locally a yellowish-brown sandy loam is encountered below 30 inches. Small patches having a surface layer of muck, 2 to 6 inches in thickness, are scattered through the Clyde silty clay loam areas, but it was not possible to show these areas on the soil map.

The Clyde silty clay loam is developed in small flats and depressions within the Carrington silt loam and Carrington loam areas and comprises the upper parts of indefinite drainage channels, the soil extending in fingerlike lobes well up the gentle slopes of the Carrington soils. As the topography indicates, the type is poorly drained and must be tilled out thoroughly to insure good crop production.

Only a small proportion of the Clyde silty clay loam is under cultivation. Boulders and cobblestones of assorted sizes are numerous over the surface and within the soil profile. The surface boulders have been removed in the cultivated areas. A heavy growth of coarse water grasses covers the unreclaimed portions; this is cut and furnishes a coarse hay.

The soil is inherently fertile, high in organic matter, and where well tilled, under favorable moisture conditions furnishes a mellow seed bed and produces excellent corn and hay crops. Small grain is

likely to grow rank and lodge in wet seasons. Care must be taken not to work the soil when too wet, or it will clod and bake. Corn will yield 35 to 65 bushels per acre on well-tiled and well-cultivated areas. Hay crops produce $1\frac{1}{2}$ to 3 tons per acre. The soil is farmed with the closely associated Carrington types, as it usually occupies only a small part of the farm unit.

Efficient tile drainage is the first need on this type. The incorporation of crop residues and green manure to give better aeration, improve the tilth, and increase the supply of available plant food, would also be beneficial.

LINDLEY LOAM

The Lindley loam surface soil consists of 10 inches of light-brown to brown gritty loam containing a high percentage of very fine sand. This passes into a reddish-brown or yellowish-brown gritty silty clay loam containing much medium and coarse sand and a little gravel. The content of organic matter is low in most areas.

The largest areas of the type are in Sumner Township, 2 and 3 miles, respectively, northwest of Spillville. A fairly large area lies $1\frac{1}{2}$ miles west of Jackson Junction. Smaller areas extend across the line from Fayette County in the southwestern corner of Jackson Township. Other small areas of from 10 to 50 acres are widely scattered on the slopes along Turkey River, and occasional small areas along the creeks and their tributaries over the entire county. In section 14 of Bluffton Township the soil is more sandy than typical and some rock outcrop occurs close to the river.

The Lindley loam has a topography ranging from gently to steeply rolling. Its occurrence is restricted largely to slopes along stream courses. The drainage is good on the gentle slopes and excessive on the steeper slopes. The land was originally forested.

Probably about 35 per cent of the type is under cultivation. The remainder is covered with a thin and scattered timber growth and is used for pasturing livestock. The staple farm crops do well. Yields are usually somewhat lower than on the Carrington loam except in a few small acreages which have been built up with clover and barnyard manure.

The principal need of this soil is the growing of more legumes and green-manure crops to supplement the barnyard manure. The steeper slopes should be kept in grass and pastured.

Lindley loam, shallow phase.—The surface soil of the Lindley loam, shallow phase, to a depth of 12 inches is a yellowish-brown friable silt loam containing a relatively high percentage of silt. There is considerable textural variation in the surface soil, fine and coarse sand being irregularly scattered through the surface layer. In places pockets 20 to 30 feet across have the texture of a coarse sandy loam. The surface soil when dry has a light-grayish or light-yellowish appearance in the field. Below 12 inches and extending to about 30 inches is a tenacious yellowish-brown clay loam, with considerable coarse sand, small pieces of rock, and grit incorporated. At 30 inches limestone rock is usually encountered. Coarse gravel pockets are sometimes found at this lower depth. The heavy clay subsoil appears to be residual material. This phase differs from

the typical Lindley loam mainly in a heavy residual lower subsoil and a shallower depth to bedrock.

This phase is restricted to the southwest corner of the county and has a small total area. It occurs on the typical Iowan drift sheet and lies on the Chickasaw-Winneshiek County line in sections 19 and 30, Jackson Township, 2½ miles west of Jackson Junction. A small, flat, benchlike area lies just south of Little Turkey River, in section 30, Jackson Township. The topography generally is undulating, similar to that of the adjacent Carrington loam. The natural drainage is fair.

The Lindley loam, shallow phase, is all in cultivation. It is farmed and cropped very much like the closely associated Carrington loam and produces about the same crop yields. The nearness of the limestone to the surface apparently does not make the soil droughty, except in extended periods of dry weather. This land was formerly forested with hardwood trees, mostly oak, hickory, and ash. Improvement of this soil can be brought about by the addition of organic matter through green-manure crops and barnyard manure.

DICKINSON SANDY LOAM

The Dickinson sandy loam has a surface horizon consisting of dark grayish-brown coarse sandy loam containing some gravel. This is underlain at 8 to 10 inches by a yellowish-brown coarse loam containing a high percentage of fine sand. Below 18 to 24 inches a very coarse sandy gravel is encountered, the gravel ranging from medium coarse to the size of walnuts, with occasional small granite bowlders.

A variation occurs along the Chickasaw County line in the southwest corner of the county in Sumner and Jackson Townships. Here the subsoil from the 12-inch to the 30-inch depth is a yellowish-brown, coarse, gravelly silty clay loam, underlain by a yellowish-brown, coarse gravelly sand. The surface soil also has a higher proportion of silt than the typical surface soil and ranges in texture from a loam to a sandy loam.

The Dickinson sandy loam is developed in small areas in the drift region. With the exception of three small areas on the southern Madison Township line, it is all confined to the four southwestern townships, Calmar, Jackson, Washington, and Sumner, most of it being in Sumner Township.

The Dickinson sandy loam occupies the undulating to rolling uplands and short hill slopes along the smaller streams. The drainage is good to excessive, because of the open soil structure. In long dry periods the crops suffer somewhat. In a few places on the steeper slopes erosion has carried away most of the surface soil, leaving a covering of only 3 or 4 inches, with gravel exposed in places.

