SOIL SURVEY OF WORTH COUNTY, IOWA

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DESCRIPTION OF THE AREA

Worth County is located in the north-central part of Iowa, on the Minnesota State line, about 130 miles south of the Twin Cities. The county is 24 miles long east and west and nearly 17 miles north and south. It contains 12 townships and has an area of 399 square miles, or 255,360 acres.

On the basis of topography the county may be divided broadly into two parts—the eastern half, characterized by smooth country, and the western half, of somewhat rougher country. Nowhere does the surface become hilly. The western half presents a greater variation in relief than the eastern. It varies from flat or gently undulating to strongly rolling or broken, but is prevailingly gently rolling. The surface of the eastern half ranges from flat to gently undulating.

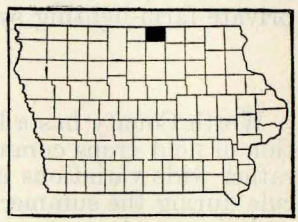

FIG. 8.—Sketch map showing location of the Worth County area, Iowa

Second bottoms or terraces are quite extensively developed along parts of the Shellrock River and Lime Creek. These are broad, relatively flat areas. The largest terrace occurs on both sides of the river, extending from just north of Northwood to below the entrance of Elk Creek into the Shellrock River above Kensett. It is 4 to 5 miles wide and 5 to 7 miles long. Another extensive terrace is in the vicinity of Fertile and Hanlontown.

The northeastern part of the county is drained by Deer Creek, the central part by the Shellrock River, and the southwestern part by Lime Creek and its tributaries.

The elevation of Worth County ranges from 1,050 to 1,300 feet above sea level. Northwood is located on a terrace at an elevation of 1,222 feet.

The farm water supply is obtained from dug or drilled wells, mostly the latter. These are operated by windmills or small stationary engines.

The population of the county in 1920 was 11,630, all of which is classified as rural. The average population per square mile is 29.1 persons. The inhabitants are largely of Norwegian descent.

Railway connections and shipping facilities are good over the entire county. The railroads serving the county are the Chicago, Rock Island & Pacific, Chicago & North Western, Chicago Great Western, Minneapolis & St. Louis, and Chicago, Milwaukee & St. Paul. Some of the outlying districts are within a short distance of towns just outside the county, such as Carpenter in Mitchell County, Plymouth in Cerro Gordo County, Lake Mills in Winnebago County, and Emmons in Minnesota.

Incorporated towns in the county and their populations are: Northwood, the county seat, 1,597; Kensett, 338; Manly, 1,476; Grafton, 233; Joice, 233; Hanlontown, 202; and Fertile, 223. Meltonville and Bolan are smaller places which serve as shipping and trading centers. Manly is a division point on the Rock Island.

The main highways are all well graded and mostly graveled. The side roads are of earth construction and heavy in wet weather, but are dragged and kept in good condition most of the time. The roads follow land lines, except where topographic features make irregularities necessary.

Country schools are maintained at 2-mile intervals through the county. The larger towns afford high-school instruction. Most farms are served by telephone, and many have electric lights from private farm-lighting systems.

CLIMATE

Worth County has a healthful climate well adapted to the production of field crops common to the Corn Belt. It is characterized by rather wide variations in temperature. High temperatures are the rule during the summer months. The winters are cold and moderately long. According to the records of the Weather Bureau station at Northwood, the mean annual temperature is 44.3° F. The average for the summer months is 69.4° F., and for the winter 16.3° F. The highest temperature on record is 97° F. and the lowest is −37° F.

The average growing season is 150 days; that is, the period between the average date for the last killing frost in the spring and average earliest in the fall. These dates are May 5 and October 2, respectively. The latest killing frost on record occurred on June 1, and the earliest in the fall on September 13. The grazing season extends from May into November.

The mean annual precipitation is 33.19 inches. Most of the rainfall comes during the growing season, from May through August. The weather is generally favorable for harvesting. Once in a great while late spring rains interfere with the seeding and care of crops at that time. Hail and wind storms seldom damage crops. Severe droughts are rare, although there may be dry periods in the late summer when crops on soils with sandy or gravelly subsoils are more or less damaged.

The following table, compiled from records of the Weather Bureau station at Northwood, gives the normal monthly, seasonal, and annual temperature and precipitation for the locality:

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

[Elevation, 1,222 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1897)	Total amount for the wettest year (1902)
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*
December	20.0	61	—24	1.24	1.20	2.68
January	12.6	50	—37	1.04	1.50	.80
February	16.3	55	—24	1.32	.80	.77
Winter	16.3	61	—37	3.60	3.50	4.25
March	29.4	80	—19	1.76	1.51	.55
April	46.1	90	13	2.47	2.22	1.26
May	58.4	90	27	5.09	1.53	9.46
Spring	44.6	90	—19	9.32	5.26	11.27
June	66.8	97	32	4.62	5.05	6.96
July	71.9	96	47	3.99	4.31	8.48
August	69.6	95	36	4.04	1.83	5.88
Summer	69.4	97	32	12.65	11.19	21.32
September	61.0	95	26	3.26	2.70	2.55
October	47.7	83	13	2.60	.91	3.11
November	32.0	73	—4	1.76	.30	2.42
Fall	46.9	95	—4	7.62	3.91	8.08
Year	44.3	97	—37	33.19	23.86	44.92

AGRICULTURE

Agriculture has been practically the sole industry of Worth County since its early settlement. The pioneers came in from the East and South about 1850. They settled largely in the vicinity of streams and forests and cultivated small fields, producing sustenance crops. Game was abundant and hunting and trapping were important factors in the life of the settlers.

Agricultural development naturally was slow, as there were no satisfactory means of disposing of crops produced in excess of local consumption. A few cattle were kept to furnish milk and meat. Prior to the coming of the railroads the growth in population was gradual. Wheat was the crop of greatest importance, followed by corn and oats. The native prairie grasses afforded an abundant supply of hay and pasture for cattle. With the building of the railroads came a great development in agriculture and a rapid increase in population. Crops were grown on a larger scale for both local consumption and shipment out of the county.

The early inhabitants did not give much attention to soil management. The soil was naturally fertile and was cropped continuously with corn and small grains. Prairie hay and pasture were plentiful. Rotations and application of manure were not practiced. In later years, however, as farming became more intensive, tame hay and pasture crops were seeded, crops rotated over various fields, and applications of manure made. This resulted from a more diversified farming system which included the raising of beef and dairy cattle and

hogs, as well as the production of crops. There are still many that follow grain farming, although the number who combine grain production and livestock raising is steadily increasing. This dual type is more favorable to the maintenance of the productiveness of the soil. Other factors that favor a continuation of good farming or the improvement of methods are the use of more modern machinery, improved strains and varieties of crops, and a better knowledge of seed-bed preparation and crop management.

The census reports for 1880 show that there were 1,145 farms in the county, of which 82.3 per cent were operated by owners. At this time wheat was the crop of greatest importance, occupying an area of 65,056 acres in 1879. Corn and oats were next in importance, each covering about one-sixth the acreage devoted to wheat. Hay at that time was practically all prairie hay, and covered an area of 19,694 acres. Barley, potatoes, tobacco, rye, buckwheat, sorgo, peas, beans, and flax were minor crops. At this time the population was 7,953.

By 1889 wheat had become a crop of less importance than corn or oats, which had increased in acreage about three times. The area in hay had increased to nearly 51,000 acres. The less important crops held about the same relative position.

The report for 1900 shows a great change from 10 years earlier. Corn had increased to about 38,000 acres, oats, which were then the most extensive crop, covered 64,139 acres, and hay of all kinds about 38,000 acres. The hay did not include much clover, there being only 719 acres seeded that year. Flax was becoming more important, 122,770 bushels being raised on 10,916 acres. Potatoes were grown on 1,278 acres. The percentage of owner-operated farms was steadily decreasing. The percentage of the area in farms and the number of farms had increased.

The census figures for 1910 show a steady increase in the number of farms, acreage of improved land, proportion of tenant farms, and in the various farm expenditures. The cereal crops for 1909 were valued at $1,272,044; hay and forage, $368,698; animals sold and slaughtered, $756,433; dairy products exclusive of home use, $317,589; poultry and eggs, $172,880. The total value of all agricultural products was over $3,000,000. There was an increase in the acreage of corn and a slight decrease for oats, wheat, barley, and potatoes. Although there was a decrease in the acreage of hay, more cultivated grasses were being grown and the total number of tons produced was greater.

From 1909 to 1919 the value of all agricultural products more than doubled, amounting to $6,675,918, exclusive of animals sold and slaughtered. The cereals and the hay and forage crops amounted to over $5,000,000.

Agriculture at the present time consists of raising the various field crops and the breeding and feeding of beef and dairy cattle and hogs.

Corn is at present the crop of greatest importance in the county. In 1919, 1,536,139 bushels were produced on 41,054 acres. The leading varieties are Murdock and Silver King. Other varieties, including Golden Giant, Kossuth County Reliance, and Minnesota No. 13, are grown to a less extent, with some corn of nondescript varieties. Soybeans are sometimes sown with the corn when it is to be hogged down or used as silage. Manchu seems to be the most popular vari-

ety for this purpose, as well as when the beans are grown for hay or seed. Although much of the corn crop is fed to stock on the farm, probably 40 to 50 per cent is sold as a cash crop. Corn is grown on all the cultivable soils of the county.

Oats are important both as feed for farm stock and as a cash crop. In 1919 about 53,000 acres produced nearly 1,500,000 bushels. The chief varieties are Medium Early Yellow, Iowa No. 103 (Albion), Iowa No. 105 (Richland), and some Iowar. These latter-named varieties are coming into more common use because they are shorter strawed and better adapted to the heavier soils, where the longer strawed sorts lodge. Oats are used as a nurse crop for clover or are sown alone. They are sown in April and are ready to harvest in July. Most of the crop is threshed from the shock, but a part is stacked. Oats are ordinarily sown on well-disked corn stubble.

Wheat is grown only to a small extent at the present time. Winter varieties are grown largely, Turkey being the leading variety. Wheat is purely a cash crop. Barley was reported on 2,016 acres in 1919. Some rye also is grown.

Hay is an important crop and consists of a number of kinds, but most of it is timothy or timothy and clover mixed. Over 16,000 acres are reported for the mixture in 1919. It is sown with oats or some other small grain as a nurse crop. Clover alone is grown to a less extent, but is sown in the same manner. Timothy also is sown alone. These crops are sometimes grown for seed. If the seed is well formed clover yields about 1 bushel per acre. Timothy seed sometimes yields as high as 2 bushels per acre. Alfalfa was reported on 46 acres in 1919. It is a crop of high value, yielding much more than either clover or timothy or a mixture of the two. It is receiving more attention and its acreage will undoubtedly be extended. With proper precautions no difficulty is experienced in obtaining a stand. Sweetclover is also a crop recently grown to some extent. It yields well and affords considerable pasturage after a hay crop is taken off. If cut before attaining too rank a growth, the hay is of good quality. It has also been used to good advantage in the reclamation of alkali land. In several cases the plowing under of a good green growth has entirely overcome the harmful effect of the alkali, permitting a successful corn growth. Wild hay is harvested to some extent, but cultivable prairie land is nearly all under plow. Hay is not used as a cash crop, being practically all fed on the farm.

