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Soil Survey
of
Poweshiek County, Iowa

By

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Iowa Agricultural Experiment Station, in Charge
and
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United States Department of Agriculture

Bureau of Chemistry and Soils
In cooperation with the Iowa Agricultural Experiment Station

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SOIL SURVEY

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SOIL SURVEY OF POWESHIEK COUNTY, IOWA

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COUNTY SURVEYED

Poweshiek County is in the southeastern quarter of Iowa (fig. 1), the northwestern corner of the county being about 23 miles southeast of the center of the State. It is in the fourth tier of counties north of the Missouri State line and in the fourth tier west of Mississippi River. The western boundary is about 45 miles east of Des Moines. The county contains 16 full townships, the lower tier of four townships being offset by a correction line, resulting in abnormally large sections along the northern boundaries of these townships. The included area is 583 square miles, or 373,120 acres.

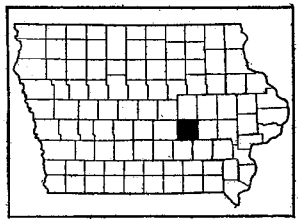

FIGURE 1.—Sketch map showing location of Poweshiek County, Iowa.

The area included within the boundaries of the county consists of a smooth plain dissected in a few small areas by streams. Before dissection and in the present undissected areas, the material underlying the surface soil consists of glacial drift identified as of Kansan age (*8*).[1] Over the greater part of the upland, however, the glacial drift is now covered by a thin sheet of loess and in the stream valleys by alluvial deposits. The dissection of these soft materials is proceeding at such a rapid rate that the loess covering has been removed along all the larger streams, and the drift is exposed on the valley slopes.

Poweshiek County is part of an original plain that sloped gently to the east and south, but the surface is now broken by a number of nearly parallel stream valleys carved to a depth ranging from 50 to 150 feet below the level of the original plain. In the northeastern two thirds of the county the streams flow in a general eastward direction, but in the southwestern third the direction of stream flow is a little east of south. Between the stream valleys are flat or gently rolling divides which are remnants of the original plain. Tributaries of the main streams head back into these divides, and minor branches ramify in dendritic systems and penetrate the greater part of the uplands, producing a gently or sharply rolling surface relief. Uneroded remnants of the plain, ranging from one fourth to three fourths mile in width, occur on many of the interstream divides and extend for several miles along the tops of the divides.

[1] Italic numbers in parentheses refer to Literature Cited, p. 39.

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The longest of these plain remnants extends for a distance of about 15 miles between Grinnell and Montezuma, now traversed by the Minneapolis & St. Louis Railroad. A number of small remnants range in size from 60 to 640 acres.

The streams show lack of symmetry, characteristic of Kansan glaciated areas. Most of the tributaries of the main streams are short, ranging from 1 to 6 miles in length, the tributaries from the north being characteristically longer than those from the south. On the south sides the slopes to the streams are short, irregular, rounded, and in some places comparatively steep, whereas those on the north sides are gradual and more or less regular to the crest of the divide.

The main streams are gradually cutting their channels deeper, that of North Skunk River lying on bedrock in many places. Most of the streams show immaturity and are gradually widening and excavating their valleys. They are subject to overflow during periods of continued heavy rainfall. Only a comparatively small amount of terrace, or second-bottom, land occurs, and this is largely along North Skunk River.

The elevations (*1*) above sea level indicate the general slope of the county. Southeastward on the main upland divide, the altitudes are as follows: Grinnell, 1,011 feet; Jacobs, 971 feet; Ewart, 963 feet; Montezuma, 948 feet; and Barnes City, 910 feet; showing a difference of 101 feet in the elevation of the flat original upland plain within a distance of approximately 25 miles, or an average slope of 4 feet to the mile. Hartwick, in the northeastern corner, has an elevation of 955 feet. Other elevations over the county below the uneroded original flat divide tops, in most places at the base or along the lower slopes, at railroad stations, are as follows: Brooklyn, 848 feet; Malcom, 892 feet; Deep River, 862 feet; Guernsey, 834 feet; and Searsboro, 806 feet. The difference in elevation between the highest and lowest points is more than 200 feet.

The flat undulating prairies in Poweshiek County were formerly covered with native grasses and wild flowers. Bluegrass and various weeds have replaced the original prairie-grass covering. Timber was once present on the slopes adjacent to the main streams and their larger tributaries, and in the southwestern part of the county considerable forest still remains, principally along and adjacent to North Skunk River and its tributaries and along the county line west of Grinnell extending southward about 6 miles. In the northwest corner of the county, along Walnut Creek and extending back a mile or more along the stream slopes and rolling uplands, some timber remains. Other small scattered timber patches lie along the eastern side along Bear Creek, North Fork English River, and Deep River. On the better drained bottom lands, usually lying close to the stream channel, are a few scattered clumps of trees. The native trees are largely oak, hickory, elm, and ash, with some walnut, maple, cottonwood, basswood, haw, and willow. Much hazel brush, sumac, and some blackberries and raspberries are scattered over the rougher slopes, mostly in the southwest and northeast corners of the county.

Poweshiek County was originally part of the Musquaka Indian Reservation. The first settlement by white men within the present county boundaries took place in 1843. The county was organized

5 years later, April 3, 1848. The population in 1849 was 443. In 1850 only 905 acres were classed as improved land, and by 1869, 98,676 acres were in cultivation.

Most of the original settlers were from the Eastern States, with a small proportion from the Southern States. Iowa College, now Grinnell College, was founded by eastern settlers at Grinnell in 1854. Among the settlers who came later were many people of German and Norwegian descent, and a considerable number of Belgians, most of whom settled in the eastern part of the county. The population at present consists almost entirely of native-born Americans.

The total population of Poweshiek County, as reported by the 1930 census,[2] is 18,727, or 32.3 persons to the square mile. The rural population numbers 13,778. Montezuma, the county seat, has a population of 1,257; Grinnell, the largest town, has 4,949; and Brooklyn has 1,345. Other towns of importance are Malcom, Deep River, Searsboro, Hartwick, Guernsey, Victor (partly in Iowa County), Ewart, and Barnes City (partly in Mahaska County).

The county is well supplied with railroad facilities. The main line of the Chicago, Rock Island & Pacific Railway crosses the central part from east to west; the Minneapolis & St. Louis Railroad crosses the western side from north to south, with a branch line to Montezuma in the southern part; and a branch of the Chicago & North Western Railway crosses the eastern side. All the larger towns are located on railroads, and no point is more than 12 miles from a railroad shipping point.

Most of the public roads follow land lines. In a few places only do the roads and public highways follow ridges or stream valleys because of rough hilly terrain. A paved road, United States Highway no. 6, extends across the county from east to west, a little north of its center. A graveled State highway, no. 146, serves the western tier of townships north and south, and State highway no. 59 extends north and south through the central part of the county. Most of the towns are connected by graveled State or county highways.

Churches and schools adequately serve every community, and consolidated schools are located at several places. Grinnell College, at Grinnell, accommodates about 1,000 students. Good high schools are located in all the larger towns. Rural mail delivery and telephone service reach all sections. Radios in country homes number 1,142.

The interests of the county are primarily agricultural. A washing-machine factory, glove factory, manufacturing creamery, brick and tile plant, poultry-packing plant, and canning factory are located at Grinnell. Poultry, eggs, and cream are marketed through local agencies. Some livestock is sold direct, but mostly through local agents or shipping associations. Ottumwa, Chicago, Mason City, and Omaha are the principal livestock markets. Surplus grain is shipped to Minneapolis and Omaha.

The southwestern two thirds of the county lies within the coal-measures deposits of Iowa. Coal was once mined in sec. 36, Sugar Creek Township, but the beds are too thin for economic production. Clay, suitable for brick and tile production, is abundant, and shale is plentiful along Buck Creek and North Skunk River.

[2] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given whenever possible.

Good water is abundant over the entire county and is pumped by small engines or windmills. There are a few springs, most of them along stream bottoms. Small veins and seeps throughout the loess-covered Kansan drift furnish water to the greater number of wells. Most of the wells used for livestock are about 200 feet deep, and some are 400 feet deep. These wells have their source in the Mississippian limestone. Deeper footing, reaching down into the carboniferous formations, usually to a depth of 2,000 feet or more, must be made for wells supplying cities. Most of the water is of good quality, hard but free from obnoxious minerals.

CLIMATE

The climate of Poweshiek County is marked by a wide range in temperature, but it is favorable for the production of all the general farm crops of the region. The mean temperature for summer is 72.2° F. and for winter 22.6°. The highest temperature recorded is 107° and the lowest −24°. The winters are usually cold and the summers hot. Droughts for extended periods are unusual, as sufficient rain usually falls during the summer to carry the crops to maturity without serious damage.

Table 1, compiled from the records of the United States Weather Bureau station at Grinnell, gives the normal monthly, seasonal, and annual temperature and precipitation for Poweshiek County.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Grinnell, Poweshiek County, Iowa*

[Elevation, 1,031 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	25.7	60	−20	1.07	0.24	2.26
January	19.4	57	−24	1.06	1.66	.49
February	22.8	62	−23	1.15	.15	1.23
Winter	22.6	62	−24	3.28	2.05	3.98
March	35.2	81	0	1.84	.80	1.52
April	49.5	87	18	3.40	2.75	2.82
May	60.6	95	32	4.56	3.89	4.92
Spring	48.4	95	0	9.80	7.44	9.26
June	69.5	99	38	4.84	1.29	9.39
July	74.4	102	44	4.20	1.92	11.57
August	72.6	107	37	3.68	2.05	7.45
Summer	72.2	107	37	12.72	5.26	28.41
September	64.9	96	28	4.21	4.50	4.57
October	52.5	87	14	2.68	.42	3.60
November	37.8	80	0	1.74	.98	2.16
Fall	51.7	96	0	8.63	5.90	10.33
Year	48.7	107	−24	34.43	20.65	51.98

The mean annual rainfall is 34.43 inches, of which 9.80 inches falls in March, April, and May, and 12.72 inches in June, July, and August. The precipitation in winter is mainly in the form of snow. In the absence of snow protection, wheat and legumes are sometimes damaged. Southwesterly winds prevail in summer and northerly winds in winter.

The average frost-free season of 165 days, sufficient for maturing the corn crop, extends from April 26 to October 8. Frosts have occurred as early as September 18 and as late as May 21. Hailstorms are rare and are local in extent, but windstorms occasionally damage the growing crops.

AGRICULTURAL HISTORY AND STATISTICS

Agriculture has been the chief industry of Poweshiek County since the time of the first settlement, when it was restricted to small acreages of wheat, corn, oats, and flax, sufficient to supply home needs. The grain was hauled to the nearest mill and ground for family use. Wild game and fish were abundant, and the timber along the streams and adjacent uplands provided fuel. The broad unfenced prairies furnished luxuriant native grasses for the few head of livestock kept. Settlement progressed slowly until the advent of the railroads, when the opening of new markets gave a great impetus to farming, and settlers came in rapidly. Fencing laws closed the open range, and more land was cropped annually, so that by 1870, 151,419 acres were classed as improved land as compared with 2,906 acres in 1850. By 1880 the acreage of improved land had increased to within 8 percent of the present acreage.

With the great increase in the number of farms, more timber was used for fuel, and the acreage of native forest trees decreased. In 1870 native forest covered 18,379 acres, which decreased within 5 years to 12,197 acres. The 1930 census reports only 1,115 acres as woodland not used for pasture, and 10,355 acres as woodland pastures, but these have been much cut over, largely denuded of trees, and support only a thin stand of second-growth oaks, elm, hickory, ash, and other hardwood trees, with some hazel brush, buck brush, sumac, blackberry, and other undergrowth.

Farming since 1880 has progressed steadily with only a slight change in character. General farming has always been the chief agricultural pursuit, consisting of the growing of grain and hay and the raising and feeding of livestock. Dairying has developed into an important source of revenue on many farms.

Corn has been the leading crop from the earliest settlement, and corn, oats, and hay have regularly been grown on 90 percent or more of the cropped land. In 1929 corn occupied about 50 percent and oats 25 percent of the total land in crops. About 7 percent of the entire corn crop of 116,332 acres in 1929 was hogged down, and almost 2 percent was cut for silage. Sweet corn is an important cash crop on a number of farms, mainly in the vicinity of Grinnell, where a canning factory is located. In 1929 yields of sweet corn ranged from 3½ to 4½ tons an acre, and the price ranged from $10 to $14 a ton.

Table 2 shows the acreages and yields of the principal crops in 1929, as reported in the 1930 census.

TABLE 2.—*Acreage and yield of the principal crops in Poweshiek County, Iowa, in 1929*

Crop	Area	Yield	Crop	Area	Yield
Corn:	*Acres*	*Bushels*	Hay, total—Continued.	*Acres*	*Tons*
Harvested for grain	104,285	4,316,923	Clover	14,476	22,478
		Tons	Alfalfa	1,497	4,595
Cut for silage	1,278	10,915	Other tame grasses	61	80
Cut for fodder	2,548		Wild grasses	17	29
Hogged or grazed off	8,221		Small grains cut for hay	32	40
			Annual legumes for hay	80	152
		Bushels		*Trees*	*Bushels*
Wheat	763	14,781	Apples	16,523	13,177
Oats:			Cherries	1,435	300
Threshed	57,708	2,099,956	Peaches	2,691	1,188
Cut and fed unthreshed	360		Pears	486	337
Barley	2,957	78,968	Plums	2,523	1,746
Rye	45	803			
Potatoes	529	61,969		*Vines*	*Pounds*
		Tons	Grapes	9,416	117,672
Hay, total	42,985	63,389			
Timothy and (or) timothy and clover	26,822	36,015			

More than 60 percent of the hay acreage consists of clover and timothy mixed and almost 34 percent of clover alone. The alfalfa acreage increased from 8 acres in 1899 to 1,497 acres in 1929, with an average yield of slightly more than 3 tons an acre in the latter year.

