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Soil Survey
of
Hancock County, Iowa

By

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United States Department of Agriculture, in Charge

and

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Iowa Agricultural Experiment Station

Bureau of Chemistry and Soils

In cooperation with the Iowa Agricultural Experiment Station

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SOIL SURVEY OF HANCOCK COUNTY, IOWA

By F. R. LESH, United States Department of Agriculture, in Charge, and T. H. BENTON and G. B. KILLINGER, Iowa Agricultural Experiment Station

COUNTY SURVEYED

Hancock County, with an area of 570 square miles, is approximately square in outline. It is in the north-central part of Iowa, in the second tier of counties south of the Iowa-Minnesota State line. (Fig. 1.) Garner, the county seat, situated in the east-central part of the county, is about 120 miles due north of Des Moines and about 23 miles slightly southwest of Mason City.

Practically the entire area of the county is an uneven plain, having an average elevation of about 1,236 feet above sea level, which is the known elevation of the town of Britt (*7*)[1] in the west-central part of the county. That part of the county lying north of Britt and Garner has a somewhat greater elevation and the plain has a general slope from here to the south, as indicated by the flow of the drainage. In the northeastern part of the county, from the point where State Highway No. 15 crosses the Winnebago-Hancock County line and southeastward, the drainage and general slope are to the east. The surface relief of the entire county, ranging from nearly level or rolling to moderately hilly, remains as it was left by the ice sheet which deposited glacial till and débris. Most of the broad uneven ridges and low knolls do not rise more than 40 feet above the intervening depressions. Morainic relief occupies much of the northern half of the county and extends along the eastern side from the Cerro Gordo-Hancock County line westward to a north-south line through Britt and Kanawha. South of Hutchins, southwest of Britt, and west of Kanawha, the drift-plain type of relief is very slight. The land consists largely of wide depressions separated by comparatively low divides, or the only change in level may be merely a few slight swells of a few inches elevation.

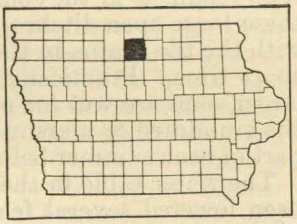

FIGURE 1.—Sketch map showing location of Hancock County, Iowa.

The land forms constituting the surface relief of the county as it is to-day have suffered dissection or erosion to only a very slight extent. The natural drainage channels, especially toward their sources, are not the results of stream erosion but are low belts, between the higher elevations, which the drainage waters have sought out and followed to more distinct rapid-flowing waterways. The larger streams of the county have definite channels, but the water

[1] Italic numbers in parentheses refer to Literature Cited, p. 28.

flow is sluggish and its cutting power is very slight. The actual flood plains of the two branches of Iowa River or of the four branches of Boone River are in few places more than one-eighth mile wide, but the bench lands in some places extend back 1 or 2 miles to meet the upland slopes. East Branch Iowa River and West Branch Iowa River carry off the rainfall of about 60 per cent of the county; the four branches of Boone River drain the somewhat flat area southwest of Britt; Winnebago River drains Ellington Township; and Lindner Creek, Plum Creek, and Buffalo Creek carry off the rainfall of Bingham Township.

During the early days of agricultural development the farm sites were confined to the more rolling lands where surface and subsurface drainage were good. The run-off and seepage from the slopes were rather rapid, and the water collected in local depressions, from which it escaped by evaporation, by very slow infiltration through the heavy clay subsoils, or by very slowly finding its way into sloughs or definite stream channels. In wet seasons water stood in the low places throughout the summer, but in dry or normal seasons the water subsided and the marshy sloughs afforded good pasture lands or produced large crops of wild hay. Probably three-fourths of all the creek and river channels in the county have been dredged and straightened, and these large open ditches, ranging from 6 to 12 feet in depth, together with the tile drains in the fields, carry off the rainfall in a surprisingly short time. Practically all the smaller depressions and many of the larger ones are wet for periods of only a few days, as compared with the inundated or marshy conditions that prevailed during the greater part of each summer before artificial drainage systems were developed.

The water table in the wetter areas of the county has undoubtedly been lowered several feet, and the puddled soil condition that formerly existed in the wet depressions has been transformed to a granular soil structure which, in turn, facilitates internal drainage. The water reserve in the subsoil has been reduced to such an extent that shallow wells go dry during the summer, and the only dependable wells are those drilled to a depth ranging from 60 to 175 feet.

In areas bordering the larger streams drainage is removed by natural channels. The upland slope to the terraces is sufficient to insure good run-off of water; and the terraces, having gravelly subsoils, easily take care of their own rainfall as well as the run-off and seepage of the adjoining upland slopes. The water table of the first-bottom land fluctuates directly with the water level in the stream channel.

The first settlement in Hancock County, known as Upper Grove, was made 1 mile east of Goodell in 1854, but there is no town on the site at the present time. A year later a settlement was started along Winnebago River almost due south of Pilot Knob which lies in sections 3, 4, 9, and 10 of Ellington Township.

The county was organized during the winter of 1857–58. The earliest settlers were from New York, Ohio, Indiana, Illinois, and Missouri and were of English, Teutonic, Scandinavian, and Irish descent. In recent years many Mexicans have been brought into the county by the sugar-beet industry.

About 1895, according to the older settlers, the task of straightening and deepening the existing natural drainage channels began, and

this work continued and was practically completed during the next 10 years. Since that time the work of tiling the low wet places has been continued, until now the combined natural and artificial drainage systems reach almost every farm in need of drainage. During the period of speculation in farm land values, 1918 to 1920, attempts were made to drain Eagle Lake and East Twin Lake, but the results were unsatisfactory. The ditches have since been dammed, but the lakes have only partly returned to their former condition.

According to the 1930 census the population of Hancock County is 14,802, all classed as rural. Of this number, 9,501 are classed as rural-farm and 5,301 as rural-nonfarm. Garner, the county seat, has a population of 1,241; and Britt has 1,593. Kanawha, Klemme, Woden, Crystal Lake, Hayfield, Miller, Goodell, Denhart, Corwith, Stilson, Hutchins, and Duncan, are smaller towns. Nearly all the small towns maintain a post office, churches, and consolidated schools. Pupils who desire a high-school education must attend at Garner, Britt, Kanawha, Klemme, Goodell, Corwith, or Crystal Lake. More than 100 rural schools provide adequate educational facilities for the grade pupils. Very few farms are without telephones or rural delivery of mail.

All the towns mentioned are served by one or more of the three railroads traversing the county, which are branches or trunk lines of the Chicago, Rock Island & Pacific; the Minneapolis & St. Louis; and the Chicago, Milwaukee, St. Paul & Pacific. United States Highway No. 18, a paved highway, passes east and west through Garner and Britt. State Highway No. 15 is paved south of Garner to within a short distance north of Goodell and is gravel surfaced from Garner to the north county line. State Highway No. 111 connects Britt and Kanawha. The different towns of the county are connected by gravel-surfaced roads which are kept in good condition and open during the winter months. Trucks are used to deliver grain, livestock, milk, and cream to towns and markets throughout the year.

CLIMATE

The climate of Hancock County is continental. The different seasons are distinctly marked by wide variations in mean temperature and average precipitation. Outdoor agricultural operations begin between the first and the middle of April and cease about the middle of November. A rather high mean summer temperature, considering the latitude of the county, of 69.5° F., plenty of rain which is usually evenly distributed throughout the summer, together with the strong absorptive capacities of the brown and black soils for the sun's heat, constitute ideal conditions for rapid plant growth.

The average last killing frost occurs on May 10 and the average first on October 1. This gives an average frost-free season of 144 days. The latest and the earliest recorded killing frosts occurred on May 31 and September 12, respectively. Extremes in the precipitation and temperature during the growing season or late frosts in the spring and early frosts in the fall are rather exceptional.

During the spring months the rather vigorous wind movement shifts rather large quantities of fine soil particles and dries the surface soil, but not to a detrimental extent. Occasionally during the summer very warm winds blow from the south and southwest which, if the

precipitation up to that time has not been normal or above normal, tend to dry the surface soils and cause the corn to wilt and the pastures to turn brown from lack of moisture.

The normal monthly, seasonal, and annual temperature and precipitation, as recorded by the United States Weather Bureau station at Britt, are given in Table 1.

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

[Elevation, 1,236 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1920)
	°F.	°F.	°F.	Inches	Inches	Inches
December	20.5	55	−26	0.80	0.25	0.64
January	14.2	56	−28	.68	.77	.24
February	17.6	55	−28	.81	.10	.27
Winter	17.4	56	−28	2.29	1.12	1.15
March	30.5	73	−11	1.25	.13	2.09
April	46.2	83	13	2.57	.91	2.39
May	58.0	90	27	4.90	2.13	4.17
Spring	44.9	90	−11	8.72	3.17	8.65
June	67.4	91	35	4.53	4.02	8.48
July	71.2	99	42	3.98	1.60	5.91
August	69.9	97	34	3.77	2.40	8.52
Summer	69.5	99	34	12.28	8.02	22.91
September	62.4	90	24	3.46	1.37	4.42
October	49.7	86	5	2.40	1.29	1.83
November	33.5	75	−4	1.45	.15	2.63
Fall	48.5	90	−4	7.31	2.81	8.88
Year	45.1	99	−28	30.60	15.12	41.59

AGRICULTURE

The agricultural history of Hancock County is a repetition of the story of the development of many other counties of the prairie States. The pioneers settled in the wooded areas of the county along the stream banks where fuel and water were at hand. They first grew such crops as the soil would produce to supply food for home consumption and feed for the livestock. These crops were wheat, corn, oats, buckwheat, flax, and garden crops. Part of the wheat and livestock were exchanged for such necessities as could not be produced on the land. In 1879, according to the report of the Federal census, almost three times as many acres of wheat as of corn were sown in the county, and almost four and one-half times as many acres of wheat as of either oats or hay.