Nearly all of the type is in cultivation to common field crops. Only on slopes adjacent to stream courses is there any timber. The type is closely associated with the Carrington soil types. Crop yields are good in favorable seasons and are comparable to those on the Carrington fine sandy loam. Incorporation of organic matter through the plowing under of green manure is important for increasing the moisture-holding capacity and also the supply of plant food, which is rather rapidly leached away because of the porosity of the soil. This type usually covers only a small part of any farm.

DUBUQUE SILT LOAM

The Dubuque silt loam is a residual soil, characterized by a shallow soil horizon, from 6 to 8 inches deep, of a grayish-yellow or light yellowish-brown color, overlying sandstone or limestone. The soil is purely residual, derived mostly from sandstone, and is noncalcareous.

This type covers a small total area in this county. The largest typical development is in section 17, Madison Township; others are in sections 19 and 20, Calmar Township, east of Spillville; sections 1 and 12, Calmar Township; section 30, Bluffton Township; and section 7, Springfield Township. Several areas too small to map are scattered through sections 24 and 30, Bluffton Township. The soil is developed on the upper rounded shoulders of the hill slopes and across the undulating ridge tops.

The Dubuque silt loam is used mostly for small-grain and hay crops. Because of the shallow soil the crops are subject to injury by drought. This land is farmed with other soil types, as the areas are very small and closely associated with the Dodgeville and Tama silt loams.

Small areas of a deeper residual soil have been included with this type. The soil to a depth of 10 inches is a heavy brown silt loam to silty clay loam, free from sand particles or grit, and is underlain by a yellowish-brown tenacious clay, which under normal field-moisture conditions appears faintly mottled with brown. This subsoil layer rests on a limestone bed at depths of 18 to 30 inches. This variation occurs only in the extreme southwest corner of the county in sections 19, 29, and 30, Jackson Township, on each side of Goddard Creek, and has a total area of less than 200 acres. It is purely a residual soil derived from limestone. The surface is flat with a very gentle slope toward the stream courses. The surface drainage and the under-drainage appear to be adequate. This land is all in cultivation to field crops.

BOONE FINE SANDY LOAM

The surface soil of the Boone fine sandy loam to a depth of 6 inches is a light-brown to medium dark-brown fine sandy loam. This passes into a light yellowish-brown fine sand to very fine sand, which grades at 15 inches into a pale-yellow fine to very fine sand, appearing almost white in the sunlight when dry. The darker-brown coloring in the surface soil is due to the presence of organic matter accumulated through the growth of grass and its subsequent decay. The St. Peters sandstone, the parent rock from which the soil is derived, is exposed in many places in the northern half of the county; it is whitish or pale yellow in color. The soil covering is variable in depth, ranging from 3 to 4 inches at the upper shoulder of the slope to $2\frac{1}{2}$ to 4 feet toward the base.

The type has a small total acreage and occurs mainly in small exposures. It occupies the lower slopes adjacent to streams and the slopes of residual limestone ridges, the limestone usually overlying the sandstone on the ridge crest.

The largest area is on a high upland ridge one-half mile east and northeast of Freeport. Other areas are in sections 7, 8, and 18, Highland Township; section 11, Hesper Township; section 31, Cal-

mar Township; section 6, Washington Township; sections 1, 2, 7, 8, and 17, Glenwood Township; and sections 1, 3, 4, 14, 20, and 29, Pleasant Township. Small areas occur along Trout Run in Decorah Township. In sections 7 and 8 of Glenwood Township the soil seems to be in part residual and in part wind blown. On the lower slope the soil is deeper and appears like washed talus material or wind-blown material. Strips are mapped with and below Rough stony land along the lower slopes on the upper fork of Canoe Creek and along the Upper Iowa River between the Upper Dam and Lower Dam.

This soil is of minor importance agriculturally, because of its small extent, and is most valuable for pasture. The large area on the high upland ridge east and northeast of Freeport is farmed and cropped like the Carrington loam. The other areas support a growth of grass and most of them are used for pasture.

DODGEVILLE SILT LOAM

The Dodgeville silt loam is a very dark brown to black heavy silt loam to silty clay loam to a depth of 8 inches. Under this is a layer of dark-brown to black, light silty clay loam from 12 to 24 inches in thickness, which rests on limestone. Where the limestone lies at a depth of nearly 3 feet there is usually an inch or two of buff or light yellowish-brown silty clay or clay, often with a bluish-green or drab mottling, directly on the limestone. Small irregular limestone fragments, ranging in size from a pea to a 6-inch rock or slab, are scattered through the soil horizon, largely in the first 10 inches. In places a small amount of coarse sand is encountered in the surface layer and extending to a depth of 10 or 12 inches, particularly near the edge of the Iowan drift. The soil mass, excepting the extreme lower part and the incorporated bits of limestone, rarely gives a calcareous reaction.

On some of the ridge tops and slopes the soil is shallow and contains more and larger limestone fragments than are usually found. In places on the shoulders or crests of the ridges and in spots on the slopes the soil consists of light-yellow or buff-colored silt loam, which is only 4 to 6 inches deep and is derived from sandstone. This is identical with the Dubuque silt loam, but the spots were too small to show on the map.

The Dodgeville silt loam is the most important and extensive of the residual upland soils in the county. The largest areas are in Calmar and Madison Townships near or adjacent to drainage ways on the upland ridges and slopes. Small isolated areas occur throughout the county. In some of these the soil is slightly mixed with loess at the surface. An area in section 20, Decorah Township, has a considerable proportion of loess in the surface soil. A large area occupies some of the tops and gentle sloping sides of long high ridges 5 miles northeast of Calmar. Soil of heavier texture is found in sections 7 and 8, Calmar Township; three small areas in sections 22 and 23, Madison Township; and 1 mile north of Fort Atkinson.

The topography is gently undulating to gently sloping as a rule. The drainage is somewhat deficient, except on the slopes adjacent to small stream courses, where the run-off is good, and sometimes is excessive and causes erosion.

The Dodgeville silt loam is farmed to the same crops as the adjacent upland types. Usually only a small acreage of this type is found on one farm. Corn ordinarily yields 25 to 50 bushels per acre. Oats yield 20 to 45 bushels per acre. Clover and timothy make a good growth on most of the type.

The Dodgeville silt loam must be handled under proper moisture conditions, as it is inclined to bake or clod. In other respects the handling and cultivation may be similar to that employed on the Carrington silt loam.

