

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION,
C. F. CURTISS, DIRECTOR; W. H. STEVENSON, IN CHARGE SOIL
SURVEY; P. E. BROWN, ASSOCIATE IN CHARGE.

SOIL SURVEY OF HAMILTON COUNTY,
IOWA.

BY

KNUTE ESPE, OF THE IOWA AGRICULTURAL EXPERIMENT
STATION, IN CHARGE, AND LAWRENCE E. LINDLEY,
OF THE U. S. DEPARTMENT OF AGRICULTURE.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1917.]



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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., December 4, 1918.

SIR: In the extension of the soil survey in the State of Iowa during the field season of 1917 a survey was undertaken in Hamilton County. This work was done in cooperation with the Iowa Agricultural Experiment Station.

I have the honor to transmit herewith the manuscript report and map covering this work and to request their publication as advance sheets of Field Operations of the Bureau of Soils for 1917, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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MAP.

Soil map, Hamilton County sheet, Iowa.

SOIL SURVEY OF HAMILTON COUNTY, IOWA.

By **KNUTE ESPE**, of the Iowa Agricultural Experiment Station, In Charge, and
LAWRENCE E. LINDLEY, of the U. S. Department of Agriculture.—Area
Inspected by **THOMAS D. RICE**.

DESCRIPTION OF THE AREA.

Hamilton County, Iowa, lies just northwest of the center of the State, and about 60 miles north of Des Moines. It is approximately in the form of a square, containing 16 land townships, and has an area of 57 square miles, or 364,800 acres.

The county lies just inside the eastward limit of the region covered by the Wisconsin glaciation, which was the last great ice invasion of this continent, and its topography is typical of the great area overrun by that ice sheet. The length of time since the glacial invasion has been too short for any considerable erosion to have taken place, and, except along the courses of the larger streams, the topography is for the most part constructional rather than erosional.

As a whole the surface is level to very gently undulating, but there are many local topographic contrasts to the level prairies, such as precipitous slopes along Boone River, extensive valleys, prominent hills, and numerous low swells. South and east of Stratford, for instance, on a level plain entirely free from erosion, there occur groups of hills or sometimes a single hill, ranging from 50 to 75 feet in height. These are quite regular in shape and look more like artificial mounds than natural features and seem to bear no physiographic relation to the surrounding country. One such hill is encountered $3\frac{1}{2}$ miles east and $2\frac{1}{2}$ miles south of Stratford and others in secs. 15, 35, and 36 of Marion Township. These elevations are known to geologists as morainic hills.

A series of knobby mounds extends north from Wall Lake, east and north from Jewell, north of Randall, and then north through scattered swells and knobs, culminating in higher hills around the east of what was originally Iowa Lake. A similar chain of hills begins at the southwest corner and extends interruptedly across the county through the vicinity of Stanhope, Kamrar, and Blairsburg.

A few shallow, marshy lakes occur here and there through the upland. Mud Lake, the largest, situated northwest of Jewell, was

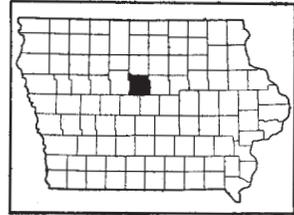


FIG. 1.—Sketch map showing location of the Hamilton County area, Iowa.

artificially drained some time ago, but the operations were only partly successful. Iowa Lake, in Rose Grove Township, the second in extent, has also been reclaimed, but the lake bed is practically useless as far as the production of cultivated crops is concerned. Wall Lake, $2\frac{1}{2}$ miles south of Jewell, which covers about one-half square mile, is a shallow body of water, having an average depth of only about 7 feet. In its present condition it is little more than a marsh. Goose Lake, situated one-half mile east of Jewell, occupies an area probably less than one-fourth square mile. It is in reality only a slough.

The general elevation of the county is between 1,100 and 1,200 feet above sea level. The prevailing slope is to the south. Boone River has cut a valley through the western part of the county which is little more than a trench, lying about 50 feet below the adjacent upland where it enters the county and about 150 feet below at the point where it joins the Des Moines River, $3\frac{1}{2}$ miles north of Stratford. In few places does the valley exceed one-half mile in width, and usually it is less than one-fourth mile. The river consequently has not formed any considerable flood-plain area, but it is bordered by a number of narrow, disconnected terraces, seldom more than $1\frac{1}{2}$ miles in length.

Skunk River heads in the northeastern corner of the county and traverses the east-central part from north to south, draining all that part of the county not reached by the Boone River, with the exception of a small area along the eastern boundary line, which is tributary to the Iowa River on the east. The flood plain of the Skunk River is less than one-quarter mile in width and is overflowed practically every year.

The two rivers have few tributaries. They rise in broad, shallow depressions, apparently left by the glacier, and are sluggish. Drainage is naturally imperfect over the greater part of the county. In this respect this region is quite characteristic of the whole Wisconsin-drift area, as poorly established drainage is one of the factors which distinguish it from the other, older drifts, whose streams have had more time to erode back into the prairies.

The interstream areas are generally extensive, flat to gently undulating plains with only an occasional minor drainage course. Streamlets have not eroded into the broad divides except along the margins, and consequently they have very poor natural drainage. This condition is best represented in the plain surrounding the town of Highview and including most of the territory north and west of the Boone River. Another such area extends north and south through the east-central part of the county. Beginning just east and south of Ellsworth, it reaches north between Williams and Blairsburg, whence it may be traced to the north county line in more

or less disconnected areas. A third such area lies roughly in the triangle whose points lie in the towns of Jewell, Kamrar, and Stanhope, while a fifth and smaller area lies just west of the town of Randall.

An extremely small proportion of the upland and terraces is unsuitable for tillage. Many ponded areas and low sags are yet in pasture, but these will become good corn land if drained. The lands adapted only to forestry are the narrow flood plains of the streams and the short slopes that generally border both sides of these flats.

Water for farm use is obtained mostly from wells drilled into one of the two principal water beds of about equal importance. One of these beds is the sand and gravel beneath the Wisconsin drift, reached at a depth of 90 to 120 feet, and the other is the sand and gravel below the older Kansan drift, encountered at a depth of 150 to 200 feet. A few wells obtain water at various depths from underlying sandstones or limestones. There are a few flowing wells along the Boone River, along the Skunk River, and in the southwestern part of the county.

According to the State census of 1915 the total population of Hamilton County is 20,514, or 35.5 persons per square mile. The rural population, including all towns below 2,500 as rural, which is the custom of the Federal census, is 14,680, or 71.5 per cent, giving a density of about 26 persons per square mile.

The State census gives Webster City, the county seat and largest town, a population of 5,834, Jewell 1,074, Stratford 601, Williams 550, Ellsworth 530, Blairsburg 298, Stanhope 357, and Randall 200.

The county is quite well supplied with railroads, being traversed by the main line of the Illinois Central, two branch lines of the Chicago & Northwestern, and the Fort Dodge, Des Moines & Southern Interurban line. These afford direct communication with Chicago, Dubuque, Omaha, Sioux City, and Des Moines. Every station has one or more grain elevators and a stockyard, and no farmer need haul grain or live stock farther than 6 or 7 miles.