Flax is a crop of some importance, being reported on 1,873 acres in 1919. It is grown chiefly on poorly drained soils broken for the first time or on Muck or Peat. While the average yield is about 10 bushels per acre, many fields yield around 15 bushels. It is purely a cash crop.

Trucking is of some importance in the eastern part of the county on the Carrington silt loam. Onions and potatoes are the leading truck crops. The chief varieties of potatoes are Rural New Yorker, Irish Cobbler, and Early Ohio. Yields vary from 80 to 200 bushels per acre. The main outside market is Mason City. A large part of the crop is sold within the county.

Some sweet corn is grown in the vicinity of Bristol, in the western part of the county. It is sold to the canning factory at Lake Mills,

just over the line in Winnebago County. Country Gentleman is the most popular variety.

Crops of minor importance grown on a small scale are beans, sugar beets, and sorgo. Sugar beets are disposed of at a sugar refinery in Mason City. The crop requires considerable labor but gives good returns. An area of 487 acres is reported for 1919, producing 3,384 tons of beets.

The livestock industry in Worth County is of great importance and goes hand in hand with the production of the staple crops. The total number of cattle in the county on January 1, 1922, was 36,931, of which 22,632 were not kept for milk.[1] Of the beef breeds, the Shorthorn and Hereford are the most popular, although there are some purebred Aberdeen Angus herds in the county. A good many steers are fed each year. It is estimated that from 20 to 30 carloads of western steers are shipped in each year to be fed. The remainder of the feeding stock is picked up here and there in the locality of the feeder. These animals do not usually sell at very high prices, because they lack breeding and uniformity. There is not much "short-feed" stock marketed, most of it being fed five or six months through the winter or from spring to fall.

Dairying is an important industry in Worth County, but the majority of dairy cattle are grade stock. Holstein and Guernsey are the most popular breeds. Interest in purebred stock is increasing and much improvement is expected along this line. The value of dairy products, excluding home use, in 1919 was $777,992. It is estimated that about $600,000 worth of business passes through the cooperative creameries of the county yearly. They are located at Northwood, Manly, Tenold, Grafton, Fertile, Joice, Hanlontown, and at Silverlake, in Hartland Township. Five creameries outside the county also draw trade from within its limits; they are located at Emmons in Minnesota, Deercreek on the State line, St. Ansgar in Mitchell County, Plymouth in Cerro Gordo County, and Lake Mills in Winnebago County. A cow-testing association is in operation in the county, and much interest is being taken in the improvement of the herds. The creameries are having their cream and butter scored monthly by experts from the agricultural college at Ames.

Hogs are raised on every farm to some extent. The most popular breeds are Poland-China and Duroc-Jersey, with some Chester White, Hampshire, and spotted Poland-China. The total number in the county ranges from 40,000 to 60,000. They are fed to weigh 200 to 350 pounds and sold when the market seems best.

Each farm has a flock of poultry, and some flocks are large. The value of poultry and eggs produced in 1919 was reported as $490,718. Culling of flocks has been carried on extensively over the county and is improving the poultry industry to a great extent. Many breeds are represented.

Sheep feeding and breeding is not important, although there are a few flocks in the county, and some farmers ship in a few feeders each year.

Cooperative shipping associations have been formed over most of the county and now serve farmers from the vicinity of Carpenter (in Mitchell County), Bolan, Northwood, Manly, Hanlontown, and

[1] Iowa Year Book of Agriculture, 1921.

Joice. They did considerable business in 1922 and have been a great help to shippers as compared with the old system of selling to local buyers. Four cooperative elevators are in operation in the county. These are located at Joice, Hanlontown, Manly, and Grafton. There are also private grain and stock buyers at all shipping points.

Some of the better farmers practice a rotation of corn–corn–oats–clover. Few of these, however, average more than 15 to 25 acres of clover seeding annually on a quarter section. The growing of clover is confined chiefly to owner-operated farms. Rented farms generally have a small acreage of clover or none at all.

Modern equipment is in common use on practically all farms. One and two bottom sulky plows are used. These are pulled by 3-horse to 5-horse teams or by tractors. The State census for 1921 gives the number of tractors in the county as 247, and more have been put into use since that year. Disks, harrows, and modern planting equipment are in common use. One-row and two-row corn plows are also used and several corn pickers were noted.

Several outside markets are available for the farm products. They include the Twin Cities (St. Paul and Minneapolis), Chicago, Omaha, Kansas City, and Des Moines. Austin, Minn., Mason City, and Waterloo absorb some of the hogs and beef cattle. Grain and other crops are usually shipped to the larger markets. Some crops of minor importance are disposed of locally.

General recognition is given to the fact that the dark-colored, well-drained types with heavy subsoils are the best soils for the production of the common grain and forage crops; also that the crops on soils underlain with gravel at shallow depths are subject to damage in dry seasons. The first-bottom soils are recognized as being fertile but undesirable because of lack of drainage and liability to overflow. The very light textured soils are known to be only moderately productive, but adapted to early maturing truck crops. The areas that are too rough for cultivation are generally utilized as pasture or woodlots.

Corn land is generally plowed in the fall if possible. Where the field is in clover and the last growth is pastured, it is generally plowed the following spring.

Manure is used generally, but is not available in as large quantities as desired. It is usually put on sod and plowed under for corn. In 1920, 31 farmers reported the use of commercial fertilizers at an average cost of $317.23 per farm. Fertilizers are used chiefly on truck crops. Limestone is coming into use.

Farm buildings are good as a rule, the barns sometimes better than the dwellings. A considerable number of farmhouses are equipped with modern heating and lighting systems.

The Federal census reported 1,461 farms in the county in 1920, with an average size of 166 acres. Of these, 57 per cent were operated by owners, 42 per cent by renters, and 1 per cent by managers. Farms are rented mostly on a share basis. Cash rents range from $5 to $12 per acre.

Farm labor is obtained largely from local sources. Some foreign labor is employed during harvesting periods. This is supplied from the Twin Cities or Des Moines. Wages range from $30 to $45 per month, or $2 to $3.50 per day.

Land values vary with the type of soil and the location. The prices range from $50 or less to $250 or more an acre. The average price of 445 sales made from January, 1920, to June, 1922, was $172.43 an acre. The average value of land the county over would be about $155 to $160 an acre.

SOILS

The soils of Worth County have been differentiated in this report into a number of series and types on the basis of their physical characteristics and their chemical constituents as far as these could be readily ascertained in the field. The characteristics of the soils of any region are determined first by the character of the parent material, and second by the processes of soil formation, including weathering, leaching, aeration, and oxidation, to which the soils have been subjected during their development. The soil-forming processes, which are controlled to a large extent by climatic conditions, have been of greater influence in fixing the present character of the soils in this area than the composition of the parent rock.

Worth County lies in the prairie region of the United States, where a temperate climate, smooth topography, and moderately plentiful supply of moisture have favored a luxuriant growth of grasses and prevented the spread of forest. Century after century of this condition has resulted in a large accumulation of organic matter in the soil through the decay of grass roots. On relatively small areas of greater relief, where surface and subsoil drainage were more efficient, a forest growth had established itself. The soils of such forested areas have not accumulated any large quantities of organic matter and have a light-colored surface layer. The soils of the area may therefore be separated on the basis of their most obvious characteristics into dark-colored and light-colored soils.

The dark-colored soils of the area fall into two major groups whose differentiation is based on characteristics produced by drainage conditions of either soil or subsoil, or both, during their development; and each of these groups may be subdivided with reference to the extent to which leaching has advanced, as expressed by the amount of lime carbonate remaining within the surface 3 feet.

The soils of one of these groups, of which the Carrington series is representative, were developed under conditions of good soil and subsoil drainage. In the typical profile there is a surface layer of dark-brown to almost black color and granular structure, ranging from 8 to 14 inches in thickness. This is underlain by a brown horizon, lighter in color than the surface, somewhat granular in structure, and ranging in thickness from a thin layer to 12 inches. Below this the material is brown to yellowish brown, is heavier in texture than the two upper layers, and is friable and coarsely granular in structure. This layer gives way to the parent material at depths of 30 to 60 inches. The carbonates as a rule have been removed to a depth of several feet. This group includes, besides the Carrington soils, members of the Dickinson series on the upland and of the Waukesha and O'Neill series on the high terraces. The Clarion, Pierce, and Dodgeville series are similar to the group described in their surface soils and upper subsoils, but the lime of the parent material is present within 3 feet of the surface in sufficient quantities to cause effervescence

when treated with acid. These soils are young, that is, they have not reached the stage of weathering which may be regarded as mature for this climatic belt.

The soils of the second group, which were developed under conditions of poor drainage, have a surface layer of black color and normally well-defined finely granular structure. This is generally underlain by a gray or mottled gray, yellow, and brown subsoil, heavier in texture than the surface. The details of the profiles of these soils vary considerably, depending upon the depth to which good drainage and oxidation have extended. In some cases both soil and subsoil have developed under cover of water or at least a predominantly wet condition. Weathering under such conditions has produced the Clyde, Bremer, and Wabash series, which have been leached of the greater part of their carbonates within the surface 3 feet, and the Webster, Benoit, Lamoure, and Sogn series, which contain sufficient carbonates to effervesce when treated with acid. The Floyd series has developed on a flat or very gently rolling upland, where the soil has been fairly well drained but the deeper subsoil has been frequently wet, resulting in a slight mottling in the lower subsoil. This series may be regarded as being in an intermediate stage of development between the well-drained soils represented by the Carrington series and the poorly drained group represented by the Clyde series.

The areas of light-colored soils are very nearly coextensive with the area covered by forest when the country was first settled. These soils therefore owe their principal characteristics to their development under a forest growth. The soil profile has a surface layer varying in depth from 3 to 8 inches, having a gray or grayish-brown color and a silty floury structure. This is underlain by coarsely granular, heavy material extending to depths of 2 to 3 feet. Below this the texture is lighter and the structure less compact. The light-colored soils in this area have been classed with the Lindley series.

The principal characteristics mentioned above have been imparted to the soils by the great soil-forming processes, and no account has been taken of the characteristics due to the composition and the processes of accumulation of the mineral matter from which the soils have been developed. In the following pages the differentiation into series has included a consideration of the source of the upland material.

With exception of the small areas of residual soils, the upland soils of Worth County have developed over glacial deposits that make up a part of the débris left by two continental ice sheets. The invasions of these glaciers were separated by long periods of time and the material carried by them differed in composition. The upper and more recently deposited drift sheet, known as the Wisconsin drift, covers the western half of the county. The surface, with its rolling topography, with many knobs and depressions, shows the morainic character of this material. The newness of this drift is expressed in the calcareous nature of the soils where the topography was not favorable to exceptionally rapid leaching. Over large areas the lime has been removed by leaching to depths of 12 to 20 inches below the surface, but the upper and lower subsoils contain lime in sufficient amounts to effervesce with acid, and in many places contain masses of lime-rock flour or fragments of limestone. The Clarion and the Pierce series are derived from this calcareous drift.

The Iowan drift is exposed over a broad even drift plain characterized by a smooth, undulating surface, with occasional flat, poorly drained areas. This material was probably less calcareous originally than the Wisconsin drift, and in addition has been subject to leaching for a greater period of time, so that the soils now contain much less lime carbonate than the soils developed over the younger drift. In only a few places is sufficient lime present to effervesce with acid.