JACKSON SILT LOAM

The surface soil of the Jackson silt loam is a grayish-brown or grayish yellow-brown, smooth silt loam, 8 inches deep. This changes to a yellowish-brown to buff silty clay loam, which passes at 15 inches into a lighter-colored but more compact yellowish-brown clay loam. The lower subsoil is somewhat friable and similar to the subsoil of the Fayette silt loam. Spots or pockets of mixed sandy materials occur here and there over the type, usually close to the stream course or overflow land. In a few places fine sandy material has been washed down from the adjacent slope and accumulated in a thin layer of 2 to 5 inches in strips or patches at the back of the bench near the slope.

The Jackson silt loam is developed mainly along the Upper Iowa River, beginning 1 mile east of Bluffton, on the terrace benches in small scattered areas well above overflow, extending down the river as far as its exit from the county. A few small areas are found along Canoe Creek and one along a small tributary of the Upper Iowa River in section 21, Glenwood Township. The largest area is on a high eroded bench about 30 feet above the river channel, $2\frac{1}{2}$ miles northeast of Freeport. Other areas are in section 12 of Decora Township and section 36 of Pleasant Township.

The type is flat with an almost imperceptible slope toward the stream. The surface is unbroken except for the courses of small streams from the upland and occasional slight erosional marks along these dissecting channels. The drainage is fair.

The Jackson silt loam is all under cultivation to the common crops. The yields are slightly lower than those on the Judson silt loam. Corn produces 25 to 45 bushels per acre normally, and oats from 20 to 40 bushels per acre. Clover and timothy do well and yield 1 to $1\frac{1}{2}$ tons per acre.

The greatest need of this type is the incorporation of more organic matter. Green manures should be used to supplement available stable manure. The soil is usually slightly acid throughout the 3-foot section.

O'NEILL SANDY LOAM

The surface soil of the O'Neill sandy loam to a depth of 8 inches is a dark-brown loose sandy loam containing considerable coarse sand and some gravel. The upper subsoil is a light-brown to brown coarse sandy loam or gravelly loam. Large quantities of coarse gravel and small rock fragments are found in the soil layers. The subsoil below 20 inches is a heterogeneous mixture of sand and gravel.

The O'Neill sandy loam occurs in small scattered areas, largely along Turkey River and its tributaries. Two very small areas lie along Little Turkey River and a few small bodies lie along the Upper Iowa River.

This type is a second-bottom soil, situated well above overflow. The topography for the most part is flat, with a few low ridges formed by wind action. Drainage is thorough because of the loose structure, and the soil is very droughty in dry periods. It is cropped and handled much the same as the O'Neill loam. The organic-matter content is low, and legumes should be grown to increase the fertility and the moisture-holding power.

O'NEILL FINE SANDY LOAM

The O'Neill fine sandy loam to a depth of 10 inches is a dark-brown to dark grayish-brown fine sandy loam. This gives way to a yellowish-brown fine sandy loam to sandy loam, which passes at 20 inches into a yellowish-brown, coarse gravelly sand. There is the usual textural variation found in most sandy terrace soils. The surface soil ranges from a very fine sandy loam to the typical fine sandy loam texture. In a few spots the gravelly subsoil material occurs in pockets and comes within 10 to 12 inches of the surface.

The type is practically restricted to the Turkey River and its tributaries in the drift region. The largest development is northwest of Spillville. The areas are small, isolated, and usually only a few feet above the first bottoms. In periods of extremely high water, small parts of some of the areas may be inundated for 12 to 24 hours.

All of this type is under cultivation, being devoted to field crops or pasture grasses. The soil is mellow, friable, and easy to cultivate. The drainage is good, and during prolonged periods of dry weather it is droughty. It is farmed and handled like the O'Neill loam.

The addition of organic matter through growing more green-manure crops is the principal need. Liming would be beneficial for growing clover and alfalfa.

O'NEILL LOAM

The surface soil of the O'Neill loam to a depth of 8 inches is a brown to dark-brown mellow loam containing a relatively high percentage of fine sand. The subsoil from 8 to 28 inches is a yellowish-brown or light-brown sandy loam. Below 28 inches a yellowish-brown sandy loam to sandy gravel is encountered. This layer contains much coarse, assorted, waterworn gravel, which is bedded so compactly as to be almost impenetrable with a soil auger. Large gravel and small boulders are frequently found in the lower soil horizon and occasionally scattered through the upper subsoil and surface soil.

The O'Neill loam is a terrace soil. It is most extensively developed in the western part of the county along Turkey River and its larger tributaries. Other areas lie along Little Turkey River and a tributary in the extreme southwestern corner of the county. A

few narrow strips lie along the Upper Iowa River between Freeport and the Lower Dam.

This type lies well above overflow on distinct benchlike terraces, 5 to 20 feet above the normal stream level. The drainage is good. In periods of light rainfall, the crops may be affected by drought.

Corn, oats, and hay are the leading crops. Corn yields 25 to 50 bushels per acre, depending on seasonal conditions. Following a green-manure crop, an appreciable increase in yield is noticeable. Oats yield 20 to 40 bushels per acre. A few melons and truck crops are grown on this type, mostly in the vicinity of Freeport; these yield well. As a rule this type occupies only a small part of a farm.

The content of organic matter is low because of the porosity of the soil and consequent susceptibility to leaching. Large applications of barnyard manure and more frequent growing of green-manure crops are needed to insure and increase crop yields. As the soil and subsoil are both acid, crushed limestone would be beneficial, especially in growing clover.

BUCKNER SANDY LOAM

The surface soil of the Buckner sandy loam is a brown, incoherent sandy loam containing much coarse sand and some gravel. The subsoil below 8 inches is a yellowish-brown sandy loam containing some coarse material to a uniform depth of 28 inches; here the lower subsoil becomes a lighter yellowish-brown loamy sand to sand containing occasional bits of gravel.

The Buckner sandy loam is restricted to the terraces of the Upper Iowa and Turkey Rivers and the tributaries of the latter. The benches lie 5 to 15 feet above the stream course. They are smooth and nearly level, except for a few shallow and narrow ridges formed by wind action.