The country roads are of dirt construction, except for some of the main highways, which are graveled. All the traveled roads are kept in fair condition by means of road drags. Extensive road improvements have been in progress for the last few years.

CLIMATE.

The average annual precipitation as recorded at Iowa Falls, in Hardin County, to the east, where climatic conditions are practically the same as in Hamilton County, is 34.55 inches. Of this amount about two-thirds falls during the growing season. Considering the retentive character of the soils, the average precipitation, and its distribution, the climate is quite well adapted for the crops generally grown, and particularly for corn. Drougths of a month's duration

may occur during July and August and affect the corn somewhat, but the excellent moisture-holding capacity of the soils prevents any great injury. A marked excess of moisture, especially in the spring, is of more serious concern, as it delays planting and maturity and hinders tillage. In some seasons the inadequate drainage makes it necessary to replant corn in low places.

The precipitation usually comes in light showers or slow, gentle rains. Hailstorms are very infrequent. In the driest year recorded at Iowa Falls (1894) there was a precipitation of 19.52 inches, and in the wettest year recorded (1867) the rainfall amounted to 54.66 inches.

No complete Weather Bureau record has been kept in Hamilton County, and the records of the station at Iowa Falls are the most nearly representative of local conditions. The normal monthly, seasonal, and annual temperature and precipitation as recorded at that point are given in the following table:

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

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute Minimum.	Mean.	Total amount for driest year. (1894.)	Total amount for wettest year. (1867.)
	° F.	° F.	° F.	Inches.	Inches.	Inches.
December.....	21.3	58	-21	1.37	0.89	2.46
January.....	13.8	52	-34	1.21	0.72	1.74
February.....	16.8	59	-28	1.64	0.20	5.49
Winter.....	17.3	59	-34	4.22	1.81	9.69
March.....	30.6	84	-17	1.86	1.65	3.17
April.....	46.4	93	3	3.13	4.33	2.14
May.....	58.5	92	24	4.60	1.63	7.64
Spring.....	45.2	93	-17	9.59	7.61	12.95
June.....	67.3	98	37	5.40	2.85	17.20
July.....	71.9	103	40	4.19	0.09	4.30
August.....	69.5	98	31	3.71	1.56	4.29
Summer.....	69.6	103	31	13.30	4.50	25.79
September.....	60.9	96	26	3.54	1.57	4.26
October.....	48.4	85	11	2.36	3.78	1.82
November.....	32.6	76	-4	1.54	0.25	0.15
Fall.....	47.3	96	-4	7.44	5.60	6.23
Year.....	44.8	103	-34	34.55	19.52	54.66

The normal growing season is about 146 days in length, as the average date of the last killing frost in the spring is May 6, and that of the first in the fall, September 29. The earliest killing frost on record occurred September 12, and the latest recorded in the spring, on May 31.

The mean winter temperature as recorded at Iowa Falls is 17.3° F., the spring mean 45.2°, the summer mean 69.6°, and the fall mean 47.3°. From summer to winter there is thus a range in temperature of 53° F. The winters are generally cold. A minimum temperature of 34° below zero has been recorded. Windbreaks are necessary to protect stock in winter.

AGRICULTURE.

Agriculture in Hamilton County consists mainly of the growing of corn, small grain, and hay, combined with the raising and feeding of hogs and other live stock, and is extensive rather than intensive. Moderate yields are obtained from large acreages by the use of labor-saving machinery rather than big yields on small acreages at the expense of high-priced labor. As a consequence, the average size of the farms is slowly increasing, with a corresponding decrease in the total number of farms. In 1905 there were 2,271 farms in Hamilton County; by 1910 the number was reduced to 2,031, and in 1916 the total number was 2,018. The average size increased from 161 acres in 1910 to 169 acres in 1916.

Spring wheat was formerly grown on a large scale, but it has steadily declined in acreage for the last 15 or 20 years. This falling off has undoubtedly been due to the effects of continuous cropping and to the larger profits derived from the growing of corn as artificial drainage spread over the country. The decrease in the acreage of wheat as recorded in the Iowa Yearbook was from 2,476 acres in 1905 to 1,996 acres in 1910 and 385 acres in 1916. Flaxseed was produced to some extent when the country was first settled, but flax is scarcely grown at all now except as a first crop on virgin soil. The same is true of buckwheat and rye. On the other hand, the acreage devoted to corn has increased, amounting to 115,170 acres in 1905, 105,653 acres in 1910, and 123,576 acres in 1916. As the drainage has been improved the acreage in wild hay and pasturage has rapidly decreased. The native grasses have been displaced by timothy and red clover, which have become important crops on every farm. In 1905 there were 25,722 acres in wild hay. By 1910 the area had decreased to 17,038 acres, and there was a further reduction to 6,599 acres in 1916.

With the growth of population, the improvement of transportation facilities, and the rise in land values, better methods of agri-

culture have gradually been adopted. Artificial drainage has increased the area of improved land very rapidly in the last 15 years. When the county was first settled perhaps 25 to 30 per cent of the land was too wet to cultivate. Reclamation by drainage has reduced the acreage of wet land to less than 2,000 acres. Between 90 and 95 per cent of the entire county is now improved.

Most of the farming operations center around the production of corn, and only such other crops are grown as will fit in the rotation and not interfere with corn production. The bulk of the corn produced is fed to live stock. Dent corn is grown entirely, and the yellow varieties predominate. Reids Yellow Dent and strains of this variety are most popular. Boone County White, White Silver Mine, and Silver King are the leading varieties of white corn. All these varieties were introduced by the early settlers and have been improved to meet local conditions of climate and soil by selection. As a result many strains of each variety are to be found. Early maturity and good yields have been the two prime factors sought for. Wireworms and cutworms do some damage to corn in certain years, especially when the season is wet and cold. Foxtail, morning glory, and milkweed are the chief weed pests. Approximately 124,000 acres, or 60 per cent of the total area in all grain crops, was devoted to corn in 1916.

Oats rank next to corn in point of acreage. In 1916 this crop was grown on 90,392 acres, or about 39 per cent of the total acreage devoted to all grains. Except that the weather may be a little too hot during the period when the heads are filling, the climate is well adapted to oats. The crop fits well in the rotation. Seeding is done before it is time to prepare the ground for corn, and harvest comes after the corn has been laid by. Also, straw is necessary for roughage and bedding, and oat straw is much preferred to any other kind. The growing of small grain permits of fall plowing, and furnishes an excellent opportunity for the application of manure for the next year's crop of corn. White and late-maturing oats are favored, although a considerable quantity of early oats is produced. Many farmers put part of the land in early oats and the balance in late oats, thus guarding against a total loss from possible adverse weather conditions at the time of filling and also prolonging the time of harvest, which is of considerable importance, since oats usually lodge when ripe. Some farmers report that early oats do not grow so rank and are not so apt to lodge as the late varieties. Early Champion and Kherson, Green Russian, Iowa 105, and Iowa 103 are the main varieties grown. Oats are a cash crop and are marketed at the local elevators, usually as soon as thrashed.