During the next 20 years the production of livestock increased rapidly. The corn, oats, and hay acreage increased in proportion, these crops being used both as feed for the livestock and for sale on the market. The advent of the railroads, the building of improved country roads, and the draining of land by means of ditches and tiling in the wetter parts of the county furthered development.

Although numerous other crops may be successfully grown, none has proved quite so well adapted to the existing natural, economic, and man-made conditions as those grown at the present time. Corn, oats, hay, and legumes, as the principal crops, and wheat, rye, barley, and sugar beets, as crops of less importance, are adapted to the black soils of this county. These soils are naturally rich, and the long growing season, with a high average temperature and adequate precipitation, favors the production of these crops. Artificial drainage has rendered the formerly wet lands even more productive than those naturally well drained. All the crops grown, with the exception of sugar beets, are such as can be handled entirely by machinery on the level or slightly rolling land. The fact that the present farming population of the county has descended from several generations of grain growers and livestock raisers, who have migrated from Ohio, Indiana, and Illinois, presents an important reason for the continuation of the existing agricultural systems. Mineral resources, forest cover, and sources of power do not exist to create any other industry.

The Federal census for 1880 reported 539 farms which covered 24 per cent of the area of the county. Of the land in farms, 70.5 per cent was classed as improved land. In 1890, the 1,067 farms constituted 56.2 per cent of the land area, of which 64.6 per cent was improved land. The census of 1900 shows 1,703 farms occupying 95.8 per cent of the land area, of which 92.2 per cent was improved land. According to the 1930 census, the 1,936 farms in the county, with an average size of 181.9 acres, occupied 96.5 per cent of the land area. Of the land in farms, 88.6 per cent is classed as improved land which includes crop land and plowable pasture; the remaining 11.4 per cent includes woodland, other pasture land, and waste land.

Table 2 gives the acreage and yield of the principal crops in Hancock County in 1929, as reported by the 1930 Federal census.

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

Crop	Acres	Yield	Crop	Acres	Yield
Corn:		*Bushels*			*Bushels*
Harvested for grain	102,124	3,922,879	Mixed grains	2,129	76,082
		Tons	Potatoes	1,584	194,902
Cut for silage	5,189	47,737			*Tons*
Cut for fodder	6,067		Hay crops, total	28,938	42,340
Hogged off	8,797		Timothy and (or) timothy and clover mixed	16,735	22,142
		Bushels	Clover	2,997	4,820
Wheat	255	5,342	Alfalfa	3,607	9,158
Oats:			Other tame grasses	977	1,112
Threshed	92,108	3,454,279	Wild grasses	4,277	4,453
Cut and fed unthreshed	151		Small grains cut for hay	55	73
Barley	11,015	322,501	Annual legumes for hay	290	582
Rye	1,336	21,860	Sugar beets	1,950	15,085

In 1879, wheat was the principal crop, and corn ranked second in acreage. Since 1889 the acreage devoted to corn and oats has steadily increased, until in 1929 these two crops had a combined acreage of 214,436 acres. In spite of the modern methods of tillage, the acre yield of corn has gradually decreased since the first census, but the oat yield has increased by almost a third. This may be attributed to the fact that for a time in certain parts of the county continuous cropping to corn was practiced.

Very little of the corn crop but much of the oat crop is sold direct. About 600 tons of fertilizer were used in 1929, principally 0–9–27[2] or 0–8–32 mixtures for potatoes, and 0–20–0 (superphosphate) for corn and oats. Practically no lime or nitrogen is brought into the county, the nitrogen being obtained by growing sweetclover, alfalfa, or red clover. About 50 per cent of the farmers of the county have practiced plowing under legumes during recent years.[3]

Very few farms have changed hands recently.

As much of the farm work as possible is done by the farmer and his family or by the exchange of labor among the farmers. The largest use of hired labor is in the growing of sugar beets. In this industry Mexican labor is used, but such laborers are inefficient and are poorly paid.

Ordinarily the farm buildings include a 2-story house; a large barn for storing hay and housing livestock; a corncrib and oats bin, combined or built separately, and equipped with an elevator for unloading grain; hog and poultry houses; and either a windmill or gas engine for pumping water. Most of the houses and barns are painted and well kept, and on many farms all the buildings are painted and kept in good repair.

The usual equipment of farm implements includes two cultivators, plows, disks, harrows, a mowing machine, hayrake (generally of a side-delivery type), hay loader, oats and corn binders, and two farm wagons. Corn pickers are rapidly coming into general use. A tractor and from four to eight horses furnish belt and motive power for the farm. Grain separators or threshing outfits and many corn-shelling outfits are owned by groups of farmers, who use them only for their own crops and do not rent them.

SOILS AND CROPS

The principal crops of Hancock County are corn and oats, the combined acreage of which in 1929 was equal to 53.2 per cent of the area of the county. The distribution of these two major crops is very uniform, there being only a very few sections on which their combined acreage does not constitute from 50 to 60 per cent of the land. Corn, the major crop, occupies about 33 per cent of the total tillable land, oats 30 per cent, tame grasses and clover 10 per cent, alfalfa 1 per cent, and minor crops about 13 per cent. Stream bottoms and steep slopes which are used as permanent pastures, woodland, roads, and land occupied by farm buildings account for the remaining 13 per cent of the farm land. The influence of the soil type on the distribution of the principal crops is very slight. Sugar beets, which occupy less than 1 per cent of the tillable land, are the only crop grown on only one or two soil types.

Practically all the soils of the county are loams or silty clay loams. These soils, so similar in characteristics, occur in areas so intimately intermingled that any plan of growing corn on one soil type and oats on another is entirely impractical. Crops produce the heaviest yields on the nearly level black heavy-textured soils which are naturally fertile and have excellent moisture-holding capacities. However, those soils having an undulating or rolling surface relief, which are

[2] Percentages, respectively, of nitrogen, phosphoric acid, and potash.
[3] Information furnished by county agricultural agent.

of a more sandy or loamy character and have a less intensely dark color, give average yields that are not much less than the yields obtained on the nearly level black heavy soils. *(3, p. 21.)*

The correction of soil acidity in this county is not a serious problem, as available lime occurs either in the surface layer or within the subsoil very near the surface soil in nearly every soil.

As the soils of the county possess nearly all the characteristics necessary to the growing of crops on a moderately large scale, extensive rather than intensive farming methods are practiced. The surface relief, which ranges from nearly level or undulating to slightly rolling on nearly all the farms, greatly favors the use of modern farm machinery. The fact that corn, oats, and hay may be handled entirely by machinery is no doubt an important reason for their choice as major crops even though other crops are as well, if not better, adapted to the soil.

The soils of Hancock County may be classified into three groups on the basis of their natural drainage conditions as follows: Soils having restricted drainage, well-drained soils, and excessively drained soils. In addition to these three groups, a group of organic soils has been differentiated.

In the following pages of this report the soils of Hancock County are described in detail, and their agricultural relationships are discussed; their distribution and location are shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 3.

TABLE 3.—*Acreage and proportionate extent of soils mapped in Hancock County, Iowa*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Webster silty clay loam	112,768	30.9	Clarion loam, shallow phase	2,240	0.6
Webster loam	28,864	7.9	Waukesha loam	4,288	1.2
Fargo silty clay loam	21,568	5.9	Sioux loam	9,984	2.7
Benoit silty clay loam	2,112	.6	O'Neill loam	12,416	3.4
Benoit loam	2,560	.7	Pierce loam	2,624	.7
Lamoure silty clay loam	10,688	3.0	Dickinson fine sandy loam	4,480	1.2
Wabash silty clay loam	704	.2	Peat	9,984	2.7
Wabash loam	1,024	.3	Muck	8,000	2.2
Clarion loam	74,048	20.3			
Clarion loam, rolling phase	56,448	15.5	Total	364,800	

SOILS HAVING RESTRICTED DRAINAGE

This group includes soils which, as a result of a flat surface or a low topographic position, are either incompletely drained during a part of the year or in which the water table is near the surface. When this region was first occupied by farmers, the land comprising these soils was all poorly drained and a large part of it was covered by standing water during a part of the year. Artificial drainage by means of ditches and tiling now removes the surplus water so efficiently that crops can be grown on the upland and terrace soils without damage, except in unusually wet seasons or on the comparatively small lower-lying areas. The soils of the stream bottoms are for the most part still undrained, but a large area of these soils may be converted into valuable farming land by proper drainage. The present continuous and rather intensive system of cultivation on the upland has been possible only for the last 20 years, or since the drainage systems were constructed.

This group of soils includes eight soil types belonging to five soil series—Webster silty clay loam, Webster loam, Fargo silty clay loam, Benoit silty clay loam, Benoit loam, Lamoure silty clay loam, Wabash silty clay loam, and Wabash loam. The common characteristics of these soils that distinguish them from the other soils of the county are those which develop when soils have been subjected for a long time to conditions of excessive moisture. The surface layers are black, as conditions have favored the accumulation of large quantities of organic matter. The luxuriant grass vegetation before the land was cultivated gave these soils a higher content of black organic matter than the better-drained soils of the county, and the preservation of this material has resulted in a deep black color. In places the large quantity of decayed vegetation on the surface and in the upper part of the surface layer produced a mucky or peaty character. This high organic content is decreasing under constant cultivation and as a result of the mixture, by plowing, of the organic material with the mineral soil below. As a rule the texture of the soils of this group is heavy, ranging from heavy loam to silty clay. The presence of a small quantity of very fine sand in most places improves the texture to some extent. Under conditions of optimum moisture, even the heavier soils have a crumbly or granular structure and are easily tilled. The surface soils are underlain by gray or mottled gray and yellow, or gray and brown, subsoils somewhat heavier in texture, as a rule, than the surface soils. The details of the profiles of these soils vary considerably, depending on the composition of the parent material from which they were derived and the depth to which good drainage and oxidation have penetrated. The separation of these soils into series has been based on these characteristics of the deep subsoils. The Webster soils have developed over glacial material in poorly drained areas. Both surface soils and subsoils are of fairly heavy texture. The soils of the Fargo series have a similar profile, but they occur on water-laid material, on poorly drained terraces, or in depressions. The Benoit soils are developed from water-laid material and have sandy and gravelly subsoils. The Lamoure and Wabash soils occur on the recent deposits along streams and differ mainly in lime content, the Wabash soils containing no lime, whereas the Lamoure soils in many places have lime in their surface soils and in all places in their subsoils.