The internal drainage is good to excessive, owing to the porosity and open structure of the soil. In extremely dry weather crops on the type are affected materially, but with seasonable precipitation good crop yields are obtained.

The Buckner sandy loam is all under cultivation. Corn yields 25 to 45 bushels per acre and oats 25 to 40 bushels. Timothy and clover give fair returns. This soil is adapted to growing truck crops. It is much earlier than the heavier upland soils. As the individual areas are small, the land is farmed with other soil types.

As the incoherent structure would indicate, this type is deficient in organic matter. Turning under green-manure crops occasionally to supplement the available barnyard manure should be beneficial.

BUCKNER LOAM

The Buckner loam consists of 15 inches of a dark-brown friable loam, underlain by a brown to light-brown sandy loam to loamy sand. The surface soil varies in texture from a heavy loam to almost a sandy loam. The subsoil is nearly uniform in texture, occasional small pockets of coarse sand and gravel being encountered. Both soil layers are low in lime.

This terrace soil is developed commonly along all streams of any size in the drift region and along the Upper Iowa River. Two areas in sections 9 and 16, Glenwood Township, are lighter in color than the typical soil, being a lighter brown in both soil and subsoil. These occupy higher positions, from 15 to 20 feet above the stream channel, and contain a higher percentage of silt, being almost a silt loam toward the bench edge bordering the first bottom. Small areas in sections 15, 27, and 34, Washington Township, and sections 30 and 32, Calmar Township, along Turkey River, contain a high percentage of fine sand and approach a fine sandy loam in texture. The flat terrace benches slope gently toward the stream, and generally lie 4 to 8 feet above the first bottoms. The drainage is good.

The Buckner loam is practically all under cultivation. Yields ordinarily compare favorably with those of the Carrington loam, but in periods of drought or irregular rainfall the yields are appreciably lower. The soil is easy to handle and cultivate under a wide range of moisture conditions. Usually only a small acreage is included in an individual farm.

The soil can be improved by growing more green-manure crops and making larger applications of barnyard manure. Liming will benefit legume crops.

JUDSON SILT LOAM

The Judson silt loam to a depth of 20 inches is a dark-brown to black friable silt loam, containing varying proportions of very fine sand. The subsoil below 20 inches is a dark-brown to black, friable, heavy silt loam to a light silty clay loam, in color only a shade lighter than the surface layer.

The most typical and largest development is along Trout Run. Other small isolated areas occur widely scattered along the Turkey and Upper Iowa Rivers and a few of their tributaries.

There is considerable variation throughout this type in both soil and subsoil. Many small pockets and short wavelike ridges contain a high percentage of very fine sand in surface and subsurface layers and approach a loam in texture. Along the Upper Iowa River, southeast of the fair grounds at Decorah, the subsoil is lighter in texture than the surface soil, being a loam to very fine sandy loam. An area at the northern edge of Decorah is similar in texture.

The Judson silt loam occurs in small units on terraces or second bottoms. The surface is flat, with a few slight irregularities due to cutting and deposition of colluvial wash by small upland streams. These either cut narrow channels through to the main drainage or form alluvial deposits spreading out in fan shape where they empty on the terrace bench.

These terraces lie from 4 to 8 feet above the streams, and in periods of excessive floods parts of the benches, particularly along Trout Run, may be inundated for 10 to 15 hours. The natural drainage is good in both soil and subsoil.

The Judson silt loam is all under cultivation. It is naturally high in organic matter, and produces yields comparable to those on the Tama silt loam of the upland. It is cropped more continuously to corn than the upland soils. The general need of this type is to maintain and increase productiveness through systematic growing of clover and turning under an occasional green-manure crop.

PLAINFIELD FINE SANDY LOAM

The Plainfield fine sandy loam is a uniformly light-brown to brown fine sandy loam to a depth of 24 inches, below which it is a yellowish-brown fine sand, uniform in texture.

The largest individual area, containing about 80 acres, is on a high terrace, 30 to 50 feet above the river, just north of Spillville. The surface texture here is nearly a loam. A few small bodies are mapped along the Upper Iowa River, the largest lying one-half mile north of Freeport. The Decorah Country Club golf course covers part of this area. The surface texture in this development ranges from fine sandy loam to fine sand. The surface is somewhat ridgy and has a definite slope to the northwest. In the southern part of this bench a coarse gravelly clay loam drift is encountered at a depth of about 3½ feet. The base of the terrace bench here seems to be Iowan drift material, probably deposited by masses of floating ice during the glacial period, the sandy covering having been deposited by wind or water at a later period. Other small areas are found in sections 7 and 8, Glenwood Township, and section 36, Pleasant Township.

Included with this type is an area adjoining the Fayette County line in section 32, Jackson Township, which is adjacent to an area of Plainfield loam, as mapped in Fayette County. The soil is a grayish-brown, friable fine sandy loam about 8 inches in depth, passing into a yellowish-brown or light-brown fine sandy loam, underlain at 26 inches by a bed of stratified sand. It lies about 12 feet above the stream channel and has a smooth surface sloping gently toward the river.

The Plainfield fine sandy loam covers a small total area and is of little importance agriculturally. Except for the area occupied by the country club grounds, all is in cultivation. Crop yields are extremely variable, depending on rainfall and seasonal variations. The soil is droughty in dry periods and the drainage is excessive. However, the type has exceptional moisture-holding capacity considering the loose and open structure of the soil.

The greatest need of this type is for organic matter to increase the fertility and moisture-holding capacity and check the tendency of surface drifting. Lime would be beneficial in growing legumes.

MILLSDALE LOAM

The Millsdale loam to a depth of 10 inches is a dark-brown to black, loose loam containing much fine sand. At 10 to 12 inches there is an abrupt change, the subsoil being a reddish-brown sandy loam or fine sandy loam containing considerable coarse sand. Underlying these soil horizons is a floor of stratified limestone at depths varying from 24 to 34 inches, averaging about 30 inches.