Timothy and clover form the bulk of the hay crop and are usually grown together, the clover dying out in two or three years and leav-

ing a good stand of timothy. Occasionally they are sown separately and grown for seed. Some farmers grow clover alone for hay as well as for seed. It can be grown without much difficulty anywhere in the county, and is rarely damaged by winter freezing. Liming is seldom practiced. The average yield of timothy and clover is about $1\frac{1}{2}$ tons per acre. Approximately all of the hay is fed on the farm. The 1916 Iowa Yearbook reports 25,340 acres in tame grasses, which gave an average yield of 1.2 tons per acre.

Wheat is grown in a few fields, mostly to make flour for home consumption. The yield averages about 15 bushels per acre. In recent years some winter wheat has been sown, and it is steadily gaining in favor. Yields of 20 to 30 bushels per acre are quite common, and it seems reasonable to expect that winter wheat may eventually displace a considerable acreage of oats.

A small acreage of barley is grown for feed. The crop is not considered of desirable quality for malting purposes, but makes a better feed than oats and in certain years is a better cash crop. However, it is probable that it will not be grown on a much larger scale than at present.

Buckwheat and flax are sometimes grown on reclaimed land. Usually one crop only is grown, and then the land is used for corn. Farmers say that flax is valuable for subduing virgin sod land, but that it exhausts the productiveness of the soil and does not produce good crops on used land.

Millet is grown only as a supplementary and catch crop. It is quite customary to seed millet on corn ground which has been "drowned out." In some cases it is grown on reclaimed peat or muck soils or on alkali land.

Alfalfa has been grown on a small scale for the last few years and on the whole has proved quite successful. Growers say that inoculation and good drainage are absolutely necessary and the yield has also been increased by the use of lime and barnyard manure. Three cuttings are usually made in a season. The greatest drawback to growing alfalfa seems to be the danger of freezing out in severe winters. It is a good forage crop as well as a profitable sale crop and a good soil renovator, but it does not fit so well in the rotation as clover and timothy. Alfalfa is harder to get established, and is most profitable when left for 5 or 10 years.

Sweet clover grows wild along the roads, railroads, ditches, and fence lines. It grows quite rank, from 4 to 6 feet high, and it would be easy to secure and maintain a stand of this crop in any part of the county.

On nearly all farms there are small apple orchards, which ordinarily produce a heavy crop every other year. The Duchess, Wealthy, Whitney, and Yellow Transparent are the most common varieties.

Spraying is done to a small extent, and has given very good results. Cherries and plums do well and are grown quite extensively in small home orchards. Strawberries are also produced successfully.

Live stock, chiefly cattle and hogs, are kept on every farm. Few farmers have specialized in purebred stock, but purebred males are largely used in order that good grade animals may be raised. Farmers have regarded the feeding of live stock as profitable in order to use the roughage, wastes, and low-priced grains for which there is no ready market. In addition, manure is highly necessary for maintaining the productiveness of the soils. A greater profit can usually be realized by marketing the crops in the form of live stock than as grain or hay.

Probably the most important live-stock industry is the raising of hogs. Nearly every farm has from 40 to 80 hogs and a dozen or more brood sows. On some farms all the corn produced is fed to hogs. The leading breeds are Poland-China, Duroc-Jersey, and Chester White. The Iowa Yearbook reports a total of 85,478 hogs in the county in 1916. Most of the beef animals fed during the fall and winter months are raised locally, as every farmer has his own breeding stock. Some feeders are shipped in from Kansas City, Omaha, and other market centers. The cattle are usually marketed in Chicago. Very little effort is made to keep the strains of cattle pure, and most of the stock is grade Shorthorn or Angus. In 1916 there were 36,611 cattle in Hamilton County.

Farmers recognize that the blacker and heavier soils, especially those of the bottom lands and artificially drained areas, are best adapted to corn, while the lighter textured soils of higher elevation and more rolling topography are best adapted to small grains. The forested, or formerly forested soils, are said to make the best bluegrass pasture, and to be better adapted for small grain than for corn. Farmers are beginning to recognize the fact that peat and muck soils and alkali lands should be kept in grass, as they yield especially good crops of timothy.

Where corn follows small grain or timothy and clover the ground is usually plowed the preceding fall, but where corn follows corn this is not practical. Farmers, as a rule, prefer fall plowing, as it kills more weeds and leaves the soil in better tilth at corn-planting time. Both disk and smoothing harrows are used in preparing the seed bed. Practically all the corn is checked-rowed $3\frac{1}{2}$ feet apart, planting three kernels to the hill, and is given three to five cultivations. Most farmers give a shallow stirring after the second cultivation in order to maintain a dust mulch to hold the moisture. Corn is planted from the 5th to the 20th of May, and cultivation usually ends about the 4th of July. Husking begins about the middle of October and

usually is finished by Thanksgiving. Some corn is cut for fodder, and some for ensilage, but the greater part is husked from the standing stalk, after which cattle are turned into the fields. The average yield is about 40 bushels per acre.

Oats are usually broadcasted, disked twice, and harrowed once to break down the cornstalks and cover the seed. The drill has been coming steadily into use, but there is much difference of opinion as to its advantages. Land for oats is seldom plowed, as the crop usually follows corn. Timothy and clover are seeded with the grain. Seeding is done from the 1st of April to the 1st of May and harvesting usually comes after corn has been given its last cultivation, or about the middle of July. The average yield of oats is 35 to 40 bushels per acre.

Almost all the farms are equipped with machinery of the latest design. Among the important machines are gang plows, manure spreaders, two-row cultivators, hay loaders, corn binders, and tractors. Draft horses of good size are used on most farms, three, four, or five horses being employed in many of the operations. The State census of 1915 gives the average value of machinery on farms as \$3,440.

Some forms of crop rotation have been practiced for a long time, but only a few farmers follow a definite system. Farmers realize the need of changing crops to insure good yields, and corn and oats are generally alternated, the corn land receiving the manure. This is especially true on farms which derive all their pasturage and hay from land too wet to cultivate. Another general plan has been to grow corn for one to three years and then one crop of oats or barley, with a seeding of red clover and timothy, the clover and timothy being used for pasture or hay for several years before the ground is again planted to corn. Corn and oats are often alternated for a period of five to six years, after which the field is seeded down for pasture or hay for several years. Varying rotations similar in a general way to these are followed, differing for the most part in the length of time the field is left in grass. Rotations which allow the most extensive growing of corn are looked upon with most favor by the farmers.

In 1916 there were 2,018 farms in Hamilton County, of which 907 were operated by owners, 250 were operated by owners who leased some additional land, 426 were rented for cash, 331 were rented on shares, and 230 under a combined cash and share system. Cash rental varies from \$5 to \$7 an acre. About 43 per cent of all the farms are operated by the owners. The average size of farms is given in the 1916 Iowa Yearbook as 169 acres. Few farms are less than 80 acres in extent and few are over 320 acres.