Webster silty clay loam.—Webster silty clay loam is the most extensive soil in the county and to a large extent determines the agriculture. This soil is highly adapted to the production of corn and more than any other soil type keeps cash corn the dominant crop, other crops being grown only to rest the land from continuous corn cropping.

The surface soil of Webster silty clay loam, to an average depth of 18 inches, is black silty clay loam. The structure of the surface soil is finely granular, but the granules are not distinctly formed and loose silt is present in the dry soil. This soil may or may not be calcareous, but in most places it ranges from neutral to slightly acid. The surface layer is underlain to a depth of about 27 inches by dark-gray plastic silty clay loam or silty clay, the dark-gray color predominating, but light-gray spots and streaks are common. Small glacial gravel and bowlders are commonly abundant in this layer, but not sufficient lime is present to effervesce with acid. The next lower layer, which continues to a depth of 50 inches, consists of silty clay

loam which is grayish yellow or gray mottled with light gray or yellow. Lime is abundant in this layer and occurs both evenly disseminated through the material and in small, soft concretions. Small glacial bowlders and pebbles occur throughout this layer, and the soil material which is little altered by weathering, is the glacial drift from which the soil is derived. The next lower layer, which extends to a depth of more than 6 feet, is highly mottled gray, brown, and yellow glacial drift. Small iron concretions occur in this layer, and iron stains discolor more than half the material. The lime content is high, but lime concretions are not so abundant as in the layer above. The material in this layer has a silty clay texture and is plastic.

Webster silty clay loam occurs on the flat drift plain of the southwestern part of the county, where it covers large continuous areas broken only by small areas of other soils. In other parts of the county it occurs in narrow, irregular, tortuous areas, broadening out in places to a width of one-half mile or more. In a few places it occurs along broad, flat swales through which pass streams or drainage ditches. In such depressed areas some material has been washed in from higher ground over the original surface soil, but the material deposited in this way is so similar to the original surface soil of Webster silty clay loam that it was difficult to indicate such areas on the soil map, and no practical purpose would be served by such a separation. The only parts of the county in which Webster silty clay loam does not occur are the outwash terraces north of Eagle Lake and smaller similar terraces southwest of Hutchins.

Webster silty clay loam is the most desirable cornland of the county and where well drained is probably not excelled by any other soil in the State. The average yield of corn is between 40 and 50 bushels an acre, but exceptionally high yields of 75 or 80 bushels are produced on this soil when it is properly managed. Yields lower than the average are, as a rule, from fields that have been cropped to corn continuously or to corn and oats as alternating crops. Red clover, sweetclover, and alfalfa all do well on this soil, and these crops benefit the soil by returning the nitrogen removed by the corn and oats. Fall plowing on this heavy type of soil has proved profitable and usually causes higher yields than spring plowing. Freezing and thawing of fall-plowed land throughout the winter months breaks down the cloddy condition which ordinarily forms when the sod is turned. Unless the planting of corn has been delayed by spring rains or the growing season has been exceptionally wet, not much loss from frost in the fall before the corn has matured has occurred during recent years.

Nearly all the sugar beets grown in the county are produced on this soil and are not very successfully grown on any other soil. Normal acre yields range from 10 to 12 tons.

Although the oat acreage is not so large as that of corn, a large part of the oats produced in the county are grown on this soil. The average yield is 50 bushels[4] an acre, with exceptionally high yields amounting to 65 bushels.

Mixed hay is grown only on about one-third as large an acreage as corn or oats. The yield is from 1½ to 2 tons an acre. Alfalfa is not widely grown, though it yields from 2 to 4 tons an acre a season.

[4] Estimated by county agricultural agent.

Red clover, in the mixed seeding, and sweetclover, alone, are the legumes most commonly grown. Little or no difficulty is experienced in obtaining a stand of either red clover or sweetclover, but alfalfa sometimes requires an application of lime to insure a good stand. Wheat, rye, and a small acreage of barley were grown on this soil in 1929.

The successful results in growing vegetables for home use, including sweet corn, beans, cabbage, tomatoes, peas, asparagus, and potatoes, indicate that, if markets were available, such crops could be profitably produced.

Webster loam.—Webster loam occurs in comparatively small areas within the extensive areas of Webster silty clay loam, occupying only slightly higher topographic positions than the heavier soil. Owing to its slightly higher position, to its more sandy or more loamy surface soil, and to its granular subsurface soil, which affords more effective internal drainage, practically all of Webster loam is tillable without the use of tile or artificial drainage. Other widely scattered areas occur throughout the county, except in the outwash-plain areas and terrace formations.

The surface soil of Webster loam differs from the corresponding layer of Webster silty clay loam in that it has better drainage, a lighter or more sandy texture, and a slightly lighter color, though it is still very dark, being very dark grayish brown instead of black. As farm land it is equally as valuable as Webster silty clay loam, is used for the same crops, and produces practically the same yields of corn, oats, hay, and other field crops.

The subsurface layer differs from that of the heavier Webster soil in having a greater thickness of dark-colored silty clay loam or silty clay. Below this, at a depth ranging from 25 to 35 inches, yellowish-brown silty clay or silty clay loam is reached, which contains dark streaks of organic infiltration from the layers above. The lower part of the subsoil is very similar to that of Webster silty clay loam.

Fargo silty clay loam.—Fargo silty clay loam, in general appearance, is very similar to Webster silty clay loam. It occurs in areas of different sizes on the terraces or second bottoms along the rivers and larger creeks. The black surface layer has an average thickness of almost 14 inches and is similar in color and texture to the surface layer of Webster silty clay loam. As a rule the surface layer contains more lime than the surface layer of the Webster soil, and in most places it will effervesce when treated with acid. The subsurface layer, which continues to a depth ranging from 24 to 35 inches, is dark-gray loam, usually high in lime. The next lower layer, which extends to a depth of several feet, is light olive-gray or gray clay, in many places mottled with brown.

Although this soil was originally poorly drained, its topographic position on terraces makes it less difficult to drain than many areas of Webster silty clay loam. Where the land is sufficiently drained by tiling, it is highly productive. This type of soil is preferred by many farmers for growing alfalfa and other legumes. Sugar beets produce well, but only a small proportion of the crop is grown on this soil.

Benoit silty clay loam.—Benoit silty clay loam is a second-bottom or terrace soil and occurs in positions very similar to those occupied by Fargo silty clay loam. The largest areas of Benoit silty clay

loam occur along Winnebago River, West Branch Iowa River, East Branch Iowa River, and around the headwaters of Boone River.

Benoit silty clay loam differs from Webster silty clay loam in containing more fine and medium sand particles in the surface soil and a large quantity of free lime and lime nodules in the subsurface layer. The subsoil, extending from a depth of 26 to a depth of 32 inches, contains a large quantity of coarse sand and some small gravel. At a depth ranging from 30 to 36 inches, a heterogeneous mixture of coarse sand and fine gravel, as well as large numbers of lime nodules, is present. This mixed sand and gravel is gray in color and highly calcareous.

The customary crops of corn, oats, and hay are grown on this soil. Much of the land is used for pasture, or wild hay is cut from it. The yield of any of the common crops is somewhat less than on Webster silty clay loam. During very dry seasons this soil, owing to its gravelly subsoil, becomes too dry for good cornland.

Benoit loam.—Crops grown on Benoit loam in dry seasons show signs of drought more quickly and the yields are smaller than those obtained on Benoit silty clay loam. This is owing to the more porous character of the loam soil and to its higher content of sand. As a rule the surface and subsurface layers are not so thick and the gravelly subsoil is not so deep as in the silty clay loam. The difference between the subsurface layer of Benoit loam and the subsurface layer of Webster silty clay loam lies in the yellowish-brown gritty clay loam, in which occur some dark yellowish-brown mottlings and splotches of organic infiltration at a depth ranging from 21 to 27 inches. Below a depth of 27 inches is a pale-yellow heterogeneous mixture of coarse sand and fine gravel, which is high in lime.

This soil occurs in a few places contiguous to Benoit silty clay loam and is slightly more extensive than that soil. The usual crops of corn, oats, and hay are grown on this soil, but the yields are lower than on Benoit silty clay loam.

Lamoure silty clay loam.—Lamoure silty clay loam occurs along almost every stream and drainage channel of sufficient size to have a first bottom. The surface soil, to an average depth of 10 inches, is black silty clay loam or silty clay. It is underlain by a grayish-brown plastic clay loam or silty clay loam subsoil mottled with gray and yellowish brown. The subsoil is everywhere calcareous, and in places the surface soil contains enough lime to effervesce with acid. Lime nodules are numerous between depths of 10 and 36 inches.

Along the larger streams, Lamoure silty clay loam is overflowed at frequent intervals and for this reason is very little used for the production of cultivated crops. Unless this land is so situated on the farm that it may be used for pasture, the wild grasses are cut for hay. As a result of inundation, the land in places may have a slight covering of sand and in other places it may be pitted with innumerable small depressions a few inches deep, in which water stands after the flood waters subside. The surface is flat, or it may slope gently toward the stream channel and form a broad V-shaped trough. This soil is very similar to Fargo silty clay loam in most respects, but in general it is less well drained. Where artificial drainage is possible the soil should be as valuable as the Webster soils.