Glacial bowlders of varying size occur on the surface and in the soil over the entire drift-covered part of the county. They range in size from a few inches to several feet in diameter, but those of small size are most numerous.

The indurated rock strata which underlie the drift are exposed in only a few comparatively small areas in the stream valleys. These exposures are mainly of Devonian limestone, which weathers rapidly into a dark-colored soil. The Dodgeville and Sogn soil series have been developed on limestone.

The deposits which form the oldest alluvial or terrace soils were laid down when the Shellrock River and larger creeks served as courses for the immense volume of water released by the melting and receding glacier. Since that time the volume of water carried by the streams has been comparable with the flow at the present time. With this great decrease in the volume of water the streams have cut their way to the present lower level into new, narrower channels, 5 to 15 or 20 feet below the level of the original alluvium. The Waukesha and O'Neill series on the high terraces have developed profiles similar in their principal features to those of the well-drained upland soils. The Benoit and Bremer series of the terraces have been developed under conditions of restricted drainage and have mottled subsoils.

First-bottom or recent-alluvial soils occur along streams or occasionally in depressed upland areas, and are subject to periodic inundation at times of high water. They are composed of material carried down from the uplands, reworked, and assorted by the streams and deposited on their flood plains. The first-bottom soils are classed with the Wabash, Lamoure, and Cass series.

Thus the soil materials of the county, as modified by weathering either in place or after erosion and sedimentation, have given rise to a number of types of soil. These soils are classed into series on the basis of color, origin, and structural characteristics, and the series are divided into soil types on the basis of texture. Brief descriptions of the several series represented in the county follow.

The surface soils of the Carrington series are dark brown or very dark brown to nearly black. They are underlain by a lighter brown to yellowish-brown or yellow subsoil, lighter in color at lower depths. The subsoil is heavier than the surface soils, ranging from a silt loam to silty clay or clay. The topography is gently rolling to rolling or strongly rolling. The sandy loam, silt loam, and the loam, with a rolling phase, are mapped in Worth County.

The Clarion soils differ from the Carrington in that they contain sufficient lime to effervesce with acid. The presence of this lime as limestone pebbles, rock fragments, and lime-rock flour gives the subsoil a whitish cast. Natural drainage is good. The loam and a rolling phase of the loam occur in the county.

The Lindley series is characterized by gray or grayish-brown surface soils over a grayish-yellow, smooth and silty upper subsoil. The lower subsoil is clay loam to clay of brown or yellowish-brown color. Coarse sand and occasional rocks or pebbles occur through the soil profile and over the surface. The series is derived from drift weathered under a forest vegetation. The loam and silt loam are mapped.

The Pierce series includes types with dark-colored shallow surface soils, underlain by beds of unassorted sand, gravel, and larger stones.

The Dickinson series differs from the Carrington series in that the subsoil below 18 to 26 inches is composed of sand and gravel. The loam and sandy loam are mapped.

The surface soils of the types included in the Floyd series are black or nearly black, and underlain by a gray upper subsoil, heavier in texture than the surface soils. The upper subsoil resembles that of the Carrington series, being yellowish brown, but the lower subsoil is faintly mottled or stained with iron. The silt loam type of this series is mapped.

The Dodgeville silt loam is a residual soil derived from limestone. The surface soil is dark brown to very dark brown, and overlies a brown silty upper subsoil. The lower subsoil is a yellowish-brown or yellow heavy silt loam to silty clay or clay. In places it is stiff and waxy just above the bedrock. The topography is gently rolling and natural drainage is good.

The types of the Webster series are characterized by deep surface soils of very dark brown or nearly black color. The subsoil is gray, or mottled gray, brown, and yellow and is calcareous. It is heavier textured than the surface soils, ranging from silty clay to clay. The Webster soils are derived from calcareous drift, weathered under conditions of poor drainage. The surface is slightly undulating to flat or depressed. The clay loam, silt loam, and loam occur in the county.

The types of the Clyde series are very similar to the Webster soils, except that they are not so highly calcareous. They are formed by the weathering of drift under poor conditions of drainage and have deep, black surface soils, underlain by a heavy, gray, drab, or mottled gray, brown, and yellow subsoil. The silt loam was mapped.

The Sogn series is represented in Worth County by a somewhat variable soil which has been formed mainly from limestone material weathered under poor drainage conditions. The surface soil is black and overlies a heavier subsoil of gray, brown, and yellow color, which is calcareous in the lower inch or two of the profile. Bedrock is encountered at depths varying from 18 to 40 inches. A poorly drained phase of the silt loam is mapped.

The types of the Waukesha series are very dark brown in the surface soil and have a brown to yellowish-brown or yellow subsoil, heavier in texture than the surface soil. They are developed on flat terraces and have good natural drainage. The silt loam is mapped.

The soils of the O'Neill series are dark brown. The upper subsoil is yellowish and silty or loamy and the lower subsoil consists of loose, incoherent, stratified sand or gravel, or both. Drainage is excessive and the soils droughty except in years of large rainfall. The series occurs on terraces lying 5 to 20 feet above overflow. The sandy loam and the loam, with a deep phase, occur in the county.

The Bremer soils are black in color and overlie a drab or gray, or a mottled gray, brown, and yellow subsoil of silty clay to clay texture. They are alluvial soils occurring on flat terraces and have fair to deficient drainage. The silt loam is mapped in this survey.

The types of the Benoit series are characterized by a black surface soil and a drab clay upper subsoil, which grades into coarse sand at about 26 inches. These soils are developed on terraces lying 10 to 25 feet above overflow. Natural drainage is generally deficient.

The types of the Cass series are black or very dark brown in the surface soil, with a gray or gray and brown upper subsoil grading into loose, incoherent sand at 18 to 28 inches. The silt loam of this series is mapped in Worth County.

The types of the Wabash series have dark-brown to black surface soils, the dark color in many cases extending below the 3-foot section. The subsoil is gray to drab, heavy silty clay to clay loam. Iron stains are present in the lower part and in the poorly drained areas are present in both surface and subsoil. The Wabash soils occupy first-bottom positions and are subject to frequent overflow. Drainage is usually poor. Only the silt loam of this series is developed in the present survey.

The Lamoure soils are identical with those of the Wabash series, except that they are calcareous. The silt loam only is mapped.

Peat and Muck represent organic deposits in different stages of decomposition. In Peat the material is only partly decomposed, traces of the original structure of the plants from which it is derived being clearly discernible. Muck is black in color and smooth in texture. It is organic matter in a much more advanced stage of decay than is Peat. Both these soils occur rather extensively in Worth County.

The following table gives the name and actual and relative extent of the several soils mapped in Worth County. The distribution of these soils is shown on the accompanying map by means of colors:

Areas of different soils

Soil	Acres	Per cent	Soil	Acres	Per cent
Carrington silt loam	58,112	22.8	Bremer silt loam	3,584	1.4
Carrington loam	45,888	21.4	Webster loam	3,392	1.3
Rolling phase	8,768		Waukesha silt loam	2,816	1.1
Clarion loam	20,480	14.0	Dickinson sandy loam	2.304	.9
Rolling phase	15.296		Sogn silt loam, poorly drained phase	1,792	.7
Clyde silt loam	19,328	7.6	Dickinson loam	1,728	.7
O'Neill loam	7,616	7.5	Lindley silt loam	1,216	.5
Deep phase	11,456		Pierce sandy loam	960	.4
Webster silt loam	7,744	3.0	O'Neill sandy loam	896	.4
Lindley loam	7,232	2.8	Carrington sandy loam	896	.4
Muck	7,168	2.8	Webster clay loam	832	.3
Wabash silt loam	5,760	2.2	Cass silt loam	704	.3
Peat	5,696	2.2	Dodgeville silt loam	640	.3
Floyd silt loam	4.992	1.9			
Lamoure silt loam	4,096	1.6	Total	255,360	
Benoit silt loam	3,968	1.5			

CARRINGTON SANDY LOAM

The surface soil of the Carrington sandy loam is a dark-brown sandy loam, 10 inches deep. The subsoil to 20 inches is a brown or yellowish-brown sandy loam, and the lower subsoil to 36 inches is a yellowish-brown to yellow sandy loam to sandy clay or clayey sand.

The topography of the Carrington sandy loam is gently rolling to rolling, and natural drainage is good. In some places where stronger relief is shown the surface soil contains less organic matter and has a brown or grayish-brown color. In such areas drainage is likely to be excessive.

The type is not extensive in the county. The largest area comprises parts of sections 7, 8, 17, and 18 of Barton Township. The next largest area is in sections 32 and 33 of Fertile Township. Except for these two areas, the type occurs only in disconnected bodies of little importance.

This soil has a lower value than the Carrington loam. Its chief needs are organic matter in the form of barnyard and green manure, and a legume in the rotation. The soil is lower in nitrogen than the loam and silt loam of the same series. Manure will add phosphorus also, in which the soil is low. These means of improvement also will increase the water-holding capacity of the soil. Some of the lower lying areas rising out of the Carrington silt loam in the eastern part of the county are much more desirable than the average of the type.

CARRINGTON LOAM

The surface soil of the Carrington loam is a dark-brown to very dark-brown mellow loam, with an average depth of 12 inches. This is underlain to about 20 inches by a lighter brown silty loam to silt loam containing noticeable quantities of sand. The lower subsoil, to 36 inches, is a still lighter brown to yellow, heavy silt loam to silty clay or clay loam, containing a slight admixture of sand and fragments of rock or gravel, but not in quantities sufficient to modify perceptibly the heavy texture or the water-holding capacity of the soil. The subsoil is variable with respect to the presence of sand and rock or gravel, but the predominating texture is heavy. Occasional bowlders occur in the surface or within the soil section. In many places these have been removed from cultivated fields.

The soil is relatively high in organic matter, which has given it its prevailingly dark color. It is naturally a prairie soil, although it now supports more trees than the silt loam of the series. Some variations in color and depth of surface soil are found on hills and slopes, but the areas occupied by such departures from type are of small extent. The variations consist essentially of a thinner and slightly lighter colored surface soil on the ridges and points of hills and a deeper soil of more silty texture on the lower slopes. Another variation consists of patches having a rather open subsoil, which are too small and irregular to be shown on a map of the scale used in this survey. This variation is confined to a strip running north and south through the west-central part of the county, particularly following a high ridge a couple of miles east of Joice.

A variation occurring in Hartland, east Silver Lake, and most of Brookfield Townships consists of the presence of small "pot-hole" areas within the type, rather than a variation of the Carrington loam itself. These areas are in few places large enough to map. The soils in these spots are largely Clyde silt loam, Muck, Peat, or a soil of the Webster series. They are naturally poorly drained and in some places the areas are shown by swamp symbol.

The topography of the Carrington loam is gently to moderately rolling. Natural drainage is good. The type is most extensively developed in a north-and-south strip through the west-central part of the county, extending to within a mile or two of the southern county line. In the eastern half of the county the type occurs in small areas associated with the Carrington silt loam.