In general the farm improvements in this county are good. The houses are well built and comfortable and many of the newer houses have all modern conveniences. Large painted barns, granaries, hog houses, and chicken houses are quite common. There are 91 silos in the county.

Land values in this county have been steadily increasing. Forty years ago the best land could have been bought for \$5 or \$10 an acre, while present values range from \$175 to \$300 an acre, depending upon the improvements, soil, and location. About \$225 is the average price for the county.

SOILS.

Hamilton County lies within the Wisconsin drift region of Iowa. This drift consisted originally of more or less finely ground and weathered rock, gravel, sand, pebbles, and bowlders of various kinds and sizes, formed by the action of the ice on the underlying bedrock of limestone, sandstone, and shales, and on whatever soil had been formed from earlier ice invasions. The material at the surface has disintegrated under the influences of weathering until it has been reduced to a fine silty clay intermixed with a variety of coarse rock particles ranging from sand to bowlders 2 to 3 feet in diameter. In the mass it ranges from pale yellow to yellow, is quite compact and retentive of moisture, has a high silt content, and a thickness of 6 to 16 feet in Hamilton County. The upper portion of the drift has been modified by weathering and by the addition of organic matter so that the color has been changed to dark brown or black. The prevailing texture is a loam. The area of sandy loam is very small and there are no stony soils. Gravelly soils also are negligible in extent. There are no areas of clay large enough to map, but there is a considerable development of clay loam. Throughout the uplands the immediate surface deposits are quite uniform in character.

Beneath the Wisconsin drift lies another, older drift, formed by a much earlier ice invasion. It outcrops in the road, ditch, and railway cuts and in river banks in all parts of the county, and is known to the farmers as blue clay. It does not outcrop at the surface anywhere in the county, being completely covered by the Wisconsin drift, except in the places mentioned. This drift consists of a bluish, gritty, well-oxidized clay, interspersed with greenstone pebbles and well-rotted and crumbling granitic cobbles, and is easily distinguished from the later drift.

All of the interstream areas are prairies, forested only along the banks of the larger streams. There are no wide variations in physical properties of the soil or in their origin, and consequently the uplands consist of wide areas of closely related types. The varia-

tions that do exist are due primarily to differences in topography which have affected the drainage.

The surface soils are prevailingly dark brown or black to a depth ranging from 10 to 30 inches in some cases. The black color is due to organic matter resulting from the luxuriant growth of grasses and plants, whose remains have accumulated on account of the poor drainage conditions. In the areas of shallow water, where the maximum accumulation of organic matter has taken place, areas of Muck and Peat and Rogers silt loam have been developed. In the better drained and more undulating to rolling areas occupying the morainic deposits, types having dark-brown to black soils and brown and yellowish subsoils with a greenish cast, are developed. These areas were left by the glacier with much better natural drainage and have consequently reached a more complete stage of oxidation, aeration, and leaching than the level plains. They did not support such luxuriant growth of vegetation and consequently do not have as high a content of organic matter.

The poorly drained plains supported a heavy vegetative growth, which gave rise to a high organic-matter content and a densely black color in the surface layer. Having no run-off, these plains were not badly leached, and the soils still maintain their original high content of lime. They have undergone little oxidation or aeration. The soils in this division are mapped in the Webster series, the Webster loam covering most of the surface, while in shallow depressions is found a heavy soil classed as the Webster clay loam. It also, owing to its poor drainage, has a high organic-matter and lime content. Its heavy texture is due, at least in part, to the washing in of silt and clay from higher surrounding land. This soil also occurs in depressions within the Carrington and Clarion areas.

The Webster series consists of black soils with dark-drab or gray subsoils. The soils are high in organic matter and are quite calcareous. Their surface is flat to very gently undulating, and much of the land requires artificial drainage for successful cultivation.

Another upland soil, occurring in only one area, has been correlated in the Rogers series, which includes types with gray, highly calcareous surface soils, underlain by a somewhat heavier subsoil. The type in Hamilton County occupies an old lake basin whose natural drainage is very poor.

In eroded strips bordering the stream valleys a brownish soil, classed in the Miami series, has been developed. These soils consist of light-brown to grayish surface soils, with yellow to brown, compact subsoils, heavier in texture. The areas of Miami soil are for the most part forested and were all originally forested.

The alluvial soils of the county are inextensive. The material forming these soils has been derived almost entirely from the

Wisconsin drift. Materials of this kind occupy terraces and first bottoms.

On the terraces the types have been correlated with the Waukesha series, characterized by dark-brown to black soils, underlain by a sandy or gravelly loam subsoil which has a low moisture-holding capacity, and the Hancock series, occurring on the lower stream terraces or benches, which includes types with black soils and brown or gray subsoils. Some colluvial material enters into the soils of this series.

The alluvial soils of the present flood plains belong in the Wabash series, which includes types with dark-brown to black soils, high in organic matter, overlying drab subsoils.

The following table gives the name and the actual and relative extent of each type mapped in Hamilton County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Webster loam	211,520	58.0	Peat.....	2,112	0.6
Carrington loam	54,464	27.8	Carrington fine sandy loam	1,728	.5
Steep phase.....	3,520		Rogers silt loam.....	1,408	.4
Clarion loam.....	43,712	12.0	Muck.....	768	.2
Webster clay loam.....	31,040	8.5	Meadow.....	384	.1
Wabash loam.....	4,480	1.2	Carrington gravelly loam	320	.1
Hancock very fine sandy loam....	3,456	.9			
Waukesha loam.....	3,136	.9			
Miami silt loam.....	2,752	.8			
			Total.....	364,800	

CARRINGTON GRAVELLY LOAM.

The Carrington gravelly loam consists of a dark-gray to black friable loam to sandy loam 10 inches deep, underlain by a brownish or grayish-brown, loose loam or clay loam, which passes at 22 inches into a pale-yellow fine sandy loam or sand. Below the 3-foot section clean yellow sand is encountered. Throughout the profile the material is loose and gravelly.

This type occupies mainly conspicuous smoothly rounded hills, but is mapped also on the level prairie southeast of Stratford and south of Stanhope and in the rougher section on the east side of Skunk River near the south county line. There are many areas too small to map.

The Carrington gravelly loam, owing to its low content of organic matter and its porous and unretentive nature, is not a valuable soil for the production of cultivated crops. Some of it is farmed but the crops are likely to suffer from drought, and the greater part is used for pasture. The type is of very small extent and of little importance.

CARRINGTON FINE SANDY LOAM.

The Carrington fine sandy loam consists of 10 inches of moderately dark brown, medium sandy loam to fine sandy loam, underlain by a rather light yellow or yellowish-brown fine sandy loam. At 4 to 6 feet below the surface a loose, pale-yellow, incoherent sand is encountered. The surface soil has a fairly high proportion of organic matter and is acid to litmus paper.

This soil occupies ridges or hills, some of which are 50 to 75 feet high, and its surface is naturally rough. The type is droughty, owing to the loose, open structure of the surface soil and to the underlying sand. It is confined to a few scattered areas on the east side of Skunk River south of Ellsworth.