Wabash silty clay loam.—The surface soil of Wabash silty clay loam is black or nearly black silty clay loam, rich in organic matter. It

ranges in thickness from 12 to 18 inches, with an average of about 15 inches. The structure is granular, and at the right stage of moisture the soil breaks up into a mellow condition. The surface soil is underlain by dark-gray plastic clay, slightly stained with iron. Below a depth of 28 inches the material changes gradually to light-gray clay containing numerous iron stains and in places mottled with brown and yellow. This soil does not contain any lime at any depth and does not effervesce when treated with acid.

Wabash silty clay loam occurs in small areas along East Branch Iowa River south of Klemme. It is poorly drained and is used only for pasture.

Wabash loam.—Wabash loam occurs as first-bottom land along East Branch Iowa River, and along Boone River near the southern county line. It is an inextensive soil. It differs from Wabash silty clay loam in that it lies a little higher although it is not entirely immune from the higher overflow waters.

The dark-brown or black surface soil ranges from loam to loamy sand, and the subsoil is very dark brown or black heavy clay. Locally, drainage is good; and were it not for the overflow hazards, this soil would be adaptable to tillage. It is now used as pasture land and, owing to its higher proportion of silt and sand, it does not compact when trampled by livestock as do the silty clay loam bottoms which are used for pasture. Bluegrass and white clover grow well.

WELL-DRAINED SOILS

This group includes soils that have good natural drainage but are retentive of sufficient moisture for the use of crops in normal seasons. The water-holding capacity is mainly due to the favorable texture of both surface soil and subsoil. The subsoils are not so heavy and impervious as to retard the removal of excessive moisture or so loose and porous as to allow the rapid escape of soil water immediately after rains that later may be needed by the crops. Only two soils, Clarion loam and Waukesha loam, are included in this group. They are very similar in appearance and productivity. Clarion loam, with its rolling phase and its shallow phase, occurs on the rolling upland, and Waukesha loam on the higher well-drained terraces.

At the time of settlement of the county, these soils could be cultivated without the delay necessary in drainage operations, and as a result they have been under cultivation longer than the other soils of the county. It is difficult to determine to what extent these soils have deteriorated under cultivation. At present they are still valuable farming soils but are less productive than the Webster soils. It must be borne in mind, however, that they originally contained less organic matter and probably less of the other elements of fertility. It is certain that the rolling phase and the shallow phase of Clarion loam have had their dark-colored surface soils thinned by erosion, and their productivity is correspondingly reduced. These thin soils and, to less degree, the other soils of the group give increased yields when manure and legumes are used to improve them.

Clarion loam.—Clarion loam is the second most extensive soil of the county and ranks almost equal in agricultural importance with Webster silty clay loam. The surface layer of this soil consists of very dark grayish-brown loam. The thickness of the surface layer

ranges from 10 to 20 inches, depending on the surface relief. In virgin sod, the upper 4 inches is loose powdery loam firmly held together by grass roots. The lower part of the dark-colored layer is slightly heavier and is firmer, but the material breaks into a loose granular mass. Below the dark-colored soil is a transitional layer through which there is a gradation downward into slightly compact grayish-brown loam or heavy silt loam. Below a depth ranging from 24 to 30 inches is pale-yellow clay loam. Lime is abundant and is mostly in finely divided form, but in places it occurs as white spots or as small concretions. Below this layer the material is less uniform, being a silty clay containing sand and gravel and discolored by white lime spots and by dark reddish-brown or rust-brown iron stains. Bowlders in greater or less quantity are scattered over the surface and through the soil. In most places they are more abundant in the lower part of the subsoil than nearer the surface.

Areas of Clarion loam occur in all parts of the county, in practically all townships and all sections. This soil occurs on the higher parts of the upland, but in many places the elevation above the general level is scarcely perceptible. Within the larger bodies of Webster silty clay loam, Clarion loam occupies low swells or gently sloping low rounded knolls or ridges. In the northern part of the county, where Clarion loam is the most extensive soil, it has a gently rolling or rolling surface relief, and areas in which the relief becomes sharply rolling are designated as a rolling phase of the typical soil.

Included with Clarion loam in mapping are local variations, occurring on areas smoother than the average or at the bases of slopes in the more rolling land, in which the surface soil is darker and the dark color extends to a greater depth than in the typical soil. The subsoil in these areas may be stained with iron or slightly mottled below a depth of 30 inches. In other places the surface soil is not so deep and is slightly lighter in color and more sandy in texture. Such areas have the more rolling relief and, if not calcareous in the surface soil to a depth of 6 or 8 inches, are mapped as Clarion loam, rolling phase. On the other hand, areas in which the surface soil and the subsoil are both high in lime are shown on the soil map as the shallow phase of Clarion loam. Throughout the eastern and northern parts of the county Clarion loam areas are broken by small gravel pockets ranging from 30 to 150 feet square and from 2 to 15 feet deep. Part or all of the gravel has been removed from many of these pockets. Gravelly spots from which the gravel has not been removed are indicated on the soil map by gravel symbols, and the gravel pits are shown by gravel-pit symbols. The surface soil overlying undisturbed gravel pockets is dark-brown gravelly sandy loam ranging from 7 to 15 inches in thickness. Many of the small areas of gravelly sandy loam have not been indicated on the soil map on account of their small size. If they were of sufficient size they would be mapped as Pierce loam.

Clarion loam is a fertile soil and is used almost entirely either for growing farm crops or for pasture. Corn, oats, and hay are the principal crops, but wheat, rye, barley, garden crops, apples, and small fruits are produced locally. This soil is not so well adapted to sugar beets as the Webster soils, and only a very small acreage is used for this crop.

The average yield[5] of corn is between 30 and 45 bushels more an acre than on the rolling land, and this difference is more marked during dry seasons. Oats yield from 30 to 40 bushels an acre and, like corn, are more productive on the more nearly level soil areas. Mixed hay yields from 1 to 2 tons and alfalfa from 2 to 3 tons an acre.

Little difficulty is experienced in growing red clover; but in order to obtain a good stand of alfalfa, lime must be applied. Commercial fertilizers are used to a small extent by some of the better farmers of the county. On most farms the only return of plant food to the soil is by the use of barnyard manure. The quantity of manure produced on each farm is sufficient to cover only a very small percentage of the tillable land each year. The only plant residues returned to the soil are the oats stubble, the cornstalks on most farms where the corn is harvested for grain only, and the short growth of clover or grass which may spring up before fall plowing begins.

Clarion loam, rolling phase.—The rolling phase of Clarion loam occurs on the strongly rolling and hilly land north of Winnebago River, on a long narrow ridge lying directly south of this river and extending southwestward to the county line west of Hutchins, and on higher and steeper areas along the larger streams of the county. The areas of this rolling land are closely associated with typical Clarion loam and differ mainly in their surface relief. Comparatively rapid erosion takes place on the rolling areas, and the dark-colored surface soil is removed almost as fast as it is formed.

The surface soil of the rolling phase of Clarion loam is dark grayish-brown finely granular friable loam. The thickness of the dark-colored layer in few places exceeds 10 inches, and over the greater part of the area of this soil it ranges from 5 to 8 inches. In spots this layer has been entirely removed, exposing the lighter-colored subsoil material. Below the surface soil is brown or yellowish-brown friable silty clay which changes to buff-colored silty clay at a depth of about 18 inches. Lime occurs at different depths; where erosion is rapid the lime-bearing layer is brought near the surface. The rapidity of leaching depends on the character of the soil material and the quantity of water passing through the soil. In most places lime occurs between depths of 18 and 30 inches. Bowlders and gravel left by the removal of the soil are scattered over the surface in greater abundance than on the typical soil. These rock fragments are also abundant throughout the entire soil profile.

The slope of this land allows rapid run-off of the rainfall, and the sandiness of the soil favors more rapid percolation of water through the soil. As a result of these conditions, crops on this soil suffer more in times of drought than those on the typical soil.

About 75 per cent of this land is arable, but it is not all cultivated on account of the tendency to wash and gully. The untilled land is nearly all used for pasture. Under cultivation this soil returns lower yields of corn than typical Clarion loam. This difference has been estimated as ranging, in normal years, in different places, from 5 to 10 bushels an acre. Oat yields range from 5 to 15 bushels lower.

Clarion loam, shallow phase.—The surface layer of the shallow phase of Clarion loam is characterized by dark grayish-brown or grayish-brown floury loam which is high in lime content. Many lime nodules

[5] Estimates by county agricultural agent.

and small rock fragments occur in this layer. The subsurface soil is pale-yellow loam or heavy fine sandy loam, containing a high percentage of silt and very fine sand. It is underlain by very pale yellow or grayish-yellow heavy fine sandy loam or loam.

Land of this phase is inextensive and occurs in conjunction with the rolling phase. Crop yields are much the same for corn, oats, and mixed hay as those obtained on the rolling phase. Corn has a tendency to "fire" severely on this soil, especially during dry seasons. The land is prized for the growing of red clover, sweetclover, and especially alfalfa, on account of the high lime content of the surface layer.

Waukesha loam.—Waukesha loam is a soil of the well-drained terraces occupying a position between the first bottoms and the upland. The surface soil ranges from dark grayish-brown to very dark grayish-brown friable loam containing a rather large quantity of fine sand and medium sand. This layer is underlain by brown or slightly reddish brown heavy loam or silty clay loam. The lower subsoil layer is yellowish-brown or yellow silty clay loam or silty clay. At a depth ranging from 30 to 40 inches the material is silty clay in which are embedded coarse sand and gravel. In places loose sand and gravel underlie this soil but at such depth that a droughty condition is not produced. The water-holding capacity of this soil distinguishes it from the Sioux and O'Neill soils that are underlain by gravel at a slight depth.