This type occupies terrace positions, generally 15 to 20 feet above overflow. Most of it is on the west terraces of the Turkey River, 2 and 3 miles south of Fort Atkinson, about 20 feet above the stream course. There is a fair-sized area southeast of Festina. In section 18, Orleans Township, at the Howard County line along a small tributary of the Upper Iowa River, there is a small area that slopes toward the stream course and merges gradually with the bottom

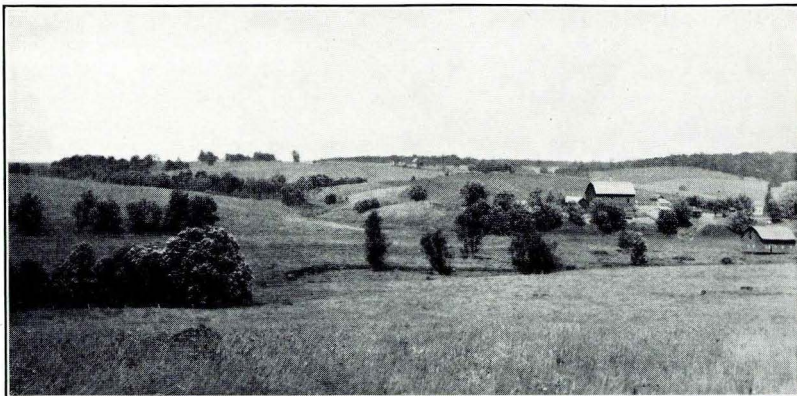


FIG. 1.—TOPOGRAPHY OF THE FAYETTE SILT LOAM NORTHWEST OF CALMAR
A scattered growth of scrub trees, mostly oak, is found along the draws over much of this land

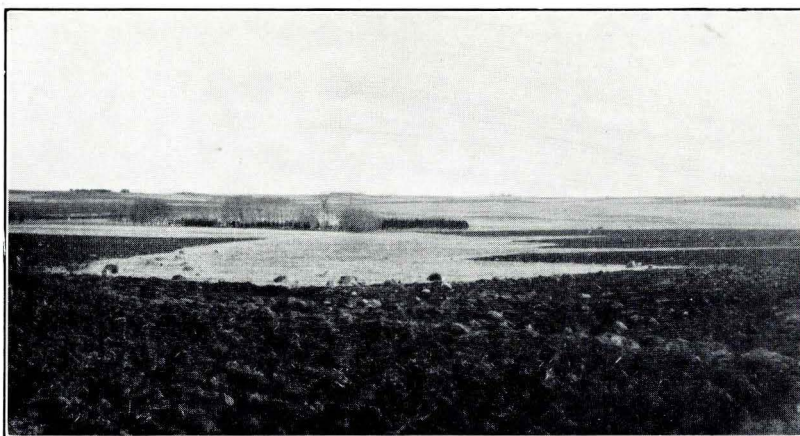


FIG. 2.—CARRINGTON LOAM AND CLYDE SILTY CLAY LOAM
Points or fingers of Clyde silty clay loam extend well up the gentle slopes of areas of Carrington loam. In these nearly flat draws are many large granite boulders

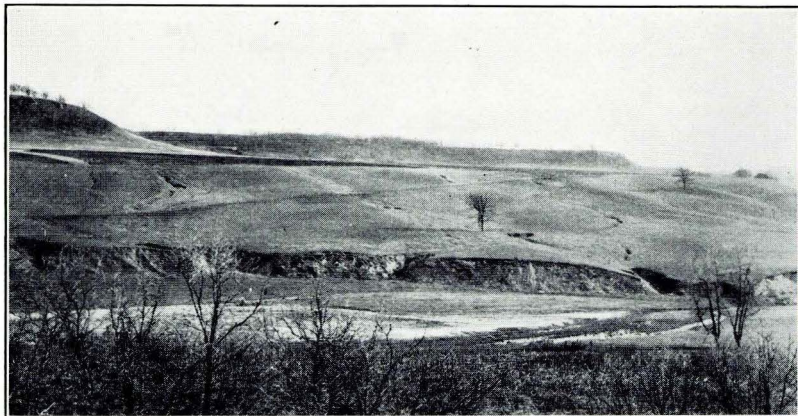


FIG. 1.—MILLSDALE SILT LOAM ON A FLAT TERRACE OVERLYING LIMESTONE



FIG. 2.—PASTURE LAND ALONG A SHORT DRAINAGE WAY

A narrow strip of Wabash silt loam in the foreground and a rough slope in the background on which occurs Dodgeville silt loam

land, so that the soil boundary between them is arbitrarily placed. Another small area is in section 7, Glenwood Township. The surface of the type is generally flat and nearly level, the area in Orleans Township on the Howard County line being an exception.

Because of its small total area, the Millsdale loam is unimportant agriculturally, although it is all under cultivation. The soil is fairly high in organic matter and normally produces yields comparable to those on the Carrington loam of the uplands. The type has fair natural drainage. Only in a few places, where the limestone comes within 12 to 15 inches of the surface, is there any tendency to droughtiness in normal seasons.

MILLSDALE SILT LOAM

The Millsdale silt loam is characterized by a dark-brown to almost black heavy silt loam to a depth of 15 inches. The upper subsoil is a brown to dark-brown heavy silt loam containing small pieces of white quartz or limestone. When dry the subsoil near the parent limestone has a reddish or chocolate-brown color. The soil lies on a solid limestone bench at a depth of 24 to 30 inches. In places there is a layer of 3 to 4 inches of rotten limestone directly on the limestone bench and underlying the soil layer. There is considerable variation in the texture, the range being from a light silt loam to a light silty clay loam. The heavier-textured parts are usually small pockets or strips which are very slightly depressed and are too small to show separately on the map. Considerable sand is incorporated in the surface soil in places. Small areas of Millsdale loam, too small to show separately, also occur throughout the type.

The Millsdale silt loam is found chiefly in the south-central part of the county. Nearly all of it lies south and southeast of Fort Atkinson along Turkey River and extends up Brockcamp Creek to Festina, which is built in part on this soil. The areas occupy flat terrace benches 20 to 30 feet above the stream. (Pl. XXXVIII, fig. 1.)

This type is practically all in cultivation to the staple crops. In a few places the limestone floor comes within 4 to 6 inches of the surface, and such spots are inclined to be droughty. The soil is relatively high in organic matter and produces crop yields comparable to those on the better upland soils. The moisture-holding capacity is good and the natural drainage fair. The general need of this type is to maintain the organic content by the use of green-manure crops.