CARRINGTON LOAM.

The Carrington loam consists of about 15 inches of dark-brown to black, mellow, friable loam, grading into brownish, more compact clay loam which in turn gives way to brownish-yellow or sometimes greenish-yellow, gritty clay loam at 24 inches. Some gravel occurs over the surface, and in the soil mass the proportion increasing with depth. Usually the lower subsoil is calcareous, and particles of soft limestone can always be found in the substratum below 4 feet. Unmodified, yellow glacial till is encountered below the 3-foot section.

In the rougher areas, subject to erosion and leaching, the surface soil is lighter in color, since the organic content is lower than elsewhere, the layer of dark material is more shallow, and the subsoil is more oxidized, sandier, and on the crest of morainic hills, gravelly. In the more nearly level areas, less subject to leaching and washing, the soil is darker, the black color extends to a greater depth, and the subsoil is sometimes a greenish-yellow clay.

The Carrington loam is confined to the smooth-sloped hills or swells in the morainic belt of the county and to the undulating prairie bordering the larger streams. Drainage is everywhere adequate.

There is little waste land in this type. The soil is quite easily tilled and desirable for the prevailing type of agriculture. Although the soil is not as durable and productive as the Webster loam, it has the advantage of good natural drainage, is easier to work, and is a slightly earlier soil. The staple farm crops are grown. Corn ordinarily yields 40 to 45 bushels per acre and oats 40 to 45 bushels. Corn is not so frequently injured by frosts as on the Webster soils, and oats have less tendency to lodge, as they grow less rank and ripen a little earlier. Timothy and clover yield about $1\frac{1}{2}$ tons of

hay per acre. Both spring and winter wheat are grown, giving a yield of about 15 bushels per acre. A few acres are devoted to barley, which yields on the average a little less than oats. No commercial fertilizers are used on this soil. On farms containing both Carrington and Webster loams the barnyard manure is usually applied to the Carrington.

In order to maintain and improve the productiveness of this soil a rotation should be adopted similar to that suggested for the Webster loam. It would be well to plow under a legume crop occasionally to replenish the supply of organic matter. Crops respond to the application of barnyard manure, but the supply of this material is always inadequate and green manuring must be resorted to. Fall plowing is known to result in increased yields. Improved methods of rotation, green manuring, and live-stock raising are more necessary for maintaining the soil productiveness than in the case of the Webster soils.

Improved land of the Carrington loam sells for \$200 to \$250 an acre, depending upon the improvements and location rather than upon any differences in the soil.

Carrington loam, steep phase.—The steep phase of the Carrington loam occupies eroded slopes and bluffs lying along the Boone River and extending short distances up its tributaries. The soil is a black or dark-brown, friable loam, usually between 6 and 12 inches deep, resting on a yellowish-brown, compact, gritty clay loam subsoil. In some places along ravines the entire surface material has been removed, leaving the subsoil exposed. At the base of some of the slopes there are colluvial and taluslike accumulations of soil material which vary in color according to the upland material from which it came, the Miami uplands giving rise to a lighter colored soil than the Carrington and Webster.

Owing to its steep topography, this phase of the Carrington loam is not under cultivation. It is too steep for the use of improved machinery and in addition boulders are embedded in the surface, making cultivation difficult. Some of the slopes are so steep as to be of no use agriculturally, but such areas are small. Originally all this land was forested, but much of it has now been thinned for use as pasture. It supports a luxuriant growth of bluegrass in most places, although on some of the slopes not well protected with trees the grass burns out during the summer droughts. Small fields on some of the lower slopes are cultivated to corn and oats. This soil is best left in forest, as otherwise it erodes badly. Thinning the trees just enough to allow the growth of grass for pasture undoubtedly is the best way to handle it.

CLARION LOAM.

The soil of the Clarion loam to an average depth of 12 inches consists of a very dark brown to black mellow friable loam. The upper subsoil is a brown or yellowish blown clay loam or clay. The lower subsoil, which is encountered usually at depths of 24 to 30 inches, is yellow in the upper part, passing into gray. The texture is usually similar to that of the upper subsoil, but in places it is more silty and friable. The high lime content in this gray layer is a characteristic of the type. This material is the Wisconsin glacial drift but little modified by weathering and leaching. The soils of the Clarion series have been produced by weathering where conditions were favorable for a relatively rapid removal of the surface soil, so that the leached and weathered portions lying over the calcareous grayish till is shallow. The surface soil has a darker color than the typical Carrington soils, being nearer black than dark brown. The upper subsoils are apparently similar in the two series, but the lower subsoil of the Clarion, with its gray color and large proportion of lime, differs from the Carrington in composition and must eventually show a difference in productivity. Gravel and bowlders are found over the surface and throughout the soil section, but these constitute only a small proportion of the soil mass.

The Clarion loam occurs on slopes bordering on flat areas of Carrington loam, but does not extend over steep slopes where excessive erosion has exposed sandy and gravelly drift.

The type occurs in all parts of the county in association with the Carrington loam. It usually occurs as an irregular and discontinuous border around the larger areas of Carrington loam. This type by reason of its topographic position has good natural drainage and in this respect it has a slight advantage over the Carrington loam.

There is no marked difference in the present productiveness of this soil and of the Carrington loam. The Clarion loam, however, being less leached, has a greater reserve of soluble plant food upon which to draw and naturally is to be considered the stronger soil and one that will maintain its productiveness under continuous cultivation for long periods.

The methods to be employed for maintaining and improving the productiveness of this soil should be similar to those suggested for the Webster loam and the Carrington loam.

MIAMI SILT LOAM.

The Miami silt loam consists of about 12 inches of light-brown to grayish, compact silt loam underlain to a depth of about 20 inches by a grayish, compact silt loam which grades rather abruptly into a

dull-brown or brownish-yellow, compact clay loam subsoil. The surface soil when dry is rather coarsely granular and light gray in color, owing to the lack of organic matter. In some cases the first 2 or 3 inches is quite dark, but this is directly underlain by a light-gray silt. The entire 3-foot section is acid to litmus. Below this depth there is a light-yellow, calcareous till which contains much stony material.

All this type was formerly forested, but much of it has been cleared and is now under cultivation. It is confined to narrow strips of upland bordering the bluffs and steep slopes of Boone River, and its outer boundary marks the edge of the forest. It grades into the adjoining Webster or Carrington loam, and no sharp boundary line can be drawn.

The Miami silt loam is well drained and has a good tilth except that in dry weather it becomes compact and hard. It is naturally earlier than the black prairie types and is perhaps better suited to small grain. Corn does not produce as large yields, but the type generally matures earlier and sounder corn. Corn is subject to some injury from drought, as this soil is not quite so retentive of moisture as the prairie types. Clover does well, though perhaps not as well as on the black prairie types. This is undoubtedly due to the high acid condition of the soil and subsoil. Crop yields are hard to estimate accurately owing to the small extent and scattered acreage of the type.