On account of its small total area, this soil holds a comparatively unimportant place among the farming soils of the county and is regarded as having about equal value with Clarion loam. The usual farm crops, with about the same average yields, are produced. Corn, oats, and hay are the principal crops grown. In exceptionally dry seasons the soil may dry out so that corn wilts, but it seldom "fires".

EXCESSIVELY DRAINED SOILS

Within this group are placed those soils which have a low water-holding capacity, owing to the porous character of their lower subsoil layers. These soils are members of four series, and only one soil type has been mapped in each series. O'Neill loam and Sioux loam constitute the soil covering of high gravelly terraces. Dickinson fine sandy loam and Pierce loam are derived from sandy and gravelly material on the upland. The surface soils of the terrace soils are loams of good water-holding capacity, but they are underlain at a slight depth by coarse sand and gravel. Water drains away rapidly through the porous subsoil, and the water retained is not sufficient to carry crops without injury through even a short drought. Pierce loam, which has a similar profile, covers the rounded gravelly knolls and ridges on the upland. Dickinson fine sandy loam, which also occurs on knolls and ridges, is of a sandy texture from the surface downward to a depth of many feet. This soil is more retentive of moisture than the other soils of the group, but crops suffer during prolonged droughts.

Sioux loam.—The surface soil of Sioux loam is dark grayish-brown or brown material containing a rather large quantity of sand and organic matter. This material gives way, at a depth ranging from 8 to 18 inches, to dull reddish-brown or light-brown coarse-textured loam or loamy coarse sand. The soil to a depth of 18 inches is acid

or slightly acid. At a depth ranging from 18 to 24 inches below the surface is light-colored loose gravel ranging from fine to coarse and containing much sand of coarse, medium, and fine grades. This coarse material continues to a depth of many feet. Small bowlders, from 3 to 12 inches in diameter, are scattered throughout the gravel and sand. The gravel has a high lime content, which characterizes soils of the Sioux series.

The gravelly subsoil drains the overlying soil of its excess moisture and a part of the moisture needed by crops. During dry seasons corn "fires" badly and the yield is only from one-third to one-half that of a normal season. The oat yield is correspondingly low under the same conditions. Red clover and sweetclover may be grown with a fair degree of success. Sioux loam, like the Clarion soils, was among the first to be cultivated in the county, on account of its good natural drainage when other soils were poorly drained. The porous character of the surface soil and of the gravelly subsoil have, however, because of an unfavorable texture and low water-holding capacity, reduced the average yields obtained. The use of barnyard manure and the plowing under of green crops have proved highly beneficial, as these additions to the soil aid in the retention of moisture and add plant food to the soil. The relative productivity of this soil places its value from one-third to one-half that of the soils having restricted drainage. In many places the value of this soil lies in the gravel contained in the subsoil, which is used to surface roads and highways.

O'Neill loam.—The appearance, texture, and structure of the surface soil and subsurface soil of O'Neill loam are identical with those of Sioux loam. The depth of the loam soil above the gravelly subsoil in most places is less than in Sioux loam, and as a result the productivity of this soil is lower. Its position as a terrace soil is similar to that of Sioux loam, and O'Neill loam usually occurs adjoining Sioux loam at practically the same elevation. The fact that the gravelly subsoil of O'Neill loam does not contain lime is the characteristic by which this soil is distinguished from Sioux loam.

The use of manures to aid in the retention of moisture and to add plant food has proved even more beneficial than with Sioux loam. Agriculturally, O'Neill loam is less productive than the calcareous-subsoil terrace soils. Like Sioux loam this land is valuable as a source of gravel for road surfacing.

Pierce loam.—Pierce loam occurs on rather prominent knolls and on the crests of narrow ridges on the surface of which more or less gravel and small bowlders are present. Most of these knolls and ridges are in the northern half of the county, where they are widely dispersed within the Clarion soils. The largest areas are in the vicinity of Pilot Knob.

The surface soil is variable in texture and in depth to the gravelly subsoil. To a depth ranging from 4 to 8 inches it is brown or dark-brown loam containing a high percentage of sand. The subsurface layer is brown or light-brown sandy loam which contains a small quantity of rounded rock fragments. At a depth ranging from 12 to 15 inches, light-colored sand and gravel, in which are mixed many rounded bowlders, occur. The subsoil is very high in lime. As Pierce loam areas are situated within areas of Clarion loam, no sharp or well-defined boundary can be determined between the two soils,

the outer margins of Pierce loam areas being very similar to Clarion loam, and the soil gradually merging into that soil.

Owing to its droughtiness and to the occurrence of much gravel and stones on the surface, only a small proportion of this soil is devoted to cultivated crops. It is used largely for pasture land, or, in a few places, is covered with a sparse tree growth consisting largely of oaks. Agriculturally it is, perhaps, the least valuable soil of the county. Like the Sioux and O'Neill soils, the gravel subsoil is valuable for road surfacing and concrete-construction purposes.

Dickinson fine sandy loam.—Dickinson fine sandy loam is widely scattered in small areas throughout areas of the Clarion soils, but it is most extensive northeast of Eagle Lake and north of Miller. It occupies mounds, knolls, ridges, and the crests of ridges.

The surface soil is moderately dark grayish-brown uniform fine sandy loam to a depth of 10 or 12 inches. Below this and continuing to a depth of 30 inches is a yellowish-brown uniform fine sandy loam or loamy sand subsurface layer which is underlain by a light yellowish-brown or light-yellow fine sandy subsoil In no place is a clay subsoil reached within a depth of 3 feet.

Although Dickinson fine sandy loam is an easy soil to handle and might be used to advantage for truck crops for which early maturity is desired, it is used in the Eagle Lake-Hayfield vicinity for the production of both wild and tame hay. Corn and oats are grown on this soil, but the acre yields are from 5 to 15 bushels less than yields of the same crops on the well-drained soils. This is distinctly an acid soil to a depth of 3 feet and is in great need of organic matter to increase its productiveness. Owing to its sandy character throughout, it is well drained, and during dry seasons it is subject to drought.

ORGANIC SOILS

The organic soils, including both peat and muck, comprise a total area of 28.1 square miles in Hancock County. A tract of almost 2 square miles, the largest body of peat mapped in the county, lies 3 miles due west of Hayfield. Several large areas also lie north of the same place. Bodies of peat, including about 1 or 1½ square miles, are 2 miles north of Britt and 4 miles west of Garner. Other areas, ranging from 2 acres to a square mile in extent, are widely scattered throughout the county.

Muck, although it does not occur in such large bodies, has a total area of 12.5 square miles. It occurs in bodies of different sizes, ranging from a few square feet to perhaps a square mile, in the bottom lands, on the terraces, and on the uplands.

Peat.—Peat is an accumulation of partly decayed plant roots, stems, and leaves. These plant remains have accumulated in depressions that were at one time filled with water, forming marshes or shallow lakes. For thousands of years the water-loving plants have grown and their remains have fallen in the shallow waters. The surface relief of a peat area is level, and the natural drainage is very poor.

To a depth ranging from 8 to 12 inches the surface layer of peat is a dark reddish-brown mass of partly decayed fibrous plant remains. Underlying this layer, to a depth ranging from 30 to 50 inches, the plant remains are less thoroughly decayed, are more fibrous, and the

mass is of lighter reddish-brown color than the overlying layer. In many places the original shape or form of the decayed plant stem is recognizable. The depth to clay or the mineral soil is extremely variable. Where the bodies of peat are small the clay usually occurs at a depth ranging from 15 to 36 inches; in the larger areas clay may lie from 10 to 20 feet below the surface.

Some of the larger areas of peat have been drained by means of large dredged open ditches and the use of tile, and they are producing special crops. The peat areas north of Hayfield, north of Britt, and west of Garner, as well as many smaller tracts in the county, are used largely in the production of wild or tame hay or the grasses are allowed to remain for pasture. A striking exception to this usage is in the area west of Hayfield where a satisfactory artificial drainage system is employed to lower the water table sufficiently to grow special crops, such as potatoes, onions, and sugar beets. The depth of the organic soil in this area ranges from a few inches to several feet. Potatoes yield from 200 to 400 bushels an acre when an acre application of about 300 pounds of 0–9–27 or 0–8–32 commercial fertilizer is used. Onions do equally well, yielding about 300 bushels an acre. Although the yield of sugar beets is generally high, the sugar content tends to be low and the beets are discriminated against by some refiners. Corn and oats are grown with different degrees of success on peat, depending largely on the depth to clay or sandy clay. In general, however, peat is not adapted to the production of cereal crops because of the lack of mineral plant-food elements.

In the smaller bodies of peat in the county the organic soil is, as a rule, from 15 to 30 inches deep. Below this depth occurs from 2 to 4 inches of black muck or mucky clay, underlain by drab or gray calcareous clay.

Muck.—Muck represents a more advanced stage of the oxidation and decaying processes which are acting on the plant roots, stems, and leaves of peat. Muck is a very dark grayish-brown or black smooth loose mellow mass of organic matter mixed with different quantities of sand, silt, and clay. In some places small shells are strewn over the surface of this material. The depth of muck varies widely, ranging from 1 inch to 36 or more inches, but the average depth to the underlying clay or sandy clay is about 18 inches.

Muck is widely scattered throughout the three soil groups. Most of the areas which occur in shallow depressions within areas of Webster silty clay loam are only a few square feet in extent and are very shallow. Such areas, on account of their small size, have been included with the Webster soil in mapping. Bodies within the Clarion soil areas range in size from a half acre to a square mile, and the muck is deeper than within the areas of Webster soils, with the exception of very small patches. Muck areas within the Clarion soil areas have been shown on the soil map. Like peat, muck occurs in sloughs or pondlike depressions which were at one time inundated but which are at present drained or are subject to inundation only part of the year. In places muck occurs in conjunction with peat and forms a narrow border between the coarse fibrous material and the mineral soils of the upland. In such places no attempt has been made to show it on the soil map, on account of its small extent. In many places the muck areas lie between the terraces and the uplands.