WAUKESHA SILT LOAM

The surface soil of the Waukesha silt loam is a dark grayish-brown to black, mellow, friable silt loam, which passes at 18 inches into a light-brown silty clay loam to clay loam, uniform in color. At about 24 inches the subsoil changes to a yellowish-brown or light yellowish-brown clay loam. The lower subsoil below 30 inches contains occasional yellowish-brown or gray mottlings and some iron stains.

The usual occurrence of this type is in small disconnected areas occupying benches 6 to 15 feet high which slope gently streamward. It usually lies a few feet above and back of the sandier O'Neill and

Buckner soils on benches adjacent to the first bottoms. Small benches are found along Turkey River, a few of its tributaries, a tributary of Walnut Creek, along the Upper Iowa River at Kendallville and Plymouth Rock, and on tributaries of the Upper Iowa River north of Plymouth Rock. The terrace $1\frac{1}{4}$ miles northeast of Plymouth Rock, along a small creek, is very old and somewhat indistinct, and the surface soil here ranges from a silt loam to nearly a loam. In section 1, Sumner Township, a small area has a gray, mottled subsoil resembling the Bremer subsoil. Dry Run has cut its bed deeply into the limestone terrace floor through Decorah. The channel is crooked and has no first bottom here. The Waukesha silt loam terrace upon which a large part of the town is built is subject to overflow for a few hours after freshets in the valley along Dry Run, but this occurs only about once in three or four years. The subsoil on the benches at Decorah is slightly heavier than typical and faintly mottled gray. The soil horizon here is from $3\frac{1}{2}$ to 6 feet or more thick, increasing in depth toward the bluffs. The largest single development is 1 mile northeast of Ossian.

The topography is typical of that of most of the terraces in the county—flat, distinct benches, cut only in a few places by tributary streams from the uplands. The drainage is generally adequate. In a few of the areas described as having a heavy subsoil some artificial drainage would prove beneficial.

The Waukesha silt loam has excellent physical structure and is inherently fertile. Except where used for location of buildings and lots, the type is all under cultivation. The average yields are comparable to those on the Tama silt loam. More legumes should be grown in the rotation to maintain the fertility.

BREMER SILTY CLAY LOAM

The Bremer silty clay loam is a very dark brown to black silty clay loam, which gradually changes to a dark-brown to black heavy clay loam at depths of 8 to 15 inches. The lower subsoil below 24 to 30 inches is a yellowish-brown, tenacious silty clay to clay, mottled with gray. The soil and subsoil are typically free from grit. Occasional iron stains are found below the 30-inch depth.

Included with this type is a small area of Bremer loam in section 34, Washington Township, as no other areas of the loam were mapped in Winneshiek County. The Bremer loam differs from the Bremer silty clay loam mainly in that the surface soil to a depth of 12 inches is a dark-brown to black, silty, friable loam. The subsoil is identical with that of the Bremer silty clay loam except for less numerous gray markings and iron stains.

The Bremer silty clay loam has a small total acreage. The individual bodies are small, isolated, and occur on flat benches well above overflow. In sections 2 and 16, Sumner Township, the areas are at the back of old terraces adjoining the upland, and the boundary between the bench and the upland is rather indistinct in a few places. The natural drainage is fair to poor, owing to the surface depressions and the heavy texture of both soil and subsoil.

The soil is naturally high in organic matter and is productive when well drained. All of it is in cultivation. Because of the heavy texture it must be handled within a narrow range of moisture condi-

tions. The general need is better drainage and the incorporation of green manure to maintain and increase fertility.

WABASH LOAM

The surface soil of the Wabash loam is a dark-brown to black mellow loam containing a high percentage of fine sand, underlain at 12 inches by a brown to dark-brown heavy clay loam containing some coarse sand and very small gravel. The subsoil layer changes at 24 inches to a yellowish-brown clay loam to clay, with occasional brown, yellowish-brown, or grayish-brown mottlings and a few iron stains.

There are the usual textural variations found in soils subject to frequent overflow. Small pockets of silty clay or clay, and rifts of sand and gravel occur over the surface and through the soil. Another variation is an area about 1 mile east of Bluffton, where the soil varies from 3 or 4 inches to 3 or 4 feet in depth, resting on a limestone floor. In a few places the limestone outcrops at the surface.

This type is developed along Turkey River, the upper part of Walnut Creek, and all streams in the drift area in the western part of the county. There are several small areas along the upper course of the Upper Iowa River, beginning 1 mile east of Bluffton and extending headwards to the county line.

The Wabash loam is an alluvial soil in first bottoms and subject to annual overflow. Broadly, the surface is flat, broken by inequalities due to dissecting channels from upland streams, partly filled cut-offs of former channels, and the silts, sands, and gravel left in rifts and irregular deposits by subsiding flood waters. Except for small pockets here and there, the drainage is good.

The areas along the larger streams are mostly in cultivation. Probably more than half the type is cropped and the remainder is in native blue-grass pasture. A considerable part of the uncultivated land supports a sparse and open tree growth. The trees are chiefly post oak, red haw, willow, and ash. Corn is grown almost exclusively on the cultivated areas. It yields 25 to 50 bushels per acre, the yield being controlled by the seasonal conditions. As the type occurs mostly in narrow strips, it comprises only a small part of any individual farm unit.

WABASH SILT LOAM

The Wabash silt loam to a depth of 14 inches is a very dark grayish-brown to black friable silt loam containing much fine sand. This is underlain by a grayish-brown or dark grayish-brown clay loam to clay, faintly mottled with gray and sometimes yellowish brown, and occasional faint iron stains.

This type is found along all the larger creeks and their tributaries throughout the loessial region. A few scattered areas occur in the drift region along Turkey River west of Ridgeway. Along the Upper Iowa River the soil is characteristically black, but is shallow in places resting on limestone at depths of 6 to 18 inches. From Decorah headwards for about 8 miles, principally in sections 6 and 7, Decorah Township; section 30, Canoe Township; and section 25, Bluffton Township, there are occasional small strips which are under-

lain by a black very fine sand to fine sand at 34 inches. These areas are very rich in organic matter and have fair to good natural drainage. Along some of the shorter tributary streams in the southeast corner of the county the soil horizon, particularly the surface soil, is lighter in color, due to the admixture of colluvial wash from the light-colored Fayette and Clinton silt loams with the alluvium from the darker upland soils.