This type is largely under cultivation, but not to the same extent as the silt loam. Corn, small grains, hay, and forage are the most important crops. Corn yields from 30 to 60 bushels or more, with an average of 45 bushels. Slight variations in the type may account for some of the lower yields; representative areas are capable of yielding 55 to 60 bushels in normal years under good soil management. Many farmers obtain yields as high as 70 to 80 bushels per acre, where special care has been taken to maintain the soil in good productive condition. The type as a whole probably yields a little less than the Carrington silt loam. Silver King is a popular variety of corn, but more of the yellow kinds are grown than the white. Oats yield 38 to 45 bushels on an average but may go much higher. Medium Early Yellow is the most popular oat variety, with some Early Champion and other varieties.

Clover is somewhat variable in yield, which ranges from 1 ton to as much as 3 tons per acre, depending on the season, stand, and other factors. Clover is usually sown with timothy. The nurse crop should be early maturing or removed early enough to permit as much growth of the clover as possible before winter. In many cases liming would result in better stands. Many farmers on this and other types of soil report increased yields of the succeeding grain crops, when a good clover stand is obtained and a part of the crop is used to improve the soil. Whenever practicable the second growth is plowed under. In some cases the second growth is pastured and the remaining growth and manure plowed under, or it is all cut for hay. The best practice is to plow under as much of the second growth as possible.

The better farmers on the type follow a 4-year rotation consisting of corn two years, and one year each of oats and clover, or a slight modification whereby somewhat less than 25 per cent of the cultivable land is in clover.

Sweetclover, although not extensively grown as yet, is meeting with greater favor each year. It affords considerable good pasturage as well as hay and yields more than the medium red variety. Little alfalfa has been grown on this type to the present time, though it has done well where good stands have been obtained. It is very desirable to include some kind of leguminous crop in the rotation because of its beneficial effects on the soil and succeeding crops.

Improvement of this type may be accomplished largely by the use of a legume in the rotation, liming where necessary, the application of farm manures in as large quantities as practicable, the tiling of swales and poorly drained spots, incorporation of crop residues, and more thorough seed-bed preparation.

Many farms are composed wholly of the Carrington loam. Although prices vary with improvements, state of cultivation, location, and other factors, they range ordinarily between $150 and $250 an acre.

Carrington loam, rolling phase.—The surface soil of the rolling phase of the Carrington loam consists of 8 to 11 inches of dark-brown loam. The subsoil to about 18 inches is a brown loam to silt loam, below which to 36 inches is a yellowish-brown to yellowish silt loam to silty clay or clay containing gritty material and an occasional rock fragment or gravel.

This soil is generally a little lighter colored than the typical soil and has a more strongly rolling topography, which in some cases is even broken. On ridges and points of slopes the surface soil is lighter colored and shallower than typical. Some areas of this phase may include small bodies of the typical Carrington loam, but these are of small size and so interlaced that they could not be shown separately.

The rolling phase occurs in areas of varying size over the central-western part of the county, but especially about Silver Lake and intermittently northeast of the lake along the county line as far east as Goose Creek. It is developed also along Elk Creek, east and a little south of Joice, and northwest of Fertile.

The natural drainage is good to excessive. Methods of management should have in view an improvement of the water-holding capacity of the soil. Crop yields are lower than on the typical Carrington loam. Corn ranges from 25 to 50 bushels, averaging 32 to 38. Yields of 60 bushels have been obtained on well-managed fields. Oats yield 25 to 50 bushels, with higher yields reported on some areas. Clover yields 1 to 2 tons per acre. Remarkable increases in the yields of crops following clover, with second growth turned under, are reported.

Erosion is destructive on the phase where it is particularly rough, and such areas should be kept in permanent pasture. Cultivated fields should be handled carefully, plowing and cultivating along contours, so that gullying and washing may be kept in check. The phase is a little earlier than the typical soil but is generally less productive. Its chief needs are nitrogen and organic matter. It can best be improved by plowing under manures and crop residues, and green-manuring crops.

Although this soil seems to be less desirable, lower priced, and less salable than the typical Carrington loam, a great many of the farms composed of it are well improved and apparently successful. The soil responds well to proper treatment and profitable yields of the common crops are obtained by good management.

Land of this type is held at $90 to $175 an acre.

CARRINGTON SILT LOAM

The surface soil of the Carrington silt loam consists of 12 to 15 inches of dark-brown to dark grayish brown silt loam. The upper subsoil to about 24 inches is a grayish-brown or brown heavy silt loam to silty clay loam. The lower subsoil to 36 inches is a yellowish-brown to yellow silt to silty clay or clay. Iron stains occur in the lower few inches of the profile, although in places they may be entirely absent. The subsoil has a somewhat crumbly structure, with a moderate degree of compactness, but is not impervious. Capillarity and aeration are good.

Variations from the cross section just described occur locally over the type. In a few areas in the southeastern part of the county the

surface soil is not over 10 inches deep, and the subsoil has a uniform buff color to the 3-foot depth. The soil is typical in every other respect, differing only in the slightly shallower surface soil and color of subsoil. An area of this variation lies at the crossroads 3 miles east of Manly. In some of the type with relatively smooth topography the surface soil may be 16 or 17 inches deep, with a brown or yellowish-brown subsoil, mottled yellow and brown in the lower depths. In places in this variation the lower subsoil is heavier than typical and natural drainage may be slightly deficient in wet years. Another local difference is found where the subsoil below 30 inches is a yellow sand, which may extend downward for a depth of several feet or may consist of a layer a few inches to a foot thick. This variation is confined to areas a few feet to possibly several hundred feet across. It results in better drainage, making the soil a little earlier, and does not in any known case make the soil droughty or less productive.

The topography of the Carrington silt loam varies from undulating to moderately rolling, but is mainly gently rolling. The most western body of the type, which lies along the southern county line and extends north for 2 or 3 miles, probably shows more relief than any other part of the type in the county, but it is only rolling or gently rolling. In this locality it was somewhat difficult to draw the boundary between the silt loam and loam, owing to the gradual change from the one type to the other.

Over most of the Carrington silt loam the drainage is good; probably nowhere excessive. In some areas where there is little fall and the subsoil is rather heavy it may be somewhat deficient in periods of wet weather. Small included areas of the Clyde silt loam generally require tiling to produce satisfactorily.

A large proportion of the Carrington silt loam is under cultivation, probably a larger proportion than of any other soil in the county. The uncultivated land is taken up by farmsteads and permanent pasture, and much of this is cultivable land. Corn, oats, timothy and clover hay, some wheat, and truck crops are the chief products of the type. Corn yields 40 to 50 bushels per acre on an average, but on many well-managed farms the range is from 50 to 65 bushels, showing the possibilities of the soil. Yields of 75 to 80 bushels are occasionally obtained but are not common. Oats average 40 to 45 bushels per acre. Yields of 45 to 60 bushels are obtained on many farms and some yields of 70 to 75 bushels were reported for the year of the survey (1922).

Timothy and clover, sown together, comprise the chief hay crop. This combination yields from 1 to 3 tons per acre. It is sown with oats as a nurse crop. About 40 acres on a quarter-section farm is sown to oats annually and about 10 to 20 acres of this has clover sown with it. While most of the hay crop is clover and timothy, some wild hay is harvested, mainly on small poorly drained areas that have not been reclaimed.

The Carrington silt loam produces its share of the county wheat crop. This is largely winter wheat. Yields range from 10 to 15 or more bushels per acre.

Most of the truck crops, such as potatoes, onions, and cabbage, produced in the county are grown on this type. While the trucking industry is not as highly developed as in Mitchell County, in the

vicinity of St. Ansgar, the Carrington silt loam is the type of soil used there for the production of truck. The same success could be had in Worth County if the farmers cared to develop the soil along that line. Among the leading varieties of potatoes are Rural New Yorker, Early Ohio, Irish Cobbler, and Green Mountain. Yields range from 100 to 170 bushels per acre. Yields of 200 bushels are produced where fertilizers are used. Yields much lower than the average are common where the crop is not properly cared for. Onions are of less importance than potatoes in Worth County. Several years are required to rid the land of weeds so that onions may be produced profitably. The crop also requires fertilization and much labor. Onions do not fit into a general farming system. However, a number of patches of 5 to 15 acres were noted in the eastern part of the county. Onions are usually grown continuously on the same field.

While Worth County is not essentially a livestock region, considerable stock is raised, and a good deal of it on this type of soil, which is well adapted to the production of the necessary feed.

Although silty in texture, the Carrington silt loam contains noticeable quantities of sand and is comparatively easy to work. One and two bottom sulky plows are used, drawn by three to five horses or by a tractor. Many tractors are in use over the county. The absence of steep slopes on this type cuts draft requirements to a minimum.

The steps necessary to maintain this type of soil in a productive condition or to increase its productiveness include the use of tile, where necessary, to provide adequate drainage, the application of manure in as large quantities as are practicable, the more extensive growing of legume crops, the use of limestone, and, possibly, the use of phosphatic fertilizers.

A 4-year rotation of corn–corn–oats–clover is strongly recommended. Such a system is necessary to maintain the content of organic matter of the soil. The second growth of clover is most beneficial when plowed under. Pasturing the second growth is next in efficiency to plowing under, as the cattle leave some top growth and return manure directly to the soil. Applications of manure are best made on clover stubble and plowed under in the fall. A light top-dressing on land plowed in spring for corn will be beneficial, but fall application has been shown to be better. More thorough preparation of the seed bed would prove beneficial. A gradual increase of the plow depth to 7 or 8 inches and more thorough working of the seed bed are to be desired.

Heretofore commercial fertilizers have been used to only a limited extent and are confined largely to carriers of phosphorus. Although they produce increases of the various common crops, their use is not necessarily economical. A trial with a small quantity of acid phosphate or rock phosphate is advised, so that the farmer may judge accurately the increase and figure for himself the advisability of more extensive use. Limestone would materially benefit legume growth, and consequently the succeeding corn and small-grain crops. The quantity necessary will vary on different farms and even within the same farm, and tests should be made to determine how much should be used. If transportation costs are not exorbitant, the use of lime is strongly recommended. It is particularly essential in growing alfalfa. This crop has been grown very successfully on

the Carrington silt loam where proper methods have been employed.

There is no natural forest on this soil. The only trees are an occasional willow or poplar and those on many farms the windbreaks that have been planted to protect the farm buildings.

Land values for this type are somewhat variable, depending on the character of the associated soils, usually Clyde silt loam, of varying agricultural value. Farms with ordinary improvements and some admixture of less desirable soils have sold for $125 to $150 an acre. Probably the average price for the type, where improvements are fair to good, will range from $150 to $200 or $225.

CLARION LOAM

The surface soil of the Clarion loam is a dark-brown or very dark brown, mellow, friable loam, with an average depth of 12 to 14 inches. The upper subsoil, to a depth of about 20 inches, is a brown loam or silty loam containing visible amounts of sand. Below this to a depth of 36 inches or more there is encountered a yellowish-brown to yellow silt loam to silty clay, having a slight grayish or whitish appearance, which is due to the presence of lime. The lime is present in the form of lime-rock flour, intimately mixed with the soil particles, and as fragments of lime rock and pebbles, and the material in this zone effervesces freely. The whitish appearance is a common characteristic of the type, and is easily discernible in the dry subsoil as exposed in road cuts.