Both tree and bush fruits do well in Poweshiek County, but very little fruit is grown commercially. Apples, the principal fruit, attained their largest planting in 1899, when 69,663 trees were in bearing; but the orchards have been neglected, and the number of bearing trees had decreased to 16,523 in 1929. Peaches are rather uncertain because of late freezes in the spring, but a considerable number of peach, plum, cherry, and pear trees are on the farms. Grapevines and patches of blackberries, raspberries, and strawberries are grown on many farms.

Hog raising and fattening predominates in the livestock industry. The 1930 census reported 139,376 hogs in the county on April 1 of that year. Cattle rank next, with 45,899 head. Dairy cows are kept on nearly all farms, there being 10,862 in 1930. Most of the work animals are horses, the census reporting 11,048 in 1930, in addition to 962 mules. Sheep are raised on the rougher areas, from 4,000 to 10,000 being fed and sold annually. The census reported 19,450 sheep and lambs on April 1, 1930. The value of wool shorn in 1929 was $25,586. Poultry is an important source of revenue to the farmer. There were 304,717 chickens on farms April 1, 1930, and 263,374 were sold alive or dressed in 1929, valued at $234,403. Egg production amounted to 1,900,563 dozens in 1929, valued at $513,152.

Commercial fertilizers are used in a limited way. In 1929, 139 farmers used fertilizer (including commercial fertilizer, lime, and manure), at a total expenditure of $9,218. More lime is being used each year. Farm manures are generally used but are insufficient

in quantity to maintain the fertility of the land. Clover and timothy mixed is the most extensively used green manure. A series of cooperative experimental plots are being laid out on the State experiment station farm to test the value of rock phosphate, superphosphate, potash, lime, green manures, and manures, alone and in combination. Practically none of the fertilizer used is mixed on the farm.

Labor was employed on 1,209 farms in 1929, at a cash expenditure of $367,683, or an average of $304.12 a farm reporting. In recent years there has been a surplus of farm labor. Day labor, used mostly in spring and at harvest time, is American and largely supplied from the local towns.

The total number of farms as reported by the 1930 census is 2,236, and the average size is 162 acres. The change in the average size of farms since 1890 has been negligible. The land in farms includes 97.6 percent of the total area of the county, or 362,213 acres, of which 312,323 acres are classed as improved land, including crop land and plowable pasture. In 1850 only 2,906 acres were classed as improved land.

The value of farms in 1850 was $59,627, and of farm machinery was $5,827. In 1870 farm lands were valued at $6,107,700; in 1880, at $8,504,002; and in 1930, at $36,495,908. The value of all farm buildings in 1930 was $10,071,006, and implements and machinery were valued at $2,691,682.

Land used for pasture in 1930 included 113,351 acres, 78,720 acres of which were plowable, 10,355 acres in woodland pasture, and 24,276 acres in all other pasture.

Table 3 shows the status of ownership and tenure of farms in Poweshiek County in 1920, 1925, and 1930, as reported by the Federal census.

TABLE 3.—*Farm ownership and tenancy in Poweshiek County, Iowa, in stated years*

Year	Farms	Full owners	Part owners	Managers	Cash tenants	Other tenants
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
1920	2,179	1,065	196	20	436	462
1925	2,148	868	299	22	334	625
1930	2,236	835	271	25	468	637

The significant feature shown in table 3 is the increase in tenancy and the decrease of full ownership. Most of the land is rented on the share basis, with cash for pasture land. Where cash rental is charged, the rental ranges widely, depending largely on the soil type and condition of the farm.

Modern machinery is used on every farm, and most of the farms are well equipped. The 1930 census reported 2,431 automobiles, 343 motor trucks, and 833 tractors in operation on the farms in Poweshiek County. Electric power is available for a number of farm homes, the 1930 census reporting 258 electric motors used in farm work, in addition to 1,164 stationary gas engines.

SOILS AND CROPS

Poweshiek County lies within that part of the United States where corn is the dominant crop and in that part of the Corn Belt where corn and other products are not generally sold for cash but are fed on the farms to produce meat, mainly pork. Corn is considered the most profitable crop and determines the type of farming. Oats and hay are the most important supplementary crops in feeding livestock, but the acreage of the two combined is considerably less than that of corn. In ordinary years more than 90 percent of the land under cultivation is devoted to these three crops.

A number of factors, natural and economic, determine the use of land. Climatic and economic conditions are nearly uniform over Poweshiek County and, together with the character of the dominant soils, determine the crops grown and the type of farming practiced. The differences in the relative acreages of crops on a particular farm may be attributed to the character of the soils and the closely related topographic features.

The dominance of corn in this section of the country is due in no small degree to the character of the principal soils. A good corn soil must be well drained, rich in available plant food, high in humus or organic matter, mellow, easy to cultivate, and retentive of moisture. To prevent erosion and to allow the use of machinery, the surface should be smooth. The soils of Poweshiek County have the characteristics favorable to corn production, and the climate is nearly ideal for the growth of the corn plant.

Poweshiek County is in the prairie region of the United States, and all the soils, except those in severely eroded and forested sections or those developed on the most recently deposited stream sediments, have dark-colored topsoils, owing to an abundance of black organic matter derived from decayed grass roots. With the exception of comparatively narrow strips along stream valley slopes and eroded areas, the upland soils have developed from silty material. The soils of the eroded upland areas, where the silty material has been removed, are developed from glacial drift. Sediments, brought down from these two materials by streams and redeposited in flood plains, make up the third kind of parent material, from which have been built up the soils of the first bottoms and terraces.

Light-colored soils occupy a comparatively small part of the county. They occur in narrow strips on steeper valley slopes throughout the upland and on small terraces. The light-colored upland soils occur on the same loess and glacial drift sheets from which the dark-colored upland soils have developed but which have been so severely eroded that decayed organic matter has not accumulated in sufficient quantities to produce soils with dark-colored surface layers. The light-colored terrace soils are developed over silt washed from the silty upland soils.

The thickness and character of the surface soil layers, as well as the condition of drainage, are dependent largely on the surface relief which, over the greater part of the county, is gently rolling, with almost level interstream divides and alluvial lands. A large proportion of the land is tillable, the comparatively small area not cultivated being made up of narrow areas of steep slope and a small area of uncultivated poorly drained land. This county ranks among the

foremost in Iowa in its proportion of land in utilization, having almost 98 percent of its total area included in farms.

As color indicates the properties of the soil and is closely related to the surface relief, it may be taken as a guide to the agricultural value. On the basis of this striking characteristic the upland and terrace soils of the county may be divided into the following two broad groups: Dark-colored upland and terrace soils and light-colored upland and terrace soils. The bottom-land soils are all dark-colored, with one unimportant exception, hence they are not subdivided in this report but are described by series and types.

In the following pages, the soils of Poweshiek County are described in detail and their agricultural importance is discussed; the accompanying soil map shows their location and distribution; and table 4 gives their acreage and proportionate extent.

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

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Tama silt loam	196,160	52.6	Bremer silty clay loam	256	0.1
Muscatine silt loam	25,728	6.9	Clinton silt loam	27,840	7.4
Grundy silt loam	8,768	2.3	Lindley silt loam	3,776	1.0
Grundy silt loam, light-colored phase	576	.1	Lindley loam	1,728	.5
Grundy silty clay loam	1,024	.3	Jackson silt loam	128	.1
Carrington loam	13,824	3.7	Wabash silt loam	32,960	8.8
Shelby loam	30,080	8.1	Wabash silt loam, colluvial phase	22,976	6.1
Waukesha silt loam	3,328	.9	Wabash silty clay loam	2,304	.6
Judson silt loam	832	.2	Genesee silt loam	192	.1
Bremer silt loam	640	.2	Total	373,120	

DARK-COLORED UPLAND AND TERRACE SOILS

The soils of this group occupy 75.4 percent of the area of the county. They occur on all parts of the smooth upland, on the moderately rolling stream slopes where erosion has not been too severe, and on the more extensive terraces. A soil mainly of colluvial origin, Judson silt loam, also belongs to this group. These soils have one principal characteristic in common, which is that the surface layers are dark colored as a result of the large supply of organic matter. The high organic content of the soils increases their water-holding capacity, assists in maintaining a uniform soil temperature, keeps the soil loose and mellow, retards erosion, and is a source of nitrogen and other plant foods. The subsoils differ in color and structure, depending on the parent materials and drainage conditions. The upper subsoil layers of the Tama, Muscatine, Grundy, and Judson soils are mainly heavy silt loams and silty clay loams, ranging in color from brown to mottled brown and gray. The lower subsoil layers consist of grayish-yellow or gray floury silt. The Carrington and Shelby soils have dark-colored surface layers of loam texture and subsoils of silt, clay, and gravel. The Waukesha and Bremer soils are developed over water-laid materials of the higher terraces.

The principal crops of the county are grown on all these soils, with good average yields. The differences in the yields on the different soils are owing more to changes brought about by surface relief, particularly the degree of slope, than to any lack of natural

fertility. All the soils of this group are more productive than any soil of the light-colored upland and terrace soil group.

Tama silt loam.—Tama silt loam is the most extensive soil in Poweshiek County, occupying so large a proportion of the area that it dominates the agriculture. It is thoroughly drained in both surface soil and subsoil, differing in this respect from the Grundy and Muscatine soils, which occupy the flat upland divides and have somewhat restricted surface run-off and subsurface drainage.

The surface soil of Tama silt loam to an average depth of about 15 inches is very dark grayish-brown silt loam, appearing black when wet. The silty texture and high content of organic matter gives this soil a loose mellow character. It works easily under a wide range of moisture conditions and is an ideal soil for corn, small grains, and other crops grown in the county. Below the dark-colored surface layer is a transitional layer, about 5 inches thick, which changes from the color and texture of the surface soil downward to brown silty clay loam. The lower part of this layer is discolored by streaks of dark organic matter from the layer above. Below an average depth of 20 inches the subsoil consists of a uniform yellowish-brown silty clay loam. At a depth of 45 inches a slight change takes place in color and texture, the material becoming more silty, and faint mottlings of gray and brown break the uniform yellowish-brown color of the overlying silty clay loam subsoil. Iron stains appear at this depth, and they become more abundant with increase of depth.

Tama silt loam covers the gently rolling upland slopes from the flat divides toward the lower stream valleys, and natural drainage is well established. The drainage ways that cross the areas of this soil are slowly penetrating the flat interstream divides. In some interstream areas the flat divides have been entirely removed by erosion, and Tama silt loam occupies the entire area.

The surface relief of Tama silt loam ranges from gently rolling to rolling, and practically all the land is under cultivation. Sheet erosion, although not very noticeable, is taking place at an appreciable rate on the more rolling areas, and the slopes adjoining the streams are sufficiently eroded in many places to expose the underlying drift soils. The surface layers of these slope soils contain considerable fine sand and grit and are mapped as Carrington and Shelby soils where sufficiently extensive to be shown on a map of the scale used.

On account of its high productiveness and easy tillage, almost the entire area of Tama silt loam, with the exception of land used for roads and farm sites, is under cultivation. The absence of stones, boulders, or grit, together with the silty texture and friable character of the soil, results in a minimum labor requirement and labor cost for plowing and cultivating, as well as slight wear on machinery. Both tractors and horses are used for farming this soil. The soil warms up early in the spring and may be worked and planted early. The moisture-holding capacity is excellent, and total crop failures are unknown.

As it is especially productive of corn, a larger proportion of this soil is planted to corn than is the average for the county. It is estimated that 65 percent of the land is in corn, and the yield is some-

what above the average for the county. For a period of years it is probable that the average yield is about 45 bushels to the acre. In favorable years, the better farmers have obtained yields of 80 bushels an acre, and on a few small fields from 90 to 100 bushels have been reported.

The next most important crop is oats. The average acre yield is about 38 bushels. On a few small fields, in favorable seasons, yields of 50 or 55 bushels may be obtained.

The total hay crops occupy a slightly lower percentage of the farm acreage than oats. Timothy and clover make up the greater part of the hay acreage, although a rather large acreage is sown to clover alone. Alfalfa is grown in small fields ranging from 2 to 10 acres in size. Liming is essential on Tama silt loam in order to grow alfalfa, and inoculation is usually necessary. Since the farmers have been making use of these treatments, good stands of alfalfa are reasonably easy to obtain.

Sweet corn is grown on a small acreage which is largely regulated by the demands of a corn cannery at Grinnell. Pop corn is grown in small patches for local consumption.

Few soybeans are grown alone. They are sown with corn and are used for hogging down, a practice which is increasing. Other minor crops are barley, rye, and wheat, all of which yield well. Crop yields differ according to the efficiency with which the soil is handled.

Rotation of crops is generally practiced. Small grains usually follow 2 years of corn. Hay seedings consist mostly of timothy and clover. Small grains are usually used as a nurse crop for clover or clover and timothy.

Tree and small fruits do well on this soil. Apples, plums, cherries, and pears are the principal tree fruits. Orchards, mostly of apples, are largely restricted to small farm plantings ranging from 1 to 3 acres. Small fruits and truck crops are grown for home use and to supply the local markets.

The principal need of Tama silt loam is the incorporation of more organic matter to hold the plant-food content to a normal point, as sheet erosion and the downward movement of the soil waters are removing more plant-food constituents than most farmers realize. Barnyard manure is used on cornland and as a top dressing for clover and timothy, but it is not produced in sufficient quantities to maintain the normal level of fertility. Both the surface soil and subsoil are very acid, and liming is necessary for best results with legumes. Very little commercial fertilizer is used. The use of phosphate has proved profitable in tests on this soil in other counties. The turning under of clover and green-manure crops should be more widely practiced. Gently rolling Tama silt loam, which has suffered little from erosion, is one of the most desirable general-farming soils of the State.