The cultivated areas of this type are mostly along the Upper Iowa River. Strips along the smaller streams are narrower and used mainly for pasture. (Pl. XXXVIII, fig. 2.) The uncultivated areas support a luxuriant growth of blue grass and a few scattered trees. The drainage is fair. Most of the land is subject to overflow after heavy rains, especially along the smaller tributaries.

The soil is mellow, silty in texture, and easy to cultivate. Corn is the chief crop, with some clover and timothy. Corn yields 25 to 60 bushels per acre, depending on the time and severity of the floods. Timothy and clover yield 1 to 2 tons per acre. White clover and blue grass grow luxuriantly in the more poorly drained situations.

WABASH SILTY CLAY LOAM

The Wabash silty clay loam consists of a very dark grayish-brown to black, heavy silty clay loam, underlain at 8 to 10 inches by a dark-brown to black, tenacious silty clay to clay. This changes at 20 to 22 inches to a grayish-brown clay loam to clay, mottled with yellowish brown and gray. Iron stains are frequently found in the lower part of the 3-foot depth. Neither soil nor subsoil is calcareous.

Along some branches of the Upper Iowa River there is a variation in both soil and subsoil from the typical, particularly in Madison and Lincoln Townships. Here, along the outer edges adjacent to the drift, much coarse sand and grit is found on the surface, with occasional granite boulders washed down from the Iowan drift. In some poorly drained spots there is a thin mucky layer of 2 to 3 inches on the surface.

This type is confined largely to the bottoms along Walnut Creek and its tributaries, Dry Run, and a branch of Turkey River in the southwest corner of Lincoln Township. Small areas occur in sections 3, 4, and 23, Military Township, at the heads of small drainage lines, and over the southeastern loessial region, particularly along the head tributaries of Yellow River.

Most of the Wabash silty clay loam is in depressed situations and is poorly drained. Practically all of it is used for grazing. Some wild hay is cut. The sinuous watercourses through this type are usually very shallow and the land is subjected to overflow after every heavy rain. Where it is practicable to straighten and deepen the stream channel, artificial drainage would make this a cultivable and highly productive soil. In its natural condition it affords excellent pasture and is most valuable for grazing.

CASS FINE SANDY LOAM

The Cass fine sandy loam to a depth of 8 inches is a dark-brown fine sandy loam. This is underlain by a yellowish-brown fine sand

or loamy fine sand, which passes at 24 inches to a lighter yellowish-brown fine sand. Both soil and subsoil are fairly uniform in both color and texture, there being little coarse material incorporated in the 36-inch depth. The soil is not calcareous.

This type is most extensive along Turkey River, in broken and disconnected strips, 1 to 3 miles in length. It also extends up Brockamp Creek to Festina and along a westerly branch entering Turkey River at Spillville. Another development is along a tributary of Turkey River 4 miles northwest of Spillville in sections 10, and 11; here the type is rarely overflowed back near the bluffs. A small area lies near the Fayette County line on Little Turkey River. There are three small areas along the Upper Iowa River 3 miles northwest of Bluffton, and one area 3 miles northeast of Freeport in section 9, Glenwood Township.

Along Little Turkey River and its tributaries there is a small development of Cass sandy loam. This differs from the Cass fine sandy loam in having more coarse material and gravel throughout the surface soil and subsoil. Because of its small total acreage, this has been included with the Cass fine sandy loam.

The Cass fine sandy loam is nearly all used for pasture, only a few small fields being in cultivation. A scattered growth of timber covers most of the type. The cultivated land is practically all used for corn. The soil is mellow and easy to work and has good natural drainage.

CASS LOAM

The surface soil of the Cass loam consists of 8 inches of dark-brown to almost black loam containing considerable fine sand. The subsoil is a dark-brown or brown, uniformly fine sandy loam, passing at 24 inches into a yellowish-brown or light yellowish-brown fine sand. Very little coarse material is found in either soil or subsoil.

The Cass loam is largely confined to the overflow land along the Turkey and Upper Iowa Rivers, extending back in a few places along tributary streams. The type is most characteristically developed along the Turkey River, where the subsoil is a light-yellow medium or fine sand. The developments along the Upper Iowa River have a high content of silt in the subsoil, the texture usually being a fine sandy loam instead of sand or fine sand.

The surface is nearly flat, with occasional low ridges and mounds worked over and deposited by flood waters. The streams follow a meandering course through the bottoms. Except in a few low swales and depressions formed by old stream courses now cut off, the drainage is good. The type, however, is subject to overflow after heavy spring and fall rains.

Forest trees, mainly willow, ash, cottonwood, walnut, and elm formerly were abundant, but only a few scattered trees remain. Owing to the frequency of overflows, the type is utilized largely for pasture. A very small part is under cultivation. The cultivated areas are reasonably productive; they are devoted almost exclusively to corn, which normally yields well. The Cass loam forms only a small part of any individual farm.

GENESEE SILT LOAM

The surface soil of the Genesee silt loam consists of 15 inches of light-brown, heavy silt loam. This is underlain by a light grayish-brown silt loam to light silty clay loam containing much fine sand.

This type is very inextensive. It occurs along a tributary of Turkey River south of Spillville in section 19, Calmar Township, and also in sections 11 and 12, Bloomfield Township, along Yellow River and one of its tributaries. Small acreages are found in sections 14 and 23, Fremont Township. The largest area is in sections 22 and 23, Canoe Township, along Canoe Creek. Here, as in section 8, Decorah Township, along the Upper Iowa River, a yellowish-brown fine sand or sandy clay is usually encountered at 30 to 34 inches. An occasional layer of light yellowish-brown fine sand 1 to 2 inches thick occurs locally in the silty soil horizon.

The Genesee silt loam is largely of alluvial origin. Colluvial wash is found in places at the outer edge of the bottom adjacent to the upland slopes. Natural drainage is fair. A few small, poorly drained pockets are scattered over the type.

Most of the type is in cultivation. Corn is grown almost exclusively and yields 25 to 50 bushels per acre. Permanent pasture of blue grass mixed with white clover is found on the uncultivated areas.