The topography is undulating to moderately rolling. For the most part, however, the type lies well and is adapted to the production of cultivated crops. It resembles very closely the Carrington loam; the chief difference between the two soils is that the Clarion soil is sufficiently calcareous in the subsoil to effervesce with acid while the Carrington is not.

A considerable area of the type in its most eastern development in the county is slightly different from the typical cross section just described in that the lime does not occur in large enough quantities within the 3-foot depth to effervesce with acid. There are, however, indications of its presence in larger quantities than in the Carrington soils in the trace of the whitish cast in the subsoil and the presence of luxuriant growths of sweetclover and red clover on roadsides and in uncultivated fields. In all places enough lime is present to effervesce at depths below 3 feet. Establishing the eastern boundaries of the type where it meets members of the Carrington series is necessarily more or less arbitrary. The Clarion loam is extensive in the western part of the county, but very little is found east of the western tier of townships.

Natural drainage on the Clarion loam is good. Only a few swales and depressions are in need of tiling. The methods of improvement recommended for the Carrington loam apply equally well to the Clarion loam. Crop yields on the two types are similar. Corn yields generally range from 40 to 60 bushels per acre, oats 35 to 55, and hay from 1 to 2½ tons. Higher yields than these are frequently obtained under good management. It is probable that leguminous crops yield a little better on this soil than on the Carrington loam, owing to the presence of more lime. Liming to correct acidity in the surface soil, however, would undoubtedly prove beneficial.

Land values compare favorably with those of the Carrington loam, ranging from $125 to $250 or more an acre, depending on the usual factors of improvements, location, state of cultivation, and the nature of the associated soils.

Clarion loam, rolling phase.—The rolling phase of the Clarion loam is very similar to the typical soil, except in topography which is somewhat more uneven. The surface soil may be slightly lighter colored and shallower, extending to an average depth of about 10 or 11 inches. The subsoil is calcareous, effervescing with acid.

This phase is confined to the western part of the county, mainly to Fertile and Silver Lake Townships. It is closely associated with the typical Clarion loam. The natural drainage is good, and in a few places excessive.

Care should be exercised in handling this soil to prevent erosion, and the steeper areas should be kept in pasture or meadow. Contour plowing and cultivation across the slope should be practiced as much as possible. Maintenance of the content of organic matter through the plowing under of barnyard manure, green manure, and crop residues will assist much in preventing both sheet erosion and gullying.

Crop yields and land values are about the same as for the Carrington loam, rolling phase. Many of the farms on this phase are well improved, but the land does not have a high sale value. More timber is present than on either the typical Clarion or Carrington loams.

LINDLEY LOAM

To a depth of 8 or 10 inches the Lindley loam is a grayish-brown or brown loam, somewhat silty in character. The upper subsoil is a yellowish-brown or grayish silty layer, of a floury nature, and this usually gives way at about 18 or 20 inches to a yellowish-brown to yellow heavy silty clay to clay loam containing gritty material and an occasional rock fragment.

This type resembles the Lindley silt loam, from which it differs mainly in having a higher content of sand in the surface soil and usually a more rolling topography. In only a few places is the surface strongly rolling or broken. Natural drainage is always good.

The Lindley loam was originally a forested soil. Much of it has been cleared and put under cultivation. In places there is some danger of washing on this type, and care should be taken to maintain the supply of organic matter in the soil. The rougher areas are better left in forest or pasture. It is a mistake to clear rough areas of the type.

Crop yields are about the same or only slightly less than on the silt loam. Land values are also similar, coming within the range of $125 to $175 an acre for well-located improved land.

LINDLEY SILT LOAM

The surface soil of the Lindley silt loam is a grayish-brown or brown, somewhat ashy or flourlike silt loam, with an average depth of about 10 inches. The subsoil is a grayish-brown or yellow, smooth silt loam, free from sand or pebbles and gravel. This gives way at various depths, generally at about 18 inches, to a yellowish-brown

heavy silty clay to clay, usually showing some mottling. In places it has a solid color, and in a number of areas there is a good deal of mottling in the lower subsoil, owing to variations in the composition of the parent drift. Some glacial pebbles, rocks, and rock fragments occur at this depth, as well as stains of iron. In the lower subsoil the material is a firm, sticky, gritty clay containing some sand and weathered rock material. In most places the subsoil below 18 or 20 inches has a crumbly structure, breaking into cubelike particles ranging in size from one-eighth inch to one inch in diameter.

In forested areas the surface layer, 1 to 3 inches thick, has a dark-brown color, below which the color is lighter. This darker color is due to the accumulation of leaf mold. Plowing obliterates this layer and the light color extends to the surface in cultivated fields. The upper subsoil is somewhat variable in color, being grayish in places. During and for a short time after rains the surface soil has a relatively dark brown color similar to that of the Carrington silt loam, but on drying it takes on its typical grayish color, which is lighter than the color of the dry Carrington soils. The surface soil of the Lindley silt loam in swales and draws is darker colored than the surrounding typical soil.

The topography of this type is undulating to gently rolling, or in some instances rolling, but is mostly of gentle relief. Natural drainage is good; no instances were noted where it was either deficient or excessive. The heavy texture of the subsoil gives the type good water-holding capacity.

The Lindley silt loam occurs in the north-central part of the county west of the Shellrock River. It is closely associated with the Lindley loam, a somewhat more extensive soil. The surrounding types are members of the Carrington series and the poorly drained Peat and Muck.

The type is deficient in organic matter, as indicated by the color of the surface soil. In its natural state it was undoubtedly forested, and some of it is still in forest. It is developed under forest conditions that have given the light-colored surface soil that distinguishes the areas from those of prairie origin.

Organic matter can be supplied to a large extent by growing leguminous crops in the rotations, plowing under as much top growth as possible, and through the incorporation of manure and crop residues, such as grain straw and corn stover. The burning of cornstalks is a wasteful practice rarely justified on any soil.

Despite the light color of this soil, it is quite productive. Corn yields average 38 to 40 bushels per acre, ranging from 20 to 50 bushels or more. Oats yield 25 to 45 bushels per acre, and hay 1 to 2 tons. Red clover appears to grow very successfully on this soil, and great benefits to succeeding crops are reported, especially where the second-growth clover has been plowed under to improve the soil. Orcharding is carried on to a small extent and the results obtained are reported satisfactory.

Values of improved land range from $125 to $175 an acre.

PIERCE SANDY LOAM

The surface soil of the Pierce sandy loam generally is a brown to dark-brown sandy loam, although locally the surface texture may vary from a loamy sand to loam. This layer is of shallow depth,

rarely extending below 6 or 8 inches. The subsoil to 36 inches is variable, containing all grades of sand, gravel, and rocks, but practically no clay or silt. In places the subsoil material is stratified, but for the most part it is unassorted.

The parent material of the Pierce sandy loam was deposited by rushing waters of the glacier, usually in a stream course under the ice or immediately at the edge of the glacier. It occurs most often in kames and eskers, which are long, narrow, or round knoblike formations rising 15 to 30 feet above the surrounding land surface. The type is mapped along Elk Creek, along Beaver Creek west of Fertile, and in a few isolated bodies in the western and north-central parts of the county.

Areas of this type have practically no value for cultivation. They support only a straggling growth of wild grasses, which for the most part die during the hot summer months. The only value for farming is as pasture land. The chief use made of it, where easily accessible, is as a source of road-building material. Some areas suitable for this purpose have been a source of considerable income to the owners.

DICKINSON SANDY LOAM

The surface soil of the Dickinson sandy loam is a dark-brown to dark grayish brown sandy loam, with an average depth of about 10 inches. This is underlain to about 24 inches by a brown sandy loam to loamy sand. The lower subsoil consists of brown or yellow, incoherent fine sand.

The surface is gently rolling to rolling and natural drainage is generally excessive. The type is not of great importance. It occurs in small bodies scattered over the county, and is therefore usually farmed with the adjoining types of soil. Liberal applications of manure, the plowing under of crop residues, and a legume in the rotation constitute as much special treatment as is practicable on this type of soil, as it occurs in small patches and does not yield highly. Handling it the same as the rest of the field, with perhaps a little extra care, will make it fairly productive.

DICKINSON LOAM

The surface soil of the Dickinson loam is a dark-brown to very dark brown, mellow, friable loam, with an average depth of 12 to 13 inches. This grades into a brown or yellowish-brown loam or silty loam, extending to a depth of 20 to 24 inches. The lower subsoil is somewhat variable and may consist of sand or of gravel alone, or of a mixture of the two. The two largest areas of the type, which occur in the northwest corner of Bristol and the northwest corner of Brookfield Township, have a gravelly subsoil. The rest of the type in the county has largely a sandy subsoil.

The topography of this type is undulating to gently rolling, or in a few places rolling. Natural drainage is good to excessive and crops suffer for want of moisture in years of low rainfall. Considerable corn fired on this type the year of the survey (1922). The type is nearly all under cultivation. It has developed under prairie conditions, and the part not under cultivation supports a growth of wild grasses and is used as wild hay or pasture land.

Crop yields are somewhat variable, depending on the season and moisture supply. In favorable years corn yields 30 to 45 bushels, oats 30 to 40 or more, and hay 1 to 2 tons per acre. In dry years the yields are considerably lower. The chief needs of the type are thorough seed-bed preparation and cultivation. Deep plowing and maintaining a high content of organic matter through the liberal use of manure, green manure, and crop residues will increase the water-holding power of the soil and assist in obtaining maximum yields.

Land values range from $80 an acre for unimproved cultivable land to $150 or $175 for well-improved farms.

FLOYD SILT LOAM

The surface soil of the Floyd silt loam is a very dark brown to black, smooth silt loam, high in organic matter, about 16 inches deep. This is underlain to about 24 inches by a grayish-yellow or gray silty clay to clay loam, frequently stained with iron. The lower subsoil is a yellowish-brown to yellow silty clay to clay loam, mottled yellow and brown and stained with iron. Glacial pebbles commonly occur in the subsoil, as well as an occasional larger bowlder.

The Floyd silt loam has developed under prairie conditions. It occurs on flat upland divides in the eastern part of the county, where it is associated with the Carrington silt loam and Clyde silt loam. The surface is flat to sloping. Natural drainage is fair to deficient, tiling being necessary in many places to put the land in satisfactory condition for farming. There being but little fall, the run-off is slow and most of the rainfall enters the soil.

There is little variation within the type. A few sand pockets are found at depths below 30 inches, but they are not extensive, and there is no indication that such areas are less productive than the typical soil.

Practically all of this soil is under cultivation. It is farmed in a general way in the production of the common field crops. Corn yields 40 to 65 bushels per acre, oats 40 to 60 bushels, and clover and timothy mixed 1¾ to 2½ tons. Higher yields than these are reported but are not common. Other small grains and vegetables are among the crops of minor importance. The type is considered one of the better soils of the county.

The Floyd silt loam is generally farmed the same as the adjoining type of soil, which is commonly the Carrington silt loam. Its chief needs are adequate drainage and careful handling to avoid impairing its physical condition. It can be improved through the plowing under of manure, crop residues, and an occasional crop of clover, which should be included in the rotation. The use of limestone is recommended where alfalfa or sweetclover is to be grown. Land values range around $200 an acre.