In general the small bodies of muck are cultivated to the same crops as are grown on the surrounding Webster, Clarion, or terrace soils, and, unless the muck is deep, crop yields equal those obtained on the adjoining soils. Oats have a tendency to lodge, consequently a mucky soil is used largely for corn, hay, or pasture. Probably the best use for deep muck is for the production of hay and for pasture, at least until more mineral soil has become incorporated in the organic material. A great variety of weeds thrive on muck, especially in neglected cornfields and in pastures.

ALKALI SPOTS

The farmer thinks of "alkali spots" as those places in the fields in which corn fails to mature. These spots range in size from a few square feet to an acre, though the larger areas are few. They occur in connection with, or adjacent to, drained sloughs, ponds, or other low-lying bodies of land. Few spots occur in the lowest parts of the drained soil, but they occupy positions corresponding to the former shore lines or banks of small ponds. Some alkali spots occupy elevated positions which were of the nature of islands before the pond was drained. In plowed fields during the spring these spots may be located by the gray color of the surface soil, providing moisture conditions are normal. When the soil in these spots is dry or nearly so it is loose and ashlike instead of crumbly. The subsurface soil of such areas, below a depth of 8 or 10 inches, is decidedly gray, owing largely to the high content of lime and other salts. At a depth ranging from 20 to 30 inches, the usual Webster subsoil clay is reached (*1*, *8*).

WET SPOTS

Within the group of soils having restricted drainage are many small shallow depressions which have not as yet been properly drained. These spots observed during the survey have been indicated by marsh symbols. The surface soil of such areas is heavy silty clay loam or clay loam and in many is mucky to a depth of 2 or 3 inches. These poorly drained areas in cultivated fields are practically unnoticeable and are of no consequence in the agricultural value of the land.

A large area of Fargo silty clay loam southeast of Eagle Lake is poorly drained and is indicated on the map by marsh symbols. A poorly drained area of Webster silty clay loam occurs south of West Twin Lake, and an area of undrained muck lies south and east of East Twin Lake.

RECOMMENDATIONS FOR THE MANAGEMENT OF HANCOCK COUNTY SOILS

A soil rich in organic matter and plant-food elements may be rapidly reduced to a state of low productivity by improper cultivation and treatment; and, on the other hand, this same soil may be kept in a highly productive state for a long period of years by the proper rotation of crops, by the use of lime and fertilizers, and by the turning under of crop residues (*6*).

A farmer's success depends largely upon his knowledge of his land. He must know what crops grow best on certain soils, as well as have a knowledge of the necessary plant-food elements which must be

returned to his soils under certain cropping systems. A working knowledge of these facts is necessary in order that he may maintain the fertility of his land.

Almost all the soils of Hancock County, in their virgin state, were abundantly supplied with plant-food elements, lime, and organic matter. They have withstood the abusive cropping and fertilizer treatment of the past remarkably well (*2*). Now that the cropping systems are rapidly changing from the continuous growing of corn, or corn and oats alternately, to corn, oats, and hay, largely legume hay, these soils will partly return to their former state of productivity. This return of fertility will especially benefit the well-drained soils and the excessively drained soils. The soils that have restricted drainage have been under cultivation for a period of only 10 or 15 years and as yet have lost but a small part of their original productivity.

It is estimated by the county agricultural agent that 50 per cent of the farmers are plowing under legumes. This adds nitrogen, the most costly of commercial fertilizers, as well as organic matter, to the soil. The number of farms using lime is increasing. Added to these steps of soil betterment is the extension of the dairying and livestock industries on the grain-growing area of the county. A few of the better farmers are using superphosphate with crop residues to advantage.

The Iowa Agricultural Experiment Station at Ames has carried on some interesting experiments on Clarion loam, using manure; manure and lime; manure, lime, and some form of phosphate; and manure, lime, and a complete commercial fertilizer. An increase in crop yields has resulted in almost every case. By using crop residues instead of barnyard manure in the above experiments, the results were equally as good (*4*).

It would seem from these experiments that the Clarion soils of the well-drained group, as well as the excessively drained soils, are reaching a stage where the replacement of plant-food elements will be profitable, and before many years this will be necessary in order to maintain crop yields. Although nearly all the soils of the county are rich in lime, either in or near the surface layers, the use of lime in some form is being advocated. In fact it is necessary to lime some of the more acid surface soils at the present time in order to get a good stand of alfalfa.

The chief problem in the management of the Webster soils is to obtain sufficient and proper surface and subsurface drainage. This problem is rapidly being solved by the extensive systems of tiling used in the cultivated fields. Tile-drainage systems properly installed give entirely satisfactory results and do not interfere in any way with tillage operations. The open dredged ditches for the large drains have long been in use, and they involve little trouble or expense beyond the initial rather heavy expense of construction. Occasionally they must be cleaned of accumulations of silt, clay, and sand, and the willow and poplar growth must be cut out to insure free flowing of the water.

The peat soils of the county have to some extent been turned into profitable farm land by proper drainage, deep plowing, and an acre application ranging from 300 to 400 pounds of commercial fertilizer of an 0–9–27 or an 0–8–32 mixture.[6]

[6] Figures furnished by county agricultural agent.

Alkali spots are rapidly being turned into crop-producing soil by thorough tiling and heavy applications of strawy manure or crop residues in the form of straw or cornstalks, by turning under green crops (*5*), and by the application of 200 pounds of muriate of potash to the acre.

The value of fall plowing is generally accepted by the farmers of the county. The freezing and thawing during the winter and spring months break down the cloddy condition of the soil and mellow it so that the rainfall and the water from the melting snow in the spring are absorbed freely to a great depth. This creates an insurance against droughts during the growing season. A fall-plowed field may be disked over once in the spring and be in condition for seeding, as a rule, whereas if the land were plowed in the spring, two diskings would be required to put it in condition for seeding. Another advantage of fall plowing is that it is begun as soon as the oat crop is removed, or when there is a lull in farm operations, and continues at every spare hour until the ground becomes frozen. Field work usually ceases before the first of December.

SOILS AND THEIR INTERPRETATION

Hancock County lies in the prairie region of the United States, where a rather heavy precipitation and moderate temperatures promoted a very luxuriant growth of prairie grasses. The decay of these grasses through the centuries has imparted to the surface layers of all the soils of the county a high content of organic matter which has produced a black or dark-brown color. The native trees grew sparsely on the banks and hills along East Branch Iowa River east of Goodell. The banks of Winnebago River and the more rolling country to the north were covered with a forest growth. Pilot Knob, which lies in sections 3, 4, 9, and 10 of Ellington Township, is still covered with a tree and hazel-brush growth. A fringe of trees bordered East Twin Lake, West Twin Lake, Eagle Lake, and Crystal Lake. The virgin tree growth consisted of oaks, hickory, soft maple, locust, boxelder, ash, walnut, elm, and willow. Local basins or shallow ponds scattered throughout the county supported cattails, lilies, and other aquatic vegetation. Coarse rank slough grasses grew profusely throughout the lowlands, and the less rank and more varied prairie grasses constituted the natural vegetation of the higher ground.

The thickness of the black surface layer and the intensity of its blackness are directly influenced by the drainage of the soils; and the drainage is determined by the surface relief and the character of the substratum.

Only two types of parent material occur in Hancock County—the glacial drift which underlies most of the upland soils, and the alluvial material which underlies the terraces and bottom lands along the streams; the two outwash plains in the county; and a few upland areas of sloughy character, which are covered with water after heavy rains or melting of the snows in the spring. This alluvium is reworked glacial material which has been removed from the higher land by erosion and redeposited by water action. The parent material of all the upland soils of the county is the deposit of the late Wisconsin glaciation, the most recent drift deposit in the State. This deposit consists of moderately heavy till, is composed largely of silt and clay,

with a small proportion of sand, and is rich in lime. An extremely small part of the till consists of stony material. Only a few scattered granite, quartzite, or greenstone bowlders occur on the surface, and shale and limestone fragments are found at a considerable depth in drilling wells. Slight oxidation is evident beneath the surface and subsurface layers to a depth ranging from 8 to 15 feet.

So far as reliable records show, the soils of Hancock County probably have developed under a mean annual precipitation of about 30.6 inches and mean summer and winter temperatures of 69.5° and 17.4° F., respectively. The depth of freezing ranges from 2 to 3 feet.

On the basis of characteristics produced by drainage, the dark-colored soils may be divided into three groups.

The members of the first group are those soils having restricted drainage, in which conditions of excessive moisture have retarded soil development and immature or abnormal soils have resulted, as is indicated by their gray, or gray slightly mottled with brown, subsoils. The members of this group were in the virgin state very poorly drained. They have been changed to fairly well drained soils through a system of large open arterial ditches which carry off the waters of the tile network underlying the tillable fields. These soils retain the highest content of organic matter and as a result are the darkest-colored soils in the county, being black or nearly so.

The second group comprises those soils which have been developed on well-drained areas where the soil-forming processes have acted without interruption and have produced the mature or normal soil profile of this region. The surface layers of these soils contain less organic residues, have a lower degree of productivity, and are dark grayish brown or very dark grayish brown in color.

The third group includes the excessively drained soils which have a sand or gravel substratum. They have lost their productiveness to an even greater degree than have the well-drained soils, through oxidation and leaching processes and rapid subsoil drainage. They are dark grayish brown or dark brown in color.