MUCK

The soil classified as Muck consists of black, finely divided vegetable matter containing some fibrous or peaty material in spots. The surface cumulose soil is from 6 to 8 inches deep, and rests on a black, plastic, tenacious silty clay to clay. The lower subsoil below 24 inches is often a grayish-brown or gray clay, mottled with brown and gray. The black clay usually extends to a depth of 36 inches in the center of the areas, the grayish-brown clay being encountered toward the outer edge. Shells of mollusks are numerous in the lower subsoil and in places throughout the soil section.

The total acreage of Muck is very small, and its occurrence is restricted to small depressed areas, mostly in the center of the Clyde silty clay loam areas. A small area along Walnut Creek, one-half mile north of Ridgeway, is rather peaty; other small areas lie in sections 6 and 8, Madison Township; section 7, Jackson Township; and section 34, Sumner Township. The largest developments in the county are in sections 22 and 23, Orleans Township, and in an old slough cut-off 2 miles east of Bluffton along the Upper Iowa River bottoms. This last area is swampy and somewhat peaty.

Very little of the Muck has been drained. Most of it is used for pasture, and some wild hay is cut. The cultivated areas are used largely for corn, which yields 20 to 60 bushels per acre on the more compacted and well drained areas. Small grains produce a rank straw growth and are inclined to lodge. Muck is sold only with associated soil types and usually forms only a small proportion of a farm.

The improvement of this soil begins with thorough drainage. Then the areas are usually pastured or used for hay for two or three years. Because of its high organic-matter content, the type is cropped largely to hay and corn.

ROUGH STONY LAND

The Rough stony land comprises the steep to abrupt slopes adjacent to the streams where they have cut deeply into the underlying limestone. This type also includes the perpendicular limestone ledges commonly found along the larger streams and particularly along the Upper Iowa River. These limestone ledges are designated on the map by rock-outcrop symbols.

The greater part of the Rough stony land occurs along the Upper Iowa River and extends back along most of its tributaries from 1 to 6 miles. There is also considerable of the Rough stony land along Canoe and Paint Creeks and up their tributaries. Only a few scattered strips occur along the bluffs bounding Turkey River.

A timber growth occupies much of this type in continuous strips one-fourth mile to 3 miles long and in small broken patches. The trees on the lower slopes are usually pines or cedars, with a belt of birch trees above extending to or near the top of the slope. At the top and skirting the upland border of the valley wall are broken strips of hardwood trees, mostly oaks, and patches of underbrush. Many large, scattered hazel thickets cover the less abrupt slopes along the tributary streams.

In places a very narrow strip of cultivable soil, 20 to 30 feet wide, is found on the extreme lower slope. Except for these few strips, this land can be utilized only for grazing.

SUMMARY

Winneshiek County is located in the northeast corner of Iowa. Its area comprises 686 square miles, or 439,040 acres.

The topography ranges from gently undulating in the Iowan drift region of the southwestern and western parts of the county to rolling with a maximum relief of 60 feet, and rough in the northeastern loessial area with a maximum relief of 600 feet. Except for the Iowan drift area, the county is covered with Mississippi loess overlying the old Kansan till or solid limestone. Small areas of residual soils are found in the central part of the county within the loess area.

Two contrasting types of drainage occur; the sluggish run-off in the Iowan drift, and the rapid and thorough drainage through deeply cut courses in the Mississippi loess region.

The elevation of the uplands is from 1,200 to 1,360 feet above sea level. The lowest point, 760 feet above sea level, is in the valley of the Upper Iowa River near the east county line.

The population, according to the Federal census, was 22,091 in 1920, with 81.7 per cent classified as rural. Decorah, the county seat, has a population of 4,039.

The temperature has an extreme range of from -37° F. in winter to 108° in summer. The mean annual temperature is 45.7° . The winters are usually short and cold. The mean annual precipitation is 32.53 inches.

Agriculture, the chief industry, consists of livestock farming combined with grain growing. Dairying is an important source of income on most farms. Crops grown are largely fed on the farm. Corn, timothy and clover hay, and oats are the important staple crops.

The number of farms was 2,915 in 1920, with an average of 147 acres per farm. Of the total number, 74.3 per cent were operated by owners.

Farm land ranged in value from \$30 an acre for rough land fit only for pasture to as high as \$300 an acre for the black, loessial prairie soils, at the time the survey was made.

The soils are prevailingly loams in texture in the drift region and silt loams in the loessial section. They are in general very fertile, retentive of moisture, and easy to farm. The average corn yields rank with the highest yields produced by counties in the State.

The Tama silt loam, a rich, dark-brown to black, loessial soil, and the Fayette silt loam, a light-colored loessial soil, very fertile and producing particularly fine clover crops, are the important soils of the loessial upland region. The Fayette soils differ from the Tama soils in having a more rolling surface, which was originally forested. The Clinton silt loam is a light-colored loessial soil, formerly forested, which is well drained and differs from the Fayette soils mainly in having a heavier subsoil, not friable.

The Carrington loam, the principal Iowan drift soil, is dark colored, retentive of moisture, well drained, undulating, and fertile. The Clyde silty clay loam, occupying depressions within the Carrington types, is naturally poorly drained but inherently fertile, producing good crops when thoroughly tilled.

Muck is formed within areas of Clyde soils which were ponded formerly. The surface soil consists mainly of decomposed vegetable matter.

The Lindley soils are the light-colored drift soils, having less organic matter in the surface soils, but otherwise similar to the darker Carrington soils. The Dickinson sandy loam is a medium dark drift soil containing much sand and gravel and a few small bowlders in the subsoil.

The terrace types are represented by the Waukesha, Bremer, Millsdale, and Judson soils in the dark-colored group; by the Buckner and O'Neill soils, of a sandier texture and medium dark color; and by the light-colored Jackson and Plainfield soils, the first being a heavy silt loam, and the second, a very loose sandy soil.

The bottom-land soils are predominantly of the Wabash types, dark colored and high in fertility. The Genesee soils differ from the Wabash only in being light colored instead of dark and having a lower content of organic matter. The Cass soils are dark-colored, fertile soils, underlain by sandy subsoils.

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