DODGEVILLE SILT LOAM

The surface soil of Dodgeville silt loam is a very dark brown silt loam, with an average depth of 10 to 14 inches. The upper subsoil, to a depth of about 24 inches, is a brownish silt loam, slightly heavier than the surface soil but still of silt loam texture. The lower subsoil is a yellowish-brown silt loam to heavy silt loam or silty clay. Limestone bedrock is encountered at depths varying from 20 inches to 8

or 9 feet. Generally the layer of material, an inch or two thick, immediately above the bedrock is a heavy waxy clay of slightly mottled brown color. The soil section is free from sand and gravel or bowlders.

The topography of this soil is gently rolling, and the natural drainage is good. The soil, which resembles in a general way the Carrington silt loam, is the equal of the latter in productiveness, except in areas where the bedrock lies close to the surface or outcrops. In such places it has no great agricultural value. Areas of this kind form only a small part of the type. The soil endures dry weather as well as the Carrington silt loam, and the methods recommended for handling the latter apply equally well to this soil.

The Dodgeville silt loam is not extensive in Worth County and occurs only along the Shellrock River. Well-developed land of this type has about the same value as the surrounding Carrington silt loam.

WEBSTER LOAM

To an average depth of about 15 inches the soil of the Webster loam is a black or a very dark grayish brown to nearly black loam, relatively high in silt. The upper subsoil to about 22 inches is a drab or gray silt loam or heavy silt loam. The lower subsoil is a mottled gray, brown, and yellow silty clay to clay, stained with iron and containing sufficient lime to effervesce with acid. Some pebbles and fragments of limestone and other rocks occur through the soil profile and locally on the surface.

The topography of the Webster loam areas is flat to billowy or very gently undulating. In the depressions the soil is generally more silty, but on the whole the type has a fairly uniform loam texture. Natural drainage is not very well established and tiling is necessary in many places to provide adequate underdrainage for good crop production.

With the exception of an area in sections 19 and 20 of Deer Creek Township, the Webster loam is confined to the western part of the county and is typically a Wisconsin drift soil. In the western part of the county it generally occurs over flat, more or less depressed areas or at least on a lower level than the surrounding country, through which drainage ditches, many of them the former channels of sluggish streams, have been dredged. It is derived from calcareous drift weathered in place.

This soil, when well drained and managed, produces large yields of the common field crops. It is a little later than the soils of the Clarion and Carrington series, but earlier than the Webster silt loam and clay loam. It yields about the same as the Webster silt loam. It is frequently sown to flax the first year broken, and then put into a regular cropping system. No special crops are grown in the county on this soil except a few sugar beets, which yield from 8 to 12 tons per acre. The beet crop requires considerable hand labor and does not fit well into the prevailing system of farming for this region. However, with a market as close as Mason City, it should be a profitable crop.

The Webster loam has a large accumulation of organic matter. It contains a little more sand than the silt loam and can be worked more easily and under a wider range of moisture content. It is not,

however, entirely free from the peculiarities of a poorly drained soil, and the recommendations for handling the Webster silt loam will also apply to this type.

The value of this type is determined largely by the value of the surrounding types. The price ranges from $100 to $225 an acre.

WEBSTER SILT LOAM

The surface soil of the Webster silt loam is a black or nearly black smooth silt loam, with an average depth of 15 inches. The upper subsoil to about 24 inches is a drab or gray clay loam. The lower subsoil is a gray, brown, and yellow mottled clay loam to clay, containing iron stains and sufficient lime to effervesce with acid.

This type is fairly uniform. In a few places a variation noted consisted in a solid instead of a mottled gray or drab color in the subsoil. The lime in the subsoil ordinarily occurs as limestone flour or fragments, but where the uniform colored material appears no rock fragments are present. Locally the surface soil contains a little sand, but not enough to modify the texture. Very small depressions of heavier texture than the silt loam are included, as they are not large enough to map. The subsoil in some places contains small gravel, and in spots it may be a sandy clay or a brown sand below 30 inches.

The topography of the Webster silt loam is flat, the type occupying level areas on the divides, with soils of the Clarion and Carrington series on the gently rolling to rolling surfaces. The natural drainage is fair to deficient. Tiling is generally necessary to permit plowing, cultivation, and good plant growth.

The Webster silt loam is most extensively developed in the Wisconsin drift region in the western part of the county. The largest single area, however, is in northeastern Grove Township, and a few smaller areas are scattered through the Carrington silt loam east of the Shellrock River.

This soil has been developed over calcareous drift weathered in position under conditions of poor drainage.

A considerable part of the Webster silt loam is under cultivation, although some areas are still in virgin sod. It is devoted to the production of the common field crops, corn, small grains, and hay and forage. Flax usually is sown on newly broken ground. Sugar beets are known to do well on this type of soil in other areas, but only a few are produced on it in Worth County. It is a productive soil for crops common to this region. Corn yields 40 to 70 bushels, oats 40 to 60, and hay 1½ to 3 tons per acre. Corn is a little later in maturing than on some of the better drained soils. A short stiff-strawed oat, such as Iowa No. 105 (Richland), will decrease the damage from lodging.

This soil is relatively high in organic matter, but the use of manure, crop residues, and a legume in the rotation are necessary to maintain its productiveness. The chief immediate need is adequate underdrainage. Although a few areas may not require tiling, most of the areas would be greatly benefited by tile drains. The soil is naturally productive, and with drainage and careful management produces as well as or better than most of the soils of the county. Limestone would also improve the physical condition of the soil as well as correct the acid condition that exists in many places despite the fact that the subsoil is calcareous. Leguminous crops such as clover and

alfalfa do well on the type when once established. Land values range from $125 to $250 an acre.

WEBSTER CLAY LOAM

The surface soil of the Webster clay loam is a very dark grayish brown to black clay loam extending to a depth of 15 to 18 inches. The subsoil is a drab or gray clay loam stained with iron, which grades at about 24 inches into a gray and brown or yellow mottled clay containing lime in sufficient quantities to effervesce with acid.

The Webster clay loam is not extensive in Worth County. It generally occurs as small depressions within areas of the Clarion soils.

The surface is flat or depressed. Natural drainage is poor and tiling is necessary to fit the land for cultivation. The soil, however, is naturally productive and when drained and properly handled produces very good yields. The surface soil is very heavy and can be worked satisfactorily only under a narrow range of moisture content, as it puddles very easily. This drawback may be overcome to a large extent by plowing under manure, straw, and green-manure crops, which will give the soil a more friable and mellow structure. The first season or two after breaking sod on this type it is customary to use the land for the production of flax. After this the ordinary field crops of the region are grown.

The lowest spots may contain alkali accumulations. Such areas may be identified by the presence of a white powdery coating on the surface. These areas should be tiled and manure applied. If this be done, the alkali should be leached out within a few years.

CLYDE SILT LOAM

The surface soil of the Clyde silt loam consists of about 16 inches of a very dark grayish brown to nearly black silt loam. The upper subsoil to about 24 inches is a drab or gray silty clay to clay loam, slightly stained with iron. The lower subsoil is a mottled gray, brown, and yellow clay loam to heavy clay loam or clay, containing some sand and gravel and an occasional bowlder or subangular rock fragment, such as is common to the subsoil of all drift soils.

The Clyde silt loam has a flat surface and occurs both in depressions and on flat divides. The greater part of the Clyde silt loam occurs in that part of the county containing the Carrington silt loam, there being only a few small areas west of the center of the county. In the western half of the county the poorly drained upland soils are of the Webster series, the chief difference between the two series being that the Webster soils are highly calcareous in the subsoil while those of the Clyde series are not.

Numerous variations from the typical soil occur throughout the county. The most notable consists of the presence of sand in the lower subsoil. This is generally encountered at a depth of about 30 inches or more and seldom at shallower depths. It is probable that natural drainage is more thorough on this variation than on the typical soil, but so far as could be determined it was in no place excessive. Since the typical soil is naturally poorly drained, the water table lies at no great depth and the presence of this layer of sand would not endanger the water supply to the soil.

A few areas mapped as the Clyde silt loam are really of silty clay loam texture, but they are too small to warrant a separate classification on the map. They are more poorly drained than the silt loam and more difficult to reclaim.

Two other textural variations also occur. One of these is found about one-eighth mile east of the southwest corner of section 10, Barton Township, where the surface soil is a dark-brown loam 12 inches deep, overlying a grayish-brown loam, slightly mottled, which passes at 20 inches into a sandy loam to sandy clay of yellow color. The other occurs in the southwest quarter of section 9, Grove Township, where the surface soil is of loam texture. In some very poorly drained areas, where water stands a part of the year, the surface is mucky in spots to a depth of 1 to 3 inches.

It would be very difficult to place a specific value on this soil as a whole, owing to the wide variation within the different areas of the type from a cropping standpoint, although uniform in color, texture, and cross section. The difference is due to the position, natural drainage, and the extent to which drainage has been developed through the use of tile and ditches. Natural drainage is deficient over most of the type. Some bodies, by virtue of their position, possess better natural drainage than others, and when the drainage is improved by tiling the soil is made very desirable for cropping and has a high agricultural value. Areas having much drainage do not represent a large proportion of the type. Over the greater part artificial drainage is essential for crop production. Without this the land is valuable only for the production of wild hay or for grazing. When thoroughly drained and put under cultivation the soil is very productive.

Crop yields on areas properly drained and cropped compare favorably with those on the Carrington silt loam and frequently exceed them. Corn may yield as high as 70 bushels or even more per acre, but the average yield is considerably lower. Other crop yields are in proportion.

When first broken the Clyde silt loam usually is sown to flax; in subsequent years the general cropping system is followed. Not until the land has been cropped for a year or two do yields reach normal. Although naturally fertile, this soil decreases in productiveness under continuous cropping with corn and small grains. It is desirable that a legume be seeded at intervals of four or five years and a regular rotation followed. The use of manure and the plowing under of an occasional legume crop will help to maintain the yields. The methods suggested for handling the Webster silt loam will apply equally well to this soil as the two are similar in many respects from a practical standpoint.

Land values vary with drainage, state of cultivation, associated types, location, and other local factors. Prices range from $50 to $200 or more an acre.

SOGN SILT LOAM, POORLY DRAINED PHASE

The surface soil of the Sogn silt loam, poorly drained phase, is a very dark brown or nearly black silt loam, mellow and rich in organic matter, extending to an average depth of 16 inches. The subsoil is a gray or drab silty clay loam containing some mottling of brown and yellow as it approaches the 24-inch depth, below which it is a

grayish-brown or gray, or a mottled gray, brown, and yellow silty clay to clay loam. The lower inch or two of the material resting on the bedrock contains bits of weathered limestone. In the typical cross section the bedrock is usually encountered at depths between 30 and 40 inches. Numerous inextensive local variations occur within this type in areas immediately bordering the Shellrock River. Here the surface soil may be as light textured as a rather sandy loam and black in color. This may continue the same texture or may grade into a drab-colored subsoil just above the bedrock, which is encountered at depths varying from 8 or 10 inches to the normal depth of 30 or 40 inches.

The surface of this soil is flat or depressed and natural drainage is not generally good, although it may in some cases be sufficient. Areas immediately bordering the Shellrock River are subject to inundation and undoubtedly are composed largely of alluvium. The more extensive areas lying some distance from the stream, while subject to less frequent inundation, are depressed and poorly drained and subject to at least partial inundation or standing water at times of heavy spring rains or thaws.