Muscatine silt loam.—Muscatine silt loam ranks third in area and second in agricultural importance among the dark-colored soils of the county. Except in the southeastern part of the county it is the soil of all the flat interstream upland divides. Because of its almost level surface and high clay content, natural drainage is restricted, and the land must be tile drained in order to obtain maximum crop production. The subsoil, although heavy and sticky,

allows the tile to draw well. This soil, when properly drained, is the strongest in the county.

The surface soil, to a depth of 18 inches, ranges from very dark grayish brown to almost black. The texture is heavy silt loam and in places almost silty clay loam. The soil becomes heavier with depth and at a depth of 10 inches is generally silty clay loam. Between depths of 18 and 25 inches is a transitional layer streaked and spotted with dark organic infiltration from the layer above. Below this layer the subsoil is yellowish-brown silty clay mottled with gray and brown. Over the greater part of the area of this soil the subsoil is not extremely heavy and is slightly less compact and less silty than that of Tama silt loam. This soil is not uniform, however, and presents every gradation in the subsoil between the friable silty clay loam subsoil of Tama silt loam and the heavier subsoil of Grundy silt loam. Muscatine silt loam in the southeastern part of the county grades into Grundy silt loam. In Grundy silt loam the subsoil contains more gray mottlings and is slightly heavier in texture. The change in character of subsoil is so gradual, however, that the line of separation between these soils is more or less arbitrary.

On account of the flat surface and the slightly impervious subsoil, natural drainage was originally very slow, and this was the last soil in the county to be brought under cultivation, but since the land has been tiled, drainage has been so improved that crops are rarely damaged by excessive moisture. Moisture, however, is retained in this soil to a greater degree than in the naturally drained soils, and crops are not so quickly damaged by drought. In the past, Muscatine silt loam supported a luxuriant growth of wild prairie grasses, and moisture conditions favored the accumulation of organic matter. As a result of the better moisture supply and a higher content of organic matter, this soil ranks slightly higher in productiveness than Tama silt loam, and in this respect takes first place among the soils of the county.

Muscatine silt loam approaches a silty clay loam on all the flat or slightly depressed areas. In such locations a few small areas of Muscatine silty clay loam, ranging from 5 to more than 20 acres in extent, are included with Muscatine silt loam in mapping because of their small total area and their slight difference in texture. The silty clay loam differs from the silt loam in being slightly heavier textured in both surface soil and subsoil. These small areas of heavier silty clay loam grade imperceptibly into the silt loam. Drainage is slower in the heavier soil, and slightly closer tiling is required to insure prompt removal of excess rain water.

Muscatine silt loam, where well drained, is regarded as slightly more valuable for general agriculture than Tama silt loam. Corn yields are consistently larger, and the average, year after year, is about 50 bushels to the acre. Oats yield well, but in wet seasons there is apt to be some lodging. The yield ranges from 38 to 65 bushels an acre. Hay crops do exceptionally well on this soil, ranging from 1 to 2 tons an acre. Clover and timothy mixed is the principal hay crop, but red clover alone is increasing in favor. The small fields of alfalfa yield from 2½ to 5 tons an acre.

This soil is medium acid in reaction. Lime is very beneficial for legumes in general, and it should always be used for alfalfa. Fall

plowing is highly desirable as it allows earlier planting in the spring. Short stiff-strawed varieties of oats, which withstand the tendency to lodge in wet seasons, are desirable. This is an exceptionally strong corn soil, but in order to obtain maximum crop production the land must be well tiled. The usual rotation has been corn, corn, and oats, but green-manure crops, preferably a straight legume seeding, should always be included in the rotation.

Well-tiled farms, with good improvements, command the highest price of any farm land in the county.

Grundy silt loam.—Grundy silt loam differs from Muscatine silt loam in its slightly heavier texture and more mottled color of the subsoil, both of which are results of imperfect drainage while the soil was forming. This soil occurs only on the flat interstream divides in the southeastern part of the county, occupying the same relative position as Muscatine silt loam.

The dark-colored surface soil is similar to the surface layer of Muscatine silt loam, but averages from 1 to 2 inches thicker. The subsoil is brown or yellowish-brown silty clay which is very heavy, plastic, and highly mottled with yellow, some gray, and a few iron stains.

An imperceptible gradation occurs from Grundy silt loam to Muscatine silt loam, and the line of separation between the two soils is somewhat arbitrary. When the county was first settled, the drainage of Grundy silt loam was less adequate than that of Muscatine silt loam, but like that soil, artificial drainage on Grundy silt loam by means of tiles has provided for a rapid removal of surplus water from the soil, so that crops are seldom damaged in wet seasons.

The crops grown and yields are so similar to those on Muscatine silt loam that little difference can be pointed out. Without the use of fertilizer, but by means of crop rotation, including a legume, such as medium-red clover, in the rotation, an average of 85 bushels of corn an acre were grown on a 40-acre tract southeast of Montezuma.

This soil is farmed by methods similar to those employed on Muscatine silt loam. It seems to retain water for a slightly longer time than that soil, so that crops sustain slightly less damage in extremely dry years, but in wet seasons the land drains a little slower and the supply of water in the soil may be greater than in Muscatine silt loam. These differences are slight and affect the yields very little.

Within the areas mapped as Grundy silt loam are a few small depressed areas where the surface soil is somewhat heavier, approaching silty clay loam in texture. These spots need closely spaced tile drains to insure good drainage. The soil ranges from medium to strongly acid and is rich in natural plant-food material.

Grundy silt loam, light-colored phase.—A few areas of a light-colored phase of Grundy silt loam occur in the northeastern part of the county, where they occupy flat divides adjacent to areas of light-colored rolling Clinton silt loam. They represent a transitional soil between the Clinton and the Grundy soils.

The surface soil to a depth of 10 inches is grayish-brown floury silt loam, the lower part of which is in many places lighter colored. Below this, extending to a depth of 18 inches, is tough plastic olive-

gray silty clay. The lower subsoil layer is brown, very tough plastic silty clay which, below a depth of 25 inches, becomes more yellow and contains gray mottlings and iron stains. This soil differs from typical Grundy silt loam mainly in the lighter color of the surface soil and the slightly grayer shade of the subsurface layer.

Originally this soil was poorly drained like the other soils of the flat divides, but now drainage has been established and the greater part of the land is under cultivation.

This soil ranks considerably below typical Grundy silt loam in agricultural value, but all the crops of the county are grown on it. The average yield of corn, unless the land is heavily manured, is about 30 bushels to the acre. Oats and other small grains yield relatively better than corn, falling only slightly below the average for Grundy silt loam. Hay crops do well.

This soil is lower in organic matter than the darker soils and responds readily to the use of stable manure. As it is strongly acid, applications of lime would be beneficial in growing clover and other legumes.

Grundy silty clay loam.—Grundy silty clay loam occurs in a number of comparatively small areas within areas of Grundy silt loam in the southeastern part of the county. These areas occupy flats or slight depressions on the interstream divides, where drainage originally was, and in places still is, inadequate. After rains, water stands for a longer time than on the areas of Grundy silt loam.

This soil differs from Grundy silt loam only in slight changes brought about by excessive moisture. The surface soil is heavier and almost black, and the subsoil is heavier and more brightly mottled.

The correction of poor natural drainage requires closer tiling than on Grundy silt loam, it being necessary to lay the tile as close as 4 to 6 rods apart. When properly drained this is one of the strongest corn soils in the county. It has good moisture-holding capacity, but unless plowed and cultivated under proper moisture conditions, it will bake and clod. In extremely dry weather, large cracks sometimes form and may injure the grain roots, but deep plowing and careful mulching or stirring of the soil after rains will tend to prevent such damage.

A few small depressed areas within the almost level Grundy silty clay loam areas about 1½ miles east of Montezuma have a gray color developed below the surface soil. These spots are from 50 to 200 feet in diameter; and, although they are tiled as closely as the surrounding heavy silty clay loam soil, they do not drain so well. Water always stands in these depressions after rains longer than on the adjacent soils having surface soils of the same texture. A thin gray silt layer, from one eighth to three fourths inch thick, occurs below the surface soil, being thickest toward the center of the depression. Crops do not grow so well on these spots as on the adjacent soil.

Grundy silty clay loam does not differ widely in productiveness from Grundy silt loam. The heavier surface soil makes cultivation a little more difficult, particularly in wet seasons. When moisture conditions are favorable, the yields of all crops are fully as large as on Grundy silt loam. All this soil, formerly prairie, is now in cultivation. Corn yields on well-drained land range from 40 to 80

bushels an acre, clover and clover and timothy yield from 1½ to 3 tons, and oats in favorable seasons yield from 40 to 60 bushels, but lodging is likely to reduce the yield greatly in wet seasons because of a rank growth of straw, caused by the high fertility of the soil. The rotation on this soil is largely corn and oats, with occasional seedings of clover.

This soil ranges from medium to strongly acid, and lime is beneficial, especially in growing legumes, as it improves the tilth by causing flocculation of the soil particles, and it tends to liberate the plant-food elements. In places good stands of medium-red clover are obtained without the use of lime.

Carrington loam.—Carrington loam occurs in narrow strips on the gentle slopes to tributary drainageways in all parts of the county but principally in the northern part. Although the areas are narrow and irregular in outline, they make up an important total acreage of 21.6 square miles.

The surface layer of this soil, to an average depth of about 12 inches, is dark grayish-brown friable loam which carries various quantities of silt, and in places it is almost silt loam in texture. It was not practical to indicate these fine gradations in texture on the soil map, as the areas affected are small and changes occur within short distances. Between depths of 12 and 17 inches is a transitional layer consisting of dark-brown heavy loam streaked with darker organic matter brought down from the layer above. The lower subsoil layer is yellowish-brown silty clay loam or clay loam. A few glacial gravel deposits and boulders occur throughout the soil, becoming more plentiful with depth.

A variation in texture occurs in the extreme northern part of the county, on slopes which are gently rolling, where a higher percentage of silt in the topsoil results in a silt loam texture. Streams have not cut so deeply into the underlying drift, and the original silt covering has been only partly removed, leaving many spots and strips where the surface soil has this silt loam texture. These spots were included with Carrington loam in mapping because of their small size.

On many slopes, small areas of the underlying yellowish-brown or reddish-brown silty clay drift substratum are exposed. These areas range from 3 to 15 feet wide and from 10 to more than 100 feet long. On a few hill slopes erosion has removed the more friable topsoil from nearly the entire slope, leaving yellowish-brown or reddish-brown gritty clay areas containing much sand, gravel, and a few small boulders. Some seeped spots occur within these areas, ruining small areas on the slopes for cultivation unless thoroughly tile drained.

The greater part of this soil lies, geologically, in the Kansan drift region and a smaller part in the extreme northern part of the county on the Iowan drift. The exact boundary line between these two drift sheets is very difficult to determine, as the greater part of the county is deeply covered by loess. It has been impossible to observe any differences in the soils developed on the small exposures of the two drifts, and all areas have been mapped as Carrington loam.

Carrington loam is everywhere well drained. It occurs on smooth gentle slopes along shallow drainage ways and swales where the

silty material that originally covered the upland has been removed by erosion and the glacial drift has been exposed.

With the exception of a comparatively small acreage on the sharper slopes, which is used for pasture, all the land is in cultivation. Corn, as on other smooth upland soils, is the most extensively grown crop. The proportion of other crops is about the same as on Tama silt loam, with which this soil is closely associated. The average yields for all crops are only slightly lower than on Tama silt loam with which this soil is farmed. In most places there is no perceptible difference in yields, but in places where the slopes are steeper, yields on Carrington loam are slightly lower.

Shelby loam.—Shelby loam is the soil of the slopes along streams and smaller drainageways over all the county except the northern part, where it is replaced in similar situations by Carrington loam. It occurs in narrow strips along many streams, and the total area amounts to 47 square miles.

As this soil occurs on eroded slopes, the thickness and color of the surface layer is variable. On the steeper slopes the soil is thin, and spots occur where the dark-colored surface soil has been entirely removed and the yellowish-brown or reddish-brown subsoil material is exposed. On the lower slopes where colluvial material has been brought down and deposited, the dark-colored material is much thicker, ranging from 15 to 30 inches in thickness. The average and most common depth of the surface layer is about 8 inches.

The surface layer consists of dark grayish-brown loam which in many places is very gritty. Below this, and continuing to a depth of about 14 inches, is a transitional layer to a brown silty clay loam, streaked somewhat with darker organic material leached from the layer above. The lower subsoil layer is yellowish-brown silty clay loam or clay loam which extends to an average depth of about 30 inches. This layer contains a high percentage of sand and gravel and a few small boulders. In places splotches of white lime occur in the material. Below this is yellowish-brown or reddish-brown clay mottled with gray and containing a few pockets of sand and gravel.

Most of the bare eroded spots on the steeper hillsides are reddish brown and are low in fertility. Here the soil is sticky and plastic, containing much grit and some small boulders. In the dry period of summer, some of the spots dry out and become very hard, and others contain seepy areas, in which the soil is termed "push soil", because when plowed it pushes ahead or to the side of the plow and does not turn a furrow, or it sticks to the plow and will not scour. Tiling around the edges will carry off the seepage and allow cultivation.

The greater part of this soil is in cultivation, as few of the slopes are so steep as to prevent plowing. The productiveness varies with the degree of slope which the soil covers and the consequent degree of erosion. On the more level areas and on the lower slopes where the soil is thicker it produces as large yields as the better soil of the smooth upland, but this can be said of only a comparatively small proportion of the total area. The other extreme in production occurs where the dark surface soil, with its organic matter, is very thin. On the eroded spots described, where the dark topsoil is entirely removed, the productivity of the land is greatly reduced.