The Miami silt loam is in need of organic matter, and frequent seeding to clover, the occasional plowing under of the crop, and heavy applications of manure are necessary to add the necessary supply of nitrogen. The acid condition of the soil to a depth of 3 or 4 feet also will need remedying in time, if not at present. Applications of burnt lime or crushed limestone will correct the acid condition and improve the soil for the growing of clover and other lime-loving crops.

WEBSTER LOAM.

The Webster loam consists of about 14 inches of black, mellow, heavy loam, underlain by a black to dark-drab clay loam which passes at about 22 inches into gray, drab, and greenish-yellow or greenish-drab, plastic clay, sometimes mottled with iron stains. The surface soil contains a relatively high percentage of silt and approaches a silty clay loam in some places. The intense black color and the depth to which it extends indicate a high organic content. The surface soil is alkaline to litmus, and the subsoil is strongly calcareous, containing lime, limestone pebbles, and marl nodules nearly everywhere. The subsoil clay is somewhat impervious and compact, but the sand particles increase in size and quantity below the 3-foot

level. At a depth of 5 feet drab and yellow, mottled drift material is encountered.

Like the Webster clay loam, this type occurs wherever the upland is flat and poorly drained. Where the topography shows a slight relief and there is some drainage development, the soil becomes lighter colored and coarser, the subsoil is less compact and has less gray color, being more greenish yellow mottled with drab. The material shows more oxidation and contains less lime, and approaches in character the surrounding Carrington subsoils. These series merge into each other so gradually that their separation in mapping is sometimes very difficult.

The Webster loam is most typical in areas around Highview and southwest of Webster City, west and northeast of Randall, and stretching from east of Ellsworth to the west and north of Williams. It occupies level plains and is naturally poorly drained, but ditches have been dredged through it and lateral tile drains laid over most of its extent.

This is the most extensive soil in Hamilton County. All of it is in farms, which include very little waste land. The type comprises some of the most valuable land in the county, its selling value ranging from \$200 to \$250 an acre.

This type, owing to its heavy texture and high organic-matter content, is better suited to corn than oats. Both crops, however, do well, ordinarily yielding corn about 50 bushels per acre and oats about 45 bushels. Timothy and clover give good yields of hay, clover yielding especially well on this calcareous soil. The yield averages about $1\frac{1}{2}$ tons per acre. The soil holds moisture well and crops are more likely to be damaged by excessive moisture than by drought, which never causes serious damage. Crops generally mature later than on the Carrington soils.

Probably the greatest need of this soil at present is efficient drainage. Obtaining an outlet is the first consideration. Dredged ditches not only should be deep enough to give the drain tile the proper fall, but they should have good fall themselves so as not to cause back-water. This has not always been insisted upon. In many places the main tile carrying water to the dredged ditch is too small and can not carry the excess water which sometimes comes to it from long distances. More frequently the lateral branches of the drainage system are too far apart for efficient drainage. The subsoil of this type is rather heavy and water does not percolate through as easily as in the areas of Carrington soil, consequently tile drains do not draw water from as great distances. Experience has shown that laterals not more than 4 rods apart are necessary for efficient drainage. As there is little run-off, the systems should be ample to take care of the heaviest rainfalls.

Most of this type has been devoted to corn and oats alternately since the county was first settled, and it is only during the last few years that much of it has been seeded down to timothy and clover. The type should be seeded to some legume, preferably clover or alfalfa, more extensively than at present, to maintain the natural productiveness. Alfalfa should do well where the soil is well drained, in view of the high lime content. Some system of rotation should be practiced. One including two years corn, one year of either oats, wheat, or barley, and one year of clover has been suggested. Alfalfa may be grown instead of clover, but this would make a longer rotation advisable. With a good stand alfalfa should be left for at least 5 years. Systematic rotations are not always practicable on this type, but it is possible and highly necessary to get the land seeded down to clover, alfalfa, or timothy every 4 or 5 years.

Fall plowing is to be highly recommended on this soil, as it is difficult to work into a good seed bed if plowed in the spring when wet. In this condition it tends to puddle and bake, while if it is plowed in the fall it can be worked into a granular condition in the spring. Deep fall plowing tends to improve the physical condition of the soil and causes it to warm up earlier in the spring. It also aids in the control of injurious insects such as the wireworm and cutworm. With proper rotation of crops and the raising of live stock, the productiveness of this soil should be easily maintained without resorting to commercial fertilizer.

WEBSTER CLAY LOAM.

The Webster clay loam consists of about 12 inches of black clay loam, which is rather crumbly and granular in structure for the first 4 inches. Below 12 inches the material grades into a black, fine-grained, plastic clay, resting at about 22 inches on a dark-drab, plastic clay, which in turn at 28 inches grades into a drab or gray, heavy, plastic clay. The lower subsoil contains considerable coarse sand and gravel, and between 5 and 6 feet passes into mottled drab and yellow drift material.

The subsoil, which contains a large quantity of limestone gravel, marl nodules, and lime concretions, is highly calcareous. Its heavy texture has retarded leaching, and the lime has consequently accumulated in this relatively impervious horizon. Scattered limestone pebbles and whitened shells of mollusk are also usually present on the surface. The content of organic matter is very large as is indicated by the depth of material of rich, black color. The surface soil also contains considerable lime carbonate, giving a strong reaction with acid.

The type as mapped is quite uniform, but there are some slight variations. The depth of the black soil, for instance, varies from

about 22 inches to as much as 3 feet. The type also includes some areas, too small to map, of plastic, tenacious clay soil, which the farmers call gumbo. Another variation, occupying long sloughs or filled-in valleys in secs. 31 and 32 of Williams Township, sec. 5 of Liberty Township, and secs. 9, 10, 15, 23, and 24 of Clear Lake Township, has a gravelly substratum several feet thick, the upper surface of which lies just within reach of the 3-foot soil auger. Like the subsoil this substratum contains much lime. It causes good under-drainage, but these areas are not subject to drought, because of the surplus moisture naturally present in situations where this development occurs. The surface soil here is not so heavy in texture as typical, being almost a loam in places.

The Webster clay loam occupies low-lying, poorly drained areas and is closely associated with the Webster, Clarion, and Carrington loams. The larger bodies occupy what were in the earlier days large sloughs, more or less connected as overflow drainage lines. A few of the largest bodies are the beds of former lakes, such as Clear Lake Township and the large area west of Randall. Small circular or oval-shaped bodies representing former ponds, some too small to map, are scattered over the county.

The flat, poorly drained surface is largely responsible for the chemical and physical characteristics of this soil. It lies not more than 15 to 20 feet below the upland and generally much less, but doubtless it has received considerable silt and clay washed in from the surrounding uplands, giving rise to a more plastic and tenacious subsoil. The poor drainage has also been favorable for the accumulation of organic matter.

Formerly these areas were too wet for cultivation and were used for pasture and wild-hay production, but in the last 15 years, since land values became so high, considerable artificial drainage has been done and at present most of the areas are more or less efficiently drained.