The Sogn silt loam, poorly drained phase, is not important agriculturally. The areas along the river bank are unsuitable for cultivation. Those located on the east side of the river a few miles above Kensett have more potential producing power, but tiling is necessary and some difficulty has been experienced in obtaining suitable outlets. Under cultivation the soil would require the same treatment as the Clyde or Bremer silt loams.

Specific values for the type are difficult to ascertain as this land is sold only with other soils. Probably $25 to $100 an acre would include the range in value.

WAUKESHA SILT LOAM

The surface soil of the Waukesha silt loam consists of 12 to 14 inches of dark-brown to very dark brown, smooth silt loam. The upper subsoil to a depth of about 20 inches is a brown, smooth silt loam, and the lower subsoil a yellowish-brown to yellow, heavy silt loam to clay loam or silty clay, compact but not impervious. The surface soil in places is more nearly a loam than silt loam, but this variation does not influence the value of the soil. Such an area lies in section 10 of Kensett Township. The area in section 12 of Lincoln Township is nontypical in that the surface soil is of good loam texture and the subsoil is a brownish loam. Masses of conglomerate rock were encountered locally below the 3-foot section.

The type has a flat or sloping topography and occurs on benchlike terraces along the larger streams of the county, 5 to 20 feet above overflow. Natural drainage is good but not excessive. The heavy subsoil is retentive of moisture and the type withstands dry periods as well as the Carrington and Clarion soils of the uplands.

The Waukesha silt loam is highly prized for general farming and is devoted to the production of the common field crops. Corn yields 30 to 60 bushels per acre, oats 35 to 55 bushels, and clover hay 1 to 2½ tons.

The Waukesha silt loam is not extensive, but is found along the Shellrock River and larger creeks of the county in areas ranging from

20 to 300 acres. It does not often comprise an entire farm and is generally farmed the same as the surrounding types. The use of a legume in the rotation, as well as manure, crop residues, and probably limestone, will maintain the productiveness of the soil.

Land of this type has a value comparable to that of the Carrington silt loam. Prices range from $125 to $225 an acre.

O'NEILL SANDY LOAM

The surface soil of the O'Neill sandy loam consists of a brown to dark-brown sandy loam, about 12 inches deep. Below this and extending to a depth of about 20 inches the material is a brown sandy loam to loamy sand, grading into a yellowish-brown to yellow incoherent sand.

Some variation is encountered in this type, chiefly in texture of surface soil. In a few places this is a brown, rather sandy loam, containing patches of loamy sand texture. Such bodies are of less value than the typical soil.

The surface is flat or gently undulating. Where the type adjoins first bottoms the slope to the bottom lands may be quite steep or have a slope equivalent to the rolling soils of the upland. Because of the open texture of the subsoil, natural drainage is inclined to be excessive, and crops suffer for want of moisture except in very wet years.

The common field crops are grown on the type, corn yielding 15 to 30 bushels per acre, oats about the same, and hay one-half to 1 ton. The proportion of this soil devoted to clover is small; grain crops, wild hay, and pasture occupy most of its area. The yields from carefully managed farms that include the more desirable parts of the type are somewhat larger than those stated.

This soil must be very carefully handled to produce maximum yields. It is low in organic matter, and the plowing under of manure, crop residues, and an occasional crop of clover is strongly recommended. One purpose of this treatment is to increase the power of the soil to hold water. Land of this type has about the same value as the Dickinson sandy loam.

O'NEILL LOAM

The surface soil of the O'Neill loam consists of 12 inches of dark-brown friable loam. Below this to depths ranging from 18 to 24 inches there appears a brown loam to sandy loam or loamy sand. The lower subsoil consists of strata of incoherent sand and gravel, or of a mixture of the two.

The type has a flat to sloping or slightly undulating topography. It is of alluvial origin, but lies 10 to 20 feet above present overflow. Natural drainage is thorough to excessive. Crops suffer from lack of moisture in dry seasons, the gravelly subsoil making a poor reservoir for moisture.

This type occupies terraces bordering most of the streams of the county. It is especially well developed along Shellrock River and Lime Creek and its tributaries.

In seasons of good rainfall, without prolonged dry spells, this soil produces good crops, corn yielding 30 to 45 bushels, oats 20 to 40

bushels, and hay three-fourths to 1½ tons per acre. In dry seasons the yields are considerably lower.

Thorough preparation of the seed bed, including deep plowing, is an essential to maximum production on this type. This should be followed with care in seeding and frequent cultivation of such crops as corn. A rotation including a legume crop, a part of which is plowed under as green manure, and the incorporation of crop residues and manure will improve the water-holding capacity of the soil as well as its productiveness. A large part of the type is under cultivation, and the rest is used as pasture or hay land. It is naturally a prairie soil.

This soil is similar in value and producing power to the Dickinson loam. Prices of farms range from $80 to $150 an acre.

O'Neill loam, deep phase.—The surface soil of the O'Neill loam, deep phase, consists of 12 or 13 inches of dark-brown, to very dark brown mellow, friable loam. The subsoil is a brown to yellowish-brown or yellow silty loam to silt loam or heavy silt loam, which becomes more sandy at about 30 inches, below which depth appears an incoherent coarse sand or fine gravel.

Little variation is found within this phase. The surface soil is a silt loam in two areas, one in section 29 of Deer Creek Township, and the other comprising parts of sections 13 and 24 of Lincoln Township and 18 and 19 of Union Township. Locally the silty character of the subsoil continues to a greater depth than usual, and the sand or gravel layer is not encountered above 33 to 36 inches.

The O'Neill loam, deep phase, is of alluvial origin. Like the typical soil it lies on terraces 5 to 20 feet above overflow. The surface is flat or sloping. Because of the underlying strata of sand, the drainage is naturally good, and in places it is somewhat excessive, though less so than the typical soil because the sandy stratum lies at greater depth. Nevertheless the soil does not stand dry weather as well as the Waukesha or Bremer terrace soils, or any of the clay subsoiled upland types.

The O'Neill loam, deep phase, is the most extensive terrace soil in the county. It is developed principally along the larger creeks of the county and the Shellrock River. It is a little less desirable than the Waukesha silt loam, but is more productive than the typical O'Neill loam, and this difference is reflected in the prices of farms on the two soils.

The phase is generally farmed like the adjoining types and is devoted to the production of the common field crops. Corn yields 35 to 55 bushels per acre, oats 35 to 50 bushels, and clover 1 to 2 tons.

The better farmers on this soil seed down 20 to 40 acres each year and plow under some of the second growth the year the clover matures. This practice, with the application of manure, the return of crop residues to the soil, and, where necessary, the addition of sufficient lime to correct acidity will insure good production, except in years of exceedingly dry weather.

Land values range from $100 to $175 an acre.

BREMER SILT LOAM

The surface soil of the Bremer silt loam is a dark-brown or nearly black, smooth silt loam, high in organic matter, extending to an average depth of 15 inches. This is underlain by a drab or gray silty clay containing stains of iron to a depth of 24 inches, where there occurs a change to gray clay loam or clay, mottled with other shades of gray, brown, and yellow.

A notable variation in this type consists of the presence of sand below depths of 33 to 35 inches. Such areas comprise parts of sections 35 and 36 of Deer Creek Township and parts of sections 14 and 15 of Kensett Township. Another variation is in the west half of section 31 of Danville Township. Here the surface soil is calcareous and a little lighter colored than the typical surface soil and a chalk-like layer of calcareous material appears at about 35 inches. The surface has numerous hummocks, and the area lies at a higher elevation than the surrounding first-bottom soils. An area occurring in the west half of section 13 of Lincoln Township varies from the typical in that the subsoil is mottled brown and yellow below a gray upper subsoil, the subsoil profile resembling that of the Floyd silt loam. In the west half of section 1 and the northeast quarter of section 2 of Barton Township the type has a grayish silt loam surface soil over a mottled ashy-gray or grayish-brown and gray subsoil of stiff waxy clay. This area is less desirable than the typical soil. The area north of the creek at this location is in forest and has a lower agricultural value than that on the south, which is under cultivation.

The surface of the Bremer silt loam is flat or sloping, but is seldom undulating. Natural drainage is deficient to fair. The soil is very productive when properly managed. Tile drains should be installed where drainage is deficient. After that a rotation including clover or some other legume, a part of which is plowed under, the use of manure and crop residues, and possibly limestone, will insure the maintenance of the producing power of the soil.

Corn on properly drained areas yields 40 to 60 bushels per acre, oats 45 to 60 bushels, and clover hay 1½ to 2½ tons. A short stiff-strawed oat, such as Richland (Iowa 105) is recommended, because this type of soil is high in nitrogen and taller-growing varieties are likely to lodge.

Land values vary with the nature of the particular areas, location and state of cultivation. The probable range is from $100 to $225 an acre.

BENOIT SILT LOAM

The surface soil of the Benoit silt loam is a black or nearly black silt loam, 10 to 15 inches deep. The upper subsoil to a depth of 24 to 26 inches is a gray or drab silty clay to clay. The lower subsoil is a coarse sand or gravelly sand. Borings over the greater part of the type with an extended auger reaching about 6 feet showed the subsoil to that depth to be the same sandy material. In places the sandy subsoil layer ranged in thickness from 12 inches to 3 feet, with clay below. The indications are, however, that over the greater part of the area the sand extends to a depth of several feet.

The surface of the type is flat. Natural drainage appears to be poor despite the sandy character of the lower subsoil, and tiling is generally necessary to establish proper drainage for crops. In places the surface soil contains alkali salts. As a rule the subsoil does not contain sufficent lime to effervesce with acid. Exceptions to this occur in the area 2 miles northeast of Northwood and in Hartland and Kensett Townships, where the subsurface layer as well as the subsoil is high in lime.

Part of the type is under cultivation, but a considerable part remains in native grasses and is utilized for pasture or hay land. Crop yields are variable, depending largely on the management. Corn yields may range from 25 to 60 bushels per acre, oats 30 to 60 bushels, and clover hay 1 to 2 or more tons per acre. Interviews with farmers indicate that the soil does not stand in high favor, although apparently it is very productive when tile-drained and well managed. Newly broken land is often sown to flax the first year or two, and then followed with corn, small grains, and tame hay. In several places on this type the injurious effects of alkali have been avoided by growing sweetclover and plowing under a part of the top growth. With this treatment corn made vigorous growth where it had failed before. The use of manure and crop residues will insure maintenance of a good physical condition of the soil and make it easier to handle.

The Benoit silt loam occurs in several areas on the terrace with the town of Northwood and also northeast, east, and south of that town. Other areas lie in the eastern part of Hartland Township and the western part of Kensett Township. The average value of land of this type is about $100 an acre.

WABASH SILT LOAM

The Wabash silt loam consists of 15 to 18 inches of black smooth silt loam, underlain by a drab or gray clay loam containing iron stains and concretions and not uncommonly some mottlings of gray, brown, and yellow. Locally the subsoil contains small quantities of fine sand. In places the lower subsoil is as heavy as a clay.