Corn is grown more extensively than other crops. The proportion of land used for this crop is about the same as for the county as a whole. Oats and timothy and clover hay are the other main crops.

Yields on the better land are about as large as those on Tama silt loam, but on the greater part of the soil they average much lower, ranging from 30 to 60 percent as large. Although nearly all of Carrington loam is in cultivation, only about 65 percent of Shelby loam is farmed. The soil problem on Shelby loam is one of erosion control and of building up the content of organic matter and plant food.

The steeper slopes should be kept permanently in pasture or timber. Corn should not be grown more than 1 year in the rotation. Green-manure crops should be used regularly and turned under to build up the humus content and to check sheet washing. Contour plowing should lessen the amount of sheet erosion. Exposed clay subsoil spots should be manured and seeded down, and lime should be applied where legumes are seeded.

Shelby loam in Poweshiek County is on the extreme northern boundary line of the Shelby soils in Iowa. The dissecting drainage lines in this county have not cut so deeply, and consequently the hill slopes covered by Shelby loam are neither so long nor so steep as similarly covered slopes in southern Iowa. On many of the gentler hill slopes along the upper reaches of streams, where the soil has been mapped Shelby loam, the material resembles Carrington loam, and there is little or no difference in the cropping value or the crop yields. So nearly alike are these two soils in the central and northern parts of the county that soil boundaries between them are more or less arbitrary.

Waukesha silt loam.—Waukesha silt loam is a terrace, or second-bottom, soil occurring along the larger streams of the county. The largest areas are along North Skunk River and lie from 20 to 30 feet above the first-bottom land. Other fair-sized areas are along Bear, Little Bear, and Walnut Creeks.

This soil to a depth of 16 inches is dark grayish-brown friable silt loam. A transitional layer between the topsoil and the subsoil proper occurs between depths of 16 and 22 inches and consists of brown silty clay loam darkened by an infiltration of organic matter which decreases downward. The subsoil is yellowish-brown sticky and plastic silty clay loam which contains practically no grit to a depth ranging from 6 to 8 feet. This soil resembles Tama silt loam in character and arrangement of layers.

A slight textural variation occurs in the surface soil from place to place. In a few low depressed areas the surface soil is almost silty clay loam in texture, and in other places sand has been washed down from the slopes and spread over small areas.

The terraces which this soil occupies are flat, with a slight slope toward the streams. They are from 5 to 30 feet above the first bottoms and well above overflow. This soil, for the most part, is well drained because of the perviousness of the subsoil, but it is retentive of moisture and crops are rarely injured by prolonged droughts.

Crop yields are about the same as those obtained on Tama silt loam. Corn is the principal crop, and oats rank second in importance. Clover, timothy, rye, and barley are also grown.

The soil is high in fertility, of excellent physical structure, and easy to farm. Most of it is medium acid, and lime is beneficial, especially for alfalfa and other legumes.

Judson silt loam.—Judson silt loam is an inextensive terrace soil, widely scattered along second bottoms of streams. Most of it occurs in small disconnected strips at the bases of hill slopes adjacent to the bottom lands, and it lies slightly above overflow. Most of the land is nearly flat, with a gentle slope toward the first-bottom soils. The boundaries between Judson silt loam and the first-bottom soils are necessarily somewhat arbitrary because of the almost imperceptible gradation between them. In extremely high flood periods, some of the Judson silt loam areas may be covered with water for a few hours. Areas of this soil occur along Buck and Sugar Creeks, which are tributaries of North Skunk River, Bear Creek, North Fork English River, and along a few smaller tributary creeks.

The topsoil, ranging from a mere film to 6 inches, is dark grayish-brown friable silt loam containing some colluvial wash which consists of very fine sand from adjacent exposed drift slopes. Between depths of 6 and 28 inches is dark-brown silt loam containing layers, ranging from one half inch to 2 inches in thickness, of lighter silt materials from colluvial wash. The deeper subsoil layer, below a depth of 28 inches, is almost black silty clay loam. The transition between this layer and the one above is very sharp.

Both surface and internal natural drainage are good. The soil is high in natural fertility, is very productive, and is nearly all under cultivation. This is a very strong corn soil, and yields range from 45 to 70 bushels an acre. All the general-farm crops are grown, the yields being about the same as on Muscatine silt loam.

This soil occurs in small areas and constitutes only a small part of the farms on which it occurs.

Bremer silt loam.—Bremer silt loam is a terrace, or second-bottom, soil occurring principally along North Skunk River. A few small areas lie along North Fork English River, Bear Creek, and Walnut Creek. The total area is only 1 square mile. The terraces on which this soil occurs lie from 4 to 30 feet above the present flood level of the streams, and the soil occupies a flat depressed position, usually at the back of the terrace where it joins the upland slope. In some places Bremer silt loam slopes gradually toward the bottoms, into which it merges almost imperceptibly.

The topsoil is very dark grayish-brown or almost black silt loam which is heavy but friable. Below this, and extending to a depth of 24 inches, is dark grayish-brown or black silty clay loam. The lower subsoil layer to a depth of 40 inches is dark grayish-brown silty clay mottled with yellow and brown. The subsoil is more friable, has less gray mottling, and is less plastic than that of Bremer silt loam previously mapped in other Iowa counties. In a few small areas the subsoil approaches the well-oxidized Waukesha silt loam subsoil in color and texture.

The surface relief of Bremer silt loam is flat or depressed, and drainage is only fair. On a few depressed areas, water stands after heavy rains long enough to do some damage to young crops, but the slope in most places is sufficient to prevent water from collecting and doing damage. Very little of this soil is tile drained.

Practically all the land is in cultivation, and all the common crops of the county are grown, yields being comparable to those on Grundy silt loam. The soil is medium acid. Too much corn is grown continuously on most of this soil, and better rotations, with more legume crops, should be used.

Bremer silty clay loam.—Bremer silty clay loam occurs only in a few small areas along North Skunk River, North Fork English River, and Bear Creek.

The topsoil, to a depth of 6 inches, is black sticky and plastic silty clay loam. Underlying this to a depth of 19 inches is uniform black tough plastic silty clay. The next layer, which ranges from 6 to 9 inches in thickness, is transitional between the dark organic-colored surface soil and the subsoil. It is dull-gray heavy tough silty clay discolored by organic infiltration which gives it a dark-colored appearance. The lower subsoil layer below a depth of 28 inches is olive-gray heavy silty clay mottled somewhat with yellow, brown, and a few rust-brown and orange-brown iron stains. No grit is present above a depth of 45 inches.

This soil lies above ordinary overflow and is classed as a second-bottom soil. Even during extremely high flood periods only a small part of the land is covered by water.

Bremer silty clay loam occurs on terraces, usually away from the streams, nearest the adjacent upland slopes. It occupies flat areas slightly lower than the surrounding terrace soils. Water stands for some time after heavy rains unless the land is artificially drained, but surface ditching will largely remove these flood waters. A very small percentage of the land is drained sufficiently to insure maximum crop production, consequently crop yields are low in wet seasons. Where well drained this soil produces high crop yields. It has a high content of organic matter and plant food.

Most of the land is cropped, despite the fact that only a very small percentage has been adequately drained. Corn is grown continuously on much of this soil. Oats and small grains are apt to lodge because of the high organic-matter content of the soil. Some of the less well drained areas are in grass which is cut for hay or pastured. Corn yields range from 25 to 60 bushels an acre, depending on drainage. In seasons of early heavy rainfall, yields are lower.

This soil should be handled similarly to Grundy silty clay loam. The surface soil is moderately acid, and lime is beneficial. Better drainage is the most urgent need of most of this land, but the cost of tiling may not be justified at present.

LIGHT-COLORED UPLAND AND TERRACE SOILS

The light-colored upland soils are developed on the severely eroded stream slopes. The dark-colored surface layer, rich in organic matter, is absent from these soils. In places this is the result of rapid erosion that has removed the dark-colored soil as rapidly as it formed, but to a greater extent it is owing to the influence of the forest growth that has spread over the protected areas in the deeper valleys. The light-colored soil of the flat terraces is the result of the forest influence. In this group the Lindley and Clinton soils are representative of light-colored upland slope soils and Jackson silt loam is a terrace soil. Grundy silt loam, light-colored phase, is

intermediate in the color of its surface soil between the light- and the dark-colored groups, and it occurs on the upland in a position between soils of the two groups.

The light-colored soils are not cultivated to so great an extent as are the soils of the dark-colored group, and more than 50 percent of the total area is used for pasture or wood lots. Corn is the principal crop on the cultivated areas, but it is not grown so frequently as on the smooth upland soils. The light-colored soils are better adapted to growing small grains and tree and bush fruits. To obtain the best results it is necessary to supply organic matter by plowing under legumes or by applying stable manure.

Clinton silt loam.—Clinton silt loam is a light-colored loessial soil occurring on the rolling uplands adjacent to or near the larger streams. It was originally timbered, and much of it is still covered with trees and underbrush. The trees are mostly oak, elm, hickory, and ash. Sumac and hazel brush constitute a dense undergrowth on many slopes and ridges.

This soil occurs largely in the southwest corner of the county along North Skunk River, Sugar, Moon, and Buck Creeks, and fairly large areas are on the slopes and uplands adjoining Deep River, North Fork English River, Walnut Creek, and Bear Creek.

The topsoil, to a depth of 2 inches, is moderately dark grayish-brown smooth silt loam. Between depths of 2 and 14 inches the material is grayish-brown or yellowish-brown floury silt loam which, below a depth of 14 inches, changes abruptly to yellowish-brown silty clay or silty clay loam. Below a depth of 22 inches the subsoil is yellowish-brown silty clay with the characteristic cubical cleavage. At a depth of 34 inches the material changes to yellowish-brown silty clay loam slightly lighter in color and texture than the material in the layer above.

In the southwest corner of the county, north of North Skunk River, is a peculiar variation common to a few sections of the State. Areas of medium-textured loessial sand, ranging in diameter from 50 to more than 150 feet, cover hill crests or hill slopes. These deposits range in thickness from a few inches to more than 30 inches. The 2- to 8-inch surface soil is dark brown, the dark organic color resulting from decayed grass and plant roots. The lower part of the surface soil and the subsoil consist of uniform yellowish-brown sand. Because they depreciate the cropping value of the land these spots are designated by sand symbols on the map, as they are too small to be indicated as a separate soil type. A few of these sand spots also occur within areas of the darker Tama silt loam soil near the boundaries of Clinton silt loam.

Clinton silt loam varies considerably, depending on the surface relief and, probably, on different parent materials. A heavy yellowish-brown or reddish-brown silty clay layer occurs characteristically in the subsoil. The material in this layer has a cubelike structure and breaks down into imperfectly shaped cubelike blocks one fourth inch in diameter. This heavier material is highly acid, the acre requirement of lime for neutralizing acidity ranging from 4 to 8 tons. The heavy layer occurs at different depths, in some places lying immediately below the surface soil and in others 3 feet or more below the surface. Where this layer is deep, the upper subsoil layer is usually friable heavy yellowish-brown silty clay loam

or silty clay and is less acid. Areas in which this last-described subsoil occur are gradational toward Fayette silt loam, the difference being in the subsoils, the Fayette soils having friable and more pervious subsoils. On the east side of Sugar Creek Township, a few small areas of silt loam having a very friable subsoil have been included with Clinton silt loam because of their similarity and the small total area covered by them. The topsoil here is more gray than buff.

Where erosion has been rapid, the heavy layer is exposed on the surface. The rougher and more broken and eroded areas, principally the steeper slopes, have been mapped as Lindley silt loam.

The surface relief of Clinton silt loam ranges from gently to sharply rolling, and drainage is everywhere adequate or excessive. In the more rolling areas, erosion is active. Because of the fineness of the soil particles, erosion progresses very rapidly and slopes are quickly denuded after breaking for cultivation, unless they are carefully handled. The more rolling land should be kept in pasture.

More than 50 percent of this soil is in cultivation, and the remainder is used for pasture and timberland. The soil is particularly adapted to the production of small grains, tree and bush fruits, and vegetables. Corn does well but cannot be grown so often as on the darker upland soils which are much higher in organic matter. Maximum yields of corn follow clover or bluegrass sod top-dressed with barnyard manure. Where clover is grown in a 3-year rotation, corn yields almost equal to those on Tama silt loam can be maintained. Timothy and clover mixed is the principal hay crop. Some wheat and rye are grown. Wheat yields range from 15 to 25 bushels an acre and oats from 20 to 40 bushels.

The topsoil is acid and ordinarily requires from 1 to 3 tons of lime an acre to neutralize the acidity. The subsoil in most places is strongly acid. Clover grows well without liming or inoculating, according to local information, but it is necesarry to lime and inoculate for alfalfa.

Where a soil-building program is used in cropping, as a 3-year rotation of corn, small grain, and clover, high corn yields are obtained, comparing favorably with those on the darker upland Tama soils. Organic matter is the immediate need of this soil.

Lindley silt loam.—Lindley silt loam occurs in narrow strips on the steeper stream slopes in the southwestern part of the county, mainly along North Skunk River and its larger tributaries, and in the northeastern part along Bear and Walnut Creeks. The land ranges from gently rolling to rough and broken.

The surface soil to an average depth of about 8 inches is grayish-brown or yellowish-brown friable silt loam, and the upper subsoil layer to a depth of 15 inches is yellowish-brown silty clay loam. The lower subsoil layer is yellowish-brown silty clay containing considerable grit, the quantity increasing with depth. Small boulders occur in places in both surface soil and subsoil, and these become more numerous with depth.