A rather distinct physiographic relationship exists among the three soil groups. The soils having restricted drainage occur at the lowest elevation, occupying flat areas over the upland, first-bottom land, and low terraces adjoining the bottom land. Where these soils occur on the upland their position is lower than that of the well-drained soils. The well-drained soils occupy the higher areas, with the exception of one soil—Waukesha loam—a terrace soil which lies from 5 to 20 feet above stream level and is intermediate in elevation between the bottom-land and the upland soils. The excessively drained soils differ in respect to position and origin. The Dickinson and Pierce soils of this group occupy the highest positions in the county, and the Sioux and O'Neill soils are terrace, or second-bottom, soils and lie in an intermediate position with respect to the lowest-lying and the highest-lying soils.

As an example of the physiographic relationship between the soils, in sec. 23, T. 95 N., R. 26 W., in which the town of Stilson is located, the highest-lying soil of this particular section, Clarion loam, rolling phase, occurs in the northeast quarter of the section. Typical Clarion loam occupies the remainder of the eastern half of the section

and occupies a lower position than the rolling phase of Clarion loam. The larger part of the western half of the section is occupied by Webster silty clay loam and Webster loam, which occur in the lowest positions and are members of the group of soils having restricted drainage. Here are represented the relative topographic positions of the two large soil groups—Clarion loam occupying the highest position and Webster silty clay loam the lowest. Between these two extremes, Webster loam is an example of a soil developed on areas of intermediate elevation, and this soil is intermediate in its drainage conditions and the depth and blackness of its surface layer. In the interpretation of the soil map and in the profile descriptions that follow, it must be kept in mind that each of these three soil types has minor variations in surface slope, color, degree of acidity, and depth to free lime. When the soil map is compared with the lay of the land, however, it is evident that a rather close relationship exists between the soils and the surface relief.

Webster silty clay loam is an example of the least advanced stage in soil development in the county. In many places it is merely an accumulation of organic and mineral materials, unconsolidated, nearly black in color, and extending to a depth ranging from 36 to 48 inches. The striking physical characteristics are the high content of finely divided organic matter and the heavy clay texture. Were it not for the presence of organic residues and lime in this heavy plastic clay, it would have little of the distinctly granular structure. Underlying the black surface and subsurface layer is dull-gray or drab silty clay or clay, which on exposure to air dries and shrinks to a marked degree, causing the formation of cracks and fissures from one thirty-second to one-fourth inch wide. The Webster soils in places contain large accumulations of secondary lime pellets or nodules between depths of 15 and 36 inches below the surface.

Webster silty clay loam as observed in a field about 3 miles southwest of Britt in the SE. ¼ sec. 7, T. 95 N., R. 25 W., shows the following profile:

From 0 to 2 inches, very dark grayish-brown or black silty clay loam containing a small quantity of fine or very fine sand, fine grass roots, and a high percentage of finely divided plant residues. This material has a rather soft crumbly structure under normal moisture conditions, and it is neutral or slightly alkaline in reaction.

From 2 to 14 inches, very dark gray or black silty clay loam or silty clay. When somewhat dry a rather fine granular structure is apparent, the granules being angular and very closely packed. Pressure readily destroys the granules, and the high degree of plasticity of this layer becomes very apparent, especially if the clay is wet. The upper part of the layer when turned up by the plow is waxy in the spots of heaviest soil material and is termed "gumbo" by the farmers. The properties of gumbo soils make it necessary that they should not be disturbed when too wet, as a cloddy condition that is difficult to correct would result. The soil material of this layer is neutral or alkaline in reaction.

From 14 to 18 inches, dark grayish-brown, faintly mottled with gray, silty clay which differs in characteristics from the material in the overlying layer in that it is more gray, slightly heavier in texture, and shows a more strongly alkaline reaction in most places.

From 18 to 27 inches, dull-gray or bluish-gray silty clay, highly mottled with dark grayish brown and the dark-colored organic infiltrations from the layer above. The material is calcareous, more or less coarsely granular, and on drying vertical exposures assume a columnar structure with coarse fissures.

From 27 to 37 inches, dull-gray silty clay which is highly calcareous and contains lime nodules and some fine sand grains. This is the transitional layer into the true glacial till parent material, and it is similar to the material in the overlying layer which is modified by infiltrations from above.

From 37 to 51 inches, dull-gray silty clay with some sand, moderately mottled with dark rust-brown iron or manganese stains and containing iron concretions. The silty clay is highly calcareous.

Below 51 inches, yellow or yellowish-brown silty clay, highly streaked with gray, which contains a high percentage of sand. Lime occurs as flakes and nodules. The yellow color at this depth indicates the depth to which oxidation extends.

Throughout the soil profile of Webster silty clay loam, the large quantity of finely divided organic matter and the high lime content have been greatly instrumental in imparting a distinctly granular structure to the otherwise heavy plastic clay. Lime tends to loosen the soil material by its flocculating effect on the clay and colloidal clay.

Examination of the profile of Clarion loam reveals the fact that this soil has reached a more advanced stage in soil development than has Webster silty clay loam. Clarion loam has three distinct horizons. The surface horizon is dark-brown or dark grayish-brown crumbly loam, ranging from 19 to 25 inches in thickness. Underlying the dark-colored organic layer is a yellowish-brown layer between depths of 25 and 48 inches, which is well oxidized and leached of lime to such an extent that hydrochloric acid gives no effervescence. Below this is the pale-yellow or grayish-yellow glacial till which is only partly oxidized and highly calcareous.

The description of a profile of Clarion loam taken in a field one-half mile south of Britt in the SE. ¼ sec. 33, T. 96 N., R. 25 W., is as follows:

From 0 to 4 inches, dark-brown or very dark grayish-brown friable loam. A rather high percentage of sand is mixed with the silt and clay materials also a small quantity of fine gravel and rock fragments. This layer contains numerous grass roots. When dry or only moderately moist the soil material is crumbly. It is strongly acid.

From 4 to 14 inches, the material consists of slightly heavier and slightly darker colored loam than that in the overlying layer. In the lower part of this layer the structure grades from soft crumbly to rather hard or firm angular granules, a mass of which is very friable and permeable to water and air. The crushed granules produce a yellowish-brown loam much lighter in color than the exterior of the uncrushed granules. Small quartz fragments and coarse sand grains are present in this layer. The acidity is less than that of the layer above.

From 14 to 19 inches, a transitional layer between the organic-bearing and the purely mineral horizons. The material is yellowish-brown or brown silt loam or silty clay loam, which is highly colored with dark irregular infiltrations from the overlying layers. Many worm casts and root veins are in this layer. The material has a small nut structure and subangular breakage. The acidity of this layer is almost equal to that of the first 4 inches of the surface soil.

From 19 to 25 inches, yellowish-brown silty clay loam or clay loam, almost uniform in color with the exception of a few faint organic infiltrations. This layer contains some coarse material, such as rock fragments and gravel. The material has subangular breakage and is strongly acid.

From 25 to 44 inches, pale-yellow silty clay loam or clay loam, containing many small rounded rock fragments throughout. The material is highly calcareous, most of the lime being in a finely divided state, although many splotches and small lime pellets occur. Faint yellowish-brown mottlings and an occasional iron or manganese stain occur in the lower part of the layer.

From 44 to 52 inches, gray silty clay somewhat mottled with yellowish brown. Large lime nodules, from one-fourth to 1 inch in diameter or even larger, and a few yellowish-brown and dark reddish-brown iron stains occur at this depth.

From 52 to 68 inches, an almost equal quantity of yellowish-brown and gray mottled silty clay, the gray occurring as streaks and splotches, with dark reddish-brown and a few yellow iron stains. This is the parent glacial till, modified only slightly and highly impregnated with lime both in nodule form and in a finely divided state. Angular and rounded rock fragments of quartz and partly decomposed limestone occur in greater numbers in the till.

Clarion loam, as just described, is the soil as developed on slopes ranging from 4° to 12°. Clarion loam, rolling phase, has developed on strongly undulating, rolling, or hilly relief. This phase differs from the typical soil largely in having a thinner dark-colored organic layer, as the result of its relief, the surface soil having been removed by erosion almost as rapidly as it was developed.

Waukesha loam differs from Clarion loam only in being developed on terraces, in having a higher percentage of fine sand and medium sand throughout the entire profile, and in having a sandy clay subsoil in which much noncalcareous fine gravel is present at a depth ranging from 36 to 40 inches.

Webster loam is intermediate in position between Clarion loam and Webster silty clay loam, and it possesses characteristics of both soils. Where it occurs within areas of Webster silty clay loam, it occupies very slight rises or mounds and has better drainage to only a limited degree. The 5-inch surface layer has the dark grayish-brown color and the loam texture of Clarion loam. Underlying the surface layer, the black color and the silty clay loam texture of Webster silty clay loam predominate and below give way to yellowish-brown silty clay loam so common to Clarion loam at this depth. The substratum resembles that of the Webster soils. Webster loam might be considered as a soil in an intermediate stage of soil development, having characteristics of Webster silty clay loam, from which it is passing, and the color and texture characteristics of Clarion loam, toward which it is approaching.

Sioux loam is the typical soil of the excessively drained group. A description of a profile of this soil observed one-half mile southwest of Klemme on the west-central side of sec. 31, T. 95 N., R. 23 W., is as follows:

From 0 to 8 inches, dark grayish-brown or dark-brown friable loam which contains a high percentage of sand.

From 8 to 16 inches, brown or light-brown loam, in which much fine sand and a few rounded rock fragments occur.

From 16 to 24 inches, brown or light-brown loamy coarse sand which is sticky when wet. Many small gravel occur in this layer. The soil material from the surface to a depth of 24 inches is acid.

Below a depth of 24 inches a layer of highly calcareous coarse sand and gravel ranging from one-fourth to 2 inches in diameter. This layer may be only a few inches thick or may extend to a depth of 15 feet.