In a few places the surface soil has a silty clay loam texture, but this variation was not extensive enough to warrant separate mapping. Such areas occur in section 34 of Danville Township, section 35 of Brookfield Township, and along the ditch running through sections 31, 30, and 29 of Deer Creek Township. The Wabash silt loam mapped along Deer Creek in section 1 of Barton Township is somewhat variable, ranging in surface texture from a loam to silt loam, has an uneven surface as a result of old meanders of the stream, and supports considerable forest growth. The Wabash silt loam in the southeast quarter of section 31 of Danville Township is a variation from the typical in that the soil is a dark-brown loam with no perceptible change for the entire 3-foot depth.

This type generally occupies narrow ribbonlike areas along drainage ways. Some areas are a little more extensive, like those mapped in places along Deer Creek. The surface is generally flat or very gently sloping, with here and there some unevenness due to remnants of former stream courses. Most of the type is subject to periodical flooding. The areas that are overflowed less frequently, which con-

stitute only a small proportion of the total area, are devoted to the production of corn, small grains, and hay. Corn yields 30 to 60 bushels per acre, oats 30 to 50 bushels, and hay 1 to 2 tons. The uncultivated land is used for pasture and the production of wild hay. There is practically no forest growth on the type. Land values are difficult to ascertain as the type is always sold in conjunction with adjoining soils.

CASS SILT LOAM

The Cass silt loam consists of an upper layer of very dark grayish brown or nearly black, smooth silt loam. This is underlain by a layer of mottled gray, brown, and yellow silty clay, containing considerable sand as it approaches a depth of 24 inches, and grading finally into a brown to yellowish-brown incoherent sand.

This type occurs on first bottoms and is subject to overflow at times of high water. The surface is flat or slopes slightly toward the stream. The largest single area lies 1 mile east of Manly. Another area of some size is mapped about 1 mile northwest of Kensett, along Elk Creek. Part of this area has the sand at lower depths than the rest of the type but still within the 3-foot section.

The Cass silt loam is used almost exclusively for pasture or wild hay land. The parts less subject to overflow would be suitable for cultivation. The type is inextensive and not important agriculturally. It has about the same value as the Wabash silt loam.

LAMOURE SILT LOAM

The surface soil of the Lamoure silt loam is a very dark brown or nearly black silt loam, about 15 inches deep. This is underlain by a gray or mottled gray and brown calcareous silty clay to clay. The presence of lime in the subsoil is the chief difference between this soil and the Wabash silt loam.

The Lamoure silt loam is developed chiefly in the western part of the county, adjacent to the calcareous upland soils, such as the types of the Clarion and Webster series. It occurs on first bottoms along streams and is subject to overflow.

The type is inextensive and is not agriculturally important. A very small part of it is under cultivation. This produces about the same as the Wabash silt loam. Much of it is in native grasses and used for pasture and the production of hay. Areas bordering areas of Peat or Muck are somewhat swampy. Land of this type has the same selling value as the Wabash silt loam.

PEAT

Peat, as mapped in this county, is somewhat variable, but the cross section generally consists of brown Peat for a depth of 18 to 20 inches, underlain by a black, smooth, mucky material which may contain a considerable proportion of mineral soil particles. Snail shells commonly occur on the surface and through the soil. The depth to which the raw surface Peat extends varies widely, ranging from 8 to 10 inches to 5 or 6 feet. The underlying material is also variable, ranging from sand to clay in texture and from gray to yellow in color.

Peat is partly decayed organic matter which still retains in part the original form of the plants from which it is derived. It ranges in color from reddish brown to deep chocolate brown. It is formed of the remains of plants growing in water in shallow lake or slough areas. The annual growth of plant life fell to the bottom as each season ended, and because of the exclusion of air by the water it did not decay but continued to accumulate year by year. Since the deposition of this material the water has been drained off and the deposits exposed. Peat eventually becomes Muck, which is merely Peat in an advanced stage of decay.

Peat occurs in the western two-thirds of the county and principally in the western half. It occupies depressed areas which were formerly under water in ponds, lakes, or sloughs. These areas are flat and irregular in shape and size, containing from 10 to 800 acres. In some of the larger areas the deposits are relatively deep.

In its natural condition much of the Peat is rough and hummocky. It supports a luxuriant growth of wild grasses and many kinds of weeds and unreclaimed areas are used as pasture land. As far as could be ascertained there is no specialization on Peat in Worth County. Some areas have been broken and planted to corn, but such efforts have not been generally successful. A few exceptional areas yield fairly good crops of corn. Flax appears to make a successful growth, with estimated yields of about 15 bushels per acre in many cases.

Underdrainage by tiling is essential to the reclamation of Peat. After this thorough cultivation will hasten the decay of the material and the fitting of the land for cropping. One difficulty encountered in the plowing of Peat lands is the presence of hummocks on the surface, which may be knee-high. Some farmers have made successful use of a heavy rotary harrow, weighted down for cutting the hummocks. This bog or hummock cutter has a slicing action and leaves the ground smooth enough to get over with a plow.

Many special crops, such as tomatoes, potatoes, sugar beets, onions, and celery, will grow well on Peat, but they do not fit well into the general farming system which is common in this county. These crops require more hand labor and capital than many general farmers have at their disposal or would care to put into such a venture. Some utilization better adapted to the prevailing type of farming would prove more popular. A recommended plan for the preliminary handling of Peat is to seed alsike clover and timothy, using an early oat as a nurse crop and cutting before maturity as a hay crop. The resulting timothy and clover growth may serve as pasture or hay, preferably the former, as the tramping of cattle will help to firm the ground.

Peat will vary greatly in its ability to produce grain. Some areas will support only a straggling growth, others will grow good stalks and not fill out the grains well, and still others will produce fair yields of the various cereal crops. These differences are due to a number of factors, including the proportion of mineral soil particles, depth of organic layer, distance to clay subsoil, character of the subsoil material, presence of or absence of alkali, and condition of drainage. These various factors give to Peat beds their individuality and help to explain why two Peat beds, apparently the same to the casual observer, may react so differently to like treatment.

MUCK

The Muck deposits in Worth County are rather extensive, and many of them are associated with areas of Peat. The material is somewhat variable, as in the case of Peat, and may vary from 8 to 10 inches to 4 or 5 feet in depth. Most of it, however, will come within a range in depth of 18 to 26 inches. The underlying material is generally a black silty clay, high in organic matter, which may extend for considerable depth below the Muck or may give way in a few inches to a gray or yellowish, or mottled gray, brown, and yellow clay loam or clay containing glacial pebbles. Muck is simply Peat in an advanced stage of decay. It is black in color and smooth in texture, decomposition having advanced far enough to break down the original form of the plants from which it is derived.

The occurrence of Muck in the county is confined chiefly to the western half, although a few areas lie east of the Shellrock River, associated with the Carrington and Clyde silt loams. The largest continuous area occurs along Elk Creek. Another large area lies northwest of Hanlontown.

Muck areas are nearly always flat. They are not always smooth, however, and may be hummocky, like Peat. Such bodies should be handled as recommended for similar areas of Peat. Drainage conditions vary widely. Much of it is poorly drained and under water during wet parts of the year. Many beds have been tiled, and in such cases drainage is usually well established.

Proper drainage is the first essential to reclamation, followed by plowing and seeding, as in the case of Peat. Muck is somewhat less difficult to bring into a productive state than Peat, and success is met with in many cases. Reclaimed Muck is suited for growing such crops as onions, potatoes, tomatoes, and sugar beets. Grain crops produce well on some areas but not commonly. For general Corn Belt farming it is advisable to seed to some pasture or hay crops, such as alsike and timothy, for a few years before seeding to grain crops.

SUMMARY

Worth County is located in the north-central part of Iowa, on the Iowa-Minnesota State line. It is rectangular in shape and contains 399 square miles, or 255,360 acres.

The county is covered by two glacial depositions. The Iowan drift, occurring in the eastern part of the county, has a smoothly rolling topography, interspersed with flat areas. The western half is covered by drift deposited by the Wisconsin glacier, and the soils developed over it are younger and less thoroughly leached than the soils of the Iowan drift. In this part the topography varies from flat to rolling.

The drainage of the county is carried by Deer Creek, Shellrock River and its tributaries, Elk Creek, Lime Creek, and Beaver Creek. Many ditches have been dug to assist in draining the county.

Railway facilities are good, the county being served by the Chicago & North Western, Chicago Great Western, Chicago, Milwaukee & St. Paul, Chicago, Rock Island & Pacific, and Minneapolis & St. Louis Railroads. Public roads are good. Churches and schools are numerous through the entire county.

The climate of Worth County is characterized by cold winters and hot summers. The mean annual temperature is 44.3° F. The mean annual precipitation is 33.19 inches.

Agriculture is practically the sole industry of Worth County. It consists of the raising of such staple crops as corn, oats, other small grains, and hay and forage crops. Some truck and the various garden vegetables and fruits are grown on a small scale. This is accompanied by the feeding and breeding of beef and dairy cattle, hogs, poultry, and a few sheep. From 40 to 50 per cent of the corn crop is sold and the remainder fed. Other cash crops are flax, wheat, truck, and fruit.

The 1920 census reports 1,461 farms in the county with an average size of 166 acres. Of these, 57 per cent are operated by owners, 42 per cent by renters, and 1 per cent by managers. Land values range from $75 to $350 an acre.

The soils of the county are derived from three kinds of parent material—glacial drift, consolidated rock formations, and alluvium. The glacial soils are included in the Carrington, Clarion, Webster, Clyde, Lindley, Pierce, Floyd, and Dickinson series. The residual soils, those from consolidated rocks, are represented by the Dodgeville and Sogn series. The alluvial soils include the O'Neill, Waukesha, Bremer, Benoit, Wabash, Cass, and Lamoure series. Peat and Muck, cumulose soils, also are developed in considerable area.

The Carrington soils are the most important in the county. They cover the largest area and are highly prized for general farming. The silt loam, loam, and sandy loam are mapped.

The Clarion soils are nearly identical with those of the Carrington series but are calcareous in the lower subsoil. They occur in the western part of the county on the Wisconsin drift. The loam and a rolling phase are mapped.

The Webster soils do not always have good drainage, but when drained they are very productive. They are calcareous in the subsoil.

The Clyde soils resemble the Webster soils but are not highly calcareous.

The Dickinson soils are dark colored and are like the Carrington, except that they are sandy or gravelly in the subsoil and have a lower value.

The Lindley soils are light colored but produce well under good management.

The Pierce sandy loam is shallow overlying sand and gravel. It is unimportant and is not cultivated.

The Floyd silt loam is intermediate in its drainage conditions and stage of weathering between the Clyde and Carrington silt loams. It is flat or sloping, and natural drainage is not always adequate. It is very productive.

The Dodgeville silt loam is a residual soil from limestone, but in other respects is similar to the Carrington silt loam.

The Sogn silt loam is represented by a poorly drained phase which has a low value for farming.

The O'Neill soils occur on terraces and are underlain with gravel. They produce satisfactorily under careful management.

The Bremer and Benoit silt loams are terrace soils similar in value, producing well under good management.

The Cass, Wabash, and Lamoure silt loams occur on first bottoms subject to overflow. They are not cultivated to any great extent but are used as pasture and hay land.

Peat and Muck are organic soils occurring in depressions formerly occupied by ponds, lakes, or sloughs. They have not a high value for general farming, but when reclaimed are adapted to the production of some special crops.