About half the land is cultivated, and the remainder, which is left in woods, is used to some extent for pasture. Corn and other crops are grown on the cultivated part, but yields are considerably less than those obtained on the dark-colored upland soils, being about

the same as those on Clinton silt loam. This soil was originally timbered. A scattered tree growth now covers the uncultivated areas.

As its light color indicates, the soil is poor in organic matter. Available manure and legumes should be used for improving the farmed land. Permanent pasture would be the best use for this soil where not needed for crops.

Lindley loam.—Lindley loam occurs in the same general locations as Lindley silt loam but on steeper slopes, from which most of the loessial silt has been removed by erosion.

The surface soil to an average depth of about 12 inches is grayish-brown or yellowish-brown heavy loam. The upper subsoil layer to a depth of 17 inches is lighter yellowish-brown clay. The lower subsoil layer is lighter in color, consisting of bright-yellow clay mottled with gray and some brown. Many black iron stains occur below a depth of 30 inches. More or less sand, gravel, and grit, and a few boulders occur throughout the soil profile, the proportion of coarser materials in most places increasing with depth.

Only a small percentage of this land is cultivated, the remainder being in permanent pasture or timber. Originally all the land was forested with hardwoods, mostly oaks, elm, and hickory.

Drainage of this soil is excessive in most places, and much erosion has resulted in the forming of many deep gullies. Planting of trees, such as black locust, is recommended to stop the deepening of the gullies. The cultivated land should be left in grass most of the time, in order to prevent erosion.

A silty variation of this soil occupies the sharp and rough broken slopes between the adjoining Clinton silt loam soils on the upland and the first- and second-bottom land along the larger streams. It is restricted largely to the southwestern part of the county, in narrow disconnected strips on the rougher slopes. Practically all this included soil is too rough to cultivate, except an occasional small patch of an acre or less, lying at the base of a hill slope. Originally the land was timbered, and a scattered scrubby forest growth, with an undergrowth of hazel brush, still covers most of it.

The surface soil is buff or light grayish-brown silt loam ranging in thickness from 2 to 15 inches. The subsoil is heavy tough plastic yellowish-brown or reddish-brown silty clay which, at a depth ranging from 30 to 40 inches, contains considerable grit and small rock fragments. A faint gray mottling and some iron stains, both of which increase with depth, are present in the subsoil.

Jackson silt loam.—Jackson silt loam is of very small extent in Poweshiek County and consequently unimportant agriculturally. A few small areas occur along Walnut Creek and along Buck Creek at the Mahaska County line.

The surface soil, ranging from a mere film to a depth of 10 inches, is grayish-brown smooth floury silt loam. Below this is pale yellowish-brown silty clay loam containing much silt, and the material becomes gradually heavier with depth. Below a depth of 21 inches is yellowish-brown silty clay loam which is heavy, compact, and plastic when moist. The subsoil has a faint red cast.

Included with this soil, because of its small total area, is a light-colored soil which differs somewhat from typical Jackson silt loam. The difference in the two soils lies mainly in the subsoil drainage,

which in the Jackson soil is somewhat restricted, but in the included soil is good, owing to the lighter texture. The subsoil of this variation is light yellowish-brown heavy silt loam or light silty clay loam, which is well oxidized, is friable, and has good internal drainage.

The terraces on which Jackson silt loam occurs have a very perceptible slope toward the first bottoms and in most places lie from 6 to 10 feet above them. Considerable colluvial material is deposited at the foot of the upland slopes and in low places. Small spots of fine sandy loam occur in a few places. The subsoil differs considerably from place to place, being friable and well drained in some areas but rather heavy in most places, with slow downward percolation. The land is nearly everywhere adequately drained because the surface slope is sufficient to carry off excessive rain water.

Corn is the main crop, and yields compare favorably with those obtained on Clinton silt loam of the upland. Small grains yield well. Additional organic matter is needed to improve this soil. It is of low or medium acidity, but clover grows well without lime.

BOTTOM-LAND SOILS

The bottom-land soils of this county include Wabash silt loam, with a colluvial phase, Wabash silty clay loam, and Genesee silt loam. The last named is light-colored material composed of recent stream deposits. All the soils of this group are subject to overflow, and, with the exception of Wabash silt loam, colluvial phase, their agricultural value is seriously impaired by flooding and slow drainage.

Wabash silt loam.—Wabash silt loam is a first-bottom soil subject to periodic overflow. Excessive rainfall causes the streams to spread their waters over nearly all of this soil, as it occupies the immediate flood plains only a few feet above stream level. The higher lying parts back from the streams are overflowed for only short periods, and many of them are cropped to corn. However, the cultivated land includes a rather small percentage of the total area of the soil.

This is the most extensive first-bottom soil in the county, occurring along all the main streams and their tributaries. In draws at the heads of the tributaries, silty materials have been carried down from the abutting upland slopes by sheet erosion, and here the soil is mapped as a colluvial phase of Wabash silt loam.

The 5- to 8-inch topsoil of Wabash silt loam is dark grayish-brown friable silt loam. The next layer to a depth ranging from 17 to 20 inches is dark-brown silt loam slightly heavier and darker than the surface soil. Below this and extending to a depth ranging from 24 to 28 inches is dark grayish-brown silty clay loam which changes abruptly to moderately dark grayish-brown silty clay. Black, brown, and reddish-brown iron stains are common in the lower part of the subsoil.

Wabash silt loam is formed from periodic soil deposits laid down by the run-off and flood waters of the many streams and their feeder tributaries, which form an intricate network of drainage lines throughout the upland. These streams, for the most part, cut through areas of dark-colored loessial soils, and consequently the alluvial soils formed by normal erosion are dark colored.

The finer black eroded clay particles are concentrated in depressions or flats formed along many of the streams, in most places well back from the channel. Areas of silty clay loam, where of sufficient size, have been mapped as Wabash silty clay loam, but as many of them are too small to be shown on a small-scale map they are included with Wabash silt loam. In the southwestern part of the county, along North Skunk River and its tributaries, and along Walnut Creek in the northeastern part, deposits of lighter silt materials, eroded from the sharply rolling slopes of the Clinton soils, are spread over the dark-colored soil to a depth of several inches. Because of their small individual and total areas these spots are included on the soil map with Wabash silt loam.

Wabash silt loam areas, although nearly flat, are cut by stream channels issuing from the upland. On the wider bodies along the larger streams there is a scattered growth of trees, mostly close to the stream channel. The native trees are chiefly post oak, ash, cottonwood, willow, red haw, and thornapple.

The greater part of this soil is used for pasture, as periodic floods endanger crops and most farms include sufficient upland soil for crop land. This is rich cornland, producing high yields in dry years, but, on account of frequent overflows and the uncertainty of crops, most of the land is left in luxuriant native grass and bluegrass and is pastured. On the wider stream bottoms a considerable acreage of corn is grown which gives high yields in favorable seasons. This soil is not considered a cropping soil, not because of lack of fertility but owing to periodic flood damage.

Wabash silt loam, colluvial phase.—Wabash silt loam, colluvial phase, is dark-colored friable silt loam occurring in gentle draws at the heads of the smaller drainageways throughout the county. Definite channels have not yet been formed in many of these draws over much of the area, and over the remaining part the incipient channels are very shallow. The gentle draws reach to the flat upland prairie and are gradually invading the almost level areas of Muscatine soils, which occupy the narrow remnants of an originally extensive flat plain.

The topsoil of this soil is very dark grayish-brown friable silt loam. Below a depth of 14 inches and extending to a depth of 30 inches the material is dark grayish-brown silty clay loam, only slightly heavier than the surface soil. Between depths of 30 and 42 inches the subsoil is dark grayish-brown silty clay loam. The surface soil differs considerably in texture, but it is characteristically heavy, in many places consisting of intricately mixed areas of silty clay loam and silt loam, the silty clay loam patches being almost black. However, these variations are too small to separate on a small-scale map.

Surface drainage is excellent in most places, but internal drainage is slow. In depressions, where the heavier-textured variations of the soil occur, drainage is restricted and tiling is necessary. For the most part, however, tile is not used, as the natural drainage is adequate, and flood waters are quickly removed. This soil also occurs in a few nearly flat basinlike bodies at the heads of tributary streams, where water may stand for a short time after rains.

Most of the land is in cultivation. It is farmed in conjunction with the gently rolling Tama silt loam, from which the soil material has

been washed. The same staple crops are grown as on Tama silt loam, and yields are equal to or greater than on that soil. Wabash silt loam, colluvial phase, is very rich in humus, and small grains frequently lodge unless stiff-strawed varieties are grown. Clover grows luxuriantly in the draws. In most places the soil is acid, requiring from 1 to 2½ tons of lime an acre to correct the acidity.

Wabash silty clay loam.—Wabash silty clay loam is a bottomland soil occupying the flood plain, generally farthest removed from the stream channel and abutting the upland hill slopes. The soil occupies a flat or basinlike position which prevents run-off, so that it is naturally poorly drained. The heavy surface soil and subsoil also restrict the downward movement of water. Small patches of shallow muck occur in a few small ponded areas.

The largest bodies occur along North Fork English River, North Skunk River, and Bear Creek, and a few small areas lie along other streams.

Wabash silty clay loam to a depth of 10 inches is very dark grayish-brown or black heavy and sticky silty clay loam underlain by dark grayish-brown or black silty clay. Between depths of 19 and 26 inches is dark grayish-brown or dark-gray silty clay containing a few faint yellow-brown mottlings. The lower subsoil layer is yellowish-brown or grayish-brown silty clay, highly mottled with yellow and some gray. Iron stains become noticeable at a depth ranging from 36 to 40 inches. Both the mottlings and the iron stains increase with depth.

Probably 50 percent of this soil is cultivated, and the remainder is in pasture. Most of the areas have sufficient slope streamward to carry off the ordinary flood waters of the smaller tributaries and the rain which falls after cropping. Corn yields from 40 to 60 bushels an acre in favorable seasons. Some wild hay is cut from the more poorly drained areas.

A high organic content is characteristic of the deep black topsoil. Restricted drainage is the chief cause of small crop yields. Drainage could be improved by more surface ditching, but the expense for tiling would hardly be justified, because of the uncertainty of late damaging floods.

Genesee silt loam.—The 14-inch topsoil of Genesee silt loam is yellowish-brown or grayish-brown smooth floury silt loam. Below this is light yellowish-brown silty clay loam containing a high percentage of silt and some fine sand. At a depth of 21 inches this material is underlain by light yellowish-brown silty clay loam mixed with much silt and some very fine sand. A few orange-brown iron stains and splotches occur, which become more numerous below a depth of 36 inches. In places this soil is composed of alternate layers of darker-colored silt and clay. Another variation is characterized by a layer of light-colored silt, from 4 to 20 inches thick, over black silty clay. Such areas would have been mapped as Ray silt loam if of sufficient extent but have been included with Genesee silt loam because they were few and small.

This soil is unimportant agriculturally, because of its small extent. Most of it occurs along streams in Sugar Creek Township, and a small area is along Walnut Creek in Jefferson Township. It is used only for pasture, as it is subject to periodic overflow.

SOILS AND THEIR RELATIONSHIPS

The soils of Poweshiek County owe their most striking characteristics and their distribution to three main factors (1) the character of the geologic formations from which they have developed, (2) the soil-forming processes acting on the parent materials, and (3) the length of time these processes have acted without interruption.

The parent soil material over the greater part of the county was loess. In the upland, comparatively small areas, from which the silty loess was removed by erosion, show an exposure of glacial drift. As a result, all the soils, with the exception of comparatively small areas of loam over the drift exposures, are silt loams or silty clay loams. The alluvial soils, consisting of silt loams and silty clay loams, are developed over sediments brought down mainly from the silty soils of the upland.

In the well-developed soils, the most pronounced characteristics are the result of environment, especially of the prevailing climate and vegetation.

Poweshiek County lies in the prairie region of the United States, where a temperate climate, smooth land surface, and a moderately plentiful supply of moisture have favored a luxuriant growth of native grasses and prevented the spread of much forest growth, except over the rougher hill slopes along the streams. The most common characteristic of prairie soils is their black color, which is common to all soils developed under a luxuriant grass vegetation. This dark color is owing to the finely divided carbonaceous material derived from the decay of fine grass roots. Favorable moisture conditions and temperature apparently prevailed for the maximum bacteriological and chemical soil-forming activities and the preservation of the resultant organic content.

Although climatic conditions and surface relief have combined to produce a dark-colored soil developed under the influence of a grass vegetation, the county is outside the true chernozem region. The precipitation has been sufficient to leach the readily soluble salts to a depth of many feet and to prevent the accumulation of carbonates in any horizon.

It is generally conceded by soil scientists that the soil-forming processes of a region impress themselves best on soil material having a smooth or gently rolling surface relief that provides efficient drainage. The soil must also remain undisturbed for a sufficient length of time to reach a stage of maturity.

Well-drained soils developed on smooth flat or gently rolling surfaces are the most extensive in this county and include those in which the soil-forming processes have effected their maximum results for this region. This group of soils includes Tama silt loam developed over loess, Carrington loam developed over glacial drift, and Waukesha silt loam on terrace material. Shelby loam, which also occurs on glacial drift, has the characteristics of the group, but because of erosion it is not so deeply developed.

The following description of Tama silt loam shows the characteristics developed in the well-drained prairie soils:

> From 0 to 2 inches, very dark grayish-brown silt loam filled with a dense mat of interlaced grass roots. When dry the surface soil is very dark grayish brown, but it is black when wet.

From 2 to 15 inches, very dark grayish-brown friable silt loam. The material is mellow and breaks up readily into small soil granules, most of them less than one sixteenth inch in diameter. Some fine loose silt is also present.