This is one of the three most important types of the county. It is stronger and more durable than any other type in the county, when properly drained. The heavier textured areas require more extensive drainage systems than the Webster loam. Satisfactory plowing is more difficult, as the soil tends to puddle and bake. Deep fall plowing should be done whenever possible, but the soil should never be plowed when wet. Even where handled carefully the surface often cracks during droughts, causing some injury to corn roots.

Corn produces slightly heavier yields on this type than on the loam, but matures more slowly so that selection of short-season varieties is more important on the latter soil. Oats give a larger yield of both straw and grain, but because of lodging much of the grain may be

lost in harvesting. The Iowa Agricultural Experiment Station has developed two nonlodging strains of early oats, the "Iowa 103," a white oat, and the "Iowa 105," a yellow oat, to meet this soil condition. Both varieties were developed from the Kherson oat and give very good yields.

The recommendations made for improvement of the Webster loam apply equally well to the Webster clay loam.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Webster clay loam:

Mechanical analyses of Webster clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
331904.....	Soil.....	0.3	4.5	3.3	17.9	7.2	43.6	23.2
331905.....	Subsoil.....	.4	4.0	3.0	17.7	9.0	41.5	24.5
331906.....	Lower subsoil...	1.4	5.4	3.3	13.4	13.0	39.5	24.0

ROGERS SILT LOAM.

The Rogers silt loam, locally called Muck, occurs in one area, which occupies the basin of what was originally Mud Lake. The surface soil to an average depth of 18 inches is a gray silt loam, high in organic matter and containing a high percentage of soluble salts, which in many places effloresces as a white deposit on the surface. The soil also carries many small mollusk shells. The subsoil is a gray silt loam also containing much finer divided organic matter, the quantity being sufficient to give the mass a spongy consistency. Like the surface soil it contains a large amount of lime carbonate and other soluble salts. The material extends to a depth of 8 to 10 feet without great change. Gravel and till usually underlie the lacustrine deposit.

The area occupied by this type is a wide hummocky flat. The ground is soft, yielding, and spongy. The unused land supports a luxuriant growth of giant ragweed. The type has been partly drained by dredged ditches which have existed for 8 or 10 years, but the growing of crops has not been successful. The soil is too high in soluble salts and too poorly drained for good results, but it apparently could be used for pasture or hay land.

WAUKESHA LOAM.

The Waukesha loam is characterized by about 12 inches of dark-brown to black, friable, crumbly loam underlain by a lighter colored loam to an average depth of 20 inches. This grades into a light-brown, unconsolidated, coarse loam which extends below the 3-foot section. The subsoil material contains some gravel, and the content

usually increases with depth. The soil is lighter textured and more open than any of the upland loams. It contains a fair amount of organic matter and is acid to litmus paper.

In some places the subsoil contains limestone particles ranging from sand to pebbles in size, but it is not everywhere alkaline in reaction.

The Waukesha loam occupies narrow terraces lying 50 to 80 feet above Boone River. The areas are usually not over one-half mile in width and never more than 3 miles long. The topography is level to gently undulating. The type has good natural drainage.

This soil is friable and easily tilled. It is fairly free from stones or boulders, and practically all of it is under cultivation. It is an early soil, as its open structure promotes good drainage and aeration. Crops do well on this soil, though subject to injury from drought. In years of well-distributed rainfall the yields are about the same as on the Carrington loam.

HANCOCK VERY FINE SANDY LOAM.

The Hancock very fine sandy loam consists of 16 to 18 inches of black, brown, or dark-gray, mellow very fine sandy loam, underlain by dull-brown or grayish very fine sandy loam. Usually the grayish stratum lies below the 3-foot section, and quite generally the brown or black color extends downward to 36 inches. The texture as a rule differs little throughout the 3-foot section, but the type as mapped is not always uniform in texture, as it contains small bodies of fine sandy loam and loam. In a very few places the subsoil is gravelly, though retentive of moisture.

This soil occupies the lower terraces along Boone River. These consist of narrow, discontinuous plains less than one-half mile wide and 3 miles long, lying 20 to 30 feet above the river level. Part of the type supports a forest growth, but most of it is under cultivation.

This soil is quite productive and easily tilled. Corn seems to be the leading crop, and the yields compare favorably with those obtained on the prairie soils. Oats are probably grown less extensively than on the upland soils. The type is naturally earlier than the Carrington loam.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Hancock very fine sandy loam:

Mechanical analyses of Hancock very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
331921.....	Soil.....	0.0	0.1	0.2	27.4	31.5	32.0	8.6
331922.....	Subsoil.....	.5	1.6	.4	21.5	30.3	35.7	9.9

WABASH LOAM.

The Wabash loam consists of about 10 inches of black, fine-textured loam, underlain by black, heavy, crumbly loam. This becomes heavier with depth and at 20 inches is underlain by a black to dark-drab, stiff, heavy silty clay, very granular when dry. The clay extends to a depth of about 6 feet, and below this to 8 feet there is a stratum of coarse sand and gravelly sand, with patches of rusty-brown sand. This sand is underlain by a blue to light-drab clay or silty clay, containing some gravel.

Along the ditch extending from Jewell and south of the ditch for 1 mile the surface 4 inches of soil is gray or ashy gray and sometimes quite heavy, but the elevation here is slightly lower than farther downstream and the lighter color may be due to more recent deposition. The texture of this type, as is true of all alluvial soils, lacks uniformity, varying from silt loam to sandy loam. Nevertheless material of loam texture predominates.

The Wabash loam occurs in the bottom land of Skunk River and the lower courses of several of its tributaries and also in the bottom land along Squaw Creek. It is a strong, durable soil, rich in plant food, but owing to frequent overflows is used almost entirely for pasture and hay production. A very small proportion of the type might be artificially drained. Much of it in its native state is forested.

PEAT.

Peat consists of brown to black, partly decomposed fibrous vegetable matter. It is loose, porous, and spongy in character and holds an abundance of moisture. The organic deposit ordinarily varies in thickness from 6 to 20 inches, but in some of the larger bodies it has a thickness of 4 to 6 feet. The subsoil is a black or drab, plastic silty clay, overlying unmodified drift. The surface soil is everywhere high in soluble salts. Shells of mollusks are numerous, and the subsoil is rich in lime.

Peat occupies shallow, basinlike areas representing former ponds or lakes in which conditions have been favorable for a rank growth of water-loving plants, such as the rushes, flags, and swamp grasses.

Peat is scattered throughout the county, in areas varying in size from 1 acre to a square mile or more, as in the bed of old Iowa Lake, in Rose Grove Township. In its natural undrained condition this land is nonagricultural, and even after drainage the areas of deep Peat are not especially well adapted to crops other than grasses until the organic matter has had years in which to decay more completely. Timothy seems to be the crop best adapted to this soil, on which the yields are much heavier than on any of the upland types. Flax is sometimes sown on Peat when it is first drained, and it produces a fair crop. The small grains yield well on the better Peat areas pro-

vided the grain ripens before the crop lodges, which is ordinarily the case. Considerable difficulty is experienced in harvesting the crop, however, as the ground will scarcely support such heavy machinery as the binder. Corn does not do well on Peat, at least where the organic soil is over 12 or 14 inches deep, as in that case it is too wet, cold, and late. Early frosts are almost certain to injure corn, and in many places the alkali content is so high as to prevent much growth. On Peat soils less than 1 foot deep good yields of corn are obtained as the roots penetrate through the peaty layer and get mineral plant food from the subsoil. Millet yields well on either shallow or deep Peat, producing 1 to 2 tons per acre.