O'Neill loam is identical with Sioux loam in character, except it is noncalcareous throughout the entire profile or to the clay which lies beneath the gravel. This is the basis on which the O'Neill soils are separated from the Sioux soils. Another less important characteristic is that O'Neill loam is in many places more excessively drained by the gravel substratum and may have less soil of a loamy character overlying the gravel than has Sioux loam.

Pierce loam is similar to Sioux loam in color, texture, structure, and acidity of the surface layers to a depth ranging from 12 to 16 inches, but Pierce loam is an upland soil, occurring on many of the highest elevations of the county. Most of the gravel in the substratum of Pierce loam are larger and more varied in size, and many rounded bowlders ranging from 1 to 2 feet in diameter occur within the gravel. This soil was laid down by the retreating ice and is known as glacial dump.

Dickinson fine sandy loam is dark grayish-brown uniform fine sandy loam to a depth of 10 or 12 inches. Between the surface layer and a depth ranging from 30 to 36 inches is yellowish-brown uniform fine sandy loam or loamy fine sand. The subsoil below a depth of 36 inches is light yellowish-brown or light-yellow fine sand. The material of the entire profile is acid in reaction.

The alluvial soils occurring along the small and large drainage channels do not differ greatly from the Webster soils. Small drainage ways, almost without exception, rise in Webster silty clay loam areas. As the size of the stream increases, Lamoure silty clay loam occurs where a definite channel has been formed. The Lamoure soils are characterized by the highly calcareous condition of the entire soil profile and by the fact that they are first-bottom soils and subject to overflow.

The numerous small feeder streams combine to form the master drainage ways, and the bottom lands are composed of Lamoure or Wabash silty clay loam or loam. The Wabash soils differ from the Lamoure only in their low lime content throughout the entire profile. Soils of the first bottoms differ widely in the quantities of sand which have accumulated in the surface layers during the wet seasons of the year.

Adjoining the first bottoms are the terraces consisting of silty clay loams or loams of the Fargo and Benoit series, which range from neutral to very calcareous in the surface layers, and in the subsurface and subsoil layers they are everywhere calcareous. Soils of these two series are interspersed with Sioux, O'Neill, and Waukesha loams of the terraces and outwash plains.

Table 4 gives the pH values of different layers of three Hancock County soils as determined in the laboratories of the Bureau of Chemistry and Soils by the hydrogen-electrode method.

TABLE 4.—*pH values of Benoit loam, Clarion loam, and Webster silty clay loam from Hancock County, Iowa*

Sample No.	Soil type	Depth	pH	Sample No.	Soil type	Depth	pH
		Inches				*Inches*	
338038	Benoit loam	0–8	6.37	338064	Clarion loam	44–52	8.10
338039	do	8–16	6.73	338065	do	52+	8.20
338040	do	16–21	7.02	338066	Webster silty clay loam	0–2	7.45
338041	do	21–27	7.37	338067	do	2–14	7.72
338042	do	27+	8.49	338068	do	14–18	7.85
338059	Clarion loam	0–4	5.96	338069	do	18–27	8.10
338060	do	4–14	6.02	338070	do	27–37	8.22
338061	do	14–19	6.23	338071	do	37–51	8.22
338062	do	19–25	7.37	338072	do	51+	8.12
338063	do	25–44	8.22				

SUMMARY

Hancock County is in the north-central part of Iowa. It is nearly square in outline and includes 570 square miles.

The land of the county comprises an uneven plain which remains as it was constructed by the deposition of glacial till and débris by the late Wisconsin glaciation, and the plain has been dissected only slightly by erosion or stream cutting. The surface relief ranges from nearly level to undulating or rolling.

In 1930 the population of the county was 14,802, classed entirely as rural. Britt, the largest town, has a population of 1,593. Garner, with a population of 1,241, is the county seat.

Three railroads, one concrete Federal highway, one concrete and graveled State highway, and several county highways, as well as numerous other graveled roads, afford good transportation facilities.

The schools are adequate, and telephones and rural delivery of mail serve all parts of the county.

The climate is continental and is characterized by comparatively cold winters and warm summers. The greater part of the rainfall occurs during the growing season.

Corn, oats, and hay are the principal crops, corn leading in acreage. Livestock raising and dairying are becoming important industries.

The soils of Hancock County are all dark colored, owing to large quantities of organic matter which have accumulated during their formation. The soils have formed over calcareous glacial drift or over alluvial deposits brought down by streams from the drift areas. The differences in the soils have been brought about by the soil processes under different conditions of environment, particularly with respect to moisture.

Two soils, Clarion loam, with its phases, and Webster silty clay loam, cover 67.3 per cent of the total area of the county and largely determine its agriculture. Clarion loam is a dark-colored mellow loam, overlying brown loam which, in turn, overlies the parent material, a glacial drift high in lime. This soil occurs on low rounded swells and on hills and ridges, and drainage over all areas is good.

Webster silty clay loam consists essentially of a black surface soil underlain by a gray or mottled subsoil high in lime. Below this is the calcareous glacial drift from which nearly all the soils of the county are derived.

Both of these soils are well adapted to the growing of corn, and for this reason Hancock County is a part of the best corn belt of Iowa.

Webster loam differs from Webster silty clay loam mainly in the texture of the surface soil.

Waukesha loam is a well-drained terrace soil of about equal agricultural value as Clarion loam.

Fargo silty clay loam is similar to Webster silty clay loam, but it occurs on poorly drained terraces.

Benoit loam, O'Neill loam, and Sioux loam are terrace soils with gravelly subsoils. Pierce loam covers the gravelly knolls of the upland. All these soils have a low water-holding capacity, and crops on them suffer in dry seasons.

Wabash silty clay loam, Wabash loam, and Lamoure silty clay loam are first-bottom soils. The Lamoure soil has a high lime content, but the Wabash soils are low in lime.

A few areas of peat and muck occur in poorly drained areas.

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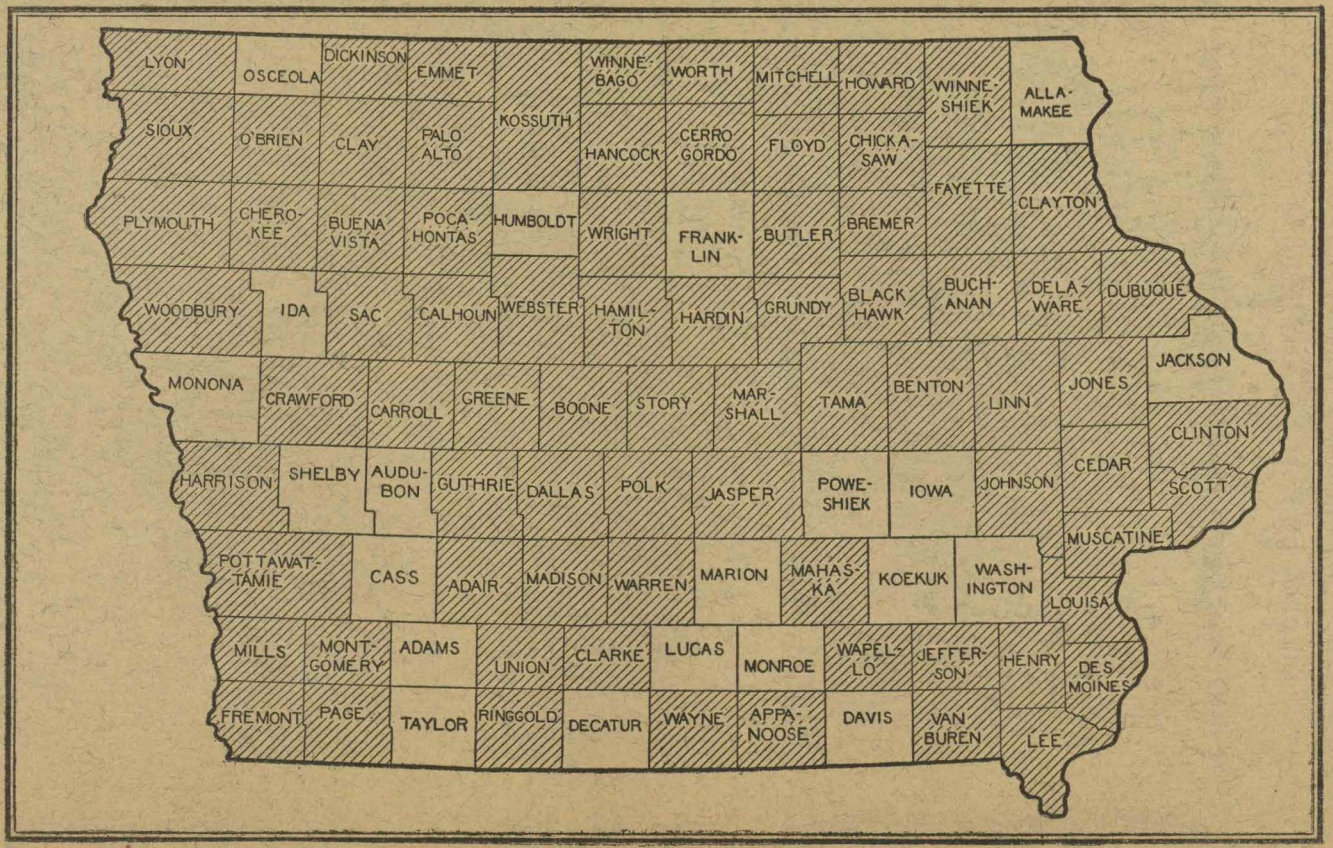
Authority for printing soil survey reports in this form is carried in Public Act No. 269, Seventy-second Congress, second session, making appropriations for the Department of Agriculture, as follows:

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 250 copies shall be for the use of each Senator from the State and not more than 1,000 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.
Detailed surveys shown by northeast-southwest hatchings.