From 15 to 24 inches, a transitional layer which consists of brown light-textured silty clay loam. Dark-colored organic infiltrations have discolored this layer until, from a distance, it appears as dark as the topsoil. It is, however, not uniform but streaked, the darkest parts being around and near old soil cracks, root holes, and worm and insect burrows. In a few places lighter-colored soil material has been brought up from below by worms. When crushed between the fingers the material of this transitional layer appears to be much lighter in color. The soil material breaks into irregular-shaped clods larger than those of the surface soil. Granulation is distinct, but the soil granules have a maximum size of one fourth inch in diameter.

From 24 to 44 inches, yellowish-brown silty clay loam well oxidized and of a bright uniform color. A few faint dark streaks and stains penetrate this layer but do not modify the normal color. The stains result from the deep penetration of inorganic infiltrates from above, which have followed the deeper old root channels and worm, insect, or animal burrows.

From 44 to 70 inches, lighter yellowish-brown silty clay loam faintly mottled with gray and yellowish brown. Some very fine sand particles are noticeable, but no coarse sand or grit. A few dark-brown or reddish-brown iron stains and concretions appear in this layer and increase in number with depth.

Below 70 inches, the material changes to light-yellow or pale-yellow silty clay loam mottled with yellowish brown and gray. Rust-brown and black iron stains and splotches are numerous, especially in the lower part of the layer where they occur in great concentration between depths of 85 and 94 inches. Lime or other carbonates are not present in sufficient quantities to react with hydrochloric acid.

Another group of dark-colored soils includes soils developed under conditions of more or less imperfect drainage. The surface soils are very dark grayish brown or black and have a well-defined granular structure. The subsoils are gray or mottled gray, yellow, and brown, and they are somewhat heavier than the surface soils. The details of the profiles of these soils differ considerably, depending on the depth to which good drainage and oxidation have reached. In some places both surface soil and subsoil have been saturated for the greater part of the year, and in others the surface soil has been drained but the subsoil has been frequently saturated. These soils occur on flat areas on the uplands, terraces, and bottoms and include all the soils of the Grundy, Muscatine, Bremer, and Wabash series mapped in Poweshiek County. Muscatine silt loam is the most extensive soil of this group. It has developed under conditions of excessive moisture in the subsoil. Following is a profile description of Muscatine silt loam:

From 0 to 2 inches, very dark grayish-brown or black heavy silt loam. A dense mat of grass roots occupies most of this layer, and coarse soil granules cling to the grass roots when shaken.

From 2 to 18 inches, very dark grayish-brown silt loam which is very sticky when wet but friable when dry. The soil is heavy in texture, approaching a silty clay loam in places. The heaviness increases with depth, but the entire layer is friable under normal moisture conditions.

From 18 to 25 inches, very dark brown silty clay loam, in which the dark color is caused by heavy organic infiltration from above, which has percolated downward along the faces of soil granules, cracks, root holes, insect burrows, and worm burrows. When the soil granules are crushed between the fingers, they are much lighter brown than the soil material in place, indicating that the dark coloring matter is

merely a coating around the soil granule. This is the transitional layer between the dark-colored surface soil and the light-colored subsoil.

From 25 to 28 inches, a layer of yellowish-brown silty clay loam of almost uniform color, similar to the subsoil of Tama silt loam, except that it contains a few gray flecks. The organic discoloration has not reached this layer except in a few fingerlike or threadlike inclusions which are not so dark as in the layer above but are darker than the true soil coloring in this layer.

From 28 to 42 inches, yellowish-brown silty clay loam distinctly mottled with gray and slightly heavier in texture than the thin layer above. Orange-brown and rust-brown iron stains, in the form of concretions, nodules, and short threadlike filaments, are conspicuous.

Below 42 inches the soil is highly mottled and is paler yellowish-brown silty clay loam, which is lighter in texture than the layer above. The material is brown with gray mottles, and it contains nodules, stains, or splotches of rust brown or black, mainly composed of iron.

Muscatine silt loam has developed over loess in the flat interstream divides where drainage was only partly restricted. Muscatine silty clay loam occurs on areas having slower drainage than areas of the silt loam. Grundy silt loam and Grundy silty clay loam usually occur in the interiors of flat divides, and they show more gray and brown mottling in the subsoils, indicative of less perfect drainage. The silt loams and silty clay loams of the Bremer series, which occur on flat terraces, and of the Wabash series, which occur in the bottoms, show the effects of excessive moisture over long periods of time.

The areas of light-colored soils are coextensive with the areas on which a timber growth had established itself when the county was first settled by white men. As trees had only encroached on the upland in eroded areas, the surface features of the eroded upland soils differ from those of the prairie soils. The soils of the light-colored group are those of the Clinton and the Lindley series on the upland and of the Jackson series on the terraces. Grundy silt loam, light-colored phase, may also be placed with this group although it is intermediate in some characteristics between the light-colored soils and the dark-colored prairie soils.

Following is a profile description of Clinton silt loam which is the best representative of this group:

From 0 to 2 inches, moderately dark grayish-brown silt loam which contains much fine floury silt.

From 2 to 14 inches, grayish-brown or yellowish-brown floury silt loam. The structure is finely granular, with a tendency to somewhat imperfect granulation, the material commonly breaking down into small structure granules, with much loose interstitial silt.

From 14 to 22 inches, uniform yellowish-brown heavy silty clay loam or silty clay. When dry the material in this layer cracks into a columnar form, and when moist it breaks into coarse aggregates of irregular shape and size.

From 22 to 34 inches, yellowish-brown tough silty clay. This is the layer of maximum compaction. The soil material, when dry, cracks into a distinct columnar form and when broken down forms small cubical clods or pieces ranging from one fourth to one half inch in diameter. The clods have a thin gray coating on their surfaces, partly or wholly covering the cubes along the lines of cleavage.

From 34 to 45 inches, yellowish-brown silty clay loam or silty clay, slightly lighter in color and texture than the overlying layer. Although the material in this layer cracks into columnar shapes when dry, the characteristic cube structure seems to be disappearing, and in general irregular-faced clods are formed on breakage.

From 45 to 58 inches, light reddish-brown clay loam containing considerable grit in the form of fine and coarse sand, small pebbles, and small irregular rock fragments. A few faint iron stains are present.

From 58 to 80 inches, slightly darker reddish-brown clay loam or clay, containing an abundance of coarse sand, gravel, and rock fragments. Some nodules and streaks of dark-brown and black iron spots, ranging from one eighth to more than one half inch in diameter, are present, and they are in greater concentration in the lower part of the layer. When these nodules are broken between the fingers, they form a fine black or reddish-brown powder. Small irregular-shaped fragments of granite, gneiss, greenstone, and sandstone are present. The material in this layer is distinctly heavier than that in the layer above.

Carbonates are not present in sufficient amounts, in any of these layers, to effervesce with acid, but there is considerable variation in the acidity of the soil profile. The topsoil has a lime requirement of about 1 ton an acre, but a rather abrupt change occurs at a depth of 12 or 14 inches, where the zone of concentration begins. Here the lime requirement is 3 tons or more an acre.

AGRICULTURAL METHODS AND MANAGEMENT

Poweshiek County includes a very high percentage of arable land. The surface relief of most of the soils is flat, gently rolling, or rolling. On the flat interstream areas adequate drainage and crop rotation suited to the soil are the most important problems of management, and on the gently rolling or rolling areas, where drainage is adequate or excessive, control of erosion is an additional important factor. Sheet erosion goes on in most places so slowly that the great damage through great losses of plant foods is not noticed. The drift soils, Carrington loam, Shelby loam, Lindley loam, and Lindley silt loam, are soils which have been formed by erosion processes, the original loessial silt covering being almost entirely removed. The result has been a mixing of the loessial silt and underlying drift materials on the gentler slopes and the complete removal of the original silt covering on the steeper slopes, thereby exposing the heavy gritty clay of the old Kansan drift which underlies practically the entire State.

A system of soil management has been worked out for the State, based on results from cooperative experiment fields located on different soils in all parts of the State. Results of experiments applicable to the soils of Poweshiek County will be given later.

The soil-management program for the State, if followed, may be expected to lower costs of production, increase crop yields, and maintain the fertility of the land. These practices are: first, drainage and proper cultivation; second, manuring and green manuring; third, liming; fourth, use of phosphates and other fertilizers; and fifth, rotation of crops.

In order to obtain maximum crop yields, soil drainage must be adequate. On six soils in the county, drainage is restricted. The upland soils are Grundy silt loam, Grundy silty clay loam, Muscatine silt loam, and Muscatine silty clay loam, all of which occupy the highest flat upland positions. Bremer silty clay loam on the low terraces, or second bottoms, and Wabash silty clay loam on the bottoms also have poor natural drainage. As the Grundy soils have very heavy subsoils, tile must be laid moderately close to obtain the best results. Without tile drainage these soils range from difficult

to impossible to handle in wet seasons, the crop yields are accordingly low, as compared with those obtained on well-drained areas. In a well-tiled field earlier working and seeding in spring can be done, and crop yields are also greatly increased. Good aeration increases bacterial activity and oxidation and makes available more plant food which greatly stimulates plant growth.

Careful cultivation is also essential to crop production. Besides keeping down the weeds, surface cultivation greatly conserves the moisture. Deep plowing is also desirable, especially on the heavier textured soils. Changing the depth of plowing is desirable so that a plow sole is not formed in the silty clay loam soils. These soils, unless plowed and cultivated under proper moisture conditions, will bake and clod. In extremely dry weather cracks, which injure grain roots, are formed. Deep plowing and careful mulching after rains will tend to prevent this condition.

A different management problem is presented over the greater part of the county where the relief is gently rolling or rolling. Here sheet erosion is continually carrying away the finer soil particles and is leaching out the carbonates and plant foods at a more rapid rate than is generally realized. Large amounts of calcium carbonate have been leached and lost in drainage waters, according to experiments. At Cornell University (*2*, *3*, *4*), Ithaca, N.Y., results over a 5-year period have shown smaller losses of calcium carbonate on cropped plots than on uncropped plots. Nitrates are also lost at a high rate through leaching and run-off. Erosion plots at the United States Erosion Experiment Station at Clarinda, Iowa, have shown a large loss of nitrates through erosion, and experiments at the Cornell (N.Y.) University Agricultural Experiment Station show very large losses of nitrates through leaching. Other plant foods are also lost at a rapid rate.

Thus, it may be seen that the control of erosion is very important because of the enormous loss in the amount of plant-food constituents as well as actual soil removal, with eventual destructive gullying. Fortunately there is only a small percentage of badly eroded land in Poweshiek County. However, the drainage channels are gradually cutting back into the remnants of the original flat upland plain. By resorting to terracing and crop rotation on the more gentle slopes, further losses through erosion can be minimized, and these thin soils can be built up to a higher state of fertility and conserved. The steeper slopes and those badly damaged by gullying should be left in permanent pasture or timber. On the rougher areas, many of which contain a scattered tree growth and considerable underbrush, there is only a meager grass growth. These areas are best suited to sheep pastures, and sheep raising and feeding seem to be increasing.

Manuring is a common practice. On the average farm the limited amount of barnyard manure available is applied to land for corn or is used as a top dressing on clover, clover and timothy, or timothy sod and is plowed under. Green manures should be used more extensively than at present. Red clover, alsike clover, Dalea, and sweetclover are excellent green-manure crops. Where the soils are thin, denuded, or low in organic matter, as are the lighter-colored soils in particular, an entire crop should be plowed under occasionally until the humus content is normal. Additions of organic matter will be beneficial to every soil in the county. Cropping to corn and small grains, which together constitute from 75 to 85 percent of the agri-

cultural crops of the county, rapidly depletes the humus and fertility. Liming is profitable on most soils not only for legumes but also for grain crops. As the acidity of the soil varies greatly, individual fields should be tested before lime is applied. The lime requirements will differ in the different soils, ranging from 2 to 8 tons an acre. A few deeply eroded spots on hillsides are neutral or but slightly calcareous. The subsoils, as well as the surface soils, are moderately or strongly acid in most of the soils in the county. Although red clover, alsike, and Lespedeza are acid tolerant to greater or less degree, lime will greatly increase the stands, and sweetclover and alfalfa will not grow well unless the soils have been limed.

Another legume crop which will grow well in acid soils is the soybean, but it does much better on sweet soil. This crop is being grown inextensively, mainly between the corn rows for silage. Soybeans, where grown alone, should be planted on the flatter or nearly level areas, as the roots seem to loosen the topsoil material, forming a fine soil mulch, which is readily washed off of slopes during normal or heavy rains, causing great damage, especially after the crop has been removed. The cultivation of soybeans on Shelby and Lindley loam slopes in southern Iowa has literally ruined hundreds of acres of land by removing practically all the surface soil and humus, which it has taken nature thousands of years to form, and leaving the heavy gritty clay subsoils exposed.

Liming and growing sweetclover or alfalfa can be highly recommended on the flat upland soils, as the deep penetration of the roots in the subsoil allows better downward movement of water along old root channels, gives better aeration and drainage, allows earlier plowing, and results in a mellow seed bed. All legumes should be inoculated, as the expense is small. This is cheap insurance which is more than repaid by crop results. Alfalfa and sweetclover must be inoculated, in addition to liming, if success is to be expected. Stands of alfalfa and sweetclover have been obtained on a few fields which were heavily manured and which were in a high state of fertility at the time of planting.