MUCK.

Muck represents an advanced stage in the decomposition of Peat. It consists of organic matter with which more mineral particles have been mixed. In Muck decomposition has reached a stage where the plant tissues can not be identified. The Muck varies in depth from 6 to 20 inches. It consists of a loose, black, fluffy mass of well-decomposed plant remains, containing considerable mineral matter, the proportion of which increases with depth until the material grades into a plastic, black clay. This in turn changes to a drab, plastic clay in the lower part of the 3-foot section. The surface material is alkaline in reaction and the subsoil is highly calcareous. In some places the soil contains sufficient alkali to injure corn. Muck is distributed over all parts of the county, mainly in small areas. It merges gradually into the surrounding Webster clay loam, and in agricultural adaptation is intermediate between that type and Peat.

MEADOW.

Meadow as mapped in this county includes the nonagricultural land in the Boone River bottoms, consisting of sand bars, sand banks, and riverwash along the old channels in the flood plain. The material is of recent deposition, and is composed of brownish and grayish, loose, incoherent sand and coarse sand. In some places there are alternating strata of sand and clayey or silty material and in some places the sandy material has an overlying layer of 2 to 4 inches of heavy material. Only a few areas of Meadow are mapped.

ALKALI.

The Webster clay loam, Peat, and Muck throughout the county include patches of soil showing a whitish efflorescence which imparts an ashy-gray or dark-gray color to the dry soil. These patches are usually found in swales, ponds, or sloughs that have recently been drained and brought under cultivation. They do not occupy the

bottom of these depressions, but nearly always occur in a belt occupying a zone which corresponds to the area intervening between the high and low water marks of such ponds before they were drained. The belts vary in size from less than 1 acre to 2 or 3 acres, and the average farm of 160 acres may include a half dozen or more such belts.

Their origin is undoubtedly due to the fact that these depressions have continually received the drainage and seepage waters from the surrounding higher land. These carry considerable soluble salts, such as sodium chloride, and as these areas either have no outlet or are very poorly drained at best, the alkali water can only disappear by evaporation, and the salts are thus concentrated and deposited as the water recedes.

Corn seems to be the crop most susceptible to injury from this alkali. In many places the crop produces no grain and only small, sickly looking forage. In many cases the plants in alkali spots die. Small grains are not injured as much as corn. Grasses do quite well, the spots being difficult to locate in grass land, though when the area is cultivated they are easily detected by the whitish cast of the soil and its loose, mellow structure in the upper 4 inches, which prevents the formation of cracks in dry weather.

Of the small grains rye shows very little injury, barley is next in susceptibility, oats third, and wheat next. Red clover, timothy, and broom grass give good yields and are only slightly injured, while alfalfa, sweet clover, and millet seem not to be injured at all. Sugar beets thrive on these spots, giving higher yields than on the other soils of the county.

Drainage seems to be the chief factor in correcting this alkali condition, as it reverses the conditions which deposited the salts. If the areas are efficiently drained the water from heavy rains, which contain no salts, dissolves the alkali salts, and they are carried away through the drainage systems. This process is naturally slow, and applications of any kind of organic matter, which when incorporated into the soil will tend to loosen it, and thus aid in the downward movement of the soil water, facilitates the reclamation.

Farmers realize the value of coarse manure for this purpose and are using it to some extent. Manure also stimulates the plants and makes them less susceptible to injury from the excess of salts. Since the subsoil in these alkali areas is heavy, plastic, and retentive of moisture, close tiling is necessary for efficient drainage.

SUMMARY.

Hamilton County, Iowa, lies just northwest of the central part of the State, in the Mississippi Basin. It comprises a total of 570 square miles or 364,800 acres.

In general, the surface consists of broad, level plains between belts of gently undulating land. There is no marked relief. The elevation varies between 1,100 and 1,200 feet above sea level.

The population of the county as reported in the 1915 State census is 20,514, of which about 71.5 per cent is rural.

The county is entirely drained by the Boone and Skunk Rivers, both being tributaries of the Mississippi. Neither stream has many tributaries, and the area as a whole has poor natural drainage.

The county is well supplied with railroad facilities, which give good communication with many large markets. The wagon roads are well kept and the rural-school facilities are ample.

The mean annual rainfall is 34.55 inches, and the precipitation is well distributed throughout the growing season. The mean annual temperature is about 45° F. There is a normal growing season of about 146 days.

The agriculture of Hamilton County, which is well developed, consists chiefly of the production of grain and hay and the feeding of hogs and cattle. Corn is the leading crop and hog raising the most important live-stock industry.

From 90 to 95 per cent of the county is in improved land, and farm values range from \$175 to \$300 an acre. There are about 2,144 farms in the county, of which about 57 per cent are operated by tenants. The average size of farms is about 179 acres.

Farm hands are paid \$35 to \$45 a month, with board. The supply of labor is usually sufficient at all times, except occasionally during harvest. The farms are equipped with modern machinery, and most of them have large, substantial buildings.

The soils of Hamilton County are derived from glacial drift. They are characterized by a deep, rich black color. Loam soils predominate. Excluding the miscellaneous types of Peat, Muck, and Meadow, the 11 different types of soils in the county are classified into eight series. The soils may be divided into three main divisions, upland soils, terrace soils, and first-bottom soils.

The most important soil type is the Webster loam. This is a deep, black, mellow, silty loam which occupies the broad level divides and interstream areas. It is highly productive and durable, but lacks surface relief and is naturally poorly drained. The Webster clay loam occupies depressions, drainage ways, and sloughs. It is a more productive soil than the loam when drained, but is not quite so easily tilled. Both soils are calcareous.

The soil occupying the more undulating areas, which have good natural drainage, are classed as the Carrington and Clarion loams. The former is characterized by a dark-brown to black, friable sur-

face soil, underlain by a yellow or brownish-yellow subsoil. It is a productive type, but apparently not so durable as the Webster soils. The Clarion soil differs from the Carrington mainly in having a calcareous zone in the subsoil.

The terrace soils are separated into two series, the Waukesha on the higher terraces and the Hancock on the lower terraces. These soils occupy very small areas, and are less productive than the upland soils.

The alluvial soils are relatively of little importance. They are devoted to pasture almost entirely, owing to the frequent overflows.

Peat and Muck, although for the most part occupying small scattered areas, have a considerable total extent. They consist of more or less undecomposed organic matter, and must be drained before they have any agricultural value.

Small areas of alkali soil occur around the former ponds and sloughs. The salt accumulations are injurious to most cultivated crops. They can be reclaimed by drainage and the liberal addition of manure and other organic matter.



[PUBLIC RESOLUTION--No. 9.]

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

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

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

Approved March 14, 1904.

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

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