The use of phosphates and other fertilizers can best be studied in the tables showing results of fertilizer treatments in the latter part of this section of the report. As shown by analysis, the phosphorus content of the different soils in Poweshiek County ranges from low to moderate. It has been proved through many experiments on similar soils in other counties that phosphatic fertilizers as a rule produce a marked effect on clovers and other legume crops and on corn, oats, and other grains. In addition to the increase in the yield, the effect is noticed mainly in the quality of the grain. Applications of phosphorus on many fields will improve the grade of grain to such an extent as to give a larger cash return if the grain is sold. Both rock phosphate and superphosphate have been used with success and profit. It is recommended, however, that small strips in the field be first treated, in order to determine whether results will justify the expense. This is especially important where the use of complete fertilizer is contemplated. Ordinarily, with a normal price for farm products, phosphorus can be profitably used. Poor stands of clover often occur on the lighter soils. Weak plants are easily winterkilled in adverse seasons, and this danger would be minimized by the application of humus and lime or lime and phosphate.

Crop rotation is an essential practice for maintaining crop yields and for building up or maintaining soil fertility. Some kind of rotation is practiced on every farm, but it may be inadequate for maintaining the productiveness of the soil. Corn, corn, and oats is a common rotation, with an occasional seeding of clover and timothy. This type of cropping is expensive in the long run, as no soil in the county can withstand continuous cropping without harmful results. The black upland soil on the flat divides can stand abuse from continuous corn growing better than most of the other soils in the county; but unless a suitable rotation is used on the rolling upland soils, the fertility is quickly depleted. On soils that need building up a 3-year rotation should be used, corn, oats or other small grain, and red clover or sweetclover used as pasture or cut for hay. For rapid soil building the entire legume crop should be plowed under during one or two rotations and the second crop thereafter. Dalea has a high fertilizing value as a green-manure crop. On soils not subject to washing soybeans can be substituted, and cowpeas also make a good growth and are acid tolerant. A 4-year rotation can be used, where the fertility is normal, without serious depletion, if a green-manure crop is plowed under. A good 4-year rotation is corn, 2 years, followed by oats, wheat, or barley, seeded down to red clover or sweetclover. Alfalfa can be included in the 4-year rotation and left for 4 or 5 years.

On the light-colored soils, it is not advisable to grow corn more than 1 year in a rotation. These light-colored soils, which are low in humus, as their color indicates, can be made very productive by the use of a good 3-year rotation. Phosphates will show good results under normal price conditions in either the 3- or 4-year rotations.

Experimental results of the Iowa Agricultural Experiment Station on field plots located on soil types similar to those occurring in Poweshiek County will be given in detail. The treatments and their results are applicable to similar soils in this county. The experimental plots are one tenth acre in size and are permanently laid out on soil types representing large areas in a number of counties. The plots are established on farms where a definite rotation is practiced, including the growing of a legume crop. The experiments are supervised by a field man from the experiment station, who applies the fertilizers and harvests the crop. The plots are located in one corner of the field and are farmed by the cooperator along with the regular crop, and they receive the same care as the rest of the field. A careful record is kept of the results.

The experiments are planned to include tests of different fertilizer treatments under both livestock and grain farming. The older fields were laid out on both grain and livestock systems of farming, but the newer fields use the livestock system only. Manure and lime serve as basic treatments when needed on the soil. Most of the fields include 13 plots with 3 check plots, but the newer fields under the livestock system use only 9 plots.

In the grain system, crop residues are the basic treatment, the cornstalks being cut with a disk or cutter and plowed under, and at least the second crop of clover is plowed under. The first crop of clover is cut on some plots, allowed to remain on the land, and plowed under with the second crop. Tests are made of the soil for

acidity, and sufficient lime to neutralize the acidity is added. Tests for lime are made once in a rotation, and lime is applied as needed. In the livestock system manure is used instead of crop residues for the basic treatment.

Rock phosphate was added, previous to 1925, at the rate of 2,000 pounds an acre, once in a 4-year rotation. After this date 1,000 pounds were used once in the 4-year rotation. The quantity of superphosphate (200 pounds an acre) was reduced in 1923 to 150 pounds annually, 3 years out of 4 in a 4-year rotation, being omitted on the legume crop.

In the earlier experiments the old standard 2-8-2[3] complete commercial fertilizer was used at the rate of 200 pounds an acre and disked in. Since 1923, a 2-12-2 mixture has been applied at the rate of 200 pounds an acre, which has the phosphorus equivalent of 150 pounds of 16 percent superphosphate. This was changed in 1929 to a 2-12-6 mixture. Potash was applied at the rate of 50 pounds an acre annually, 3 years out of 4 in the 4-year rotation.

The average crop yields and increases due to the different treatments are given in tables 5, 6, 7, and 8. These data are the averages of results from the total number of fields on the same soil type in different counties.

Table 5 shows the average results on Tama silt loam in Black Hawk, Adair, Benton, Grundy, Madison, Cedar, and Jasper Counties. This is the predominating soil in Poweshiek County.

TABLE 5.—*Average crop yields per acre and increases due to fertilizer treatment on Tama silt loam on Iowa experiment fields*[1]

Treatment	Corn[2]		Oats[3]		Hay (clover, timothy and clover, or timothy)[4]	
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*
Check[5]	53.9		55.2		1.51	
Manure	58.3	4.4	58.6	3.4	1.59	0.08
Manure+lime	60.6	6.7	63.3	8.1	1.69	.18
Manure+lime+rock phosphate	60.8	6.9	69.3	14.1	1.85	.34
Manure+lime+superphosphate	62.2	8.3	67.4	12.2	1.91	.40
Manure+lime+superphosphate+potassium	61.1	7.2	72.6	17.4	1.95	.44
Manure+lime+complete commercial fertilizer	62.3	8.4	71.0	15.8	1.84	.33
Crop residues	55.3	1.4	53.6		1.46	
Crop residues+lime	62.7	8.8	61.6	6.4	1.97	.46
Crop residues+lime+rock phosphate	66.6	12.7	61.4	6.2	2.01	.50
Crop residues+lime+superphosphate	65.2	11.3	60.4	5.2	2.08	.57
Crop residues+lime+complete commercial fertilizer	64.4	10.5	63.4	8.2	2.28	.77

[1] Data from State Soil Survey of Iowa.

[2] Corn yields averaged from 27 crops on 7 fields, except the manure+lime+superphosphate+potassium plot which is averaged from 22 crops on 6 fields, and the crop-residue plots which are averaged from 5 crops on 1 field.

[3] Oat yields averaged from 11 crops on 7 fields, except the manure+lime+superphosphate+potassium plot which is averaged from 8 crops on 6 fields, and the crop-residue plots which are averaged from 3 crops on 1 field.

[4] Hay yields averaged from 6 crops on 4 fields, except the manure+lime+superphosphate+potassium plot which is averaged from 4 crops on 3 fields, and the crop-residue plots which are averaged from 2 crops on 1 field.

[5] The yields given for the checks are the averages of the yields on all check plots on all fields.

Lime showed the greatest economic return in both crop-residue and manure plots. Manure alone increased the yield of corn and oats but affected the hay crop slightly. Rock phosphate with manure and lime had little effect on corn but caused a good gain in hay and oats.

[3] Percentages, respectvely, of nitrogen, phosphoric acid, and potash.

Superphosphate with manure and lime stimulated yields of hay and corn with slightly less effect on oats, as compared with rock phosphate. Potash added to manure and lime and superphosphate was of no value on corn but greatly increased the yields of oats and hay. Commercial fertilizer with manure and lime gave a slight increase in yields of corn but compared to the potassium plot showed a decrease in yields of oats and hay. With crop residue as a basic treatment, a negligible increase was noted. When lime was added the yields of all crops were greatly increased. The rock phosphate and lime further increased corn and hay only. Superphosphate and lime proved not so good as rock phosphate for corn and oats, but they slightly increased the hay crops. Commercial fertilizer gave great increases on hay and oats but a decrease over the phosphates on corn.

It would seem from these plots that lime used with crop residues gave the largest returns, not only of legumes, but also of corn and small grains. Both phosphates were effective for Tama silt loam. Before applications of superphosphate, rock phosphate, or concentrated fertilizer are made, tests should be made in narrow strips through the field to determine the value of the treatment.

Results on Muscatine silt loam, recorded in table 6, are the averages of 16 crops from 4 fields in Scott (2 fields), Muscatine, and Clinton Counties. Muscatine silt loam is the uneroded flat upland soil occupying the highest places on the interstream divides, principally in the northern half of Poweshiek County.

TABLE 6.—*Average crop yields per acre and increases due to fertilizer treatment on Muscatine silt loam on Iowa experiment fields* [1]

Treatment	Corn [2]		Oats [3]		Hay (clover, timothy and clover, or timothy) [4]		Winter wheat [5]		Alfalfa [6]	
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Tons*	*Tons*	*Bush.*	*Bush.*	*Tons*	*Tons*
Check [7]	65.8		43.1		1.73		22.7		0.94	
Manure	68.7	2.9	45.4	2.3	1.77	0.04	24.5	1.8	1.78	0.64
Manure+lime	72.7	6.9	51.8	8.7	1.91	.18	29.4	6.7	2.67	1.73
Manure+lime+rock phosphate	75.3	9.5	54.0	10.9	2.20	.47	29.3	6.6	2.84	1.94
Manure+lime+superphosphate	77.0	11.2	57.8	14.7	2.29	.56	26.7	4.0	2.75	1.81
Manure+lime+superphosphate+potassium			56.7	13.6	2.43	.70				
Manure+lime+complete commercial fertilizer	76.9	11.1	54.3	11.2	2.17	.44	32.1	9.4	3.19	2.25
Crop residues	67.3	1.5	44.6	1.5	1.69		19.9		1.29	.35
Crop residues+lime	71.7	5.9	47.1	4.0	1.90	.17	26.6	3.9	2.49	1.55
Crop residues + lime + rock phosphate	76.7	10.9	54.0	10.9	2.12	.39	25.8	3.1	3.03	2.09
Crop residues + lime + superphosphate	74.5	8.7	56.3	13.2	2.15	.42	27.8	5.1	2.76	1.82
Crop residues + lime + complete commercial fertilizer	74.7	8.9	56.4	13.3	2.19	.46	25.8	3.1	2.77	1.83

[1] Data from State Soil Survey of Iowa.

[2] Corn yields averaged from 16 crops on 4 fields, except the crop-residue plots, which are averaged from 14 crops on 3 fields.

[3] Oat yields averaged from 7 crops on 4 fields, except the crop-residue plots, which are averaged from 6 crops on 3 fields, and the manure+lime+superphosphate+potassium plot, in which case only 1 crop on 1 field is involved.

[4] Hay yields averaged from 5 crops on 4 fields, except the crop-residue plots, which are averaged from 4 crops on 3 fields, and the manure+lime+superphosphate+potassium plot which involved only 1 crop on 1 field.

[5] Winter wheat yields averaged from 2 crops on 2 fields.

[6] Alfalfa yields averaged from 2 crops on 1 field.

[7] The yields given for the checks are the averages of the yields on all check plots on all fields.

The data show that lime with both manure and crop residues increased all crop yields, showing a marked increase on grain crops as well as on legumes. Manure alone did not have so much effect on this soil as it does on most soils, because Muscatine silt loam has a naturally high humus content. Rock phosphate proved better than superphosphate with crop residues and lime, but with manure and lime, superphosphate was superior on corn, oat, and hay crops. The use of commercial fertilizer and potash on this soil is of doubtful value, except with higher price returns for farm products. It would be advisable always to test phosphates, commercial fertilizer, and potash on strips in the field, and study the results carefully before investing. Fields should always be tested before applying lime, in order to determine the proper amount of lime needed.

Table 7 gives the average results on Grundy silt loam in Lee (2 fields), Wapello (3 fields), Cedar, Mahaska, Wayne, Jefferson, Henry (2 fields), and Ringgold Counties. All the Grundy silt loam in Poweshiek County is in the southeast part. It has a slightly lighter textured subsoil than Grundy silt loam mapped in counties south and southeast of Poweshiek County, denoting slightly better internal drainage.

TABLE 7.—*Average crop yields per acre and increases due to fertilizer treatment on Grundy silt loam on Iowa experiment fields* [1]

Treatment	Corn [2]		Oats [3]		Hay (clover, timothy and clover, or timothy) [4]		Winter wheat [5]		Alfalfa [6]	
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Tons*	*Tons*	*Bush.*	*Bush.*	*Tons*	*Tons*
Check [7]	53.0	------	42.5	------	1.48	------	20.6	------	4.23	------
Manure	59.1	6.1	47.7	5.2	1.69	0.21	23.9	3.3	4.50	0.27
Manure+lime	64.6	11.6	49.9	7.4	1.96	.48	26.4	5.8	4.82	.59
Manure+lime+rock phosphate	67.4	14.4	53.3	10.8	2.19	.71	29.9	9.3	5.03	.80
Manure+lime+superphosphate	68.6	15.6	57.6	15.1	2.35	.87	30.9	10.3	5.11	.88
Manure+lime+superphosphate+potassium	64.6	11.6	------	------	2.25	.77	32.6	12.0	------	------
Manure+lime+complete commercial fertilizer	69.4	16.4	57.2	14.7	2.44	.96	28.7	8.1	5.29	1.06
Crop residues	58.5	5.5	48.1	5.6	1.59	.11	26.2	5.6	4.44	.21
Crop residues+lime	62.7	9.7	52.4	9.9	1.85	.37	26.6	6.0	4.61	.38
Crop residues+lime+rock phosphate	64.4	11.4	55.8	13.3	2.03	.55	27.1	6.5	4.86	.63
Crop residues+lime+superphosphate	64.2	11.2	57.7	15.2	2.05	.57	27.6	7.0	5.00	.77
Crop residues+lime+complete commercial fertilizer	63.3	10.3	56.4	13.9	2.09	.61	27.7	7.1	.94	.71

[1] Data from State Soil Survey of Iowa.

[2] Corn yields averaged from 48 crops on 13 fields, except manure+lime+superhosphate+potassium plot, which is averaged from 18 crops on 7 fields, and the crop-residue plots which are averaged from 30 crops on 6 fields.

[3] Oat yields averaged from 22 crops on 13 fields, except the crop-residue plots which are averaged from 14 crops on 6 fields.

[4] Hay yields averaged from 19 crops on 10 fields, except the crop-residue plots, which are averaged from 11 crops on 5 fields, and the manure+lime+superphosphate+potassium plot which is averaged from 8 crops on 5 fields.

[5] Winter wheat yields averaged from 7 crops on 5 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 3 crops on 2 fields, and the crop-residue plots which are averaged from 4 crops on 3 fields.

[6] Alfalfa yields averaged from 5 crops on 1 field.

[7] The yields given for the checks are the averages of the yields on all check plots on all fields.

The experimental results on Grundy silt loam show the value of applications of manure. Lime with crop residues gave good gains on grain crops as well as legumes. Lime with manure gave an increase over lime and crop residues with corn and alfalfa only. Rock phosphate and superphosphate gave substantial increases, superphosphate proving only slightly better than rock phosphate. The increased yields with phosphate only partly indicate the value of these applications, as there is an increase in the quality of corn, with a much larger percentage of no. 1 corn, which is of considerable economic importance. The effect of muriate of potash applications is not very definite, and careful field tests should be made before using. Where commercial fertilizer was applied, the yields seem to be no greater than those from phosphate applications. Because of the much greater cost of commercial fertilizer over phosphate, large increases are necessary to give an economic return. The outstanding yields are those from lime with crop residues and with manure, also where rock phosphate and superphosphate, particularly the latter, were added to these treatments, larger yields were obtained.

On Grundy silty clay loam, which is similar to Grundy silt loam, except for the heavier texture of the surface soil and the slightly heavier texture of the subsoil, lime with manure gives almost as large yields as on Grundy silt loam. Rock phosphate and superphosphate added to lime and manure treatments give the best yields of oat and hay crops, but do not have so favorable an effect as on Grundy silt loam.

Clinton silt loam, another important soil in Poweshiek County, occupying the more rolling areas and steeper slopes adjacent to the larger streams, occurs principally in the northeast and southwest corners. Clinton silt loam is a light-colored mellow silt loam with a characteristically heavy tenacious silty clay or clay subsoil. Owing to its rolling or steep surface relief and to its fine-grained silty surface soil, it is strongly affected by erosion, if not cultivated and cropped properly. It is low in organic matter, as the color indicates, and additions of barnyard manure or green manures greatly improve crop yields. Lime added with manure also gives large returns, especially on oat and hay crops, with good gains showing on corn and winter wheat in the rotation. The phosphate fertilizers show beneficial effects on the grain crops and also some on hay. The difference between applications of rock phosphate and superphosphate is slight, with rock phosphate giving slightly increased yields except with hay and wheat.

Results from five experimental fields located on this soil in Des Moines, Lee, Dubuque, Scott, and Johnson Counties are given in table 8.

TABLE 8.—*Average crop yields per acre and increases due to fertilizer treatment on Clinton silt loam on Iowa experiment fields* [1]

Treatment	Corn [2]		Oats [3]		Hay (clover, timothy and clover, or timothy) [4]		Winter wheat [5]	
	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment	Average yield	Increase for treatment
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*
Check [6]	50.6		35.6		1.25		22.9	
Manure	57.1	6.5	41.4	5.8	1.50	0.25	27.9	5.0
Manure+lime	62.3	11.7	50.8	15.2	1.83	.58	31.6	8.7
Manure+lime+rock phosphate	65.8	15.2	54.2	18.6	1.84	.59	35.2	12.3
Manure+lime+superphosphate	63.9	13.3	55.1	19.5	2.00	.75	34.5	11.6
Manure+lime+superphosphate+potassium	61.3	10.7	63.4	27.8	1.96	.71		
Manure+lime+complete commercial fertilizer	66.1	15.5	54.1	18.5	1.99	.74	32.5	9.6
Crop residues	52.5	1.9	46.1	10.5	1.28	.03	23.6	.7
Crop residues+lime	63.4	12.8	46.2	10.6	1.76	.51	27.8	4.9
Crop residues+lime+rock phosphate	66.4	15.8	45.3	9.7	2.06	.81	30.9	8.0
Crop residues+lime+superphosphate	67.9	17.3	50.2	14.6	2.02	.77	29.4	6.5
Crop residues+lime+complete commercial fertilizer	69.4	18.8	49.2	13.6	2.05	.80	32.3	9.4

[1] Data from State Soil Survey of Iowa.

[2] Corn yields averaged from 13 crops on 5 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 7 crops on 3 fields, and the crop-residue plots which are averaged from 6 crops on 2 fields.

[3] Oat yields averaged from 7 crops on 5 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 4 crops on 3 fields, and the crop-residue plots which are averaged from 3 crops on 2 fields.

[4] Hay yields averaged from 8 crops on 5 fields, except the manure+lime+superphosphate+potassium plot, which is averaged from 5 crops on 3 fields, and the crop-residue plots which are averaged from 3 crops on 2 fields.

[5] Winter wheat yields averaged from 3 crops on 2 fields, except the crop-residue plots which are averaged from 2 crops on 1 field.

[6] The yields given for the checks are the average of the yields on all check plots on all fields.

Field tests should be made of both rock phosphate and superphosphate, to determine their value for the individual farm. Commercial fertilizer gave better results on grain crops in most experiments, but because of the cost it should first be tried experimentally. Potassium seemed to be outstanding only in the yields of oats. The cost of potassium would hardly seem to warrant its use except in particular fields. Lime and manure (either barnyard or green) give the best results and are highly recommended. A 3-year rotation, consisting of corn, small grain, and clover, on Clinton silt loam proves highly satisfactory and builds up the soil. This rotation is used widely, with excellent results, by farmers on this soil in the northeast part of the State. Contour plowing is recommended on the more strongly rolling areas, with seeding down of all small surface ditches.

The steeper areas of Shelby, Clinton, and Lindley soils should be seeded down permanently, if possible, or left in timber. Many of the hillsides make poor pasture because of brush, weeds, and scattered trees, but fine grazing land could be developed by clearing such areas and seeding to pasture grasses. Old pastures now cleared can be greatly helped by disking and reseeding with mixtures of timothy, red clover, and alsike. Disks must be set straight, so that the sod will not be turned, and disking should be in one direction, as cross disking injures the sod by cutting it up too much. Reseeding should

be done early in the spring. Lespedeza is being tried for pasture on some of the lighter soils, because of its tolerance to acidity and its stamina in withstanding prolonged droughts. Results from experiments are not available as yet. Where lime occurs on hill slopes to be used for pasture, sweetclover and alfalfa should be included in the grass seeding.

Much additional information on the foregoing soil experiments is given in Bulletins 269, 276, and 280, issued by the Iowa Agricultural Experiment Station (*5*, *6*, *7*). These bulletins can be obtained by request from the soils department or the bulletin section of Iowa State College, Ames, Iowa.

SUMMARY

Poweshiek County is in the southeastern quarter of Iowa. It comprises an area of 583 square miles.

The county is part of a plain which slopes gently to the south and east. Originally this plain was smooth and mantled by layers of glacial drift and loess, but it is now traversed by nearly parallel stream valleys. The tributaries of the streams subdivide and penetrate all parts of the county, except comparatively narrow flat interstream divides.

The elevation ranges from about 800 feet to more than 1,000 feet above sea level. The northern and eastern parts of the county are in the Iowa River drainage basin, and the southwestern corner is drained by North Skunk River.

The first settlement by white men was made in 1843, and the county was organized in 1848. The early settlers came mainly from the Eastern States, a smaller proportion coming from the Southern States. According to the 1930 census, the population is 18,727, or 32.3 persons a square mile. Montezuma, the county seat, has a population of 1,257, and Grinnell, the largest town, 4,949.

The county is well supplied with railroads and is crossed by several paved or graveled highways.

The climate is favorable to the production of all the general farm crops of the region. The mean annual temperature is 48.7° F., and the mean annual precipitation is 34.43 inches. The average length of the frost-free season is 165 days, which is ample for maturing corn and the other crops grown.

Agriculture is the leading industry. The principal crops, in order of their acreage, are corn, oats, hay, wheat, and potatoes, but more than 50 percent of the cultivated land is in corn.

Poweshiek County is in the section known as the eastern meat-producing area of Iowa. In this type of farming, the greater part of the crops grown is fed on the farm to produce meat, mainly pork.

The soils, as a whole, are naturally productive, and 97.6 percent of the total area of the county is in farms. On the basis of soil characteristics and other features which affect agriculture, the soils may be separated into three broad groups, namely, dark-colored upland and terrace soils, light-colored upland and terrace soils, and bottom-land soils.

The soils classed with the first group occupy 75.4 percent of the area of the county and comprise the most productive land. Tama silt loam is the most extensive and agriculturally the most important

soil in the county. It is the well-drained dark-colored silt loam of the gently rolling uplands. The Muscatine and Grundy soils are highly productive soils that occur on the flat divides. They were formerly poorly drained but are now, for the most part, provided with artificial drainage. Shelby loam and Carrington loam occur on stream slopes. They are derived from glacial drift and contain a small quantity of gravel and boulders. Waukesha silt loam is a well-drained terrace soil and ranks with the better upland soils in productivity. Judson silt loam is a deep black terrace soil. The Bremer soils occur on terraces where drainage was formerly inadequate, and parts of the areas are still poorly drained.

The light-colored soils are developed on severely eroded stream slopes and on comparatively small terraces. Clinton silt loam occurs on the upper slopes over the loess. The Lindley soils occupy lower slopes where erosion has exposed the glacial drift. Jackson silt loam covers a small area on wooded terraces. Probably not more than one half the area of the light-colored soils is cultivated, and the cultivated areas are only moderately productive.

The bottom-land soils include the dark-colored Wabash soils and a recent alluvium mapped as Genesee silt loam. The Wabash soils are naturally highly productive, but average yields are greatly reduced by frequent floods.

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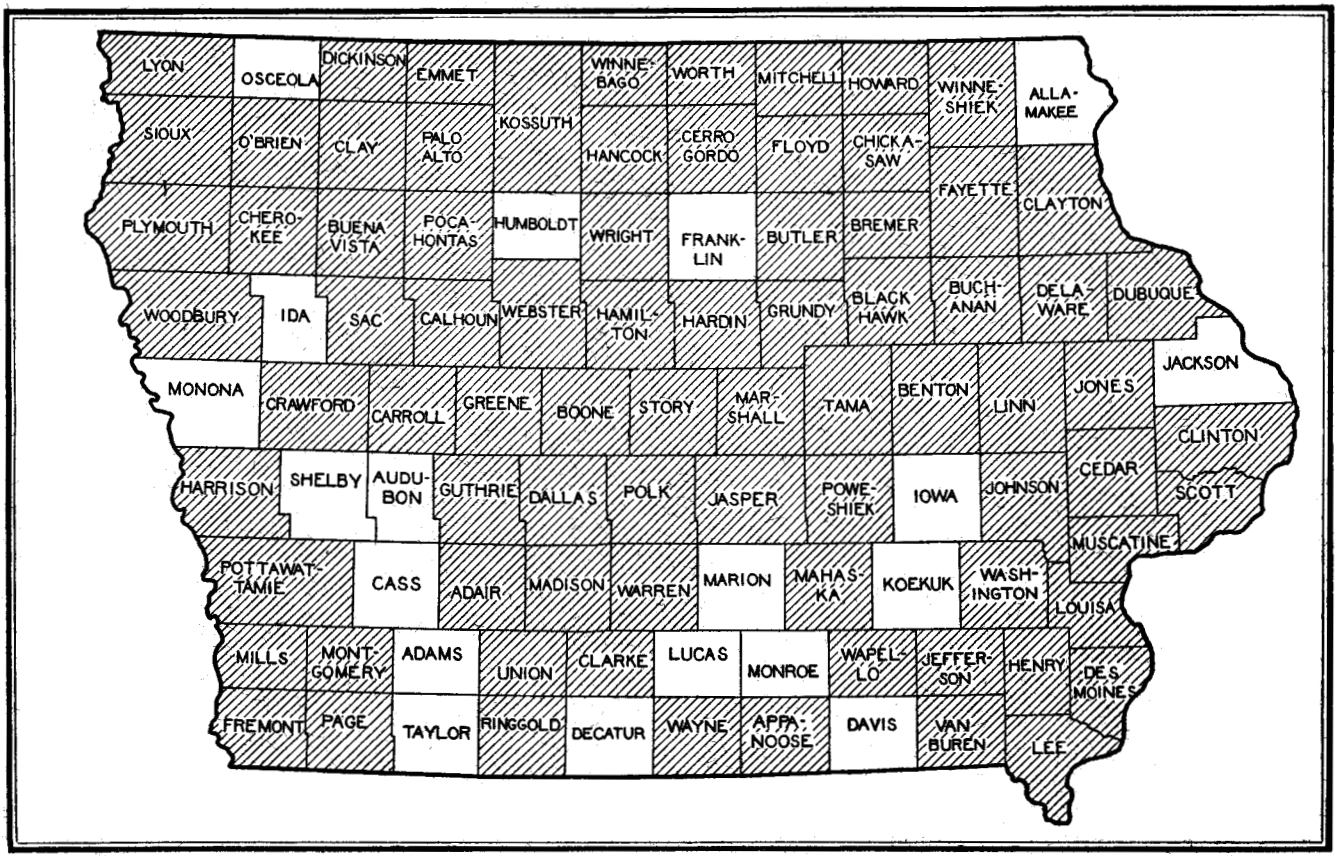
There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than two hundred and fifty copies shall be for the use of each Senator from the State and not more than one thousand copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Iowa shown by shading.

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All Other Inquiries

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